WHY BAND SAWS BREAK.

BY

JOSHUA OLDHAM.

WHY BAND SAWS BREAK.

Sixteen Reasons—And How to Avoid Them.

BEING INSTRUCTIONS TO FILERS ON THE CARE OF LARGE BAND-SAW BLADES USED IN THE MANUFACTURE OF LUMBER.

BY JOSHUA OLDHAM.

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PREFACE.

THE aphorism of necessity being the mother of invention has an exemplification in the production of this work. In my periodic visits to the saw-mills, while receiving aid from the few experts, and ideas from practical mill owners, I have felt impelled to aid the band saw filer seeking instruction. Frequent letters from those instructed, and from others hitherto entirely unknown to me, asking for instructions on various difficulties; letters also from mill owners asking to send their filer to my factory for lessons on hammering, for which they were willing to pay. My answers to the latter has invariably been that "the method of manipulation in the *manufacture* of a saw are so varied, and of such a nature that after a five years' apprenticeship it is an exception for a workman to be classed as an expert." Therefore the practical results from two weeks spent in the shop would not pay for the expense of a journey of a thousand miles or more. My answers to the former have been such information as I could impart, and an endeavor to make myself understood, which on this subject is a matter of difficulty. Such has been the success of those who have followed my instructions, that I saw the necessity of formulating a course of instruction, clear and yet concise, which might become a a text book for those who with little, if any, previous knowledge were called to the care of the band saw.

THE AUTHOR.

WHY BAND SAWS BREAK.

In the publication, in 1886, of my treatise on "Saws; their Manufacture and Use," on the subject of band-saws for log-sawing, I stated that I had for years foreseen the ultimate victory of the band saw over the circular. Since that writing their rapid introduction into new mills, and the discarding of the circular, to be replaced by the band-mill, have demonstrated the fact that the experimental stage is past. The band-saw has fully established its claim to be the chief instrument in the manufacture of lumber, and will doubtless supersede all other methods.

My purpose at this time is to redeem promises made to many friends, lumber manufacturers and filers in band-mills, of giving them such instructions as I could on the care of band saws. I presume to do so, not only from my lifelong experience as an expert in the manipulation of saw steel, and as a saw-maker and manufacturer, but also from experience gained in saw-mills by close study and observation during the past five years. I have taken off my coat and worked with the filers, receiving and imparting instruction and information.

The term "filer," as it is now understood, is destined to mark an important and distinct trade ; for there is now relegated to the filer's charge the entire care of the saw after its entry into the mill. In the various journals devoted to the lumber industry have appeared articles on the band saw, the burden of which has been the want of skillful filers. I may here bear testimony that I ean point to a numher of filers who are masters of their art, and have become so with no other guide than their own ingenuity and observation. Others I have in mind, good filers, but without knowledge of anvil work, to whom I have felt it my duty and my pleasure to become an instructor, and I have been rewarded by finding many apt and grateful pupils.

Before entering upon these instructions let us take a survey of the field of work and look at the magnitude of the task before us. That it *is* a task of some magnitude these pages will show, and yet I have to restrain myself from discussing the more intricate questions, confining your attention to those points which must become decided *essentials* in the qualifications of a filer. I dwell more particularly on the hammering, as that is the most important factor in the successful working of a band-saw.

Let us now look at the sixteen reasons WHY BAND SAWS BREAK.

They are :—

1. Feeding beyond the tensibility of the blade.
2. Using a saw when teeth points are dull.
3. Insufficient or irregular set.

4. Unequal tension.
5. Improper tension.
6. Uneven breast.
7. Irregular and uneven teeth.
8. Joint not properly hammered.
9. Too much hammering.
10. Hardening of portions of the blade around the braze.
11. Leaving thick, and making thin places, when trimming after brazing.
12. Sharp angles in the bottom of the gullets of the teeth.
13. Not having the swage for setting properly adjusted.
14. Case-hardening of portions of teeth by the emery grinder.
15. Gum accumulating at the sides and base of a tooth.
16. Chips, sawdust or other substances dropping between the saw and the lower pulley.

In the above I have given only causes, the effects of which may by care, attention and proper workmanship be appreciably obviated. There is one great reason why band-saws break, not mentioned above, and which, it seems to me, is entirely lost sight of, or not thought of, by either makers of mills, lumbermen or experts. That reason is this, viz.: Under the most favorable circumstances the life of a band saw is omited by its form of motion and the nature and construction of steel. Subjected to such an abnormal ordeal of bending and straightening, thousands of times a day, which must of itself eventually break the blade; add to this motion the tensile strain of its length, and the lateral strain of the feed: you will then know the reason why a band saw may not be worn out without breaking. We may hope by proper care, close study, and a settled practice of working, to see them have a longer existence; but the fact remains that the constant bending and straightening process causes a disintegration (not crystalization) of

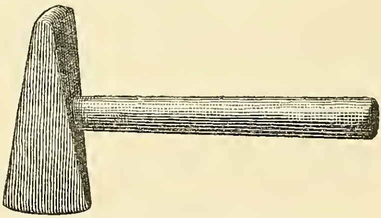

Fig. 1—The Cross-Faced Hammer.

the component particles, which must end in the destruction of the blade. As a demonstration in degree, note the breaking of a piece of wire by bending back and forth. It is often a matter of surprise to sawyers that a blade which has been doing good work commences to crack, persists in cracking, and is at last pronounced "no good," the maker perhaps coming under the same condemnation—the fact is, it is in reality all "broke up," its work is done, it has lost its cohesive quality.

Knowing the reasons why band-saws break, let us study those the effects of which may be obviated by preventing the cause. To this end I trust the instructions hereinafter laid down may aid you. I shall assume that all readers are beginners, and by such I shall try to make myself understood. To those already

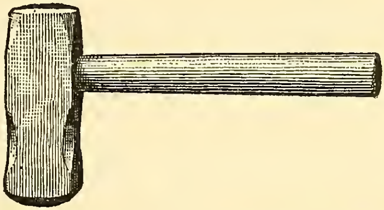

Fig. 2—The Round or "Dog-Head" Hammer.

advanced it will be a source of interest, perhaps of instruction, to read what follows.

HAMMERS.

For hammering you will require the following hammers:

One "cross-faced" Fig. 1, weight 4 pounds.

One round-faced "dog head," Fig. 2, weight 4 pounds.

One twist-faced Fig. 3, weight 4 pounds.

One blocking hammer Fig. 4, weight 2 pounds.

In the hands of a competent and expert workman the first-named hammer could be made to serve the purpose of all combined, the others named, facilitate the work and are of greater convenience for the various kinds of blows required.

The faces (striking parts) of the cross-faced hammer are at right angles to each other. The face in line

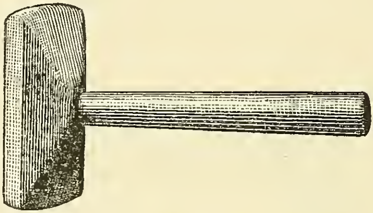

Fig. 3—The Twist-Faced Hammer.

with the handle of the hammer is styled the long face. The face at right angles to the line of the handle is the cross face. A blow struck with this hammer when held in the position shown in Fig. 1 is a long-face blow. By turning the hammer over without altering the line

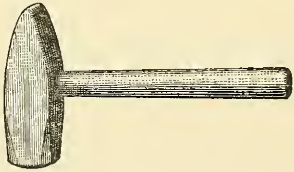

Fig. 4—The Blocking Hammer.

of the handle, but reversing the positions of the faces, cross face blows can be given with it. The round-faced or "dog head" hammer, has but one face, which, as its name indicates, is round. It is used chiefly for adjusting the tension. This hammer face must be ground convex, of an even sweep, so as to strike a round blow exactly in the middle of its face, the mark of its blow

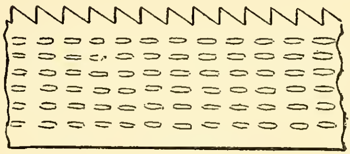

Fig. 5—Long-Faced Blows.

to be from three-eighths to half an inch in diameter. The twist-faced hammer, Fig. 3, has its two faces parallel with each other and the handle is not placed at right angles, but diagonally to the head, so that the operator may stand in front or at one side of the anvil, two feet distant, and holding the saw with his left hand against his side, may strike blows across or parallel with the blade and move the saw without changing his position. The blocking hammer, Fig. 4, the round face of

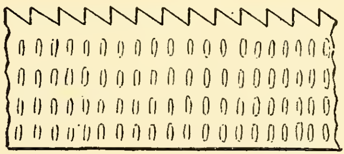

Fig. 6—Cross-Faced Blows.

which is ground like that of the round hammer, is used chiefly for work when the anvil face is covered with paper for the purpose of knocking down the lumps without affecting the tension. The cross face of the blocking hammer and the faces of the cross-faced and twist-faced hammers must be ground convex both ways,

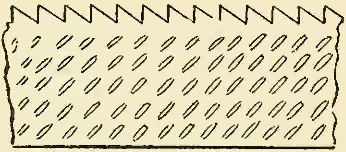

Fig. 7—Long-Faced Twist Blows.

so that the marks of the blows shall be three-fourths of an inch long, and sharp enough to show blows which are effective without cutting or bruising the steel.

By the use of the cross-faced and twisted-faced hammer the operator can, without changing his position, make all the forms of blows shown in Figs. 5, 6, 7 and 8.

In mills I find the general location of the anvil to be as shown in Fig. 9: A is the anvil, B the block or

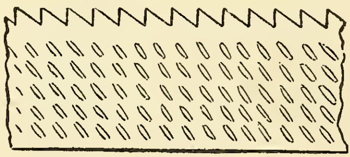

Fig. 8—Cross-Faced Twist Blows.

face plate for leveling, C is the saw and D a window. Generally there is a block or plate in front of the anvil, the same as at the back. As all the work of hammering should be done on the anvil or on the block or plate at the back, there is no necessity for any block or plate in front; the table F will be found sufficient,

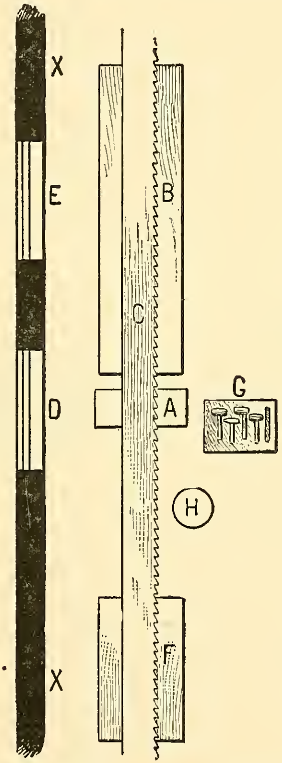

Fig 9—Proper Position of Anvil and Operator for Hammering Band Saws. *A*, Anvil; *B*, Block or Face Plate; *C*, Saw; *D*, Window (wrong location); *E*, Window (right location); *F*, Table to Support Saw; *G*, Table for Hammers; *H*, Operator; *XX*, Side of Building.

and more convenient, and should be placed at least three feet away from the anvil. The window D should be darkened, as its light is a hindrance to the operator. The location of the window should be at E, and, if convenient, a window should be in direct line with the back of the anvil, directly in front of the operator. All light at the back of the operator should be as much as possible avoided. G is a movable table on which are placed the hammers and levels, The operator should stand in the position indicated by H, which he will find most convenient for handling the saw. The space between the anvil and the table F gives room

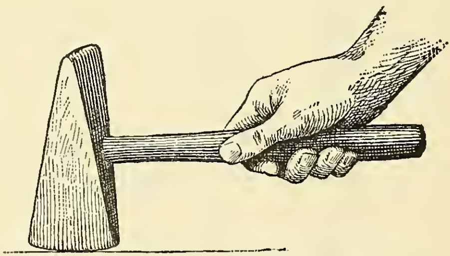

Fig. 10—Manner of Holding the Hammer.

to draw the saw back and forth, or to bend it up or down to find out the tension without the operator changing his position.

HAMMERING.

