THE SAW IN HISTORY

Henry Disston & Sons
Incorporated
Keystone Saw, Tool, Steel and File Works
PHILADELPHIA

THE SAW IN HISTORY

A comprehensive description of the development of this most useful of tools from the earliest times down to the present day

This book is dedicated to that vast army of workers whose chief weapon is THE SAW, extending from the crowded centers of civilization into the wilds that mark the limits of man's advance in his conquering march against nature.

FIFTH EDITION

HENRY DISSTON & SONS, INC.
Keystone Saw, Tool, Steel, and File Works
PHILADELPHIA, U. S. A.

HENRY DISSTON

"He created a new American industry. He gave to the United States the greatest saw works in the world, and founded an industrial university wherein a dozen useful trades are taught. Not only did he redeem us from all dependence on foreign countries, but turned back the tide and made them accept his products, and this simply by peaceful demonstration of superior skill in manufacturing."

FOREWORD

IT seems curious that the saw—so essential a factor in man's development, so intimately interwoven with the progress of civilization, so absolutely indispensable today—has had so little attention from historians.

While the history of the modern saw is more or less a history of the development of the business of The House of Disston (Henry Disston & Sons), yet to obtain a record, at once comprehensive and accurate, of this most useful of implements, extensive investigations into its origin and early development were instituted. Museums, private collections, and musty old records everywhere were delved into for information, and the result constitutes the only complete history of the saw ever compiled in one volume.

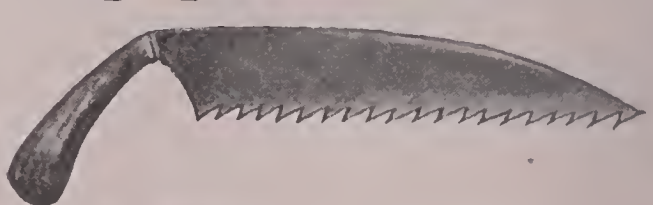
However, as with all pioneer undertakings of like magnitude, with no guide to follow save the pattern devised from its own discoveries, it is entirely likely that this work is not without defect. Such slight omissions as may be brought to light by its wide circulation will, it is hoped, be passed in tolerance in view of the difficulties attending its compilation.

Flint Saw
of the Stone Age

Ancient
Australian Saw

Ancient Egyptian Sawyer

Egyptian Saws



Blade of Ancient Frame Saw

Saw Found in a Tomb in Thebes, Egypt

THE SAW IN HISTORY

PART ONE

The Ancient Saw

THE saw is one of the most ancient tools known to man. It antedates civilization. Its use dates back to the Neolithic or later stone age, before the discovery of metals, when only the crudest of implements were constructed.

The bronze age, with its progress of mankind toward civilization, brought a corresponding development in the saw. While the length and form of the

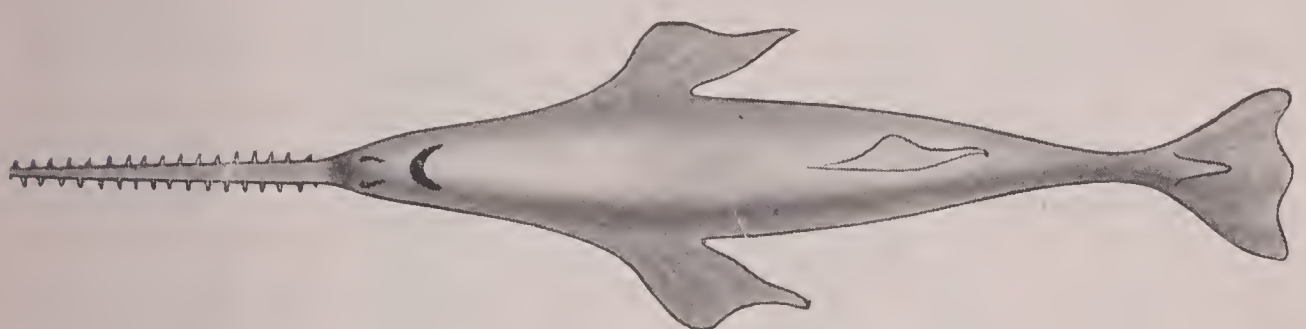


Fig. 1

stone saws of the earlier period were determined largely by accident, bronze permitted of manipulation into desired shapes, and its introduction marked a distinct improvement in form. As the ancients' knowledge of metals increased, iron was used in tool construction, especially in that of saws, and this period may be considered the genesis of modern saw-making. It is generally conceded that nature provided the examples which inspired the invention of saws. Some investigators claim the saw-fish (Fig. 1) as the first type; others, the wasp (Fig. 2), with the saw-like action of its serrated sting.

Fig. 2

A Grecian fable describing the origin of the saw relates how Talus (or Perdix), having found the jawbone of a fish (according to some authorities a serpent), produced an imitation by cutting teeth in iron. While the Grecian claim to discovery is unbacked by historical authority, such an origin seems probable.

Saws appear not to have been known in the time of Homer, for in the minute description of the building by Ulysses of his ship, no mention of them is made, although if this tool had been known, Calypso could have supplied it as easily as she did the axe, adze, augers, and other tools. Probably the Greeks, like other nations, borrowed the saw from the Egyptians, on whose sculptures it appeared at a very early period.

The few specimens of prehistoric saws existing in the museums of Europe and America, enable us to judge of the character and method of use of the primitive types. The saws of the bronze age, of which a number of typical specimens have been found, more nearly approach the forms with which we are familiar. Still more modern forms were developed as the iron age succeeded the bronze age, and some iron saws that date to Biblical times and beyond might, but for their inferior material and workmanship, be taken as models for more modern implements.

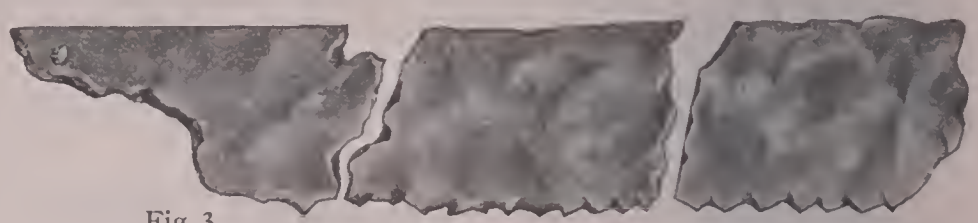


Fig. 3

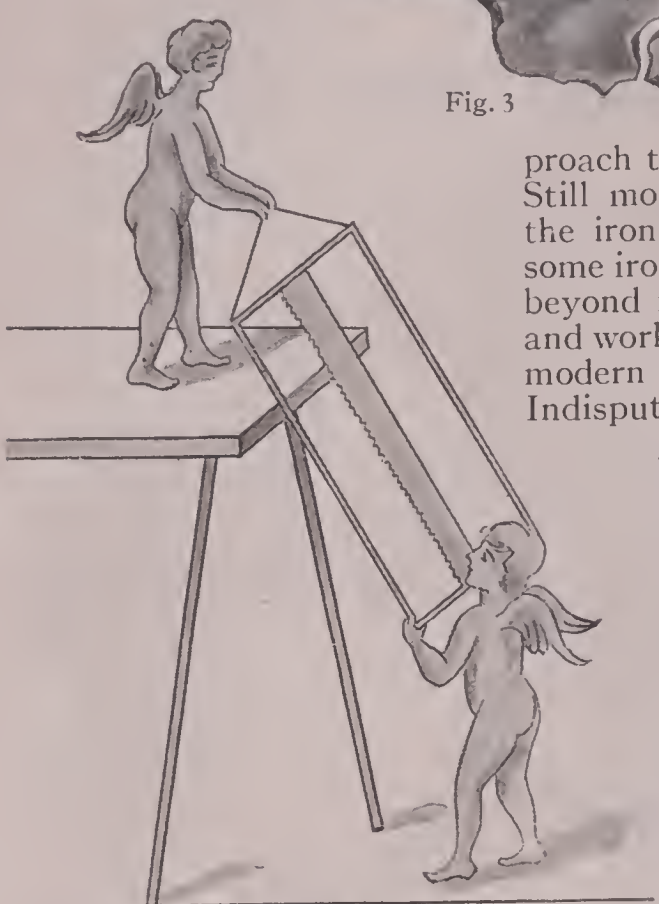


Fig. 4

Indisputable evidence that bronze saws with jewelled teeth were used by the ancient Egyptian for cutting the hardest stone was discovered by the eminent Egyptologist, Prof. W. M. Flinders Petrie. Sir Austen Henry Layard, the Assyriologist, found at Nimroud near Nineveh, a two-handled, iron saw (Fig. 3), 3 ft. 8 in. long by 4⅝ in. wide (dimensions similar to those of the present day saw). Saws are mentioned in the Bible. It is said that Christian martyrs in the days of persecution were "sawn asunder." Grecian carpenters used saws not unlike those of today. A painting discovered at Herculaneum depicts two genii at the end of a bench operating a saw (Fig. 4) resembling the modern frame saw, while a drawing found upon an ancient tomb shows a saw (Fig. 5) almost identical with the bucksaw of today. Cicero in his oration for Cluenthius, mentions an ingenious saw with which a thief cut out the bottom of a chest. Pliny states that saws were used by the ancient Belgae for cutting building-stone.

The earliest prehistoric saws were simply small flakes of flint, notched by chipping. Rarely more than 3 inches long, with irregular teeth of doubtful sharpness and held between thumb and finger, these saws had very limited cutting-power. They were used chiefly in the manufacture of ornaments from bone and soft stones. Excellent specimens found in the north of England are shown in Figs. 6 and 7. Greenwell, in his "British Barrows," says of Fig. 7:

"This instrument is very like a lance point, sharpened and thin at the base, where it was fastened to the haft; but from the many teeth at

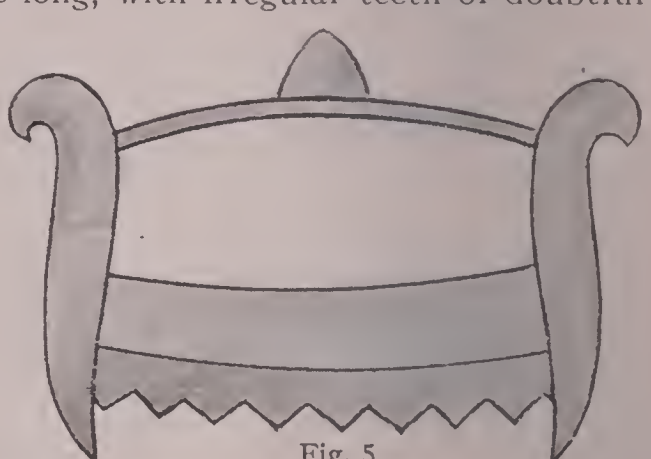


Fig. 5

regular distances from each other, I am disposed to think it has probably been a saw."

Flint saws have been discovered in the caves of the "reindeer period" in France, in the Kjokken-Moddings (ancient stone heaps) of Denmark and Sweden, in the lake dwellings of Switzerland and northern Italy, and practically throughout Europe. The smallest discovered is 1½ inches in length and none has been found longer than 9½ inches.

Figs. 8, 9 and 10 illustrate some of the primitive types. Fig. 9 appears to have been used both as a knife and a saw, and there are indications that some of the specimens once had wooden handles.

The stone-age man's ingenuity increased with his needs, and he discovered that by mounting his serrated flint chips in a groove formed in a stock of wood

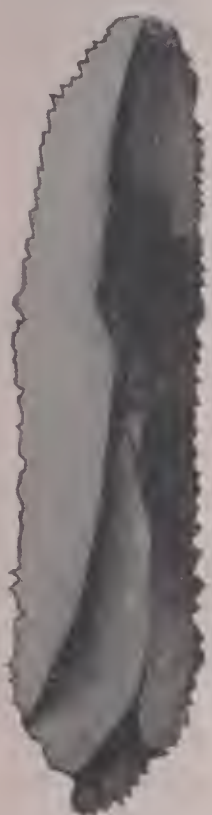


Fig. 6

Fig. 7

Fig. 8

Fig. 9

Fig. 10

he obtained a more serviceable tool. The finest specimen of this type (Fig. 11) was found in the prehistoric region of Polada, in northern Italy. Four separate flint flakes are cemented into the wooden casing with asphalt. Swiss archaeologists declare the shape of the handles indicates that this was made for the use of a left-handed man. A similar saw was found in a lake dwelling at Vinelz, Switzerland. Mounted specimens of prehistoric man's handiwork are necessarily rare because of the perishable nature of wood.

In Scandinavia, where flint is found in large blocks, the primitive saws were larger and half-moon shaped (Fig. 12). The teeth are on the straight edge, which is from 4 to 7 inches long.

Dr. Schlieman found flint saws in abundance during his extensive excavations on the site of ancient Troy.

The universal development of this implement under pressure of necessity is seen in the fact that the South Sea Islanders (far from the northern European

Fig. 11

mentioned) made a saw from sharks' teeth, the Carib Indians used notched shells, while the ancient Mexicans used a volcanic rock called Obsidian for saw teeth.

Specimens of the bronze saws which supplanted those of stone are rare, not more than about thirty having been found in all Europe. A perfect blade about 9 inches long (Fig. 13) was taken from a lake dwelling at Moermgen, Switzerland. Others have been found in France, Spain, Hungary, Italy and Sweden, and in the last-named country was found a stone mold for casting bronze saws, in which four could be cast at once (Fig. 14). The variety of other sharp tools made during the bronze age better adapted to the requirements of that period probably accounts for the rarity of metal saws among the relics.

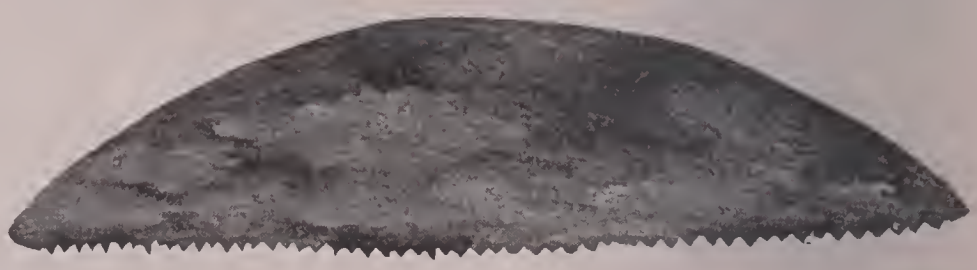


Fig. 12

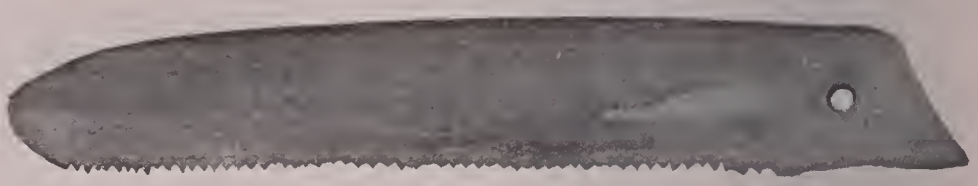


Fig. 13

The Hebrews used saws for cutting both wood and stone, as indicated in I Kings 7 : 9, which refers to "costly stones, according to the measures of hewed stones, sawed with saws, etc." Pliny believed that sawn slabs composed the marble facing of the place of Mausolus, King of Caria (350 B.C.). References by other ancient authors carry both types of saws back to the greatest antiquity. Prisoners of war, especially noblemen, were sometimes executed with iron saws, as mentioned in the Bible and elsewhere (II Samuel 12 : 31 : "And he brought forth the people that were therein, and put them under saws, etc."). This was the fate of the prophet Isaiah, under King Manassel, according to the writings of the church fathers, Justin Martyr, Origen, Epiphanius and Lactantius. This terrible punishment was known to other ancient nations, notably the Egyptians, Persians and Thracians, and in a few instances was inflicted upon Jews under Roman emperors. Ancient and Egyptian saws, so far as learned, were single handled, although St. Jerome has been thought to allude to circular saws. Flinders Petrie's findings indicate, however, that this reference was probably to stone-cutting saws.

Fig. 14

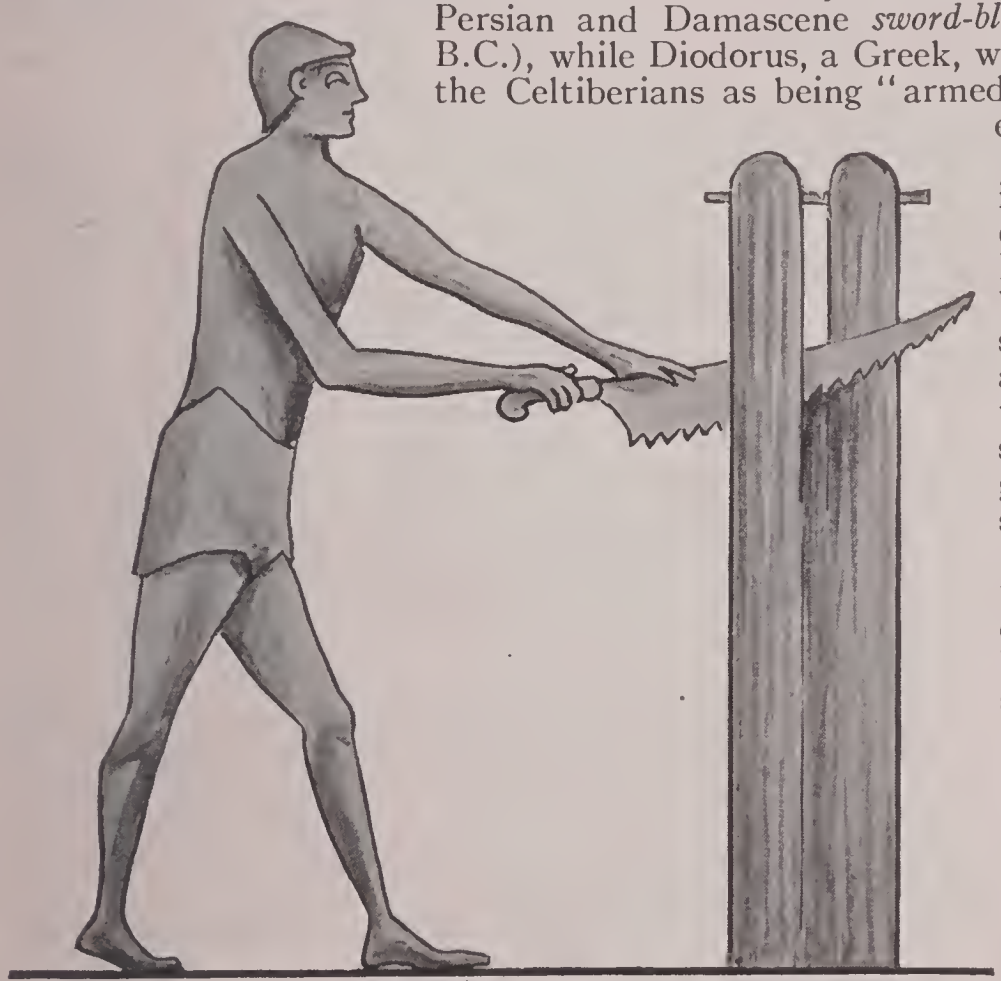
As with modern Oriental saws, those of the ancient Egyptians are supposed, from the illustrations, to have had the teeth inclined toward the handle—cutting on the *pull*—although this is not invariably the rule. The predominant type was constructed of a bronze blade attached to a handle with what appear to be leathern thongs. However, the British Museum has specimens with tangs for inserting into the handle, as with the modern knife. Double saws, strained with a cord, were

in use by the Romans. The Egyptians placed the wood to be sawed perpendicularly in a sort of frame and cut downward. The saws "under" or "in" which David is said to have placed his captives were of iron. A case of "sawing asunder" by placing the criminals between boards and beginning at the head, is mentioned by Shaw in "Travels."

Although one of the simplest and oldest of tools, it was not until the last two or three centuries that the saw attained its universal importance. Iron was necessary in its construction. Stone saws had no real value and those of bronze were little better. Moreover, bronze adapted itself so readily to edged-tool construction that these practically supplanted the saw. Many savage races and even the comparatively civilized South American aborigines never knew the saw. Beckmann states that : "In early periods, the trunks of trees were split with wedges into as many thin pieces as possible; and if it was found necessary to have these still thinner, they were hewn on both sides to proper size." And this wasteful process has continued in use to comparatively recent times in countries where wood is abundant.

The invention of steel was a powerful stimulant in the development of the saw. The date of its discovery is lost in the past. Hesiod in 850 B.C. refers to "bright iron" and "black iron," and Ezekiel in 600 B.C. to "bright iron." This latter undoubtedly was a low-grade steel.

The mention of its importation from Chalybes to Greece is the first authentic mention of steel. From ancient history we learn of the wonderful Persian and Damascene *sword-blades of steel* (335 B.C.), while Diodorus, a Greek, wrote in 50 B.C. of the Celtiberians as being "armed with weapons of excellent temper."

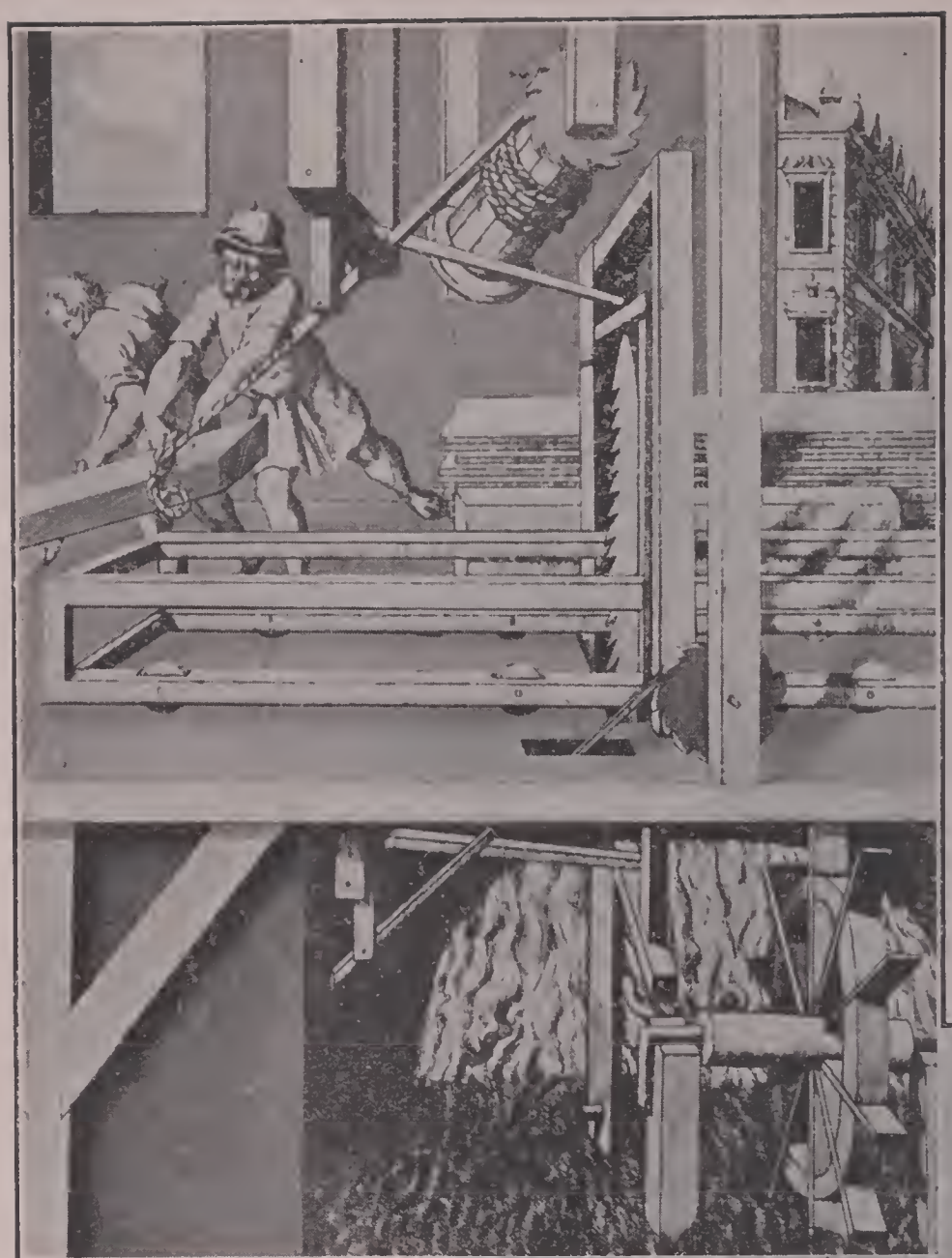


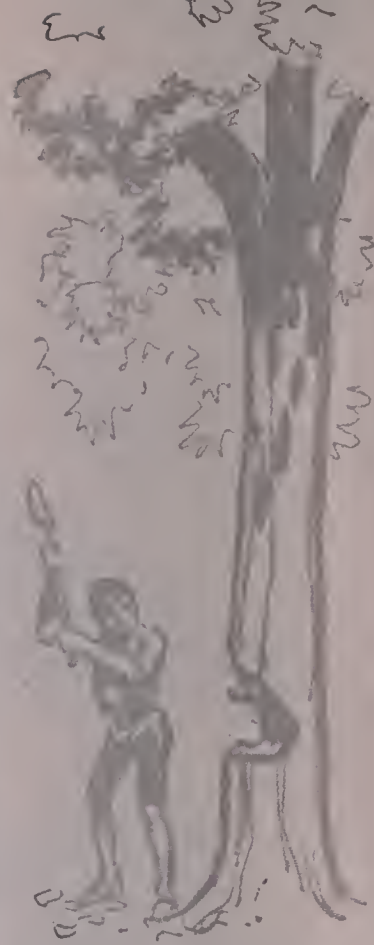
Egyptian Sawyer at Work

Ancient paintings and other discoveries show the Egyptians to have been familiar with steel in representations of similar tools. Blue and red seemingly distinguished between steel and bronze. In 1874 an iron wedge or plate was discovered embedded in the masonry of the Great Pyramid, proving that the Egyptians produced and wrought iron 5400 years ago in the time of King Cheops.

Translations of the original Scriptures mention both iron and steel—"iron," however, probably being really steel.

Steel is the only metal which could withstand the manipulation and strains in the manufacture and use of saws, and its employment is largely responsible for the wonderful development in the saw-making art.





The Introduction of Water Power into the Saw Mill. The real beginning of the Modern Power Mill—*Theatrum Machinarum Novum*, 1662

Old Saw Mill Using Horse Power—*Theatrum Machinarum Novum*, 1662

Chinese Sawyers at Work

PART TWO

Beginnings of the Modern Saw

In their modern adaptations, the many kinds of saws may be divided into two general classes, viz., reciprocating and continuous action. As examples—the handsaw (reciprocating), circular and band-saws (continuous). Reciprocating saws are naturally the oldest variety and more are in use than all others combined. This type may be again divided into "rip" and "cross-cut" saws. These are used respectively parallel with and at right angles to the "grain" or direction of the fibres. There are hundreds of styles of these saws in common use, each for a specific kind of work. In general, handsaws cut on the "push"—there being some few exceptions, constructed to cut on the "pull." Fig. 15 illustrates a Japanese saw, similar in appearance to a butcher's cleaver, with a long straight handle into which the shank or tang is driven and secured by wrapping with finely split cane. While different in shape, the metal is much the same as that used in other countries.

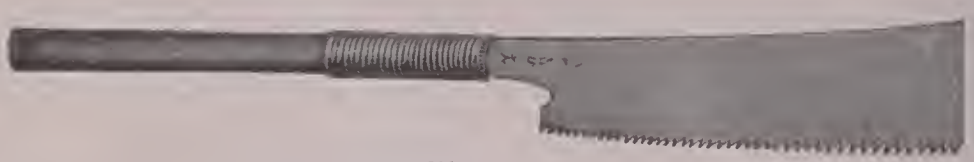


Fig. 15

To rip a plank, the Japanese carpenter places the end across a support, stands on the plank and operates the saw with both hands in a series of quick pulls.

Fig. 16 shows a Japanese log-splitting saw (a type still in use). Horace Greeley mentions observing, while touring Europe, an Italian cutting wood by rubbing it *against the saw.*

Fig. 16

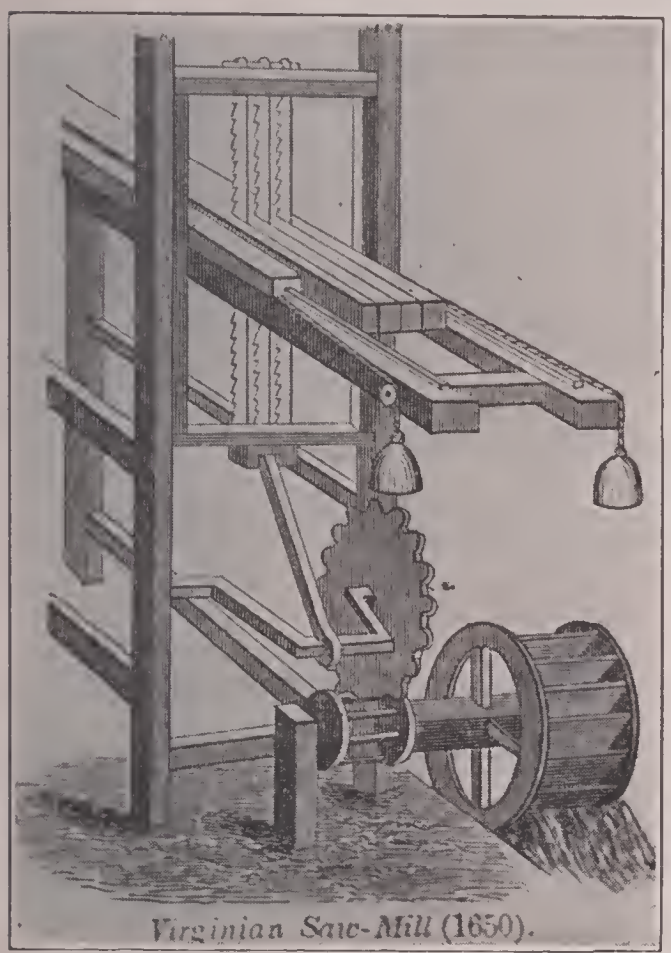
Hippocrates (B. C. 460) is said to have invented the first cylinder or drum saw, for use in the operation of trepanning the skull. The modern uses of this type of saw comprise the cutting of all kinds of flat circular forms—button-blanks, corks, sheaves for blocks, etc.—as well as staves for barrels, tubs, buckets, etc.

The development of the saw has been more rapid in comparatively recent times than in any other period. The real beginning of modern wood-cutting types dated from the introduction of the power mill—the ordinary reciprocating *up and down* paving the way for later improvement. Crude as were these old-fashioned upright saws, they were a big improvement over the

previous method of sawing a log with one man in a pit beneath it and another standing above. The innovation caused considerable unrest in the labor world, hand-sawyers fearing that their employment was gone.

The earliest mills were driven by wind power, but a 13th century manuscript shows a water-wheel saw.

Germany had water-power mills as early as 1322 (Augsburg). Holland had saw-mills nearly a century before England, where the workmen refused to permit their introduction. In 1663 a Hollander erected the first saw-mill in England, near London, but it had to be abandoned because of the riots it occasioned among the hand-sawyers. More than a century later, in 1768, a wind-power mill was erected for a lumber merchant by the name of Houghton, but this, too, was torn to pieces by a mob. The rioters were severely punished, and the owner reimbursed by the government, under whose protection several mills were built.

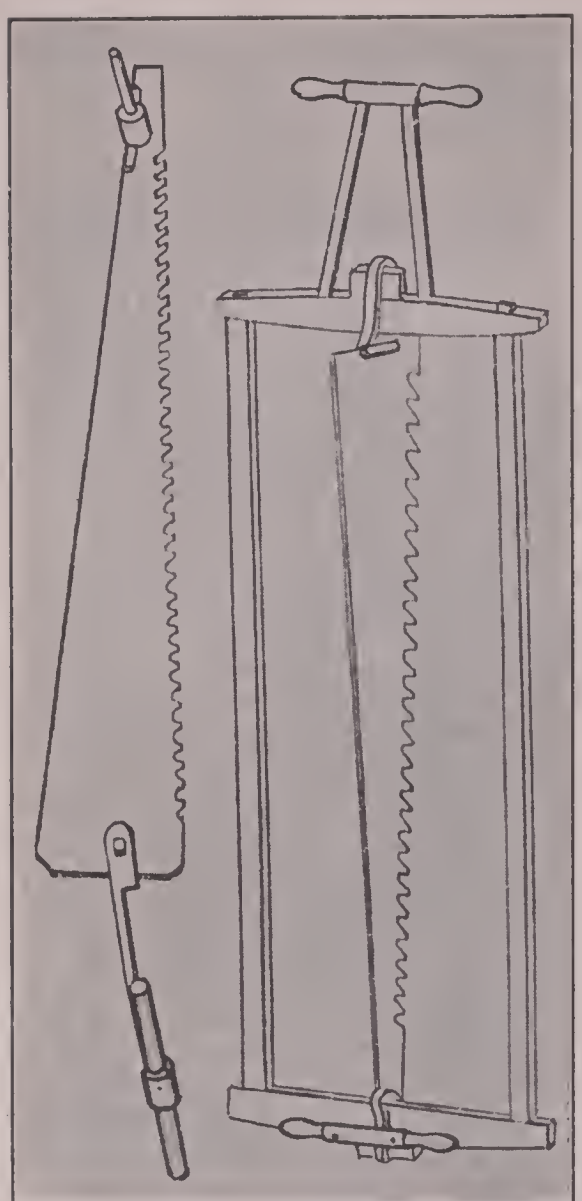


Virginian Saw-Mill (1650).