From a broken or worn-out band saw cut five pieces thirty inches long, having their ends square with the back. Before commencing work take the position for the operator shown at H in Fig. 9. Take each hammer in turn, grasping it firmly by the handle about two-thirds of its length from the head. The thumb and forefinger must be on either side, not on top, as in Fig. 10. Strike the anvil without moving either elbow or shoulder; the only movement being in the wrist, and the three fingers underneath the handle. This is important since the quality of your work will depend greatly on the nicety with which you can regulate the force and distribution of your blows; heavy or light,

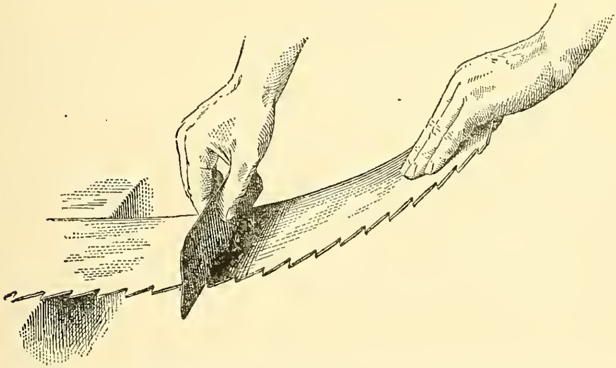

Fig. 11—Manner of Holding the Plate and Locating the "Stiff" Place.

their power must be moderated by the movement of the fingers and wrist. Too much stress cannot be placed on the matter of the proper command of the hammer; it is as much an art as the use of the hammer by the gold-beater or the silversmith. Having learned to bounce your hammer properly you may now take one of the five pieces. Laying the piece on the anvil, take the straightedge of the level, placing it edgewise, square across the blade, commencing at the end farthest from you. Find the largest lumps first, drawing the level over the full extent of each-lump; lay down the level and take the hammer, and by a careful distribution of your blows, heavy or light as the case may require, proceed to knock down one lump. Then take another, and repeat the operation until you have gone to the end of the piece; turn it over and proceed in the same manner on the other side. The direction of the blows is diametrically across the line of the straightedge (see Fig. 11), and must always be so; hence, as your instructions were to place your straightedge

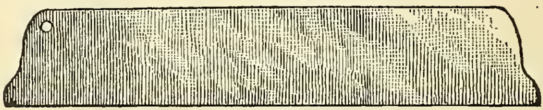

Fig. 12—The Tension Level.

square across the saw, the blows you have applied running lengthwise of the saw are long-face blows (see Fig. 5, page 11). Whichever face of the hammer you may use, as may be most convenient, the name of the blow is determined by its direction (see pages 11–12). Having taken out the long-face lumps, now proceed to take out the cross-face lumps (Fig. 6, page 11). Go over them a second time to see if you cannot improve upon your work.

To gain a knowledge of

TENSION

as applied to the band-saw, lay one of the pieces on the anvil lengthwise, and take hold of the end nearest you. Then place your left hand on the upper side, and with the thumb underneath raise it from the anvil,

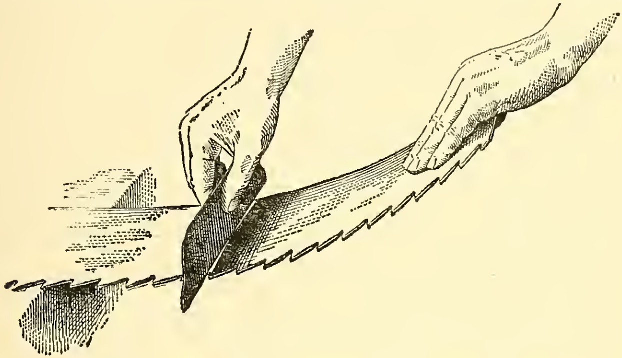

Fig 13—Manner of Locating the "Fast" Place.

letting the farther end rest on the block or plate behind the anvil. Grasp tightly and bend to a curve by a pressure of the hand and fingers. Fig. 11 shows the

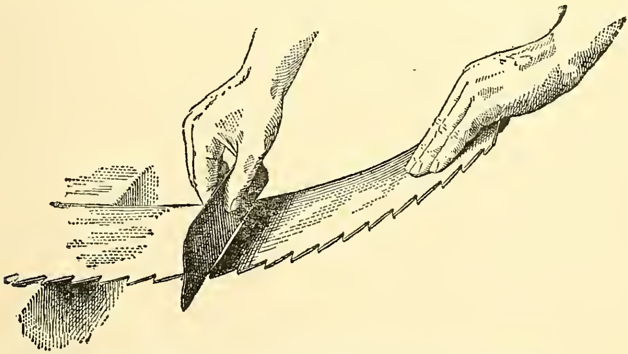

Fig 14—Manner of Locating the "Loose' Place.

manner of grasping the plate. When the straight-edge or tension level, as shown in Fig. 12, is placed across it, those parts drawn to the straightedge are "fast;" those parts which leave the straightedge are 'loose;" those parts which neither drop nor rise are "stiff." (See Figs. 13 and 14.)

The lesson upon which you are now engaged is to make these five pieces "stiff," *i. e.*, show no tension. To this end find a "fast" place. This is done by bending in the manner described; the "fast" place will show in the same way that a lump shows when the plate is not bent. (See Fig. 13.) Having located the "fast"

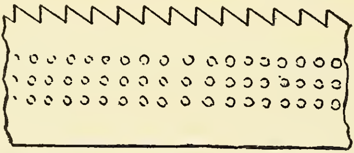

Fig. 15—Round Hammer Blows to Take Out the "Fast."

place and noted its extent, turn the plate over; you will find that it shows on the other side in precisely the same manner. With the round hammer, hammer equally on each side, try with the straightedge, and so proceed until you have taken out all the "fast."

The "loose" places are those that drop from the level when the plate is bent. (See Fig. 14.) These are removed by hammering on either side. Hammer each of the pieces until they show neither "fast" nor "loose" places, but are "stiff" throughout as stated above. Before putting each piece out of your hand "level up," *i. e.*, take down whatever lumps you may have made in using the round hammer.

All the pieces being now flat and "stiff," hammer one of them down the sides, using the round hammer for the purpose and placing your blows half an inch from each edge (see Fig. 16), and in a straight line. Repeat this until you can feel and see it work fast without being obliged to use the level. Taking another piece, hammer through the middle, distributing your blows in an area four or five inches wide, according to the width of the saw (see Fig. 15, page 18), and

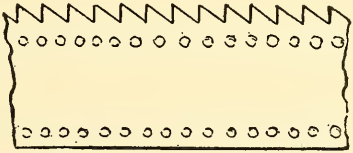

Fig. 16—Round Hammer Blows to Take Out the "Loose."

hammer until you can feel the looseness without the aid of the straightedge. You will now understand by touch and sight, and straightedge the extremes of "fast" and "loose" and "stiff" (tensile), as applied to tension.

You will observe that when the blade is bent under the level as previously described and shown in Fig. 11, a "fast" place shows convex and a 'loose' place concave. By making the bend upwards instead of downward, the 'fast' place will show concave and the 'loose' place convex, the extent of which shows where the blows should be placed. The space between the anvil and the table *F* in Fig. 9 allows room for bending the band saw up and down, to determine the exact degree of 'fast' or 'loose.'

Having lain aside three of the five pieces, each "fast," "loose" and "stiff," we will proceed, with the remaining two, to the consideration of the

TWISTS.

There are two twists, the long face, and the cross face. The long-face twist is that which must be removed by the use of the long face of the cross-faced hammer, applied in a direction diagonally across the blade, as in Fig. 7, page 12. The cross-face twist is that which must be removed by the cross face of the cross-faced hammer, applied in a direction diagonally across the face of the blade, as in Fig. 8, page 12.

Now, observe that as the long face produces a cross-face twist, the opposite blow (cross-face) will remove it, or vice versa. As for tension, so for twists; both sides of the blade must be equally hammered. Before removing either twist, place the straightedge diagonally across the blade. You will find that it shows a lump at right angles to the straightedge. Changing the position of the straightedge to an exactly opposite diagonal direction, you will find a hollow. Without changing the position of the straightedge, turn the piece over; you will find a hollow on both sides, and, in like manner, with the straightedge in the opposite diagonal direction you will find a lump on both sides, showing that both sides must be hammered to remove the twist. Now note that before you commenced to hammer a twist the pieces were straight, therefore take the exactly opposite course to remove them, using care not to hammer too much or you will produce the opposite twist to the one removed. Also note that when you lay the two pieces out at length on the face plate, you will find that the ends which do not lie flat are at the opposite corners of either piece. You may now take such piece and hammer carefully, and keeping in mind the above instructions, remove the twist, level up such piece straight and flat, then put in twist again, one a long-face and one a cross-face.

Where there is no twist, and the blows are given in any other way than either parallel with the length of the blade, or squarely across it, a twist is produced. Now hammer each of the two remaining pieces, one with long-face twist blows, which will produce a cross-face twist; the other with cross-face twist blows, which will produce a long-face twist. Distribute the blows about half an inch apart across, and from end to end of each piece in the manner described.

You will now have the five pieces thus: one stiff, one fast, one loose, one long-face twist and one cross-face twist. These pieces may be kept for reference. The short pieces are convenient for handling and turning. You might further utilize your stock of discarded blades by trying on a piece twelve feet in length or longer; following on the longer piece the instructions you have already received and the further instructions which now follow.

Like every other branch of learning,

> "There is no royal road;
> Alike the peer and peasant
> Must climb to that abode."

It would be presumption to expect that you can take a saw and adjust it with any hope of success, without some practical knowledge, and this you cannot hope to get by operating on new saws as they come from the manufacturer, or trying to adjust them in their first deviations from tension or truth. Try in a measure to master the above rudimentary lessons. The more work you do as practice, the better able you will be to keep the saws in working order.

In preparing the pieces for practice you will facilitate your work by removing the set of the teeth by hammering, or with a side file. By this means you will be enabled to make a freer use of the straightedge.

We will now proceed to the consideration of the

CARE OF THE BAND SAW.

We will take the first difficulty that is likely to confront you, and one which is not infrequent. The saws having arrived from the manufacturer are unpacked and may be found to be bent where the shortest turn in packing was made. To take this out on the bare anvil might produce a change in the tension, or affect the straightness of the breast. To avoid either of these difficulties, cover the anvil with a double thickness of brown packing paper, such as is used in hardware stores, take the blocking hammer, place the saw on the anvil, and, using the round face, hammer gently, just hard enough for the blows to be effective, without making any indentation in the steel. In all anvil work try to avoid doing too much; for if you do not you are making extra work for yourself on the other side of the blade. It is better to go carefully, using the straightedge frequently. If, after taking out the general bend, you find, on applying the straightedge, that there are several smaller lumps, do not take them down separately, but do a little on each one, going over them as often as required until the place is flat; you will by this means avoid the trouble of turning the saw. The saw, when placed on the machine, should run steadily, having no lateral motion, and when in the log should not chatter or rattle between the guide and the upper wheel.

By now considering in detail the reasons why band saws break, taking them under their separate heads, analyzing and removing where possible the cause, try to acquire such a knowledge of the maintenance and manipulation of the saws as may make their care and use a settled practice, and make it possible to get from them an amount of work commensurate with their cost. We will take them up in order as classified on page 6.

1. *Feeding Beyond the Tensibility of the Blade.*—

In the economy of nature, whether animate or inanimate, however mighty its power, there is a limit to all powers of endurance and resistance; whether it be the rugged shore against the mighty ocean, the rock against the continual dropping, or the strain be upon the human brain or muscular power, there is a point beyond which it is dangerous to work.

You've met afore the metaphor
  About the camel's back.
'Tis said that 'tis the final straw
  That makes his spine to crack.
It is as apt as it is old,
  And in the *band saw's* case
The meaning of the proverb
  Is not difficult to trace.

When used beyond its capacity to withstand, if its quality be good, it will fight a hard battle before succumbing. The pressure of the feed while expanding and making fast the teeth, crowds the openness of the tension to a dished form, causing the saw to come in contact with the side of the kerf, producing heat, which, as is natural with steel, draws towards the point of friction, gets more dished and loose, and becomes rigid. The teeth now seek one side. It matters not how perfectly the saw may have been adjusted in tension or sharpness; it is powerless to resist under these conditions, and is apt to crack on the edges or in the body.

2. *Using a Saw when the Teeth Points are Dull.*— A normal feed has the same effect on a dull

saw as feeding a well-sharpened saw beyond its capacity. Beside your sense of sight, you must cultivate your senses of sound and of touch, and be in sympathy with each particular blade. When, standing by, you hear that dull, charring sound, you will have a feeling like to that produced by using a dull wood chisel when good and quick work is wanted. Keep the saw sharp. The spring of a clock or a watch is not more delicate in degree, or more sensitive, than a band saw. The spring of a watch is wound up every twenty-four hours, and the strain upon it is comparatively light, being all in one direction, and yet how many watch springs break! Here is the main spring of the mill being wound and unwound thousands of times a day. That it bears this alone, without the work it has to do, is a triumph of the sawmaker's skill. I say, therefore, to the filers, one of your responsibilities is to see that the saws are sharp.

3. *Insufficient or Irregular Set.*—Not allowing clearance enough to escape the closing grain or fiber, which, closing at the sides and base of the teeth, produces heat, and this, if in undue degree, causes expansion of the teeth, resulting in a wavy or vibrating motion likely at any time to start small cracks at the bottom of the teeth. When the set is small the lumps on the saw, even when passed over as of no consequence by the straightedge, show bright and clean, while the hollows are of a dull color. Watch your saw carefully, and when these lumps appear, put the paper

on the anvil as before described, take the blocking hammer and carefully go over these bright spots on both sides of the blade. If the saw requires tension use the bare anvil. By watching these indications, and by a careful use of the blocking hammer and straightedge, you will, by a little practice, produce a flatter saw than by any other means. In all saws—band, gang, or circular—which are used with a swage set, the quality most desired is that which holds the corners. When saws are set irregularly the widest points lose their corners quickly, at once affecting the blade. When the saws have recently come from the manufacturer they will generally be found to have more than sufficient set. When these are dull after first use, trim with side file and sharpen, but do not set, thus determining by trial the exact amount needed, then make, and always use, a set gauge.

4. *Unequal Tension.* This is a fruitful source of trouble and of breakage; but, as you gain in experience, one easily remedied. The saw may work well at first, and yet each time it is used, or filed, its tension may be altered, not at first to an extent appreciable when at work, but the inequalities may be found by examination with the tension level before sharpening. Just as "a stitch in time saves nine," this constant vigilance will teach you the need of "here a little, there a little." It is in this way, "line upon line," that you become, almost imperceptibly, master of your work.

Having supplied each of my customers with a tension level, I may explain for the benefit of those not using saws of my manufacture, or not conversant with it, its form and manner of use. When the speed of band saws was increased to ten thousand feet per minute, together with increased feed, it was found that the tensibility of the blade would take the increased strain by having a deep, well-regulated tension. Loose tension beyond a certain degree will carry down the small "fast" places so that they cannot be located with the straightedge. With a tension level the convex edge of which has been adjusted to the depth of your required tension, the most minute portions of "fast" may be located.

The form of a tension level may be seen by reference to Fig. 12. The edge *A* is the straight edge, the edge *B* is the convex level, by the use of which is secured a uniform tension. The sweep of the convex edge fitting the tension declension, is governed by our knowledge of the speed and feed required. Placing the saw in position for hammering, commencing at the joint with the straightedge, you proceed to make it flat and straight by taking down the lumps, both long-face and cross-face. This done, take the tension side of the level, standing in the position indicated by *H*, Fig. 9, page 15. With the level in your right hand, place your left under the blade, raising it nearly to the height of the shoulder, and place the tension level squarely across the blade, at arm's length, as shown in Fig. 17. The fast portions will lie closely to the level and show in the same manner as a lump under the straightedge. Unless the saw has had an insufficient set and become heated in the body, it is not likely to have any "too loose" places.

If you have no tension level:—When the saw

Fig. 12—Manner of Grasping the Plate to Find the Tension.

drops "loose" under the straightedge, the fast places borne down by the drop may be located by using a straightedge about four inches in length, trying inwards from either edge of the saw, in the manner before described. This short straightedge covering so small a portion of the blade proportionately reduces the depth of the drop, and enables you to see "fast" places which would otherwise be borne down if the straightedge extended across the full width of the blade. However perfect in other respects, unequal tension is liable to cause a saw to crack. In view of the above fact, the importance of the practice advised in preceding pages will be conceded.

Proceed according to instructions on tension, page 17. You cannot turn the saw over in the same manner as you would a short piece, therefore be careful to mark the places on the under side with chalk, indicating where to hammer when you turn the blade; and before turning, rub out all the chalk marks on the side operated upon. This will prevent confusion when you again turn the blade.

This is the time to exercise your qualities of perception and memory, for when you have gone around one side you must take the other, and, before using the level, commencing at the joint, hammer all the places you have marked, as nearly as you can, in like amount as on the other side. Then rub out the chalk marks, and so repeat until you have the proper declension, which is obtained when you can see daylight under the edge of the level. With this exception, which is important, that portion of the blade extending for a space of one inch from the tooth, and half an inch from the back, must adhere more closely to the level than the other (or middle) portion. As the middle portion shows daylight, let the portions named (tooth and back) show darkness, but not a lump, which would be "fast."

5. *Improper Tension.*—If you are running at slow speed, or feed, or increasing it, you may have too little or too much tension. Before altering, equalize the tension. To make the tension less, or stiffer, hammer gently on the sides of the saw from end to end, not striking nearer the edge or bottom of a tooth than a quarter of an inch. To put in more tension (to "open up"), hammer in the inner portion of the blade (see instructions on tension, page 20), judging of the amount by the adhesion to the level in the one case (less), and by the falling away from the level in the other (more). If it is required to make frequent changes in tension, it is best to have two extra levels, one for more and one for less tension respectively. In opening up a saw when the tension is properly equalized, the roller may be used to advantage; but it must be used with care or more work will be made than saved.

6. *Uneven Breast.*—This cause is indicated by the existence of hollow and high places, not by uneven width. Blades may have parallel edges, but, not being in a straight line, cause a lateral movement when the saw is in motion, thus presenting an uneven and ever-changing cutting front. To draw out these places straight, take a long straightedge—six feet is a convenient length, one shorter than this is too short—place it against the back of the blade, locate the point

most out of line, making a chalk-mark on the part where the straightedge rocks. After marking throughout the entire length of the blade, you may find that it has one continuous bend; if so, hammer gently from end to end on the hollow side, hammering gently from the edge to the middle of the blade; by this means, with care, you may avoid altering the tension. Then locate and operate upon the individual places. The point of skill in drawing the breast is to distribute your blows without affecting the tension. Having made the back true to the straightedge, joint up the teeth.

7. *Irregular and Uneven Teeth.*—This condition is shown by an erratic movement of the blade when at work, especially in a long or heavy cut, or in knotty logs. High points, low points, wide and narrow points should be avoided. (See Note on Reason No. 3.)

8. *Joint Not Properly Hammered.*—In my observations in the mills I frequently find saws cracked in close proximity to the joint. On examining saws so broken I find them to be fast at or near the location of the crack. To hammer the joint properly is the most difficult part to learn of your entire task. The method of manipulation is hard to describe. During the process of brazing, the hot irons hold the saw so tightly that there is not room for expansion beneath their pressure. Outside the irons, as far as the heat extends, expansion has free play, and shows in the lumps which form on either side of the joint, which is now the con-

tracted, or fast part; therefore, after brazing, lay the joint, round (or dished) side up, on the anvil, at one side, so that you deliver the blows solidly. You will find the cross face of the cross-faced hammer the most convenient to use, but the blows must be long-face blows (see Fig. 5, page 13). Confine your blows to an area one inch wide across the width of the blade. In this case let your blows go to the extreme edges; hold the blade firmly and use either side of the anvil, according to convenience in getting solid blows. Do not be afraid of opening the joint; if properly brazed it is now an integral part of the blade, and will stand as much as any other portion; if it is to come undone, now is the best time for it to do so. This is a test for the quality of your work, whether it be good or bad.

This hammering in the manner described has also another purpose; no matter how loose the saw when broken or cut, each end on becoming a separate part becomes "fast." Now this "fastness" becomes intensified by the heat and combination of the metals. You are expanding the part upon which you are at work, at the same time drawing down, or contracting, the lumps, which are loose places on either side. As these begin to fall you may increase the area of your blows on either side of the joint. When these have fallen, trim the joint to even thickness, then adjust tension and breast according to instructions already given. Be closely observant and let each joint hammered be an object lesson in the tensibility of steel.

9. *Too much Hammering.*—Once, in a mill, while I was conversing with the filer, he pointed with pride to the band-saws and said, "I keep them well pounded," a fact verified by a glance at the saws which had the appearance of repoussé work, the high spots surrounding each indentation of the round hammer shining like silver, and the indentations enameled with deposits of gum turned black. Never make indentations with the hammer which will bruise or cut the steel; constant "pounding," as described above impairs its strength, causes crystallization and destroys its tensibility. Avoid unnecessary work by using care not to go at it in a "haphazard" manner. Have a reason for every blow, trying to place it in the right spot every time.

10. *Hardening of Portions of the Blade around the Braze.*—Removing the irons while hot and cooling the blade with water, is apt to make it brittle, unless below a certain temperature. It is desirable to retain some temper in and around the joint. To do this without danger, the following method will be found successful. After the irons are screwed down tight, and sufficient time has been allowed for the metal to run, take a wet sponge, or rag, well soaked with water, and while the irons are red hot, draw across the blade, cooling both irons and saw, continuing until the iron is black (not cold), after which leave it to cool. There will be suf-

ficient heat remaining in the irons to prevent the saw being too hard, while sufficient temper will be retained to hold the tension when hammered.

11. *Leaving Thick and making Thin Places when Trimming after Brazing.*—Thin places are weak spots; thick places adjacent making them doubly so. They may be avoided by using care to file only the thick places; using the straightedge and hammer frequently to make sure that apparently thick places are not lumps and hollows.

12. *Sharp Angles in the Bottom of the Gullets of the Teeth.*—This cause of breakage, and its effects, are now so well understood, that they are rarely seen in log-band saws; but in band re-saws the filers seem to have a persistent affection for a square-cornered file making two sharp corners in the gullet of every tooth. This cause may be entirely overcome by the use of a round file in connection with the flat one, or an emery wheel may be used one-quarter of an inch or between that and half an inch thick, thus keeping the gullets round.

13. *Not Having the Swage for Setting, Properly Adjusted.*—As the lever swages, for hand or power, are now mostly used, their proper adjustment is an important matter. In these machines the tooth rests on a small anvil, while the pressure die is forced by an eccentric movement to spread the tooth. Unless the adjustment is such that the portion of the tooth to be swaged rests solidly on the anvil, the pressure will

bend, crack, or break the point. If cracked, it will come off during the work; if bent, it will be out of line with the rest of the teeth, which must all be jointed to this, or it must remain a low point. Either of the above consequences produce conditions already spoken of.

14. *Case-hardening of Portions of Teeth by the Emery Grinder.*—If the emery wheel on the sharpener be of too hard a grade it will produce spots of a diamond-like hardness, which cannot be touched with a file. From any of these hard spots a crack is liable to start. While you are unable to file these spots, they may be removed by a light touch of the wheel when in motion. It is generally thought a work of too much time or trouble to hunt for these spots, and the saw is left to take its chances. The best instruction I can give you upon this point is to get a wheel of the proper grade and not to "crowd" it upon the work. An emery wheel will do just so much; if you try to make it do more you will spoil both wheel and work. I may here also call your attention to another fact. You may not know it, but where, in sharpening, the color of the point of a tooth goes beyond a blue, the steel is red-hot. This not only softens, but changes the nature of the steel at the extreme points of the teeth.

15. *Gum Accumulating at the Sides and Base of a Tooth.*—Keep your blades clean when not in use. By the use of waste and oil remove all incrustations of

gum or rust. In yellow pine the incrustations of gum on the sides and in the root of the tooth become almost as hard as the steel itself. Oil these over to soften them; use a scraper in the form of a wood-chisel; keep the blades clean. Another method is to have attachments to throw a spray of water on each side of the saw while at work, will be found to keep it clean.

16. *Chips, sawdust or other substances dropping between the saw and the lower pulley* cause a sharp, uneven strain. This may also be caused by the accumulation of dust in lumps on either pulley.

It will be observed that the above reasons why band-saws break, all relate to the saw itself. I have made no reference to defects in track, carriage or mill, as causes of breakage. With reference to the last-named, I may say that the manufacturers of mills have spared no pains in workmanship or inventive skill to bring the band-mill to perfection. To do good work, all machinery connected with a mill must be well cared for.

It must strike you on reading these pages, that however perfect a mill or a saw may be, when it is consigned to your care, you must meet the charge with brains and mental capacity, as well as with manual skill. Brute force and hard "pounding" have no place in the care of a band-saw; but a close application, and cultivation of a careful manipulative skill, are essential.

No matter how tedious the process, be not content that you know a little, but let each day's practice see you farther advanced. There is no place in your work for indifference, no place for mere venture, as in some mechanical trades. Each day's work presents new features and the mind must be brought to exercise its faculties before the manual labor is performed.

Resolve to become a master of the trade, a worthy member of the new guild—The Brotherhood of Filers —which must become a good American trade. Those who can master it will rise to the dignity of first-class mechanics. Do not try to grow too fast; guard against a feeling that you "know it all" before you have mastered the rudiments. Go humbly, but bravely, to your task; realize how little you know, trying by an earnest and constant application to exercise patience, and you will make such daily progress, that, almost imperceptibly, you may become a master hand.

Remember that your aim must be to have a full knowledge of the condition and working of each saw under your care, and each one should be examined and adjusted every time it comes off the machine. It is also of importance to remember that however perfectly a saw may be hammered it is always possible to find fault with the work of others. The less a man knows, granted that he knows something of the subject in hand, the more likely will he be to find fault. I pity the sawmaker whose foreman is an inferior workman. Good sawmaking, that is as far as it relates to hammering, is altogether a matter of judgment, which judgment consists in knowing *when* a saw is properly done to stand up to its work. The master workman looks at the saw as a whole, while the workman whose knowledge is small enough to make it dangerous, points out a seemingly apparent fault here and there, ignorant of the skill displayed in the adjustment of the entire blade, and may be described by the proverb, "Straining at a gnat and swallowing a camel." Do not criticise the work of others unless it be to render assistance, and count the ability to render help to a fellow-laborer a privilege, and use it.