With the discovery of Madeira, in 1420, saw-mills were erected there to make lumber for export to Portugal. Saw-mills were erected in Breslau, 1427; in 1490 by the magistrates of Erfurt in a forest which they had purchased; in Norway, 1530; at Holstein, 1547; Lyons, 1555; Zaandam, Holland, 1596; and in Sweden around 1658. The rapid development of the early saws is seen in the fact that a gang-saw mill was built on the Danube, near Ratisbon, in 1575. Gang-saws, consisting of a number of blades to cut a log into boards with one operation, have been generally regarded as of later origin than this. However, in a work of Jacobi Bessoni (Lyons, 1878) are illustrated two types of gang-saw mills, the blades in one having *teeth on both edges*. These were only isolated instances, the average mill of the period having but one blade.

America's first saw-mill was built at the Falls of Piscatauqua, on the line between Maine and New Hampshire, in 1634. Unauthenticated records, however, claim that as early as 1633, several mills were operating in New York State. Before the arrival of William Penn in 1681 saw-mills had been erected along the Delaware by the Dutch and Swedes. In 1803 there was a steam saw-mill in New Orleans, which met the fate of the early English mills, being burned by hand-sawyers. While a successful saw-mill was built in Glasgow, Scotland, in 1834, and others were established at subsequent dates, little progress was made in wood-cutting machinery until John McDowell put up a plant at Johnstown. He at once gained prominence by making the first frame-saws supplied to Glasgow as well as England—including the British Government.

These mills were all of the vertical reciprocating type—the saws being strained along a strong rectangular frame driven along suitable guides by a crank on a revolving shaft, usually below the frame. A sliding carriage,



Old-time Pit Saws Which Preceded Saw Mills

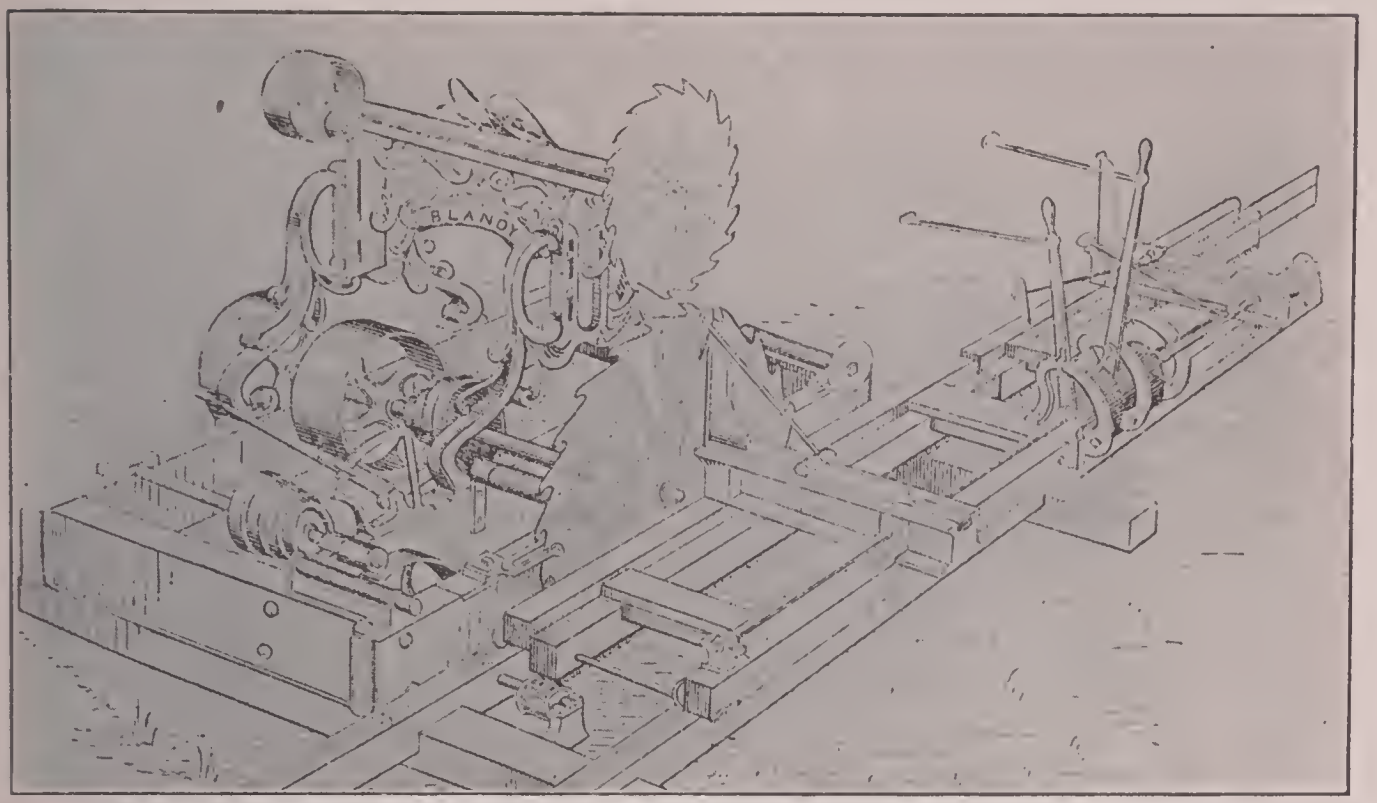
which automatically moved a certain distance at each stroke, carried the log. After each cut the log was moved laterally, the distance corresponding to the thickness of the lumber being cut. Old-time sawyers will remember when logs had to be moved with a bar after each cut.

At this time saw sharpening was a secret process. The sharpener worked in an isolated room and sawyers were required to ring a bell before being permitted to speak to him.

These stories of these early mills have been recounted at considerable length because they are inseparably connected with the development and progress of the saw-making art. The increasing requirements of the millmen necessitated a constant search on the part of saw manufacturers, not only for improvements in the design of their saws but also in the quality to meet the strains of greater speed and larger output. And one of the most important factors in modern progress has been the improvement in saw-making.

The next great progressive step was the invention (or re-invention) of the circular saw. While the hand-saw is as old as history itself, the circular saw, as now used, is a comparatively recent innovation. Circular saws were used for cutting the spaces between the teeth of clock wheels long before they were used for cutting wood (probably suggesting the milling machine now so universally used in gear-cutting). The earliest patent on circular saws is No. 1152, granted to Samuel Miller in England, August 5, 1777, although it is claimed that similar saws were in use in Holland nearly a century before. In any event, circular saws are believed to have been introduced into England for practical wood-cutting purposes about 1790. In 1804 a man named Trotter secured a patent on a circular saw, and Sir Samuel Bentham (who later invented a circular saw made in segments) made a circular saw for the British Admiralty prior to 1800. Historians credit T. Brunel with first bringing circular saws into important service. He employed them for cutting ship's blocks—an application adopted by the British Admiralty Board in 1804 for the Portsmouth Yard. Brunel patented a veneer-saw in 1805, marking another advance.

The first circular saw in this country is supposed to have been produced by Benjamin Cummins, about 1814, at Bentonsville, N. Y.—his facilities consisting solely of the ordinary tools and equipment of a blacksmith's shop. The fate so often accorded great men was his, for he now lies in a lonely, secluded spot in the northwest corner of the cemetery of the little village of Richmond, Kalamazoo County, Michigan. Half concealed from view by lilac bushes is a marble slab bearing only this simple inscription: "Benjamin Cummins, born 1772; died A. D. 1843."



Type of Early Double Saw Mill

The general use of circular saws for manufacturing lumber is supposed to have originated in a patent granted March 16, 1820, to Robert Eastman and J. Jaquith, of Brunswick, Me. Since then countless other circular saw-mill patents have been granted.

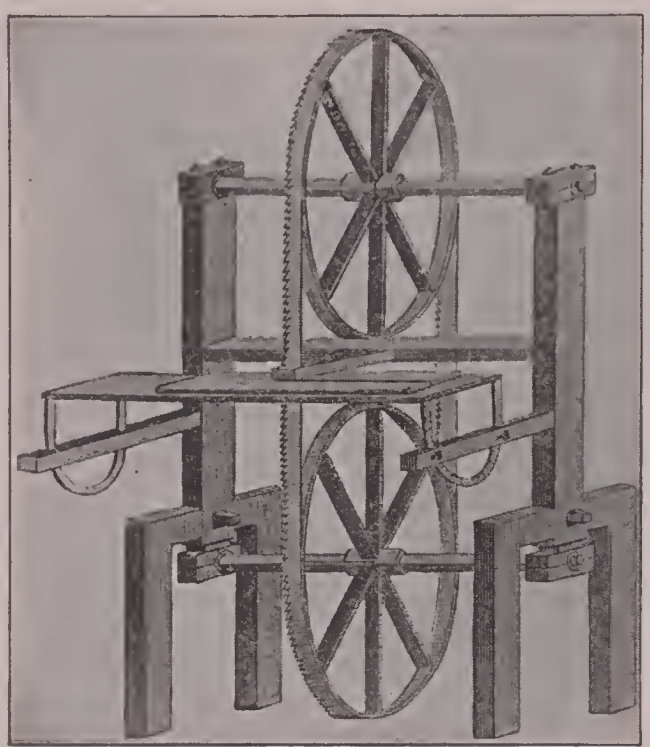
Water and, later, steam was the motive power of these saws. Many years ago 48-inch circular saws, driven by "four horses walking around," were used in our Western States. The output of these was from 500 to 1200 feet of lumber per day, depending upon the kind and quality of logs.

The early circular saws were very crude, with square mandrel holes, and were made only to special order. From 1840, however, progress was rapid—the development of the inserted tooth at about this time being one of the greatest progressive strides ever taken in saw-making. (See illustration).

No really satisfactory method of holding the teeth in place was devised until 1859, when a man named Spaulding, while experimenting in Sacramento, Cal., discovered that *curved* sockets would hold the teeth firmly and securely. This method protects the plate also by reducing the tendency to crack.

Early Types of Inserted Teeth for Circular Saws

The problem still confronted the sawmakers, however, of reducing the time and power consumed, as well as the waste in sawdust, in converting logs into boards. Eventually, the perfecting of the band-saw proved to be the solution.



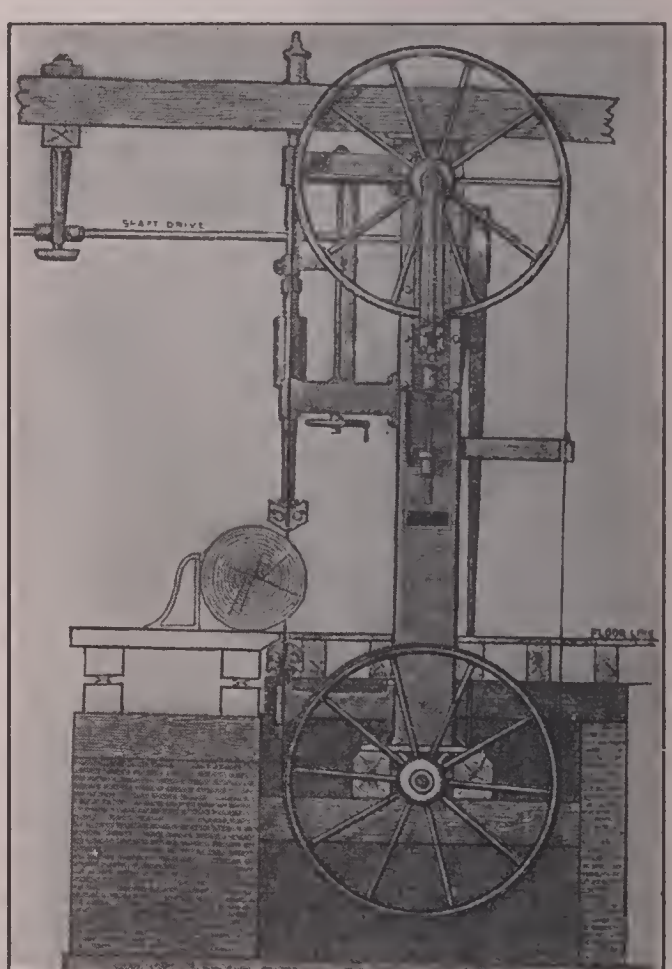
Original Band-Saw of 1808

William Newberry, of London, England, patented the first endless band-saw in 1808, although his machine was never developed further than the model submitted to the Patent Office. Although Newberry was the first of modern times to see the possibilities of the band-saw, he cannot justly be said to have originated it. Archaeologists have brought to light proof that in numerous instances the band-saw had been brought very nearly to its present form by ancient peoples. Then, too, in the patent papers of Sir Samuel Bentham in 1791 and 1793 are many forerunners of distinctly modern saws. The great difficulty, however, in making a smooth, strong joint in the steel band was a stumbling-block which arrested practical development until Newberry's time.

To Périn, of Paris, is due the credit for the improvements which made the general use of the band-saw possible. The old difficulty in joining the blade so that it would run over the wheels without breaking was not overcome until nearly forty years after Newberry gave this type of saw to the world. Then, about 1846, a Mlle. Crepin, a French woman of great mechanical genius, secured in France a patent on a machine similar to Newberry's. This patent was later obtained by Périn, and the saw greatly improved by him—a suitable joint was perfected and the band-saw became a practical reality.

The next important improvements were by Thouard, also of France, in 1842, when he put the band-saw on a commercially practical form, but it was not until Périn's final improvements were made that it became profitable for general use.

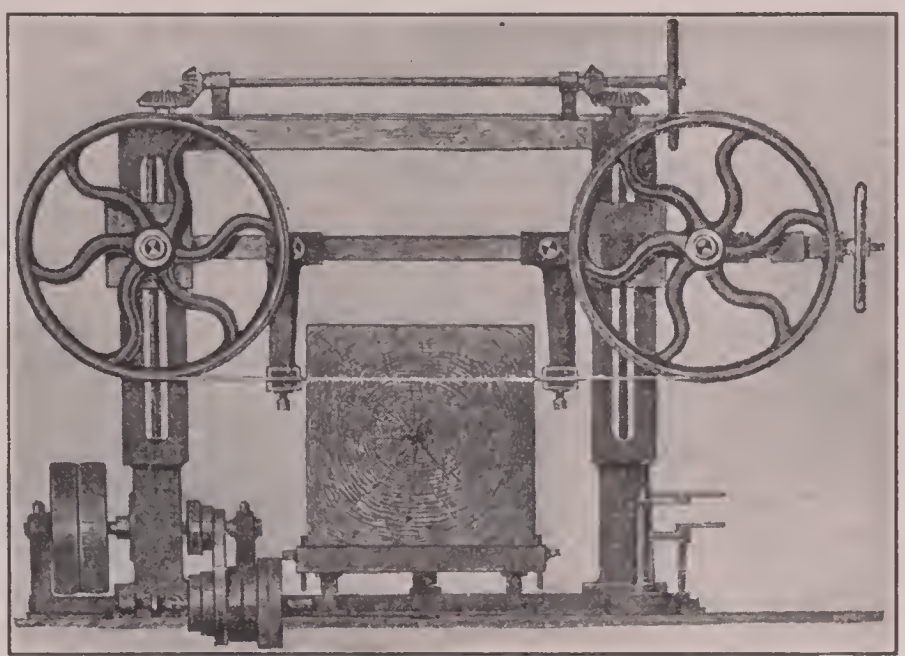
These old band-saws, although giving increased output over the up-and-down gang saws and circular



One of the first Band-Saw Machines for Mills

saws of the day, were quite small, crude, and limited in their work. The following typical incident shows the skepticism with which they were received:

About 1860 a man named McCormick purchased a band-saw in England. After a very short while in service it was removed because it did not do the work expected (probably because of unskillful management). For many years afterward it surmounted the McCormick garden fence as a pointed reminder to unruly boys to keep out of the melon patch.



One of the first Horizontal Band-Saws

One feature of the band-saw which rapidly popularized it with the mill-men was its thinness, which meant smaller kerf and more boards from a log than with any other type of saw.

An Early Mill

The fear at first felt by the operators of this type of saw soon passed, and as its use extended, improvements came rapidly.

The large proportions and perfection of form of the present-day band-saws are strikingly shown in comparison with those even of so recent a period as 1876. A 6-inch band-saw exhibited then at the Centennial Exposition by Henry Disston & Sons was considered a wonder; to-day the same firm is regularly making 18-inch band-saws—many of them *toothed on both edges* to cut the log coming and going.

This up-to-date, speedy band-saw has increased the productivity of mills to a point never dreamed of by the mill-man of bygone days. To Henry Disston & Sons is due in no small part this modern development. Their improved equipment and methods of manufacture have added much to the efficiency of the saw. Through the medium of Disston band-saws the heavy demands on a modern lumber mill are easily met, and so the old-time quest for a more efficient type of saw has ended.

PART THREE

The Modern Saw

We have now reached the point where the modern saws—the saws we know to-day—stand out as the most useful, the most necessary, the most wonderful of all man's aids in conquering nature and furthering the needs and comforts of present-day civilization.

A comparison of the saws of ancient times and the saws of to-day is startling to the average man who has not paid close attention to the saw in its present state of perfection. From the primitive stone implements illustrated in the early part of this article to the multitudinous variety of saws employed to-day, many of which we purpose illustrating and describing, is a tremendous advance. It shows clearly the extraordinary progress made by man in the comparatively short time he has inhabited the earth as compared with its reputed 100,000,000 years of existence.

Fig. 17—The Disston D-8 Hand-Saw

It is universally acknowledged that the standard modern saws for the entire world are those made by Disston. Therefore a description of the saws they manufacture for various purposes—especially the saws they make for mill-men, upon whom rests the burden of supplying the lumber requirements of the world—will give the broadest conception of the saw as it is known to-day.

Early Types of Hand-Saws

In an earlier part we stated that saws came principally under two heads, viz., reciprocating and continuous. These again may be divided into other classes.

First, we will consider those saws which come under the type of reciprocating, for saws of this kind are the more generally used.

The hand-saw, of which the Disston No. 7 and D-8 are distinctively the representative types, is now the companion of every mechanic who has anything to do with wood in his daily work. We may safely say that it is also found in a vast majority of the homes of the entire world.

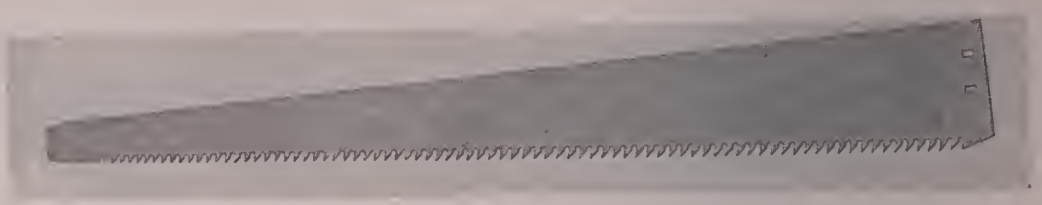


Fig. 18

Broadly speaking, the term hand-saws includes such saws as buck, hack, keyhole, plumber's, back, pruning saws in different forms, and many others for special purposes. The cross-cut or long saw and pit saw may also be included under this head.

Although each of these types is of essentially different construction from the others, because of the nature of the work it is called upon to do, the principal and common origin are the same.

One of the First Saws Made by Henry Disston

All modern hand-saws, except those of the Japanese, cut on the push or the stroke away from the user.

While the oldest civilized peoples in the world—the Egyptians, the Chinese and the Japanese—used a form of saw having the teeth inclined toward the handle, this form was not universal, as is evidenced by the saws exhumed from the ruins of Pompeii, and now preserved in the museum there. These saws cut on the thrust, just as those in use in Europe and America to-day.

The standard type of hand-saw (Fig. 17) is, of course, a direct development of the piece of stone with a serrated edge as used in ancient times. Its present shape, which differs somewhat from the earlier type of hand-saw, as will be noticed by reference to group illustration, is an invention of Henry Disston. Since he originated it, this form has been widely copied, but without success in securing the same correct hang, which affords the wonderful ease in handling, and without equaling the exceptional quality of the steel.

Making the blade skewback, as it is termed, lessens the weight of the blade and gives proper balance as well. The "let-in" handle gives better control over the saw and the peculiar shape of the butt or heel allows full sweep of the blade without danger of its catching in the work.

The amount of work which can be accomplished with one of these modern saws as compared to the old-time forms is wonderful, and could primitive man, who roamed the forests ages ago, have armed himself with one of them, the story of civilization's advance might have been vastly different.

Reference to old-time pit-saws, as previously illustrated, and that in Fig. 18, will show that this saw, as used to-day, has made little progress, in form at least, over the type used before power-mills came into existence. Quality of steel, style of teeth, and improved methods of tempering and sharpening have, of course, made it a more efficient saw, but these embrace about the only

changes made since the days when King Solomon's temple builders employed it in their work. Naturally, there is not much call for a saw of this kind now and it is almost obsolete. The cross-cut or long saw fells the trees, cuts them to desired lengths, and then the circular or band-saw transforms them into lumber more quickly and

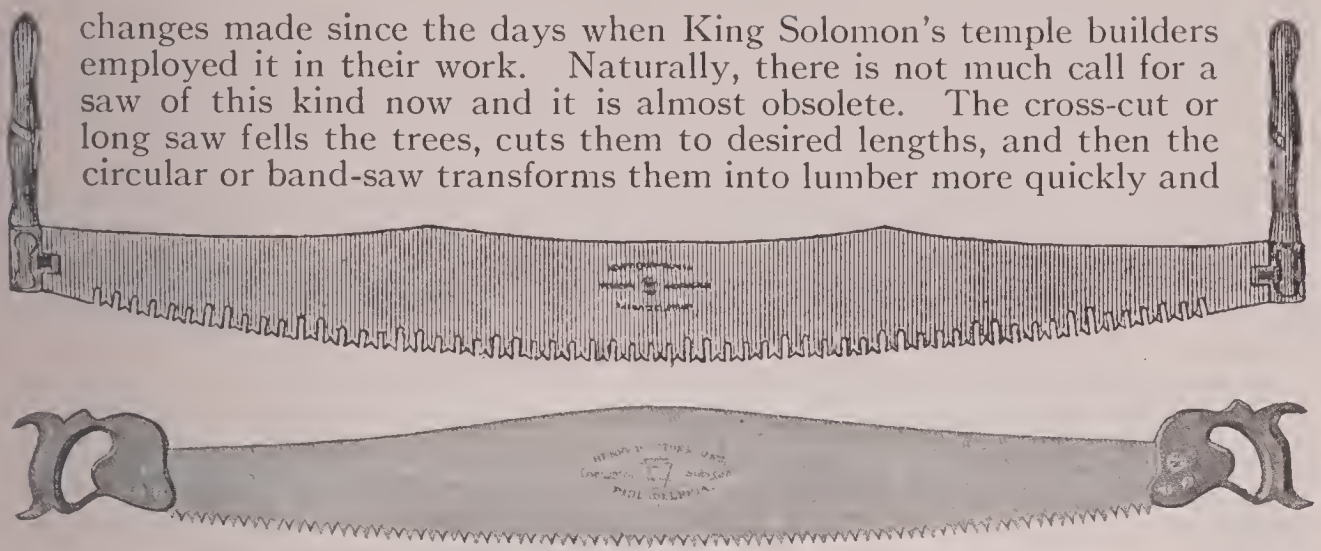


Fig. 19—Old-Time Cross-Cut Saws

uniformly than two men and an old-time pit saw could. With a modern mill of even medium capacity the output will be more in one day than these two men, in bygone days, could have done in months with their old-fashioned pit saw.

The cross-cut saw, which is of the reciprocating type, cuts on both strokes, and is another saw that retains its original form to a great extent; its improvements being represented by new methods of grinding,

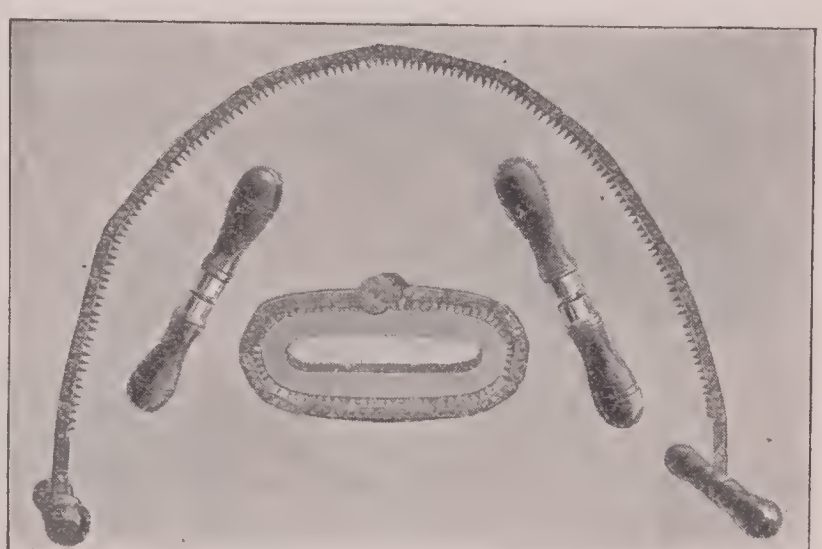
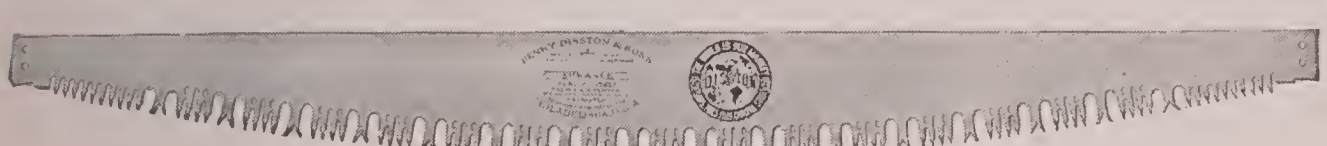
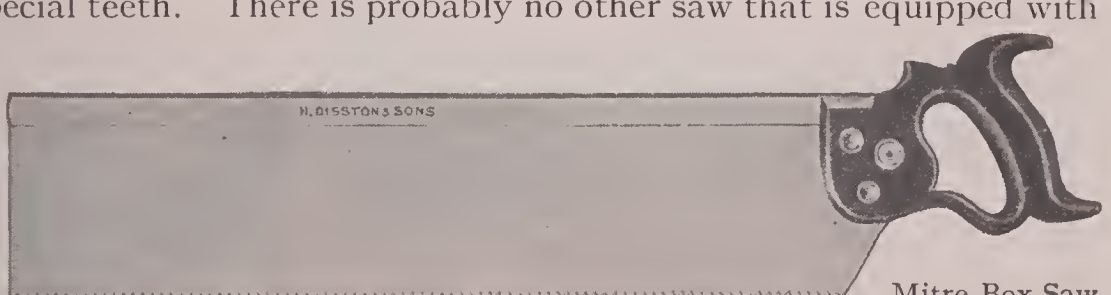


Fig. 20—Chain Saw, Open and Closed



The "Suwanee"—the Most Modern Type of Cross-Cut Saws

hardening and tempering, and many new forms of teeth. We show a few examples of the many styles of teeth; different countries and various woods requiring special teeth. There is probably no other saw that is equipped with so many varieties of teeth as long saws.



Mitre-Box Saw

The early history of the cross-cut saw is obscure—its actual beginning is lost in the misty past, and the oldest saw-makers of

today agree on only one point—that they have made cross-cut saws as long as they have been in business.

The demand for something better and more efficient, which the world's progress has constantly created, was the source of all great inventions and improvements. The felling of timber by the axe, with its resultant waste, great expenditure of labor and loss of time, led inevitably to the development of cross-cut saws. To the old up-and-down saw and the still earlier pit saw can probably be ascribed the direct inspiration.

Though saw-makers remember cross-cut saws as far back as they can recollect, the saws were always made of untempered steel. Henry Disston added their manufacture to his business. He, the first to give real strength and efficiency, also actually gave the cross-cut saw its first great start.

For many years it has been gradually supplanting the axe in the felling of trees, for it enables the lumberman to do quicker, cleaner work and saves the wood. In Fig. 19 will be seen two old-time cross-cut saws. The handles on the lower saw, merely a modification of the hand-saw type, afford the best clue to its age. The upper saw, while a great improvement over the earlier forms, lacks the finer points of quality and efficiency which distinguish the distinctly modern cross-cut saw.

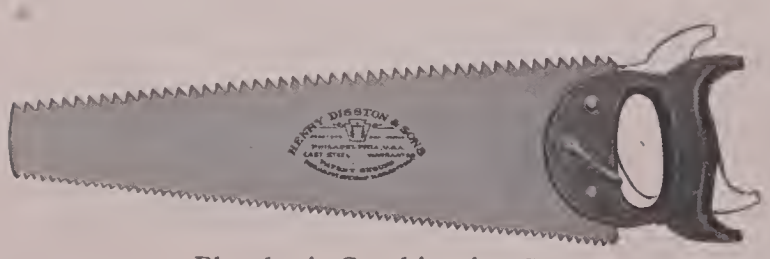
Today the immense plant which Henry Disston founded is sending the cross-cut saws they manufacture, with teeth adapted for every sort of wood, to all the inhabitable parts of the earth where there are forests to cut or lumber to be made.

One of the most important of the advances in cross-cut or long saw making was the introduction of the raker tooth. While many cross-cut saws are still made without the raker, it is really so necessary for quick clearing action that its use will probably become much more general. On green timber especially it insures faster cutting.

While the cross-cut saw finally has practically replaced the axe for felling and cutting up trees, its use is not by any means confined to this work.

A curious modification of the cross-cut saw is the chain saw. This is used chiefly by the military—the American, French, and other army engineers being equipped with it. The chain saw consists of a series of links (see Fig. 20), each fitted with saw teeth. When ready for operation a handle is attached to each end, the saw stretched against the tree, and worked back and forth. A tree, interfering with the movements of troops, can be cut away by two men in a comparatively short time with a chain saw. It is compact, and serviceable for this purpose, but would not meet the requirements of more extensive work.

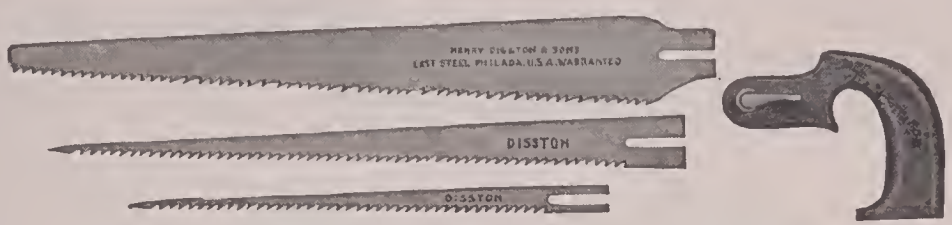
The chain saw, in suitable form, is also used by surgeons for operations on the human skull, and by veterinary surgeons for bone cutting. It has been superseded, to a certain extent, by Stohlmann's bone saw, but is still widely used. Stohlmann's saw consists of a steel wire, upon which are strung steel discs or beads with sharp cutting edges. There is a handle on each end, and its manner of use is similar to the chain saw.



Plumber's Combination Saw

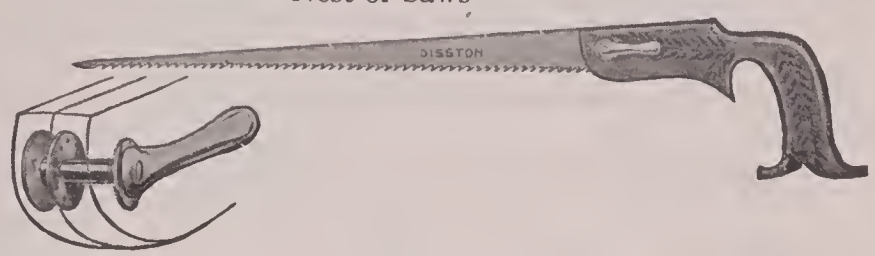
Under the head of reciprocating hand-saws we find a long line of smaller saws for various purposes. Among the largest of these is a combination saw, cutting both wood and metal, for the special use of plumbers. The fine teeth on one edge are adapted for cutting lead pipe, nails, etc., while the coarser teeth on the other edge are for sawing wood.

Then there are several forms and sizes of back saw. This type is used for very fine cutting requiring a straight or even saw cut. The blade being so thin, it is necessary to have a back of steel or brass to prevent its buckling. The larger Back Saws, 20 inches or larger, are commonly known as Mitre-Box Saws. The special shape of the butt or heel in these saws prevents its catching in the work.



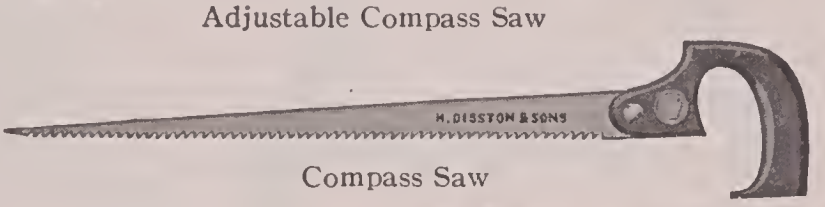
Nest of Saws

The Compass Saw is a useful little tool, having a fine, tapering blade. This saw is used principally for cutting circles where it is first necessary to make a hole with a center-bit.