When a knowledge of hammering, however small, has been attained, combined with a practical experience in the working of the mill, a desire will be aroused to attain some degree of excellence. Those who aim to be experts should spare no pains or practice to reach the desired end. As contingencies arise from time to time, always be on the alert. So much impressed have I become with the importance of constant vigilance, and the necessity of having the work done in the mill, that a sense of duty has impelled me to this task of imparting such information as may be gathered from these pages.

It is economy to have a full supply of saws, thus to preclude the possibility of your being compelled to use one whose condition you know is not such as to inspire you with confidence of good results.

FORM OF PULLEY AS RELATED TO TENSION, AND AS A REASON WHY BAND SAWS BREAK.

To the advanced expert I may propound a question for consideration.

In my early observations I found that the face of pulleys on band-mills were flat. About six years ago I filed an application for a patent for a convex-faced pulley, my specifications based on sound scientific principles and drawn from a full knowledge of the nature, construction and tensibility of steel. Finding that crown-faced pulleys had been tried and discarded, I did not pursue the matter beyond the application. I could have obtained a patent on the principles laid down; but commercially it would have been a hard matter to hold. I found that crown-faced pulleys were tried on the supposition that a steel belt, like a leather one, would seek the highest point. My specifications set forth a claim for a pulley, the crown of which should be convex to a degree corresponding with the concavity of the tension, which to my mind, then as now, is the only proper way of keeping a blade tensive throughout its entire length.

It is now generally understood that a band-saw is something more than a mere strip of steel. I still believe that my theory is correctly formulated, not from any knowledge of the various mills, but from later observations, and the principles governing the working of the blade, as set forth in these pages; and on these principles alone. I venture to make the assertion that the mill manufacturer or lumberman who will try a saw with deep tension (particular attention being paid to its regularity), and turn the face of both pulleys convex, to exactly fit the concavity of the tension of the saw when bent to the radius of the pulleys, will make a great advance toward producing a perfect running saw, with less breakage, and quicker feed, complete the greatly desired bond of union between the saw and the mill, and will have sounded the death-knell of the circular saw as a competitor of the band-saw in the production of lumber. In stating this theory, I am fully aware that those considered best able to judge are favoring a perfectly flat-faced pulley, under the impression that they thus get a more perfect exclusion of air, and a closer cohesion of the surfaces. I think that future practice will prove that flat surface pulleys are wrong.

The objection which manufacturers of band mills offer to convex-faced pulleys is that with flat-faced pulleys the saw as it wears down can be more easily adjusted to run in any desired position. It is a question whether a saw with any degree of tension would last long enough on a flat-faced pulley to require adjustment. The crown of a pulley to fit the deepest tension would be so slightly convex that I do not think any difficulty would be experienced in adjusting the blade.

My theory I demonstrate from the blade itself, thus :—I take a ten-inch wide band-saw with the tension adjusted for heavy feed, bend a portion of it to the radius of the diameter of the pulleys on the machine and place the straightedge across any part of the outside arc of the radius. It is found convex and the inside correspondingly concave. To this concave surface the face of the pulleys should be adjusted. Although the blade is perfectly flat when straight, the moment it bends to the pulley it assumes the concave form, and all the strain must be on the two edges.

In some mills I have found saws running which were rounding on the back, hollow on the breast—the more open the tension, the more rounding on the back. This condition may possibly allow a closer conformation to the bending of the saw over the pulley. It has been my intention to practically solve the above problem but the demands upon my time by my business have prevented my doing so.

SPACE OF TEETH.

Although this is a question now receiving attention in the columns of the various journals published in the interest of saw-mills, I had no intention of discussing it in this work, nor should I have deemed it of sufficient importance, but for the following circumstance. viz.: On the 17th day of November last, I visited a friend and customer who is discarding the circular saw for slabbing purposes, and has purchased a band-mill, to be in use at the opening of the next season. I found him deeply concerned by an experiment tried at a neighboring mill (also customers), whose saws, worn down to a width of five inches, would not stand the feed. By cutting out every alternate tooth, making the space two and one-half inches, they were reported as doing good work. At eight o'clock the following morning we went together to the mill in question, where we remained until noon, watching the saw work and discussing the matter with the filer, who stated in substance as follows: Wishing to finish the season's sawing with the saws in use, and having large logs, the saws would not stand the feed. After conceiving the idea of a wider space, he hammered two saws as nearly alike as possible, having tried them on the mill with the same result. He then with a cold chisel cut out every alternate tooth on one of the saws, and to his surprise the five inches wide blade with two and one-half inches space, withstood the strain of the feed given to an eight-inch wide blade with one and one-quarter inch space teeth. The speed of the saw was seven thousand five hundred feet per minute, steam feed. In relating the above to one of the best experts in the trade, he holds that one and one-quarter inch space is the proper pitch for a speed of nine thousand to ten thousand feed, and heavy feed. On the other side the two firms spoken of were so well satisfied with the result of the experiment that they placed their orders for next season for teeth two and one-half inches space. Quite recently a pitch of one and five-eighths to one and seven-eighths inches of space have been ordered. Some eight years ago I advised space of teeth half the width of the blade, with an extreme limit of three inches. At that time saws six and eight inches wide were the average widths, and two inches space the pitch of the teeth, and the best results were from the widest space of teeth ; but as the width of the blade, the speed and feed has increased, the tendency to smaller pitch has settled down to one and one-quarter inch for soft wood, one and one-half inch for hard wood.

ON THE WIDTH OF BAND SAWS.

During the past two years quite a number of band saws, twelve inches wide, have been used. The advantage to be gained by the use of a saw twelve inches wide is the increased power of resistance, and the taking of a quicker feed.

As a band saw ten inches wide requires twice the hammering of one eight inches, so one twelve inches wide requires twice the amount of labor as one ten inches. As the life of a band saw depends greatly upon its being kept in proper order, it will be seen that the care of one twelve inches wide involves a responsibility of care and skill for its successful working. Reading these pages you will have learned that a saw twelve inches wide in incompetent hands is more liable to break than one of less width, and that the power of resistance is not in the amount of metal and main strength alone, but in a nicely-adjusted blade of good quality.

Where a saw is affected by the conditions described in the "Reasons why band saws break," the greater its width the greater the danger of breakage, for if not properly adjusted the increased width multiplies the difficulties it was intended to overcome. I would not be understood as deprecating the use of twelve-inch blades, but these remarks are made to apprise you of the increased responsibility with increased width.

I have presumed that the saws you are supplied with are of good quality. In this, as in every other branch, the best is the cheapest. Under every condition the best saw stands the best.

Some mills have tried the experiment of making their own saws from bands of raw, untempered steel. For band saws, untempered steel is of no value, as the stretching on the wheels and the rotation draws out the tension without any work being done; when the work is applied they soon loose their cohesive quality, and succumb to the conditions set forth in these pages. It was found to be an expensive economy.

Several firms in the United States are making better blades than the best ever imported. When the manufacture of band saws in this country was in its experimental stage the French saws were considered the best; but during the past few years such have been the demands made upon the saws, by increasing the work put upon them, the steam feed, and increased speed, that in their endeavors to meet these demands the

American saw manufacturers have far outstripped those of any other country in the quality of their work.

HINTS ON BRAZING.

To make a strong joint, the less solder remaining between the joint the better it will hold.

The closer the scarf ends fit the less solder will remain in the joint; therefore (whether emery wheel or milling scarfer be used) after scarfing, draw-file the beveled parts, using a single-cut mill bastard-file. Apply the straightedge the way of the bevel, and across the saw, to see that it is true; you will thus ensure a close joint. The draw-file marks present the best surface, and are sufficiently rough to hold the solder. If, when draw-filing you find hard spots, lay a hot iron "blood red" across the bevel, letting it remain until cool.

Have the ends of the blade outside the joint as flat as possible before draw-filing. Draw-file to a feather-edge, then file the sharp edge dull and straight. Let draw-filing be the last operation before brazing.

Keep your fingers off the scarf; they will grease it and spoil the solder.

Put your brazing irons squarely across the saw or you will make a twist.

As soon as the hot irons are screwed down on the joint, release the saw from the screws which held it in place before brazing, there will be less liability of drawing of the breast.

A sponge moistened with muriatic or acetic acid diluted with water may be drawn across the scarf, and the silver solder may also be cleaned in the same manner.

To make a neat joint, do not place anything but the strip of solder between the joint, no paste or other mixture.

A little powdered borax sprinkled dry over the joint before the irons are applied is all that is needed to produce a good flux, and strong joint.

SAWS,

THEIR

HISTORY, MANUFACTURE AND USE.

By Joshua Oldham.

HISTORY.

THAT an implement of use for the purpose of sawing has always had a place in the economy of man, even from pre-historic times, is evident from the remains found in excavations in various parts of the world.

The invention of the saw proper is attributed by the ancient Greeks (about 1200 B.C.), to Talus, nephew of Dædalus, grandson of a King of Athens, doubtless the most skillful and prolific artist Greece ever produced, a great inventor, architect, and sculptor. Previous to his time their statuary had been but shapeless blocks, with but a faint resemblance to the human form. He carved the limbs and features to such perfection that he was credited with the power of giving life to his works. He was the inventor of masts and sails for ships, in place of oars. To him also is attributed the invention of the hatchet, wimble (boring tool), and level. Dædalus undertook the education of his nephew Talus, who must have inherited the genius of his uncle, for he displayed such precocity as to rival him in the scope of his inventions, three of which are indispensable in the modern mechanical arts—the saw, the lathe and the compass. From the contemplation of the potters' wheel he invented the lathe. Becoming possessed of the "jawbone of a serpent" * he used it to sever a piece of wood, and reproducing the shape of the teeth in iron, formed a saw. On making known these inventions, especially the saw, his fame at once became so great that it excited the jealousy of his uncle, Dædalus, who, apprehensive of his rivalry, and envious of the growing fame of his nephew, lured him to the top of the Acropolis, cast him down from thence, and buried him secretly. Being detected, he fled for his life to the Island of Crete, where, under the protection of its King Minos, he built the famed Cretan labyrinth.

Saws have been discovered in various parts of Europe belonging to a remote age—those of the earlier age made of flint, others belonging to the bronze age. The natives of the West Indian islands had saws made of sharks' teeth and notched shells.

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* Literal translation.

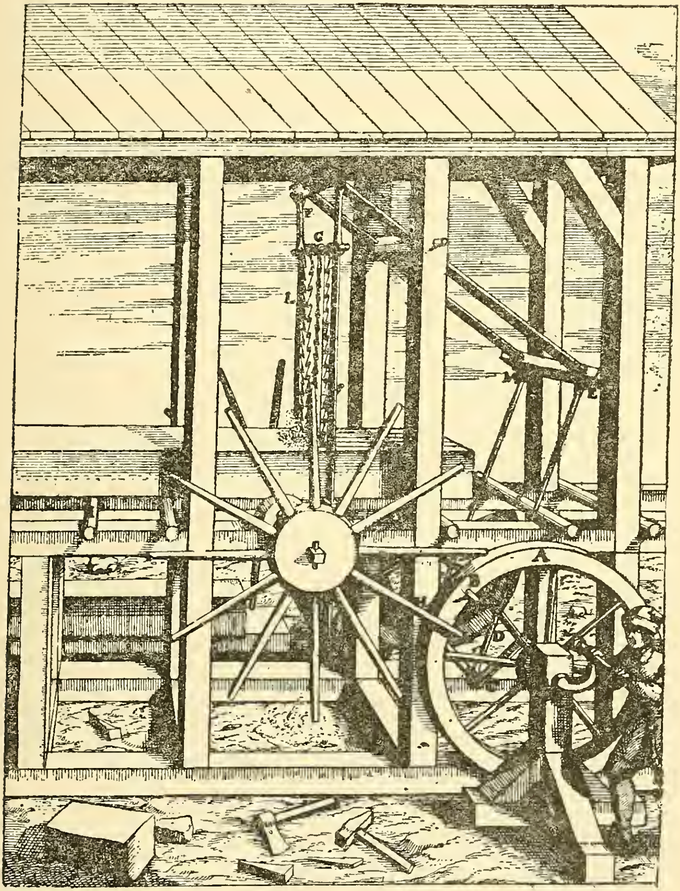


Fig. 18—Mill Worked by Hand Power.

In tracing what may be termed the modern history of the saw, the sources of information are very scant. Having searched through old mechanical and other works in Europe (Continental and English), likely to shed light on the subject, the results are not very gratifying. Sometimes casual mention is made of the use of saws in France, Germany, the Netherlands, and England; but without definite information from which to form accurate data. The writer remembers having seen two very old pictures, "The Building of the Ark" and "The Sacred Home at Nazareth," in each of which was the representation of a saw of the form of our buck saw, or, rather, the old German web saw, and the writer has in his possession an old English Bible in which, in the frontispiece to the prophecies of Isaiah, that prophet is represented with a scroll in one hand, and in the other (indicating the manner of his death), a saw, the very counterpart of our cross-cut saw of the present day.