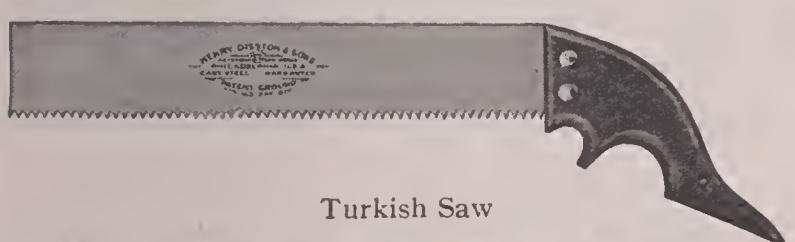
Adjustable Compass Saw

Another form of the Compass Saw is one with an adjustable blade. Not only can different blades be easily substituted but the blade itself can be adjusted to various angles in relation to the handle. Somewhat similar to a Compass Saw is a small saw called Keyhole or Pad Saw. This has a handle with a socket large enough to receive

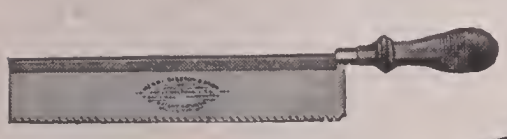


Compass Saw

Keyhole Saw and Pad



Turkish Saw



Dovetail Saw

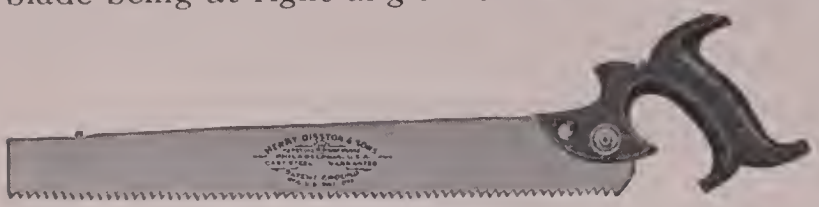
Patternmaker's Saw

Stair Builder's Saw

the saw blade. The blade, which is adjustable to any length, is held in position for use by the tightening of a thumbscrew. Disston makes a variety of these saws. One end of the blade can be used as a screwdriver, which is brought into position by simply loosening thumbscrew, pushing blade through the handle, and tightening screw again.

Another variation of the Compass Saw is the Nest of Saws. This nest is a combination of one handle and several different styles of small blades which can be adjusted to the handle, according to the size and kind of work to be done. These blades are of the keyhole, compass, and pruning types, and form a compact and handy tool. Still another

variation is the Square Hole Saw. The tooth edge on the heel end of the blade being at right angles to the rest of the blade, both angles of the corner are cut at the same time.



Joiner Saw

The accompanying illustrations show other curious forms of small size saws, each made to meet a special requirement. These include Pattern Maker's, Dovetail, Turkish, and Stair Builder's saws.

The Turkish Saw is used in Turkey and other Oriental countries. Its teeth are fitted for cutting toward the handle as required by these peoples. The Stair Builder's Saw is adjustable for depth of cut, and is used for cutting the bottom or base of balustrades when it is necessary to fit them to treads of stairs.

Another saw illustrated here is the Joiner Saw. This is employed by cabinet-makers for making joints where extremely fine cutting is necessary.

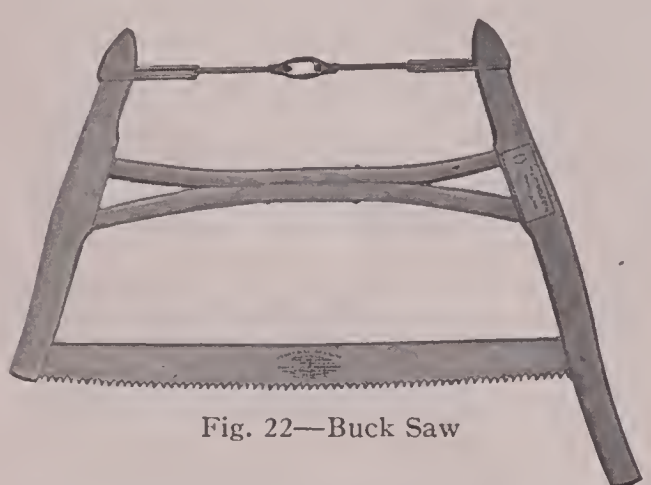
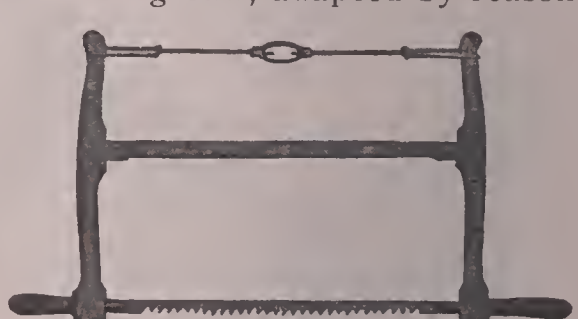


Fig. 22—Buck Saw

Special saws are also made to help the agriculturist. These are saws intended for pruning. Some are toothed on one edge only; others have both edges toothed with different styles of teeth, adapted for dry and green wood. A special type of crescent shaped pruning saw is made, principally for pruning orange trees, as it makes what is termed a "draw-cut." That is, the teeth are inclined toward the handle, which draws them into light branches, instead of pushing the branches away as an ordinary saw would do.

There is also a combination hook and saw made for pruning trees, and intended for use on the end of a long pole. This is obtainable with either straight or curved tooth edge on the saw.

Other peculiar forms of saws include the gauge saw, which has an adjustable gauge, making it particularly adaptable to tenoning, shouldering, dovetailing, curving, cog-cutting, or any purpose where a definite depth of cut is required; the Movable Back Saw, on which the back is detachable, making it convertible for use either as a back saw or ordinary hand-saw; and the Combination Saw, a saw that is equipped for use not only as a hand-saw, but also with the following tool attachments: square and rule, straight-edge, scratch awl, plumb and level. Where these tools are wanted in a compact form, nothing equals this saw. Then there is the Flooring Saw, adapted by reason of its extreme round breast, on tooth edge, to cutting through floors without the use of chisel or auger.

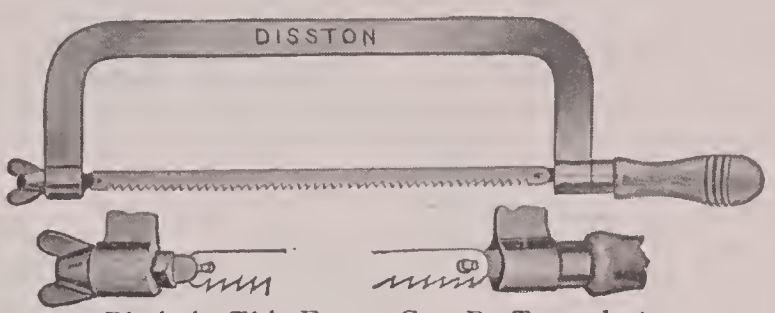


Web Saw

The next type of reciprocating saw is the "tension" type. Tension saws are those which have a narrow, thin blade strained in a frame of wood or metal. The oldest, and most generally known, form of this kind of saw is the Buck or Wood Saw. The origin of the Buck Saw, if

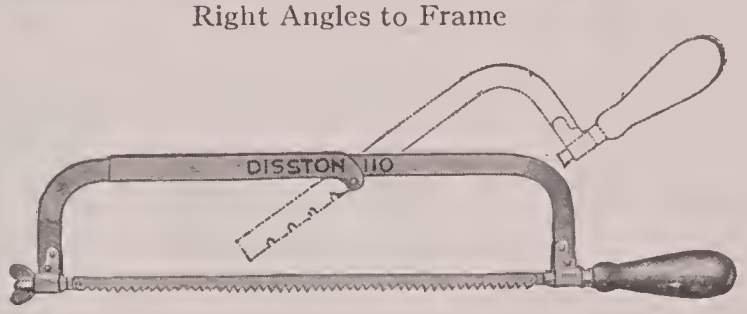
we are to believe the drawing upon that ancient tomb previously described, goes back into the very beginning of history. It is claimed by students of antiquity that frame saws were common in Egypt many centuries prior to the executing of the drawing at Herculaneum. There is no doubt that it is one of the oldest forms of saws. Its usefulness has been proved by many generations, as can be testified to by thousands of farmer boys, and though its place is being taken, to an increasing extent, on the farm of today, by the small circular saw, there are still great numbers of Buck Saws sold and used.

Fig. 22 shows an excellent type of this saw in its modern form. Compare it with the ancient saw in Fig. 5, page 6.



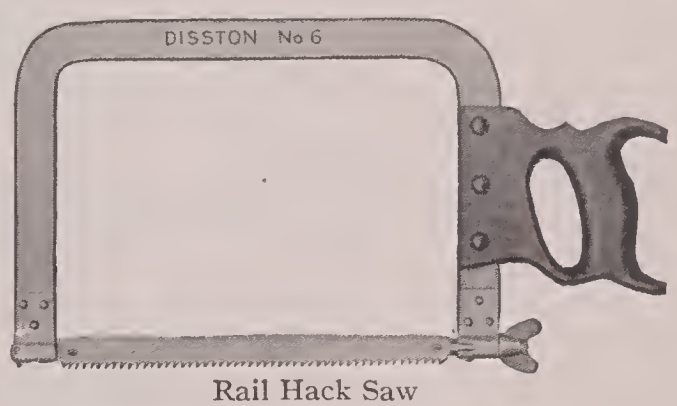
Blade in This Frame Can Be Turned at Right Angles to Frame

An interesting saw that comes under this head is the Web Saw. In some foreign countries this saw is used almost entirely as a general hand-saw. In fact, they are very partial to this type of saw, and many continue to use it, after coming to America, in preference to the usual type of hand-saw.



Extension Hack Saw Frame

Another saw widely used and practically indispensable for metal cutting is the Hack Saw. The demand for saws for cutting metal has been constantly increasing from-year to year owing to the great variety of purposes for which iron, steel, and other metals are being adopted.



Rail Hack Saw

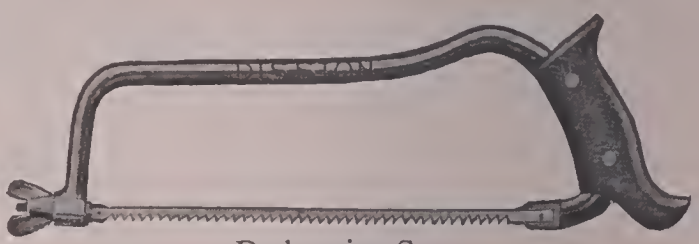
Some years back the working of metal to size was done by what may now be considered a very crude, laborious, and expensive method. It was usually done in a blacksmith shop, the smaller work being forged to shape, the larger sheared off and dressed up with a file, while in such cases where joints or mitres were desired on beams, etc., the work was sheared to length, the required angles then cut on a shaper or planer. This method afterward gave way to the adoption of shears, but this did not make an accurate angle and necessitated dressing off. All of these methods consumed considerable time.

The use of Hand Hack Saws and Circular Saws for cutting metal has rendered possible to the greatest extent the employment of metals in the trades. Modern appliances for shaping and cutting with this class of tool have reduced to a nominal figure the hitherto prohibitive cost; the work being done with greater ease, more accurately, and in much less time.

Hack Saw blades, ordinarily, are narrow in width, and from 6 to 16 inches in length; some are hardened throughout, and others on tooth-edge only, leaving the back soft.

Like other modern forms of saws, the actual beginning of the Hack Saw does not seem to have been recorded. There is a tradition that the first one was made in Ireland, but as the Irish have not been noted for mechanical pro-

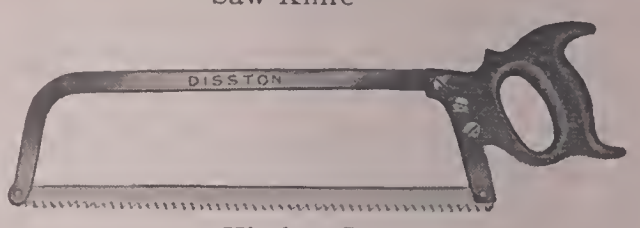
ductions of this kind, the rumor very probably started with some enthusiastic son of the Emerald Isle. Old catalogs show that in England complete Hack Saws were made in 1770, and as the industry was then well established it seems impossible to locate the exact origin of the Hack Saw. Its later history, though more complete, naturally lacks the romance that is attached to the beginning and early life-story of any product. It is certain, however, that the early blades were imported into the United States before they were made here. These imported blades were polished similar to butcher saw blades and intended to be resharpened as required; though it is stated that the old English Hack Saw Blade was extremely thick, having coarse teeth, very little set, and was slow-cutting and heavy to work.



De-horning Saw

Pork Packer's Saw

Saw Knife



Kitchen Saw

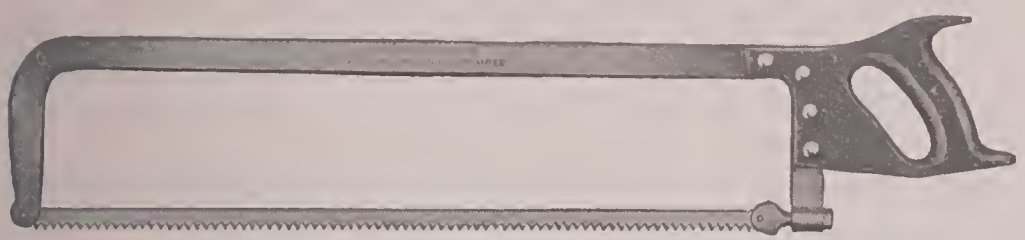
Over fifty years ago Henry Disston was making the hollow or concave ground Hack Saw Blade, and even today, for particular work, where accuracy is desired, they are still used and recommended. They are made of high quality steel, which is especially suitable for hack saws, and have milled teeth; the blade is hollow-ground to run without set, and tempered so it may be refiled. This is the highest type of Hack Saw Blade.

It was about the early eighties that the first Hack Saw blades, somewhat similar to those of today, were made. These were produced at a comparatively low price, and were so hard they could not be refiled; it being cheaper, in fact, for the mechanic to throw away the dull blade than to spend his time in resharpening, even if possible. Extra narrow Hack Saw Blades, ¼ inch wide, varying in thickness and number of points to the inch, also are made especially for the use of lock-makers and jewelers.

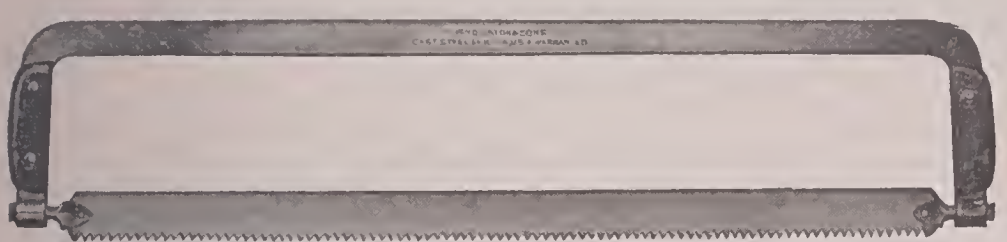
Metal saws are also made in the form of the regular carpenter's hand-saw, and in the shape of Back or Tenon saws. These are of a special steel and temper, ground thin toward the back, and may be resharpened with a good file. Tenon saws of this class are principally used in mitre-boxes for the manufacture of show cases, etc., while the hand metal saws are for purposes where a framed Hack Saw cannot conveniently be used. Large saws, in the form of long hand-saws, are also made for cutting metal, and may be operated by two men in the same manner as a cross-cut saw; the handle for small end of saw being adjustable, can be attached or detached at will. These are principally used in foundries for sawing "gates" and other parts from large castings.

In use, the Hack Saw Blade is strained in a frame. There are many different forms of frames; some having a solid steel back, and others extension backs, taking in blades of different lengths. Some are so constructed that the blade can be turned at right angle to the frame. Another style is termed the Rail Hack Saw. This has a frame varying from 9 to 18 inches from tooth edge of blade to inside of back, and is used in construction work for cutting steel rails and beams.

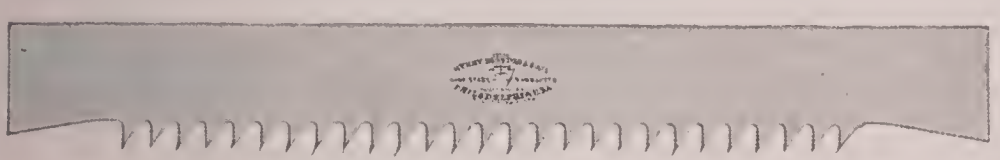
The first Hack Saw, or metal-cutting blades for power machines, were manufactured in the Disston plant at least a quarter of a century ago. They were made especially for building the City Hall Tower, Philadelphia, and the Congressional Library, Washington, D.C. Their usefulness was immediately apparent, and the demand spread rapidly. Today the frame Hack Saw and Machine Saw, for cutting all sizes and kinds of metal, have almost entirely supplanted the old method of nicking and breaking, or cutting off in a lathe.



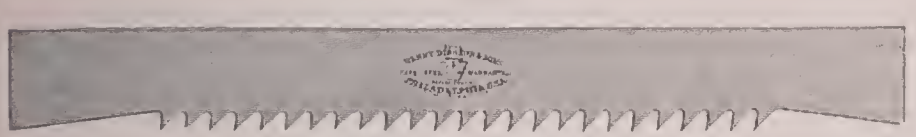
Butcher's Saw



Beef Splitter



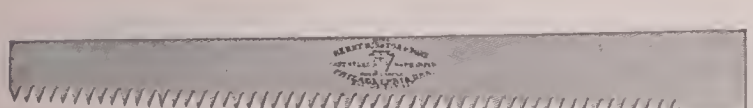
Mulay Saw



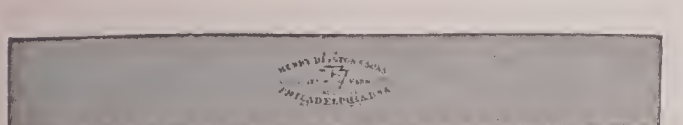
Mill Saw

Futtock Saw

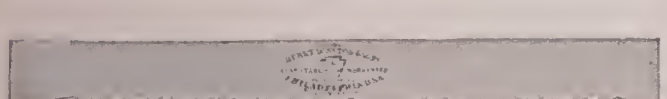
Whip Saw



Drag Saw



Gang Saw



Deal Saw

Circular and Band Saws are also extensively used for cutting metal. These will be described later, however, under the heading of Continuous Action Saws.

Closely allied in form to the Hack Saw is the Butcher Saw. The Butcher Saw, though chiefly used for bone-cutting, as its name would imply, actually derived the name from its originator, R. G. Butcher, a Dublin surgeon. This saw is quite similar to the Hack Saw, but on a larger scale, and it may have been the invention of it by Dr. Butcher, before Hack Saws came into use, which led to the rumor that Hack Saws (intended only for metal cutting) were invented in Ireland.

The difference between these two saws is really very slight. Owing to the softer nature of the material a Butcher Saw is required to cut, it is not necessary to have as high a temper in the blade as the hack saw. The blade of the Hack Saw, on the

other hand, is made very hard. The frame of the Butcher Saw is longer also, and the distance between the blade and the back is greater.

Quite similar to the Butcher Saw is the Beef Splitter. This has a handle at each end and is operated by two men to split the beef carcass before cutting up.

The Kitchen Saw is an adaptation of the Butcher Saw, which it resembles on a small scale, for the home. It is probably used most in country homes, but a saw of such general convenience is bound to increase in popularity.

Another variation of the Butcher Saw is found in the Pork Packer's Saw. This saw is slightly smaller in size, and tapers toward the end. Its name amply explains its use, as it is employed by pork butchers for cutting up pork.

A peculiar form of this type of saw is found in the De-horning Saw. This saw has a blade only 9½ inches long and ¼ inch wide. It is used by farmers and stockmen to remove, or shorten, the horns on cattle.

A tool that is classed with these bone and meat-cutting saws, and yet is more than a saw, is the Saw-knife. This is a knife with double-cutting edge, coming to a point at the end. One edge, however, is toothed for sawing, while the other is used for ordinary cutting.

A variation of the Saw-knife is the Subcutaneous Saw for surgical use. This saw has a pistol-grip handle in which is inserted a round steel shaft. Near the outer end the shaft is flattened—the upper part having a knife edge; the lower, saw-teeth.

Before dismissing the narrow-blade type of saw, we must refer briefly to Fret, Scroll, and Jig Saws, which are highly useful in the ornamental woodworking industry. The Fret Saw, in fact, has been referred to as the forerunner of the Hack Saw.

As a matter of fact, Fret, Scroll, and Jig Saws are very similar, and are used for practically the same purpose. The Fret Saw blade is extremely narrow, and made from $\frac{1}{32}$-inch wide up. The narrowest blades, while having teeth, appear to be merely a wire. The Fret Saw is used almost always by hand. It is delicate in construction, and is employed only on the finer kinds of work. The Scroll Saw, the blades of which are somewhat wider, is used on heavier work, and, although frequently worked by hand, is also used in a machine run by foot or other power. The Jig Saw, though often confused with the Fret and Scroll Saws, is distinctly a machine saw, and is used on all heavy work. The blade on a Jig Saw is ground thinner toward the back.

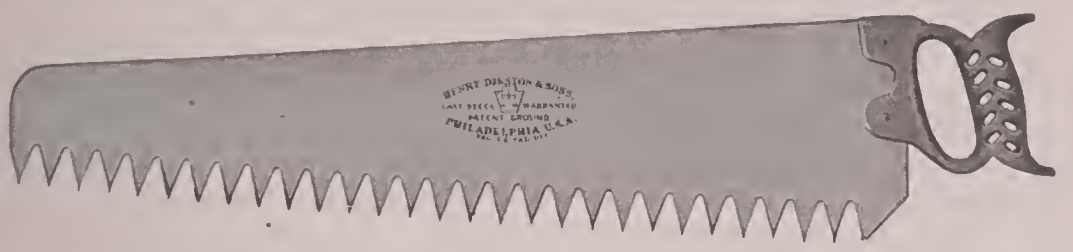
The blades of all these saws consist of a thin ribbon of steel, toothed on one edge, and, for use by hand, are stretched in a frame which is made of considerable depth between blade and back. They are especially adapted to sawing curved outlines and cutting out interior pieces.

The Jig Saw resembles Fret and Scroll Saws mainly in the purposes for

Pond Ice Saw

which it is used. It is a sawing machine with a narrow, vertical, reciprocating saw blade, on which curved and irregular lines and patterns in openwork are cut. It is especially adapted to cutting interior portions which necessitate first passing the saw through a hole. Jig Saws, with suitable blades, are employed in both wood and metal work.

A species of Fret Saw is the Buhl Saw. The name of this saw is derived from André Buhl, an Italian. He was celebrated throughout France, in the reign of Louis XIV, for inlaid work in wood. The saw, which is named for him, has a very deep frame, with a short blade, and is specially made for this class of work.



Hand Ice Saw

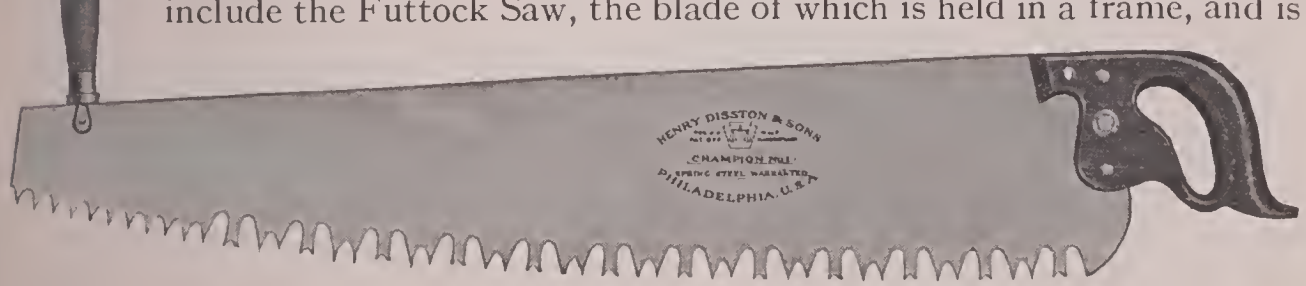
The men who cut the great ice harvests of the country must depend as much on saws as do the lumbermen. Saws especially adapted to the cutting of ice are made in two forms. One, averaging from 3 to 6 feet in length, is used with a Tiller Handle, which has a double grip, and is principally employed for the heavier cutting in the ice-field. The other is made in the form of a hand-saw. This form is convenient for one-man use when resawing of the ice-cakes is required, or where the ice-field is but a small one. These Hand Ice Saws are also used by manufacturers of artificial ice. The teeth of both are the same—extra large, strong and easy-cutting. Reference to illustrations will show how these differ from ordinary saw-teeth.

Under the head of Reciprocating Saws come also the Mulay (or Muley), the Mill, and the Gang Saw—all of which are familiar to mill-men. These saws, while better made today in every particular, are simply the outgrowth of the early types used in the first power mills. These are illustrated on page 27. A comparison of the teeth, will show that they differ more in the purposes for which they are used than in appearance.

The Mill Saw represents the earliest type of reciprocating saw. One is run in a frame, although occasionally two have been run together, but that is the exception. Gang Saws are used in sets of two machines, one for slabbing, the other for finishing the logs. In the slabber about six saws are run together in a frame, three on each side of the log, and the flat gang contains from twenty to forty saws—according to the size of the timber. A number of saws thus acting together save a vast amount of time and labor. Of course, they do not equal in efficiency the Band or Circular Saw, but are still used extensively—especially on tough timber. The Gang Saw is shorter and lighter in thickness than the Mill and Mulay saws.

The Mulay Saw is an upright mill-saw, slightly wider; but not being strained in a frame is capable of quicker reciprocating action. The shape of the teeth is about the same in all these saws, though the spacing in the Gang Saws is finer than the Mill or Mulay.

There are several other saws of special form for wood-cutting that, though not widely used, cannot be overlooked in a history of the saw. These include the Futtock Saw, the blade of which is held in a frame, and is



One-man Cross-Cut Saw

used by hand; the Deal Saw, which is used as a Gang Saw, but is smaller in length than the usual Gang; the Whip Saw, similar to the Pit Saw, but narrower in width, used by shipbuilders for cutting shapes, etc.; and the Drag Saw, a saw which is used horizontally, one end being attached to a rod, or pitman, and the end of the rod in turn attached to the side of a wheel near the rim. The rotating of the wheel operates the rod like a piston and so works the saw with a reciprocating motion. It is usually used to cut logs into various lengths as may be desired. Drag Saws are made in two forms; that is, parallel in width and tapering. The tapering type, lighter in gauge or thickness, is used in a machine, principally for cutting cord wood. There is also a Portable Drag Saw Machine for cutting down trees as well as cutting the logs to mill lengths.

A combination of the Long Saw and the Hand-Saw is found in the One-man Cross-cut Saw. The Teeth in this saw are of regular cross-cut saw design, but the blade is shorter in length, making it adaptable for easy use by one man.

Though the Egyptians are supposed to have cut stone with saws, there is no authentic record earlier than that of the building of the palace of Mausolus —already referred to—about 350 B.C. There is no question, however, that it is a very ancient art. Since those early days the sawing of stone has rapidly progressed, until today the industry is a vast one.

The modern Stone-saw—or saw for cutting stone—exists in a number of forms. The circular type will be taken up later, as we are now considering only saws of reciprocating action.

The ordinary Stone-Saw is fashioned very much after the pattern of a Buck Saw. The blade, however, is toothless, and made of mild steel about ⅛ inch in thickness. In use, various abrasive materials, such as sand, shot, etc., are fed in to do the cutting under the pressure and friction of this blade.

While it may seem an anomaly to *saw* without teeth, since even prehistoric man endeavored to cut teeth in his rude saw, it is not a new idea or discovery. The early American Indian sawed by *friction*, through the use of sand, or a thin piece of material harder than that being cut. Among the ancient Mexicans and other early tribes stones were sawed, shaped, polished, carved, and perforated entirely by friction. It is only another case of the modern saw being the outcome of some ancient form.

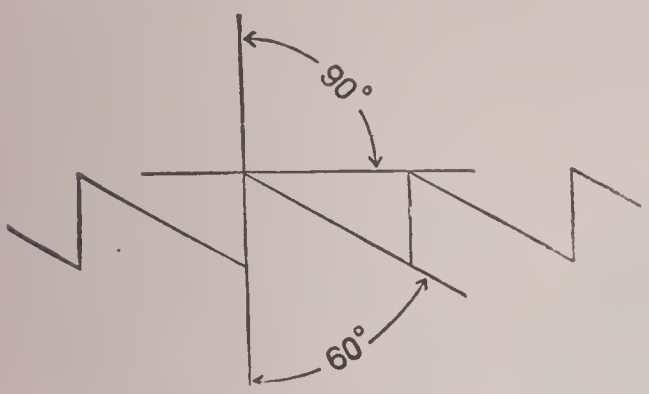
There are machine saws for cutting stone similar to mill Gang Saws—that is, several blades strained in a frame—with the exception that the teeth are absent, and the saws operate in a horizontal position. Sawing, of course, is only one of many ways in which the modern artisan cuts stone, but with these other methods we are not now concerned. Stone saws of the reciprocating type are also made with inserted teeth, in each of which a black diamond is embedded to do the cutting.

In addition to the Chain Saw, and the Subcutaneous Saw already referred to, the surgeon requires many saws for his special work. Nickelplated surgical saws, extremely small in size, are used in operations on the nose and other parts of the body. These saws are made in a large variety of shapes, according to the uses to which they are put; all have exceptionally slender blades.

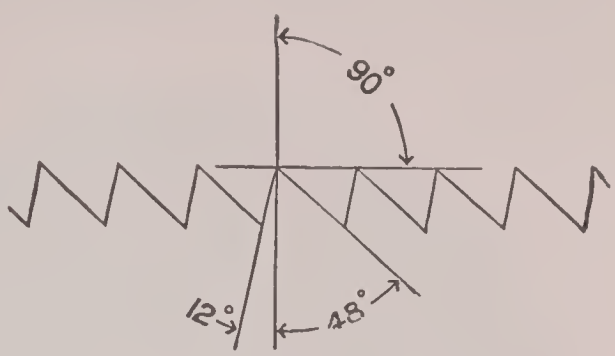
To what extent the usefulness of the reciprocating form of saw has grown is illustrated by the adaptation of this indispensable tool to scientific investigation.

It has long been a problem why some varieties of grain and plants resist the attacks of insects and various plant diseases better than others. This has recently been solved by Dr. F. Stranak, of the Bohemian Technical High School, of Prague, through the use of a tiny, specially constructed saw. The little saw is mounted upon an arm on a delicate machine made for the purpose. By the assistance of a system of weights the exact resistance to the action of the saw can be determined.

This tiny saw, which measures only one-tenth of a millimeter in width,



Rip Teeth, ½" Pitch

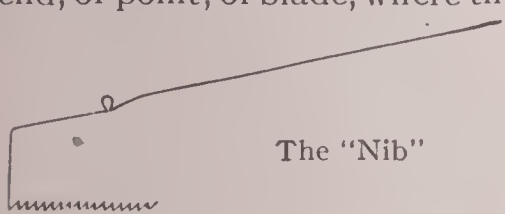


Cross-Cut Teeth, ¼" Pitch

has been arranged to cut the skin of a grain or of a plant stalk much as the jaws of an insect would do. It has demonstrated that a plant's resistance to insects and disease depends entirely upon the hardness of the protecting skin.

As a matter of interest, it may be stated that while there is a general understanding in the hardware trade that Hand Saws are 26 inches long, and Rip Saws 28 inches or longer, this is not carried out by fact. There are a great many Rip Saws made in shorter lengths, such as 22 and 24-inch, for the term "Rip" applies to shape and style of tooth only and not to the length of the saw. Likewise, the Cross-Cut, or Cutting-off saws, may be made in any length desired.

The graduation of the teeth in Rip Saws is for the purpose of enabling the user to start the saw in the work more easily by commencing the cut with the end, or point, of blade, where the teeth are somewhat finer than those at the butt.



The "Nib"

The illustrations show the method of laying-out Rip Saw Teeth and Cross-Cut Saw Teeth. The angles for the teeth remain the same as in these sketches for all sizes of teeth. It will be noted that the Rip Saw Tooth is made with a straight front, while the front of the Cross-Cut Saw Tooth is given a slight pitch, or rake.

Another thing not generally understood in saws is the relation of teeth and "points." On examining a saw it will be noticed that in 1-inch space there is one tooth less than there are "points." Saws are always ordered by the number of "points" to the inch.

Rip Saw Teeth are graduated from butt to point of blade, the narrow end being one "point" to the inch finer than at the butt. The "points" are, therefore, measured at butt of blade.

The question has often been asked: "Of what use is the 'Nib' near the end of a hand-saw?" It is of no practical use; merely serving to break the straight line of the back of the blade and is only ornamental.

Continuous Action Saws

Only the oldest forms of saws have so far been described—the reciprocating types or those principally used by hand to cut on the thrust or pull. We now come to that class which revolutionized the dividing or sawing of large timber into boards, planks, or heavy lumber—continuous action saws, both circular and band.