While the above is a condensation of a pleasant recreation and research extending through many years among "many a volume of forgotten lore," my aim has been to trace the progress made since the application of power to the saw, in the production of lumber.

From these researches I gather: That the saw-mill, run by water, was first used in France in the twelfth century; by the English in New England in 1634; by the Dutch in New York in 1663; and in England previous to this latter time.

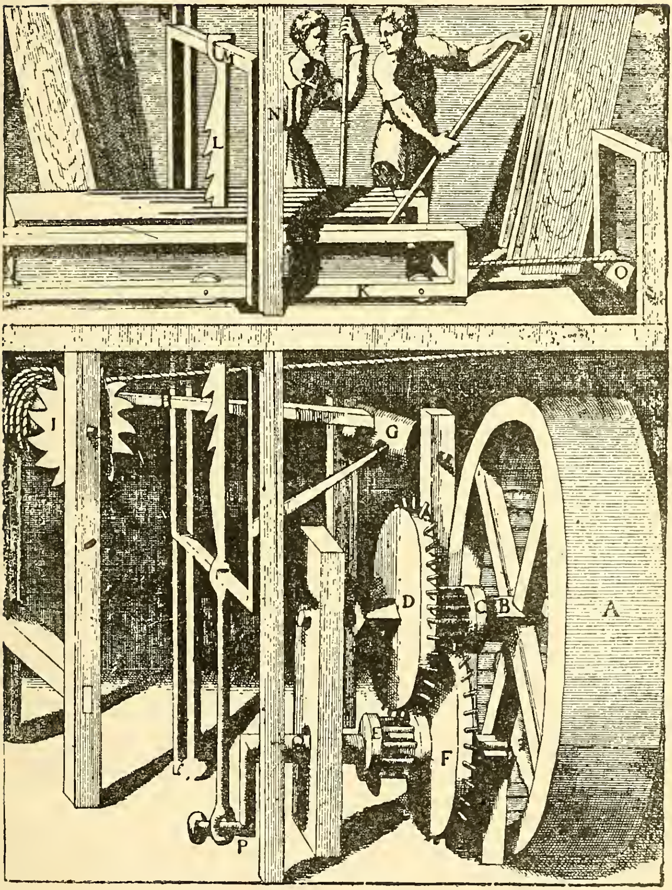


Fig. 19—Mill Worked by Foot Power.

The following extract is from a quaint but well compiled work, published in London in 1661, entitled "Humane Industry; or a History of most Manual Arts; showing forth the exellence of Human Wit." It says: "At Dantzic in Prussia, Mr. Morison, an ingenious traveler of this Nation, saw a mill, which (without the help of hands), did sawe boards, having an Iron wheel, which did not only drive the sawe, but also did hook in and turn the boards into the sawe; Dr. John Dee makes mention of the like in his preface to Euclid, but whether the mill moved by wind or water, they do not mention; we have also heard of the like set up in Kent, here in England and at some other places."

The above was the first bit of practical knowledge reached—dry land, as it were, after a voyage over a sea of surmise. The treatise on Euclid mentioned could not be found, although it was desirable as being of an earlier date, so we concluded that, however bright the lustre of Dr. Dee's mathematical light, it had sunk into oblivion. But the labor of the search brought its own reward, by the discovery of earlier works bearing on the engineering practice of that period; in the application of hand, horse, wind, and water power to machinery.

Illustrations were found of various inventions as applied to saw-mills, in use previous to that date (1661), which, in the light of the quotation from "Humane Industry," shows England to have been far behind in the matter of timber-cutting by machinery.

Knowing that it would enhance the value of this treatise as an historical sketch, and be of interest to those whom I wish to reach, I have reproduced ten engravings, each a fac-simile of the original, reduced in size to suit these pages. None of these engravings are of a later date than 1661.

The contemplation of these illustrations will form an interesting study for a leisure hour. The principles governing the use of these machines are much the same as those of the present day, and it would seem that we have here the germ of the modern gang saw.

Fig. 18 is a very convenient mill for sawing thin boards, and is particularly adapted for carpenters. A framework of wood is built having a sufficient altitude, so that the saw in reciprocating will not strike the floor. It is worked by two hand-wheels, one at A and another at the other end of the crank axle C, to which rods D M are attached for working the frame E, which is pivoted in the main frame, and works the saw frame up and down. On the upper end of this framework braces F and G are provided, to which the saws are secured according to the number and thickness of boards required.

The timber K is placed on rollers, and each time the wheel at H is struck by the projection B on wheel A, the timber is moved forward; a strong rope or chain fastened under and at the end of the block K coils itself over the axle of the wheel, and whenever the projection B of wheel A grasps the former wheel at H, the timber is drawn forward for sawing.

The mill shown in Fig. 19 may be operated by means of a treadle-wheel A by one or two persons. To the beam B of the treadle-wheel there is attached a "trillis" C with strong "spindles," and by means thereof the cog-wheels D and F; D moving on spindle E, and F on spindle C, spindle E being attached to the center of cog-wheel F. To the spindle E is attached a beam Q, which, by means of the right angular part P, moves the perpendicular bar connecting the saw L and its horizontal beam M upwards and downwards. The horizontal beam M is set into the grooves N N, and the beams intended to be sawed are fastened with clamps in the rolling framework K, at the end of which a strong rope is attached, which rope is drawn over the circular beam O and is wound up on the wheel I, the latter wheel being held in place (or held back) by the inclined bar (or arm) H.

Fig. 20 is a mill operated by animal power. As will be seen, it may be arranged so as to be used both for sawing and for grinding cereals. The upright beam A, with its horizontal cog-wheel, is driven around by the animal (as shown in the cut); a cog-wheel connects with the spindle of the trillis B, and by that means drives the other upright beam H, to the lower end of which is attached a double cog-wheel C; the upper cogs move in the trillis D on the right, and the side cogs in the trillis F on the left, the latter operating the mill-

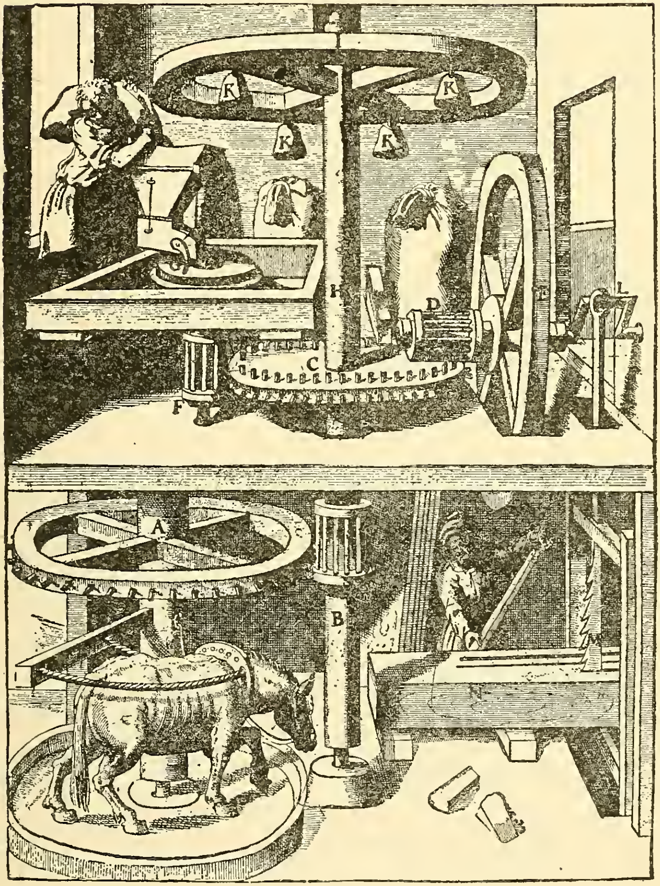


Fig. 20—Mill Worked by Horse Power.

stone G, and the former operating the wheel E, which by its connections at L operates the saw M below; thus giving actually two mills operated by one means of power. The large wheel I is placed at upper end of the beam B, and three (not four) heavy weights K are suspended therefrom; this is done both to obtain increased power and to relieve the strain on the animal below.

The mill shown in Fig. 21 may be erected at a creek or water-fall, as circumstances and surroundings may allow. It is a French idea and is erected at small expense. The water wheel E is connected by the horizontal beam D to a "trillis" over which the cog-wheel F, with its annexed angular bar G, forces both the framework H, with the saws e fastened therein, upwards and downwards. The horizontal framework I holds the beams (or boards) to be cut, and in addition thereto two heavy weights, A and B, are connected with ropes or chains to the grooved side beam K.

A skilled mechanic may elaborate on this latter arrangement as existing circumstances and surroundings may permit.

Fig. 22 is another mill erected at a stream or waterfall. The water wheel A has an iron beam (axle) which is connected by an angular handle (or arm) to the perpendicular arm B, by means of which the upper framework, together with the saw C, set therein, are operated upwards and downwards. By the same means

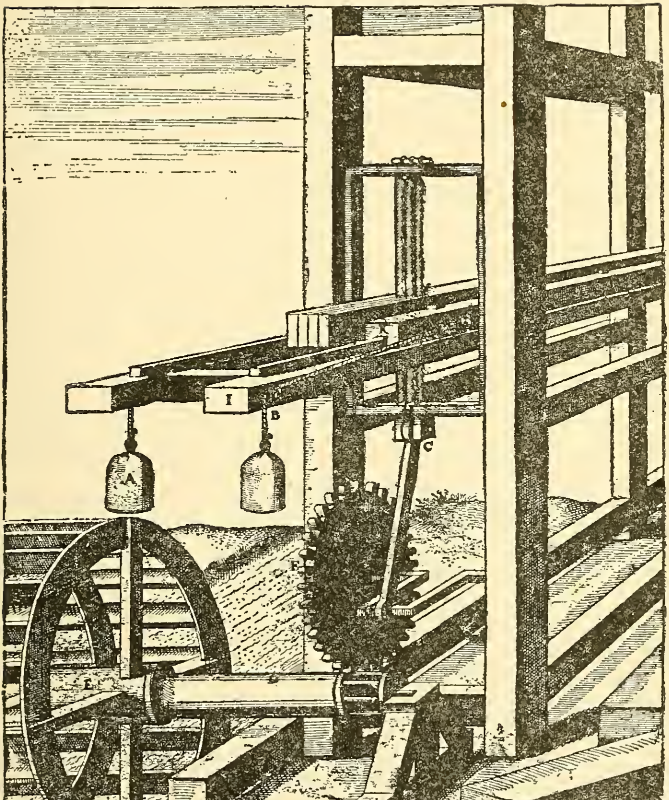


Fig. 21—A Water-power Mill.

the parts H and I, which are connected to the slanting bar D, operate the wheel D, as occasion requires.

Above the framework in which the saw is set, we find a convenient hoisting arrangement, F, by means of which the wood to be cut is drawn upon the framework; but this has no absolute connection with the mill itself and may be omitted.

Fig. 23 represents a saw-mill to be used for cutting large trees into planks (or boards), is operated by water-power, and can be erected and operated at the banks of a creek or stream.

The wheel Z is the main motive power; to this is attached a carved arm, X, which is fastened (as seen in diagram) to a horizontal bar T, with uprights running through the grooved or slide frame, S S, having a cross bar on the top thereof to which the saw is attached.

The wood, W, to be cut is fastened with wedges on an elevated platform, between beams X X and the upward and downward motion of the arm; X produces the sawing.

Fig. 24, also operated by water-power, is similar to Fig. 23, but more elaborate and powerful. In addition to the water wheel A, a small cog-wheel B is attached, which moves the spindles C and R, and by means of spindle C moves the wheel D, the curved attachment E forcing up and down the perpendicular bar F to which the saw H is attached, driving the latter upwards and downwards. The wheel N is propelled by the same power, and is attached by an iron fork (or bar) to the upright arm L and horizontal bar K, and another bar to I, which is joined to the cross bar Y, by which means the motive power for the saw is doubled by working from above and below. For the cross bar Y as many saws may be attached as the propelling water power will allow.

The hammer-mill shown in Fig. 25 is operated by water-power, by means of the water wheel A, and shaft B, to which may be attached one, two, or three projections, C, by which the hammer E on a lever D is raised and lowered.

The same motive power is used for the bellows by attaching a curved arm to B, which in its revolutions will move the bar F back and forth; this bar is attached by means of the horizontal bar G to a perpendicular beam H, at the upper end of which the attachments I, K, L, and M are connected with the bellows N and O, forcing them into action as required.

Fig. 26 shows a combined sharpening and flour grinding mill applicable in localities where no facilities for water-power exist, and is propelled by horse or other animal power. The upright shaft (or post) A, to which the propelling power is attached, moves the horizontal wheel B, the teeth or projections of which enter into the grooves of the horizontal pinion wheel C, which drives both the perpendicular wheel D and the horizontal wheel H, on the upper end which the mill stone is placed. The same wheel (c) likewise puts into motion the wheels E and F and the grinding ("sharpening") stone G. If only the flour grinding mill (and no sharpening stone) is to be used, the wheel E is removed. If the stone is to be used and not the mill, the perpendicular wheel D is removed. This, together with the arrangement of the wheels, can be easily done by any good mechanic without further explanation.

As the mill shown in Fig. 27 is in many respects similar to the previous cut, no detailed description thereof is necessary. It will be seen that the water wheel A propels the cog-wheel B, which further propels the spindle C, and the shaft D to which the grinding stones are fastened. At I a gutter is arranged, with small leaders to let water run on the stones, which can be arranged as occasion requires.

Two years later than the date of the publication of the work from which the illustrations here presented were reproduced, that is in 1663, a native of Holland built a saw-mill in London, but was prevented from working it by the threats of the hand sawyers. In 1767 a saw-mill operated by wind was destroyed by a mob. In Maine quite a number of mills were in operation in 1682. The first saw-mill in Canada is said to have been built by a man named Sawyer, at Chambly, near Montreal.

After this brief sketch of the saw from the dawn of history to its general use, it would serve no purpose to trace it through the succeeding century, in which there

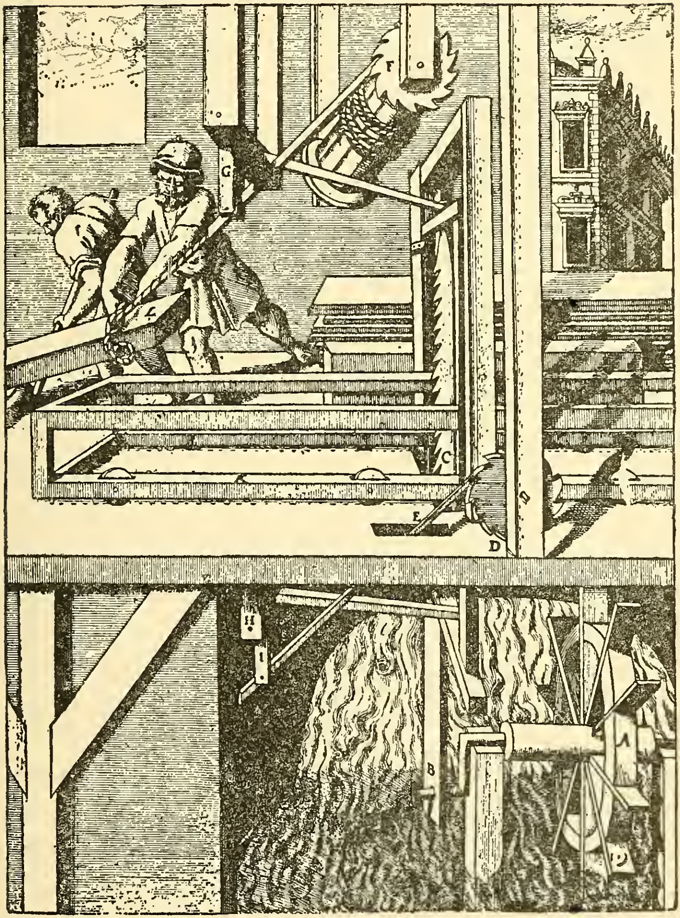


Fig. 22—Another Water-power Mill.

were no important changes until the invention of the circular saw by Samuel Miller, of Southampton, England, to whom a patent was granted in 1771 by the British patent office, and in 1808 to William Newberry, of London, for a "Machine for sawing wood, splitting and paring skins, etc." This was in all essential parts the band saw machine of the present day.

It is not shown that for the inventions of such importance to the wood-working industry, any pecuniary reward ever came to the inventors; for, although the patent was granted to Miller in 1771, it was not put to practical use until 1790 by Brunel.

The band saw lay dormant for nearly forty years after its invention.

From that time the improvements in sawing machines have been as much matters of progression and development as of invention.

It may be added that the descriptions of the reproduced plates are literal translations from the original text of the specifications, made, as the book states, by an eminent contemporary "Architect and Ingineur."

MANUFACTURE.

To Sheffield, England, belongs the honor of first making cast-steel. The process was, for some years, the secret of one man. Huntsman, of Attercliffe, a suburb of Sheffield, was its first manufacturer. The works, situated in an isolated part, were well adapted for the keeping of the secret. The melting was done in the day-time, the casting at night. To superintend the operations, it was Huntsman's custom to drive over the common, a lonely stretch of ground, upon which was a "gibbet" on the scene of a murder. In driving over one stormy night he overtook a solitary individual, who was drenched to the skin by the pouring rain. The stranger was invited to a seat with the driver, which invitation was readily accepted. On arriving at the steel works he was invited to step inside until the storm abated. This opportunity had long been sought, for, apparently asleep, the stranger took in the whole process, and in a few months Sheffield had its second steel works. From time to time new works arose, but the secret of its manufacture was for a long time confined to Sheffield. The trade soon assumed vast proportions. The names of the principal firms are as well known in this country as in England. To this branch of industry

Sheffield is indebted more than any other for its prosperity; its staple trades were articles of steel, for which it was celebrated long before the invention of cast-steel. The old Sheffield blades were made from "shear steel," which was formed under the hammer. Shear steel continued to be used long after the introduction of cast-steel, but was eventually given up, except for special purposes. The progress made in the United States in the manufacture of cast-steel has been rapid and successful.

Best cast-steel is made chiefly from Swedish iron of various brands, which vary in quality according to the location of the mine. Made into bars in the vicinity of the mine, it is shipped in this form to the steel works, where it is placed in huge furnaces built in the form of a cone capable of holding hundreds of tons; it is piled in alternate layers of charcoal and iron. When the desired quantity is piled the charcoal is ignited and the whole mass becomes a red heat; the drafts are regulated to allow it to burn from eight to fourteen days, the longer the time the better the quality. This process changes the iron from "fiber" to "crystals." It has now become "blister steel," so called from its being covered with lumps formed by a gas generated in the iron during the process of conversion, which, having no escape, forms these lumps or blisters.

Having lost all tenacity, it breaks quite easily by blows from a hammer, the broken part presenting the appearance of a mass of crystals.

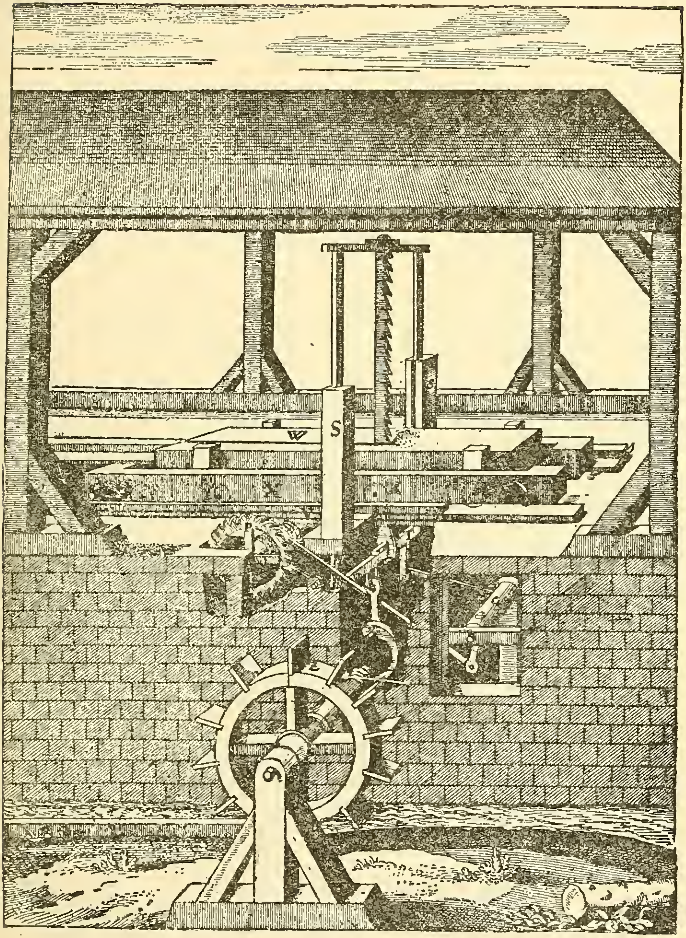


Fig. 23—Another Style of Water-power Mill.

Broken into pieces of suitable size and a percentage (say 1 in 100) of pure carbon added, together with a certain amount of scrap steel, it is placed in crucibles for melting. In the melting furnace it is subjected to an intense heat, becomes liquid, and is then poured into moulds forming ingots, the shape of which vary according to the purpose for which it is to be used.

It is rolled between powerful rollers into rods or sheets.

For saws it is rolled into sheets; and with machinery adapted for the purpose, cut to shape, the teeth punched and filed. It is now ready for the tempering furnace or oven, in which it is carefully heated, and is then immersed in a mixture of oil and other substances, which renders it as hard as glass. With the furnace at a proper heat or between heated dies, the saw is reduced to the proper temper, to obtain which is a work of great nicety and good judgment. The tempering and hammering are the most important operations in the manufacture of saws. In both of the above operations we pride ourselves on being experts. In the composition of our hardening substance are brought to bear the results of three generations of practical experience. Preparatory to hardening and tempering, the saw is subjected to a process entirely my own, by which it is improved in quality and tenacity, giving it a toughness not otherwise attained. We are thereby enabled to leave a hard temper, at the same time the saw will bear a good swedge set.

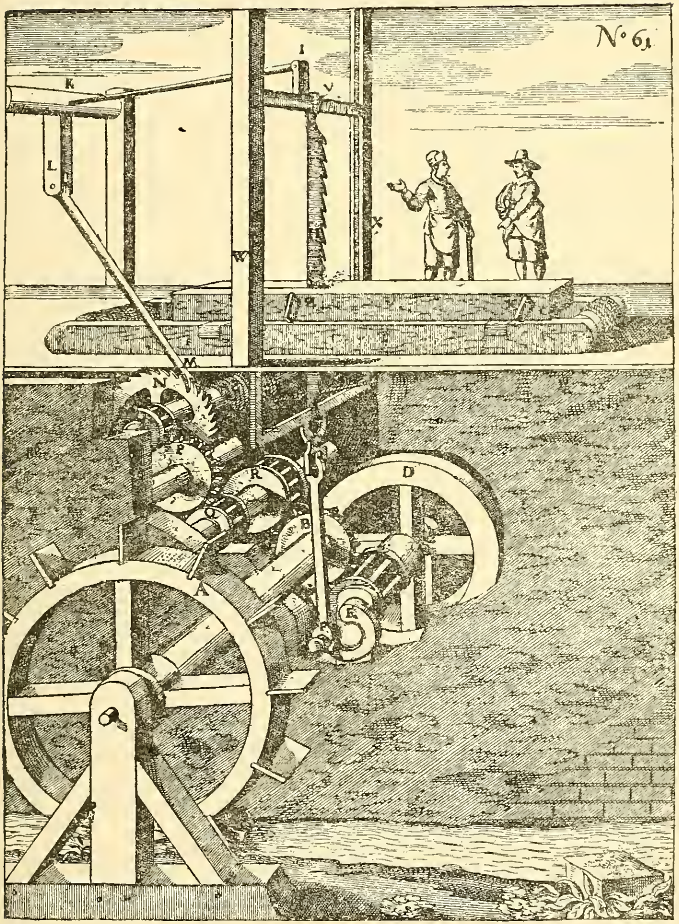


Fig. 24—A Further Advanced Style of Water-power Mill.

The hammering of saws may be classed as a distinct trade; for the ability to do this part of the work constitutes a *sawmaker.* This is a branch of the trade where machinery cannot take the place of manual labor. We have our patent tempering machines, which in the process of tempering press down the lumps; but the proper working of a saw consists in the right adjustment of the tension, and it is here that the skill of the sawmaker is called forth; for however straight or flat a saw may be, the least irregularity of the tension prevents its cutting in line. The amount of feed, kind of work, number of revolutions, are important factors to be taken into account in giving a saw the proper tension, and the experienced sawmaker will compensate in advance for any usual strain put upon the blade, by quick feed, or undue expansion of the periphery, caused by high speed. In the technical terms of the trade we leave a saw "stiff" if it is to run at a slow speed, and "open" if to run at a high speed. When a saw gets beyond extreme stiffness it becomes "fast," the sawyer terms it "buckled" or "rim-bound;" that is, the outer edge becomes expanded, while the body of the blade contracts. The extreme of openness becomes "loose." A saw will become loose if the mandrel heats, the consequence of which will be that it will "dish" to one side and run in or out of the log; anywhere but in a straight line. A practical illustration of "fast" and "loose" may be found by taking a strip of very thin sheet metal, say twelve inches long by two and one-half wide. It may lay perfectly flat on a plane surface, but rub one edge with a piece of smooth steel or burnishing tool, using a good pressure, turn it over, rub the same edge on the other side; after very little rubbing it will be found that it will no longer lie flat, it has become fast, the edge having expanded, while the middle or inner portion has contracted, and it will be found impossible to straighten it.