Circular Mitre Saw

Those who have followed this story from the beginning will readily conceive the saving of time and labor effected by continuous action saws as against the reciprocating type. Moreover, the former not only lessens the cost of making lumber, thus increasing its general use and advancing the industry, but enables the production of more lumber from the log by reason of greater economy in sawing—a thinner kerf reducing the waste in the shape of sawdust.

Gullet Tooth Circular Saw

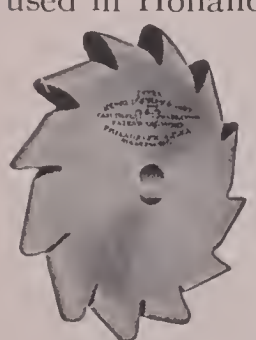
It is reasonable to say that owing to the demand, lumber today would be held at a price prohibitive to the general public were it not for the great improvement in the methods of its manufacture.

The principal types of continuous action saws are the Circular, a rotating disc; the Cylindrical, or barrel-shaped; and the Band Saw, which is a continuous ribbon of steel running on two wheels.

The solid tooth Circular Saw is the first form of continuous action saws, and even today is used to a greater extent than others owing to the variety of its work, though as time progressed the solid tooth gave way, in a measure, to the inserted (or removable) tooth for some kinds of sawing, which will be described later.

To quote from "Grimshaw on Saws:"

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


Special Grooving Saw

"The Circular or 'Buzz' Saw, not having inertia to overcome in revolving, has a higher cutting speed of teeth than the reciprocating, besides the advantage of continuous cutting."

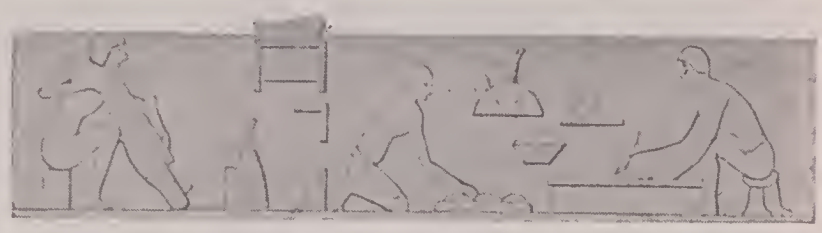
The early type of Circular Saw can hardly be compared with those of today, so great has been the advance in manufacture. Picture to yourself the old style saw, a crude, round sheet of metal hammered flat on the anvil, and with roughly punched-out teeth. Then examine the efficient saw of today, made of a high-grade steel peculiarly adapted to withstand the severe strains to which Circular Saws are subjected, ground on automatic machinery, making the saws *perfectly uniform* in thickness throughout, or giving the blade an accurate taper from thick on the tooth-edge to thin near center, or the reverse. Then, again, this machine may be ad-

justed to grind the saw perfectly flat on one side and tapered on the other. This automatic method of grinding fully insures that true and perfect balance which is also an absolute requisite in a saw for straight cutting when running at a high rate of speed.

It has not been so many years since Circular Saws were run at only one-third the speed they are today. It was, indeed, rough lumber they made in those days. The feeding of the log to the saw was done by the crude "jab," rack and pinion feed, while now steam is used in what is termed "shotgun feed" and "twin engine feed"—producing thousands of feet of well-cut, smooth lumber in less time than it took the old saw-mill to cut a few feet.

The question of high rate of speed brings up an important feature not

Segmented Veneering Saw



Veneering in Egypt. 1490 B. C.

known in the early days, and that is "tensioning" for the speed at which the saw is to run. The earlier saws were made flat and very heavy or thick throughout, many of them being as heavy as No. 3 or 4 gauge, and being run at a comparatively low rate of speed, were not affected by centrifugal force. Consequently they were hammered flat, or without "tension." Whereas, the circular saw of today not only is made much thinner (large saws as thin as 9 and 10 gauge being nothing unusual), but is run at a much higher rate of speed, the present recognized standard being 10,000 feet *rim travel*, where formerly 4,000 feet per minute was considered high. But many saws are run as high as 15,000 feet per minute, but with greatly increased risk to saw and equipment. Therefore, it is so hammered or tensioned that the center is left sufficiently "open" to offset centrifugal force when the saw is revolved up to high speed, thus keeping the edge strained on a true line, otherwise the saw would not run smoothly or cut straight.

Another great improvement is in the tooth. Instead of the ordinary V-shaped tooth, there are hundreds of patterns or special shapes for ripping, special styles for cross-cutting—each made on scientific lines to give the necessary "pitch," and lead into the cut, as well as ample throat room for carrying out the saw-dust to prevent choking; special sizes or number of teeth according to the class or character of the wood to be sawn, and also the amount of feed used.

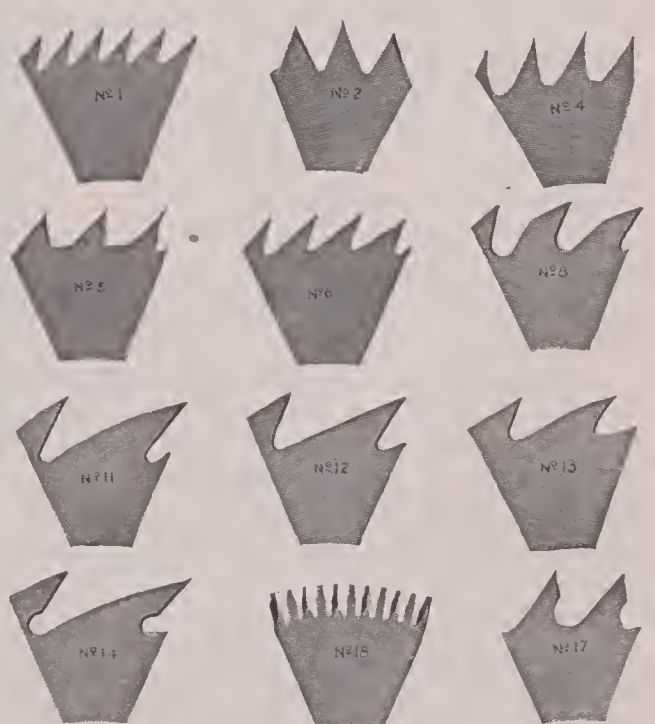
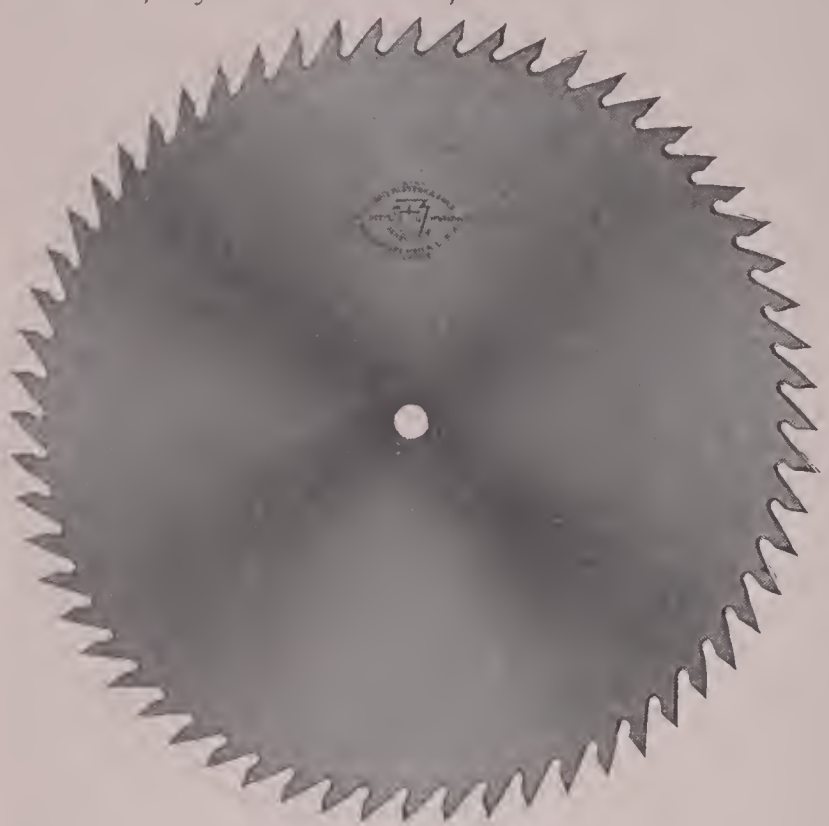


Fig. 23

And further, note in the larger teeth how ample backing is given each tooth for the reason that, in taking a heavier "bite," more strength is required.

An idea originated and patented some years ago by Henry Disston, and one which lengthens the life of the saw, is the gullet tooth. This, when required, being gummed or chambered on spiral lines by a light handworking machine, styled a Gummer, causes considerable saving of the saw-plate, for in gumming, the steel is cut down chiefly in the throat of the tooth in a direction around the blade instead of down and directly toward the center, as is the case in ordinary methods.



Circular Cross-Cut Saw

These advances, made from time to time, are the result of scientific research and experiment, looking to the accomplishment of the greatest results in the shortest time, at minimum power consumption and expense, and last, but not least, the economical sawing of the timber.

As stated before, the solid tooth types of the Circular Saw are the ones most commonly used, for the reason that they are applied to the greatest variety of work. These can be divided into two principal classes—those intended for the sawing of wood, and those adapted to metal cutting. In both these classes the range of sizes is great; the wood-cutting saws varying from 1 inch in diameter to the imposing Circular Saw 84 inches and larger for the sawing of big timber. The solid tooth Circular Saws for cutting metal, while not running in such large sizes (5 feet being usually the maximum diameter, and from that down to 1¾ inches), are notable for the character of work they perform, a feature which will be taken up further on in this history.

Considering first the Circular Saws for use on wood, we will describe, in turn, the different varieties, their forms and uses.

In the front rank, by reason of their size and more general use, are the large Gullet Tooth Saws used in cutting logs into lumber, the important characteristics of which we have described in the forepart of this article.

Shingle Saw and Method of Attaching It to Flange

Reference to Fig. 23 will show some of the general styles of teeth with which solid tooth Circular Saws are equipped. Each one of these is adapted to some special kind of work—ripping or cross-cutting, hard or soft wood—being formed to produce the best and greatest results under proper conditions.

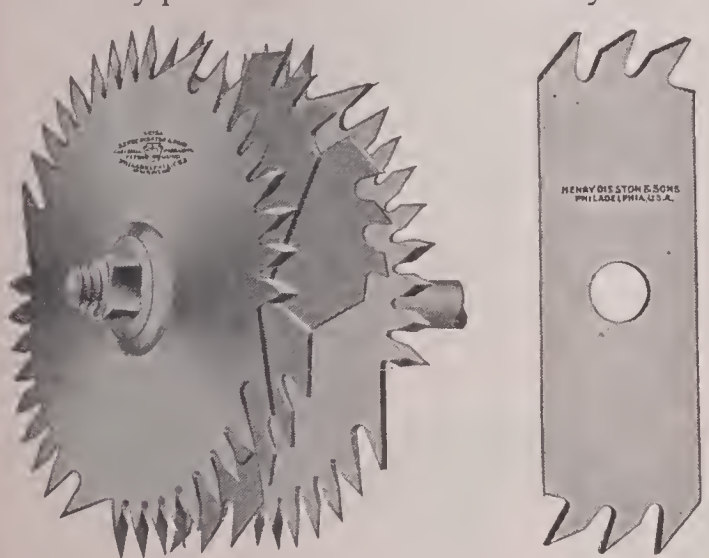
Shingle and Heading Saws, which come in diameters of 30 to 60 inches, are

reinforced on the side away from the block from which the shingles are being cut with a flange or collar. This is firmly attached to the saw blade by means of screws which are countersunk into the blade on the block side. Such saws are used in shingle machines on which shingles are cut from the log or block. Shingle saws are frequently set at intervals around a turn-table. Upon the table as many as twelve blocks are arranged, and as the table turns, one after another the blocks strike the saws and a shingle is snipped off. By this method thousands upon thousands of shingles are cut off in a day.

In cutting shingles with the Shingle Saw the block is pushed against the saw so that the saw begins to cut a thick slab and ends off thin. In the old days, when shingles were split by hand, the work was tedious and slow. After splitting, they used to shave or dress up the shingle to get the taper.

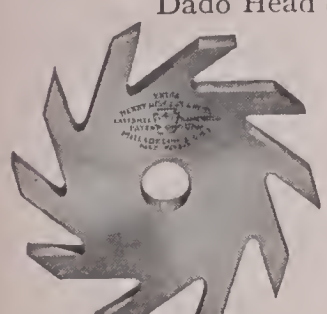
Today the shingles are cut rapidly and in large quantities. The block, being cut automatically, adjusts itself to the saw and the machines need little attention while running.

Of somewhat similar nature, in the fact of their being flanged on one side are the Veneering Saws. These are usually made in segments, ten or more in number, according to size of the saw, and are fastened tightly to the collar or flange by countersunk screws, as in the case of the Shingle Saws. The segments, when new, are from 12 to 15 inches deep, usually 7 or 8 gauge at the heel, and taper to 19 gauge or thinner on the tooth edge. The flat side of the saw is the countersunk side and the bevel of the segments is on the other side of the saw. As the veneer is only ⅛ inch or less in thickness, it readily springs away from the thick part of the flange, thus leaving it practically without friction, which, while less detrimental to the operation of segment saws, is always objectionable. Veneers are necessarily made very thin, consequently, to keep the wasted material at the lowest point, the saws also are made very thin, some veneer saws tapering to 24 gauge. The first circular Veneering Saw to run by power was that invented by Isambard M. Brunel about 1805. He introduced it in the Chatham (England) dock yards and later in his works at Battersea, where it aroused great wonder among visitors. The speed of two-thirds of a mile a minute, which these saws attained, was considered marvelous in those days.



Dado Head or Grooving Saw

Previous to Brunel's invention of the Veneering Saw, veneers were cut by hand with a saw similar to the frame pit saw, but with a thinner blade, one of the sawyers standing in the pit beneath the log. Six veneers to the inch was excellent work with this outfit. Somewhat thinner work was turned out by cabinet makers who used a hand-saw and got seven or eight sheets to an inch. With the machinery and saws of today, however, at least ten sheets to the inch are made and in much less time.

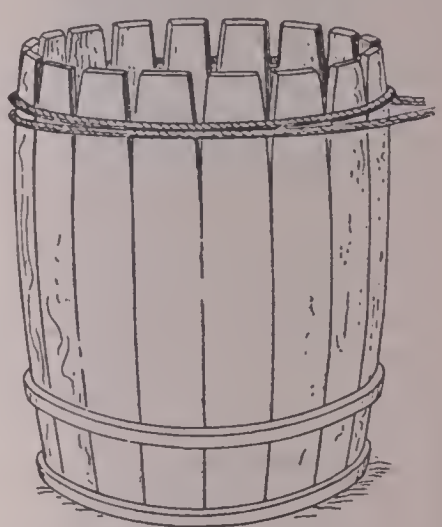

Grooving Saw

It is interesting to note that the Egyptians, whose primitive saws we have described, practised the art of veneering as early as 1490 B.C., during the reign of Thothmes III, who is believed by antiquarians to have been the Pharaoh of the Exodus.

In the illustration on page 33 is seen a man fitting a

piece of red wood to a piece of yellow wood; at least so the original depicts it. He has stuck his adze in a block of the same yellow wood, and in his vicinity are shown his tool chest and square. A man is engaged in grinding something on a slab and another is spreading what is thought to be glue on a board. The glue pot is shown heating on the fire.

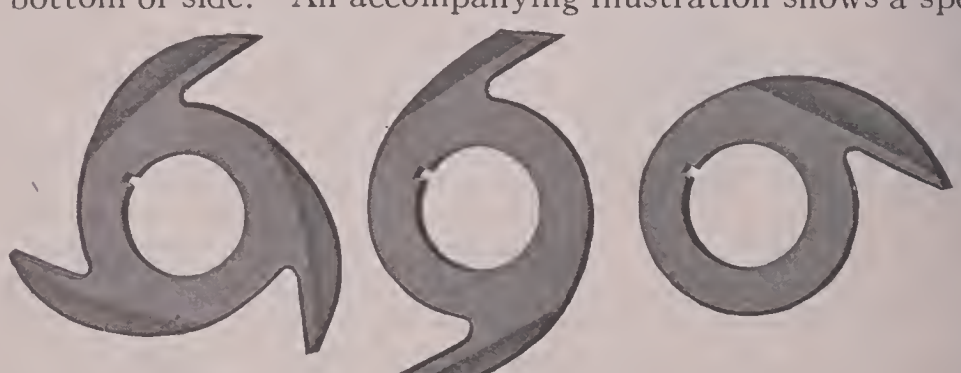
Circular Mitre Saws are a smaller type of the thin-bladed Circular Saw, ranging in size from 4 inches to 2 feet in diameter. These have a special shaped tooth. They are taper ground for clearance; therefore run without set. Such saws are used mainly in cabinet and cigar-box work where a smooth, clean cut is desired. A variation of this saw is fitted with "cleaner" teeth at intervals for faster cutting. For ripping, more of these are inserted than for cross-cutting.