By going through the same process down the middle the edge will straighten by contraction as the middle expands, and by continued rubbing it becomes loose. On the true knowledge of these two conditions hangs the skill of the sawmaker. While the above is but a crude example, the expert workman with his level, or straightedge, beneath which he bends the plate, can find the minutest portions of fast or loose, and the proper working of a circular saw depends on the nicety with which the workman with his hammer adjusts the tension.

To those who have seen or used circular saws, said to be "made without hammering," it will occur, on reading the foregoing, what an amount of useless labor is here expended if a saw can be made without hammering!

I here affirm (I know whereof I speak, and challenge contradiction), that the statement "made without hammering" is false wherever made, and an imposition on the public credulity. It is an undeniable fact that all attempts to dispense with hammering in the manufacture of circular saws have resulted in failure. I am constrained to make these last remarks, for my readers would think it strange that I should place so much importance on the use of the hammer if it need not be used in the making of a saw. All that our machinery can do for us is, during the process of tempering, while the saw is hot, to press it flat, the rest of the work, for the reasons before stated, must be done with the hammer, guided by the knowledge and skill of the sawmaker. As the tendency to thin saws increases this skill becomes more apparent and necessary.

USE.

The enormous and reckless waste formerly shown in the manufacture of lumber has commanded attention on every side. The rapid disappearance of our forests under a wasteful use, and by fires and by floods, which from time to time have devastated the districts affected by the climatic changes produced by this agency renders the subject one of great moment to the lumberman.

It is not my purpose here to go into the question of forestry, although that is a subject of as much importance to the lumber industry as the country at large. We must have lumber and from our own domain. There is enough of it with proper selection and provision for its reproduction; and above all with proper economy in its manufacture for all our wants. It therefore becomes the imperative duty of those engaged in its manufacture to produce it with the minimum of waste.

That our lumbermen are alive to the importance of this is shown by the progress made in its manufacture during the past twenty years, which has effected a great saving of both labor and material. The manufacturers of improved mill machinery have found it a remunerative business, for the lumbermen have been prompt to avail themselves of any apparent improvement, and where twenty or even ten years ago it was an exception to find a mill with facilities for hauling, sawing, piling etc., without the aid of hand labor, excepting that required to run the machinery, it is to-day an exception to find a mill of any pretensions not fully equipped with such facilities.

Not only does the economy of lumber production consist in labor-saving machinery, but there has been, and is the aim to produce from a given amount of timber the greatest amount of lumber. The progress in this direction has also been great, for where not very long ago half an inch of timber was turned into sawdust for every board cut from the log, it is now rare to find a kerf over five-sixteenths of an inch, and in most cases the best sawing is done with a kerf nearer three-sixteenths; this seems to be the minimum for circular saws of any dimension, say over forty-eight in diameter. It is a great advance on former years.

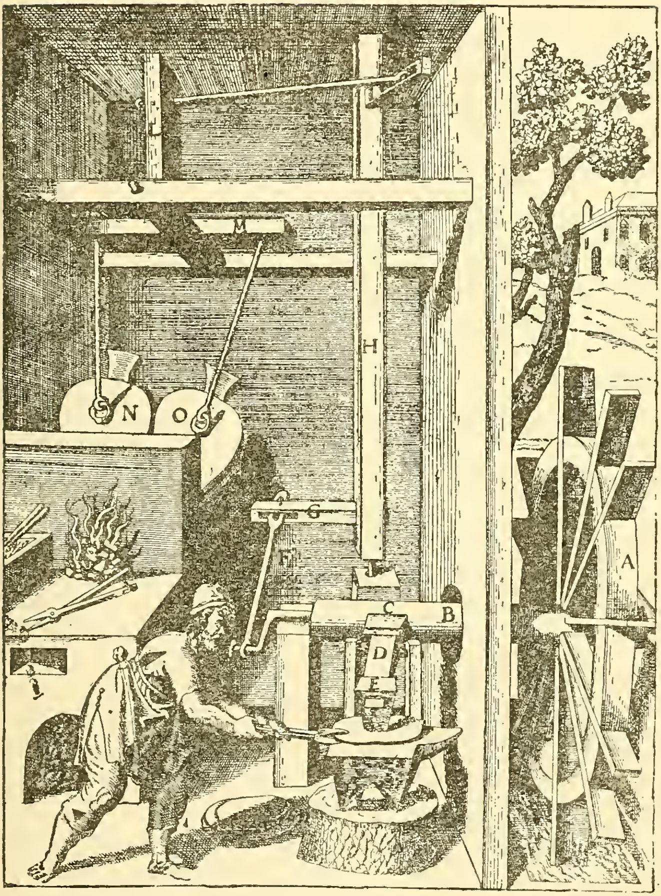


Fig. 25—Method of Working Steel into Sheets Before the Rolling Mill was Invented.

CIRCULAR SAWS.

For the past twenty years inserted tooth circular saws have held the field against solid-tooth saws of equal kerf measure, but the laudable effort of our lumbermen to reduce the kerf waste, and as the thinner the saw the greater the number of teeth, the solid-tooth saw is again coming to the front, and seems at least likely to have its full share of the work in the future.

Circular saws being articles of such general use, it seems almost superfluous to offer any remarks on their management, or the principles governing their use, but, having been engaged in the manufacture of circular saws in this city for over twenty years, and a close observer of the progress of the lumber industry, and the demand for thinner saws, I may say that the principles governing the adjustment of the tension of thin circular saws are the same now as forty years back. The conditions and terms "open," "loose," "slack center" and "limber" are older than the writer. It is only in recent years that the skill required for the various modifications of these conditions has been needed, by the use of thinner saws, in this country.

When I assert that there is for circular saws a per-

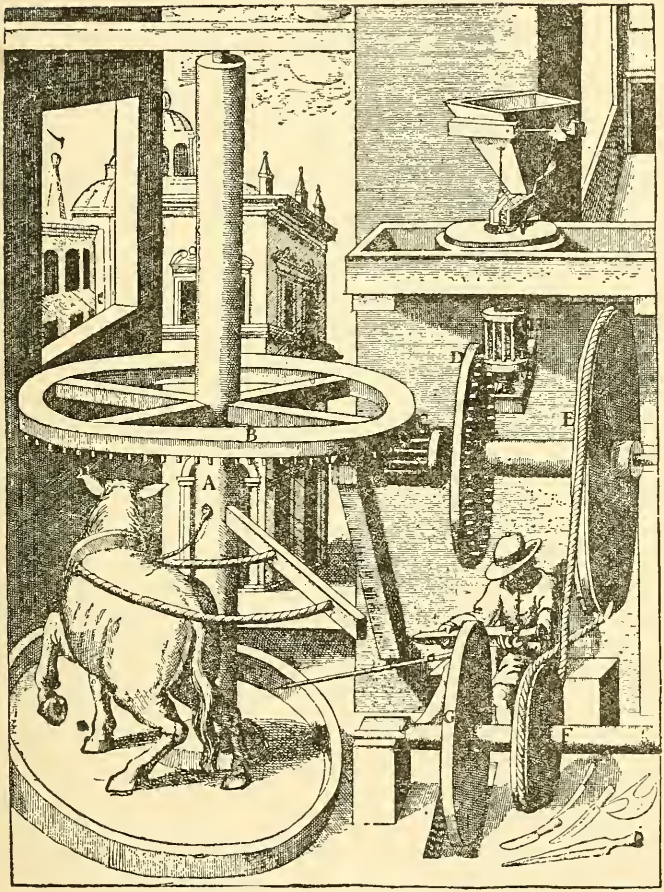


Fig. 26—The Grinding Shop.

fect method of distribution of the tension, and a correct standard of adjustment, I lay claim to no new discovery, but a proper application of the scientific principles underlying the trade I was apprenticed to learn, and the acquired skill which no patents can cover; which makes a systematic arrangement and application of the skill of the most experienced workmen.

This method is so perfect that: given the speed, feed, and kind of timber to be operated upon, and a mill in good condition, a saw may be furnished to do the work, duplicating the same at any time, a saw whose working, under the same conditions, will be invariably and inevitably the same.

There is no tool used in woodworking which calls for more care and attention than the circular saw. It is not my purpose or my duty to trespass on the domain of the sawyer by laying down rules for his observance: experience shows us that among the best sawyers there are few who agree as to the details of handling a saw, but I would make the following suggestions as to particulars to be sent with your order, presuming that your machinery is firm, well constructed and in good order: Give the speed at which the saw is to run, the kind of work it is expected to do, the amount of feed, and kind of timber to be operated upon. Also if you have good and steady power, and any other matters tending to aid in adjusting the tension, that the saw may perform its work

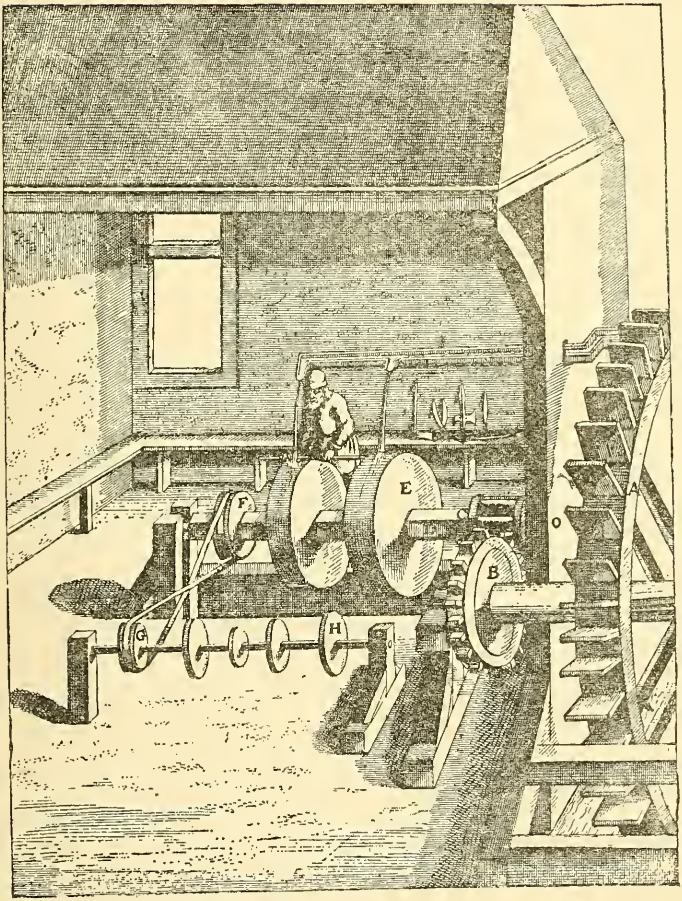


Fig. 27—Another View of the Grinding Shop.

with credit to the manufacturer, and satisfaction to the user.

I suppose for the reason of sacrificing material to amount of production, the method of packing circular saws as practiced in England has never been adopted in this country. There it is considered indispensable to the proper working of a circular saw, and the greatest attention is paid to this point. The quality of a sawyer is judged by his ability in packing; and yet with care and practice the art is soon acquired.

By its use a circular saw 48-inch x 14 G (throughout the blade) may be made to stand up to its work. The packing is done by having a recess in the table from the collar to the front part of the saw, with a strip underneath the table to prevent the material used from slipping through, and a loose plate to cover the recess, after packing. The recess is packed with oiled picked oakum, or rope hammered flat so as to pack easily and uniformly. The substance mentioned is packed in the recess on each side of the saw, care being taken to distribute it evenly, and have the pressure the same on either side, and tight enough to create by the friction of the blade against it, sufficient warmth throughout the entire diameter of the saw, to cause it to expand equally and run perfectly true. If the saw does not then cut in line, the packing is not tight enough, or too tight.

I am fully aware of the fact that the output of an English circular saw-mill cannot compare in quantity with that of an American mill, but I believe that if our American sawyers once adopted this plan of packing, they would soon be able to produce the same amount of work as with a thicker saw. If the circular saw is to compete with the band saw-mill of the future this system must be adopted. I would recommend it to the attention of those who use or manufacture sawing machinery. A saw of the dimensions named would save one sixteenth of an inch at every cut, a one-inch board for every sixteen cuts, 1,000 feet saved in one day's cut, if the capacity was 16,000 feet. It will bear consideration whether the saving would not offset, and justify a little less production by effecting such a saving of power and material.

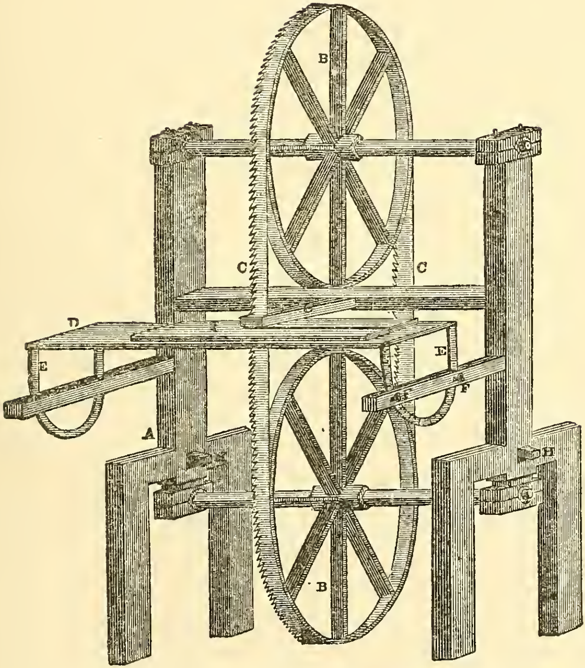
For cigar box lumber, back-board, and veneers the solid taper saw has in England almost superseded the segment saw. It is made heavy in the blade, ¼ to ⅜ thick, with a bevel 8 inches deep, ground down to 20 or 24 gauge, straight from the point to a line 2 inches below the tooth. When properly made these saws produce fine work. It is a sawyer's pride to boast how many boards to the inch he can cut with his taper saw. The smaller sizes are specially adapted for the self-feeding tables now so largely used.

BAND SAWS.

American enterprise has been slow in appreciating the band saw for log sawing. Although it has been in existence over twenty years, the number in use previous to a comparatively recent date was very small; and yet the thickest band saw takes not more than half the kerf of the thinnest circular saw as at present used (for log sawing).

The very quality which should recommend the band saw has militated against its adoption: viz., the smallness of the kerf. The standard was not economy in kerf, but how many feet could be cut in ten hours, without regard to the question of waste. When it took all a man's ingenuity to make a 6 x 8 gauge circular saw stand up to its work he was afraid to venture on a 16-gauge band saw; but as the pioneers in their use overcame the difficulties incident to their adoption and made them a success, they have gradually gained favor and the number in use is rapidly increasing.

I believe that the first band mill erected on this continent for the purpose of log sawing was by Mr. Jas. Shearer, of Montreal, about 1864 or 1865. The machine was constructed in the mill and the saw obtained from England. The saw broke after a short trial;



The Newberry Band Mill of 1808. From Specification in British Patent Office, London.

the machine was laid aside as an unsuccessful experiment.

F. Arbey, of Paris, France, was the first to manufacture a band mill for log sawing. A machine manufactured by him was purchased and brought over about 1870 to Quebec, Canada, by Mr. Simon Peters, of that city, and is still in successful operation. The writer made the first saws of American manufacture used on the above machine. A. Ransome & Co., of London, were the first to manufacture the band mill in England.

The pioneer and champion of the band saw in this country was Mr. J. R. Hoffman, of Fort Wayne, Ind.

I have foreseen from their first introduction that power feed band saws for log sawing, and re-sawing must eventually win a leading place in the manufacture, not only of wide and expensive lumber, but of the lumber of common use.

Realizing that it was as important to have a good saw as a good machine, the American saw manufacturers have for many years been bringing their experience to bear in the selection of a quality of steel whose nature and construction was best adapted to stand the strain incident to their use. While a number of our best constructors of woodworking machinery have been at work improving and perfecting the machine, they have in like manner been at work on the blade.

The greatest difficulty to be overcome in the manufacture of wide blades has been that in their use the steel was subjected to a strain different to that of any other article made from cast-steel; and difficulties entirely new were presented to both manufacturer and user. Under such circumstances, and especially when the manufacturer was not a practical workman, possessing probably neither technical knowledge or acquired skill, and dependent upon the workman's mechanical performance of the various operations in their manufacture, these difficulties were multiplied, and certain and uniform results were not to be expected. In the making of wide band saw blades those following the old precept, "Make haste slowly," patiently working and awaiting results, taking records of the life of individual saws, acquiring a knowledge of the various machines and the general principles governing their use, and the practice and experience of those using them, have been enabled to form reasonably accurate data. The proper adjustment of the tension is as important an element in the construction of a band saw blade as in a circular saw.

To formulate a system of tension has been a matter of some difficulty, for while in the use of circular saws there is some settled practice, and certain primary conditions to be observed, in the use of power feed band saws we find every sawyer a law unto himself. This could hardly be otherwise, as where there was no settled practice, experience alone could teach.

As in my remarks on circular saws, I repeat, it would be presumptuous in me to enter the domain of the practical sawyer. In venturing the following remarks it is not as an instructor; but as men of the largest experience concede that band sawing (as here spoken of) is in its progressive state the observations of a manufacturer of saws may aid the user in the proper selection and care of the blade.

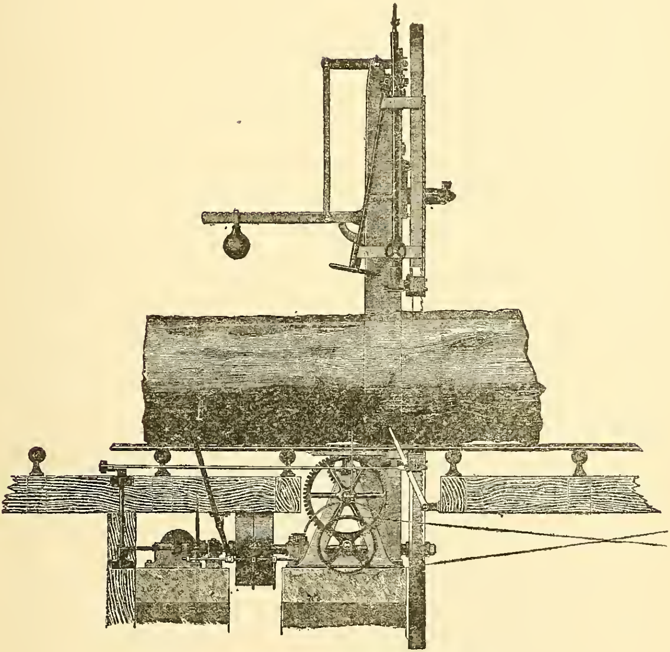
Given a good machine and a good saw, it becomes the sawyer's duty to observe the most minute conditions that will help him in the task of keeping his saw in proper form to produce a reasonable amount of work without undue strain on the blade.

I have met sawyers, who, by close attention and careful observation, anticipate the contingencies likely to arise under certain conditions, and they set and sharpen the saw, or adjust the machine to meet them. When asked how it is done they cannot (though willing) explain. It is, that each log cut adds to their experience, and they are intuitively storing up a fund of practical knowledge, which is brought to bear as each recurring difficulty presents itself.

In speaking of such to others it has been remarked by them, that to such an one it seems to come "natural."

It is seldom that such qualities do come "natural;" but it is rather the cultivation and application of those qualities which are essential to success in any calling.

A band saw properly worked should not depend on the back thrust for its resistance to the feed; to those who have overcome this difficulty it may seem a super-

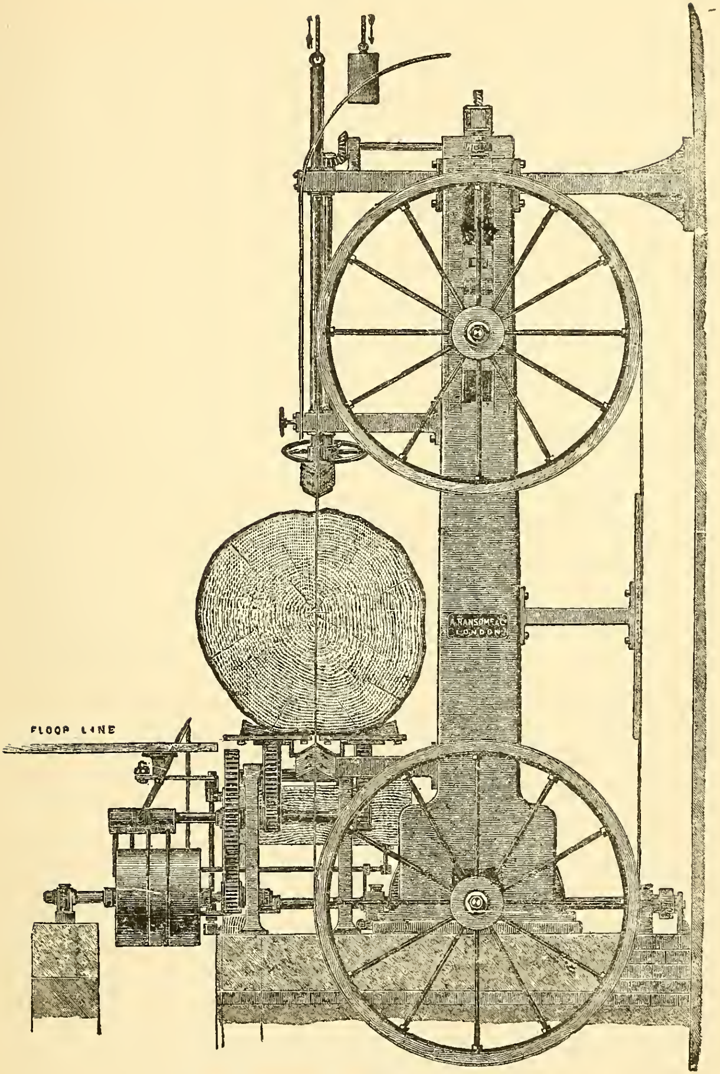


The Ransome Band Mill of 1870.

fluous observation, but in my experience, and almost invariably with those using machines for the first time, this is a cause of great trouble and sometimes of great cost. Where such dependence is placed, whether the back guide be rigid or rotary, it is only a matter of time (generally a very short time) of the breaking of the blade.

The constant bearing against the back guide, if the guide be rigid, causes abrasion. The back of the blade cutting into the guide becomes worn to a thin hard edge, in which the least extra strain is liable to start one or a number of minute cracks. If the back guide be rotary it will cause compression and spread or swedge the back of the blade, which becomes case-hardened; the result is that small cracks are thus made, hardly visible at first, but soon extending, by which the saw is eventually destroyed. It is as likely for a saw running under the above conditions to break on the tooth as on the back, for the reason that the abrasion or compression on the back of the blade contracts that part, and in like degree expands the toothed edge of the blade, which by this inequality of tension becomes the longest, and passes through the work in a wrinkled form, causing a continuous strain, as of bending back and forth; under these conditions the destruction of the blade is inevitable.

It has been affirmed that the back thrust may be overcome by giving more hook or rake to the teeth; this will help but only to a very limited extent; beyond



The Ransome Band Mill of 1886.

a certain point too much hook becomes an element of danger, as is probably known to every experienced sawyer. The art of making a saw stand to its work independently of the back guide is by the proper adjustment of the upper wheel. This being rightly understood and properly secured by the sawyer, and the proper tension having been given by the manufacturer to the saw, the back guide may be set one-eighth of an inch from the line of the blade, acting only as an auxiliary help in the case of extra strain.

Having suggested the use of saws with the teeth projecting beyond the edge of the wheels, a customer tried this and reported better results than with saws when the set portion rested on the wheels.

Regarding the pitch, depth, and shape of tooth, there is great diversity of opinion, and to discuss it in detail would take more time and space than I can here afford. I have seen them successfully used with from one inch to four inch space. Modified by experience and practice—for soft woods and for saws not thinner than seventeen gauge—the following may be taken as a rule :

Half the width of the blade for the space with an extreme limit of three inches, and a depth varying from one-fourth of an inch to five-eighths of an inch. For saws nineteen to twenty-two gauge three-fourths of an inch to one and one-fourth inch space.

It will be observed in the shapes given that there are no sharp angles. The practice of filing sharp corners at every angle of the tooth cannot be too strongly condemned. By giving one cut with a cold chisel across a bar of iron, and then bending it, it will be found, if it break at all, it is always where the cut was made. In band saw blades it will be found when the angles are filed to sharp corners the cracks invariably start at those points.

The hook given to the teeth is a matter depending on the speed, feed, and kind of timber to be operated upon, and must be left to the judgment of the sawyer to meet the exigencies of the work – as kind of timber, depth of cut, etc.

In all cases for successful work the saw must be properly set and filed, and always sharp, the teeth perfectly jointed, and set evenly. Never force a saw, especially a dull one, beyond its capacity ; this is a fruitful cause of breakage ; it must be remembered that a band saw blade is passing over the wheels 300 to 500 times a minute, being continually bent and straightened, and if the feed is more than the saw can cut it is subjected to a strain between the log and the guides which no quality of steel or temper can long withstand.

The speed at which blades should run varies from 4,500 to 7,500 feet per minute ; the tendency is to higher speed and wider saws, whereby to obtain quicker feed. Great care should be taken in starting the machine, as the saw acting as a belt has to overcome the inertia of the upper wheel, and if started too violently is apt to strain or crack the blade.

The manufacture of band saw blades requires special knowledge and skill, from the ore to the crucible, in the rolling, tempering and hammering. I may add that there are few tools used in the mechanical arts which require, to assure their successful working, so exacting a combination of sound scientific principles and delicate manipulation of materials as a saw.