Grooving Saws, as the name indicates, are designed for cutting grooves of various widths and depths. Many styles of special teeth are made in these saws according to the size and shape of groove desired. These saws are usually ground thinner at the centre than at the edge and require little or no set.

It was formerly the general practice to tongue and groove boards on a machine which had a single groover mounted on one end of the arbor, and three Grooving Saws set close together on the other end, The board was passed edgewise over the single groover, to cut the-channel. then turned, and passed on its opposite edge over the three saws, the middle one of which, being of smaller diameter, planed the edge of the tongue. This method is in general use in shops and small mills, but where large quantities of tongue and groove boards are made in stock sizes the work is done with matcher bits. A peculiar variation of the Grooving Saw is the Dado Head Saw, which consists usually of two outside and three inside cutters. This style saw will cut from ⅛ inch to any width desired by the addition of one or more inside cutters. A glance at the illustration will show the make-up of this composite Grooving Saw.

The two forms of Grooving Saw just referred to are the ones in common use. There are many solid grooving saws used, made with either straight or special patterns of teeth to cut grooves of any width, depth, or special shape on bottom or side. An accompanying illustration shows a special Grooving Saw, with round cutting-edge on the teeth, which produces a round bottom groove.



Lock-corner Cutters

It will be noticed, however, that with the solid types of grooving saw a certain thickness of saw must be had to correspond with width of groove to be cut. A number of different size grooves would necessitate a corresponding number of saws, and would entail considerable expense. This very naturally led to extensive experimenting to obtain a thin blade that would cut a groove of any desired width. Several expedients were resorted to, such as the Wobble Saw. This form, now obsolete, was

merely a thin circular saw of small diameter firmly set at an angle on the mandrel; the greater the angle, the greater the width of cut—the kerf being twice as wide as the distance that the top of the saw tilted from the perpendicular.

Another pattern of cutter-head was designed some years ago, working on the lines of the Wobble Saw. It was formed of a thin steel blade, a part of each side being pressed out of alignment. This offset form enabled a *thin* blade to cut a *wide* kerf or groove, and by the addition of one or more blades the width of groove was increased.

This, and numerous other attempts were made to perfect a thin blade cutter-head. The greatest advance, however, was made by the invention of the Dado Head, or Grooving Saw, pictured on page 35, termed the Keystone Groover. It reduces the number of saws required, being adjustable to cut any desired width of groove simply by addition of extra inside cutters.

As previously stated, the Keystone Groover consists of two outside specially toothed, small circular saws, or cutters, varying from 5 to 18 inches in diameter, and three narrow, oblong cutters, toothed on each end.

For cutting the grooves in the ends of boards to be used in making lock-corner boxes special cutters are made, called Lock-corner Cutters. These are of various diameters and thicknesses, and with one, two, or three teeth in each, according to the thinness of stock to be cut. The thinner the stock, the fewer teeth required, two being the average. The number of spaces and the width of the board govern the number of saws used in a set.

It is wonderful to contemplate the numerous different patterns of saws employed in a large up-to-date saw mill, and the variety of purposes for which they are used.

In addition to the large Circular and Band Saws used for cutting up logs, the average big modern mill is also equipped with a combination "Bull" or Rift Gang Edger, regular Edger, Resaw or Siding Saw, Trimmers, Lath Bolters, Lath Saws, Circular Cut-off or Butting Saw and Slashers. Each of these performs its own particular work.

The "Bull," or Rift Gang Edger, is used for sawing 3-inch to 8-inch Cants into Rift Boards, or Scantling. While similar in many ways to the large Gang Edger, this machine is heavier and of greater capacity.

The regular Edger Saws are usually 12 to 28 inches in diameter, and 12 to 8 gauge—that is, 7/64 and 11/64 inch thick respectively. Two or more are mounted on the same mandrel. The boards are fed through the machine by geared or belted feed rolls. The purpose of the Edger Saw is to cut off the bark edges, knots, or defects in the boards, and rapidly to saw them lengthwise to the width required. At the same time the boards can be split into pieces of different grades, which is accomplished by regulating the distance between the saws. This is done by the "edger man," through the medium of sliding collars on the edger mandrel in connection with rack and pinion gears, and hand wheels at the front of the machine. It requires quick judgment, owing to the speed of the machine.

A most serviceable saw in the modern mill is the circular Resawing or Siding Saw. In size it varies between 16 and 38 inches in diameter, and is usually very thin—often only 19 gauge, or about 3/64 inch at the rim. Boards and thin Cants, or Planks, made by the log saw are run through the Resaws and are manufactured into two or more thin boards as desired; the thinness of the blade effecting considerable economy of lumber. The "feed" is continuous, consisting usually of four gear-driven rolls, which not only feed the stock to the saw but serve as a guide as well.

Trimmer saws are made for the express purpose of reducing all manufactured stock as it comes from the saw-mill proper to fixed and uniform lengths.

There are various forms of Trimmers. Of the two most generally used, one consists of a long mandrel with a saw near each end; the saws being mounted on sliding collars that are shifted toward or from the center of the arbor, or mandrel, to cut or trim the ends of the stock squarely, and to the length desired. The shifting of the saws is accomplished by means of sprocket wheels and chains, controlled by the operator through a hand-wheel or crank.

Large Trimmers are made up of four, six, and sometimes more Jump Saws, carried by a frame, and driven from the same shaft. Some machines are made to cut from under the table, while in others the saws are hung above the table. The saws are in gang form, are set 2 feet apart, and by means of a series of either hand or foot levers, or by pneumatic tubes, any two or more of the Trimmer Saws can instantly be brought into the stock to cut any desired lengths.

The saws for these machines range from 16 to 26 inches in diameter, and are usually 10 or 12 gauge in thickness. The boards, or stock, in both forms of Trimmers are carried or fed across the saw table by continuous running sprocket chains.

Lath Bolters are also of the circular saw type, usually about 24 to 28 inches in diameter, and often used in gangs of two or more saws. They are equipped with Rip Teeth, and, as the name implies, are used to rip lath bolts from slabs or other waste lumber. Lath Saws, too, are small circular saws used in gangs of two or more. They are necessary for sawing laths from bolts prepared by the Bolting Saws.

Most mills also have a Circular Cut-off or Butting Saw, which is swung in a frame, and used for cutting timber to length, as well as squaring the ends. In other words, it is used for cutting Scantling and timber to length, the same as the regular Trimmer is used for trimming boards.

Then there are the slashers—Circular Saws used in a gang, and averaging four or more to each set. These are for cutting slabs or edgings into suitable lengths for plastering laths, picket or firewood.

There is also the Swing Cut-off Saw, which is used principally in box factories. It consists of a Circular Saw ranging in size from 12 to 20 inches. This saw is hung in a frame that is hinged to the overhead shafting. The workman, in operating, swings the saw out over a bench upon which the work is supported. The saw passes through a special groove in the bench top. After the sawing is completed, the weighted frame carries the saw back out of the way. The main purpose of the Swing Saw is for cross-cutting boards to various lengths, according to size of the box to be made.

In Double, or "Top," saw-mills, a small Circular Saw called the Top Saw is used in connection with a large Circular Saw, and is mounted above and slightly behind it. Both saws are run at the same speed rim motion, and usually in the same direction. Thus the teeth of the two saws approach from opposite directions and throw the saw-dust clear without fouling each other. The chief advantage of the double mill is that logs of larger diameter can be sawn. On the other hand, the capacity of a single Circular Saw is limited to logs whose diameter is slightly less than half that of the saw. Then, too, thinner saws can be used in a double mill, thus bringing about a very desirable economy of kerf, power and time. Top Saws are made of any diameter desired, ranging from 24 to 40 inches, and are the same gauge or thickness as the bottom saw.

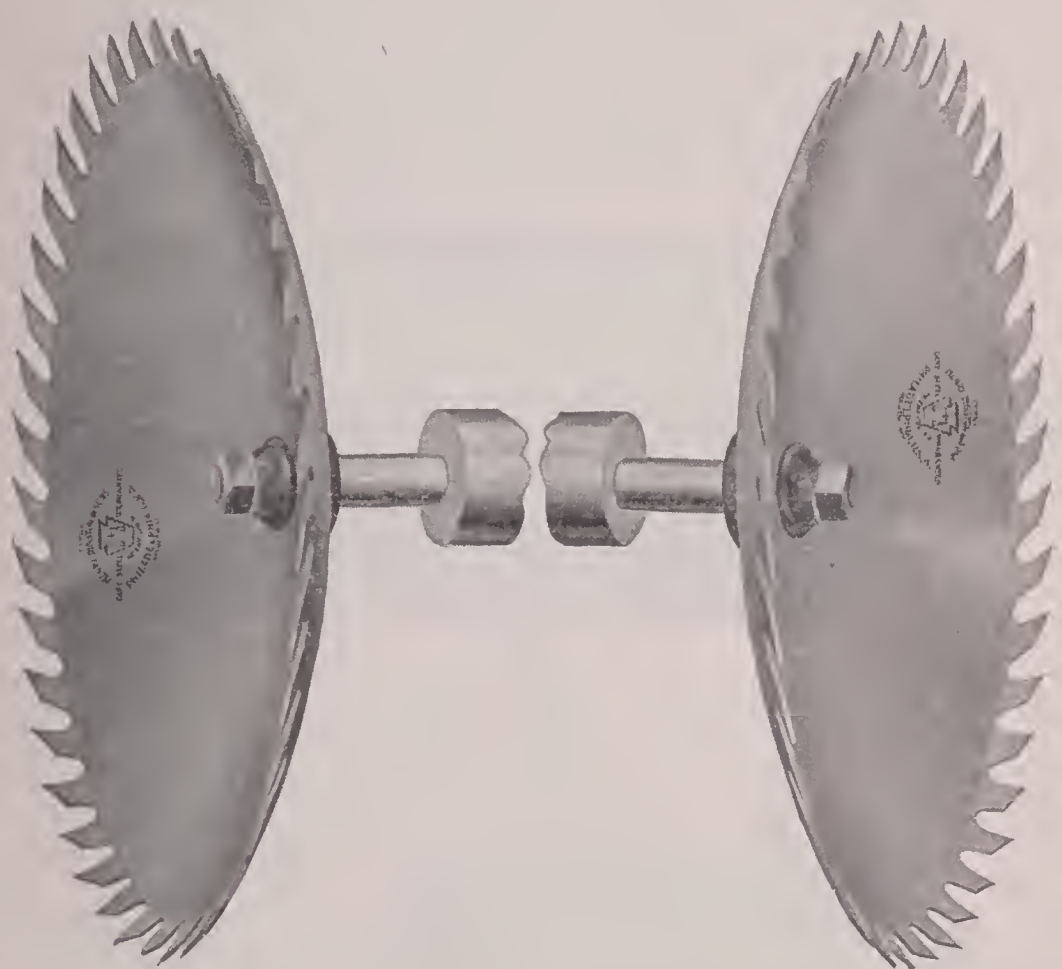
Before Band Saws were being used to the extent which they are today, it was customary to use double saw-mills in districts where very large logs had to be cut. This enabled the use of a smaller under-saw for general work. When a large log was to be cut the top saw did its share of the work.

The wide use of the band saw, however, cutting, as it does, logs of any size, has made the use of a double saw-mill unnecessary.

Circular Saws in various sizes are put to many curious uses. To the average person it will be a strange revelation to learn of the many varied materials which these saws are employed to cut.

Take sugar, for instance. At one time gangs of small Circular Saws were used to cut the large slabs of crystallized sugar into the small cubes that are familiar on every table. Today, however, cube or "lump" sugar is cut from the slabs in cutting machines, the knives of which cut upward and downward at the same time.

CONCAVE SAWS



Left hand Right hand

In addition to the ordinary sawing of wood, metals, stone, and slate, Circular Saws of the solid tooth pattern are also used for cutting Bone, Leather, Talc, Asbestos, Horn, Magnesia coverings, Paper, Cardboard, Fibre, Rubber, Tallow, Fat, Carbon, Soapstone, Mica, Straw, Amber, Shell, Pearl, Ivory, Celluloid, Coal, Ice, Camphor, Raisins, Cotton, Cotton Seed, Cake Meal, and Peanuts. Rock-salt and Hay are also sawn.

The Circular Saw will always play an important part in the manufacture of Lumber, particularly where the timber holding is limited and the timber small. The modern Band Saw, however, through its ability to handle successfully logs of a wide range of girth, manufactures the lumber at minimum expense of kerf, and is most generally selected by the larger operators who have extensive timber holdings.

In describing the modern Circular Saw, we have so far dealt only with that type of solid tooth Circular Saw which cuts a straight line. There is, however, an important group of solid tooth Circular Saws which are constructed to cut on a curved line, thus giving a special rounded shape to the article being made.

This class of saw is indispensable in the cooperage business, cutting as it does the staves, heads, and bottoms of barrels to proper form.

They are made in two principal types—Concave and Cylinder.

The Concave Saw, as its name implies, is dished or hollowed, according to the diameter of the circle to be cut, thus enabling the saw to cut on the arc of a circle. The work is usually placed upon a turn-table, which, as it turns around, carries the stock into the saw.

Concave Saws, as a rule, are made in diameters of from 4 to 20 inches, and of 16 to 12 gauge in thickness. Various other sizes, however, are made on special order. Concave Saws are made either right or left hand. When the observer is standing facing the saw with the saw running toward him, if the "dish" is to the right, it is a left-hand saw; if to the left, it is a right-hand saw.

In cooperage work, the Heading Turner has a Concave Saw, and a smaller, thicker, flat Circular Saw, mounted on the same mandrel. The stock from which the barrel heads are made, usually consisting of several pieces, is held in clamps on the turn-table and rotated obliquely against the saws. The Concave Saw cuts it round, and makes the long bevel at the same time. The small flat saw cuts the short bevel which completes the edge of the barrel head, making it of proper shape to fit the "chine," or V-groove in staves, for retaining head. In the manufacture of wheelwright material, especially in cutting felloes, or wheel rims, two Concave Saws are mounted on one mandrel. In this case the stock is placed upon a table which swings with a pendulum motion. The stock is swung a quarter turn, which brings it into the saw—then back, and in for another cut. In this connection it may be well to state that there are two kinds of felloes. The first is composed of from six to eight segments, sawn to shape. The second is usually made of two pieces, bent to shape. The operation just described, therefore, is used only in cutting small sectioned felloes. As the saws are spaced the desired distance apart, the felloe is cut between them of a corresponding thickness.

Cylinder Saw

Bilge Saw

Concave Saws are employed in the manufacture of chair parts, for cutting the heads for barrels, kegs and bottoms for baskets. In fact, anything to be cut in rounded or curved form. This kind of work was done entirely by hand, or on Jig Saws, before the invention of the Concave Saw.

In many industries Band Saws have replaced this kind of saw to a great extent, better work being done with them. Certain classes of work, however, such as barrel heads, can only be made with the Concave Saw. As a matter of fact, cooperage concerns could not use a Band Saw successfully for barrel-making.

The next group of saws in this class is of the Cylinder type—the Straight Cylinder, the Bilge, and the Bottom Saw. With slight variations these are made along lines quite similar to one another. As alluded to in the earlier part of this history, while the cylinder type of saw is of very early origin, Sir Samuel Bentham, who invented many of the prototypes of modern saws, among others originated the modern Cylinder Saw about 1804.

It consists of a steel shaft, and cast-iron head. Upon the head is screwed a drum, or cylinder, of high-grade iron or good machinery steel. To this main drum is riveted and soldered a narrow, specially hardened and tempered cylindrical steel band, a few inches wide, in which the teeth have been cut.

Where the steel band, or cutting part of the cylinder, is attached to cylinder proper, special beveled "lap" joints are employed so as to make the entire surface of the cylinder straight, smooth and uniform.

This steel band is gradually reduced in width by successive refitting, or sharpening of the saw. When reduced to such an extent that the cylinder in its entirety is too short to accommodate the length of staves to be cut, that part of the cylinder is removed by replacing with a new steel band to bring the cylinder back to its original and desired length. This process is called re-steeling.

The mandrel, or shaft, which is always of the heaviest and best material obtainable, extends beyond both ends of the cylinder to allow for bearings. In sawing, the "bolt," or stock, from which the staves are cut, is clamped between two "dogs," attached to and a part of the carriage. The carriage travels on tracks, one outside and the other inside the cylinder. The "bolt" or stock, clamped on the carriage, is then pushed against the cutting edge of saw, the stave drops into the stave-holder attached to carriage and is drawn out automatically by the return movement of the carriage.

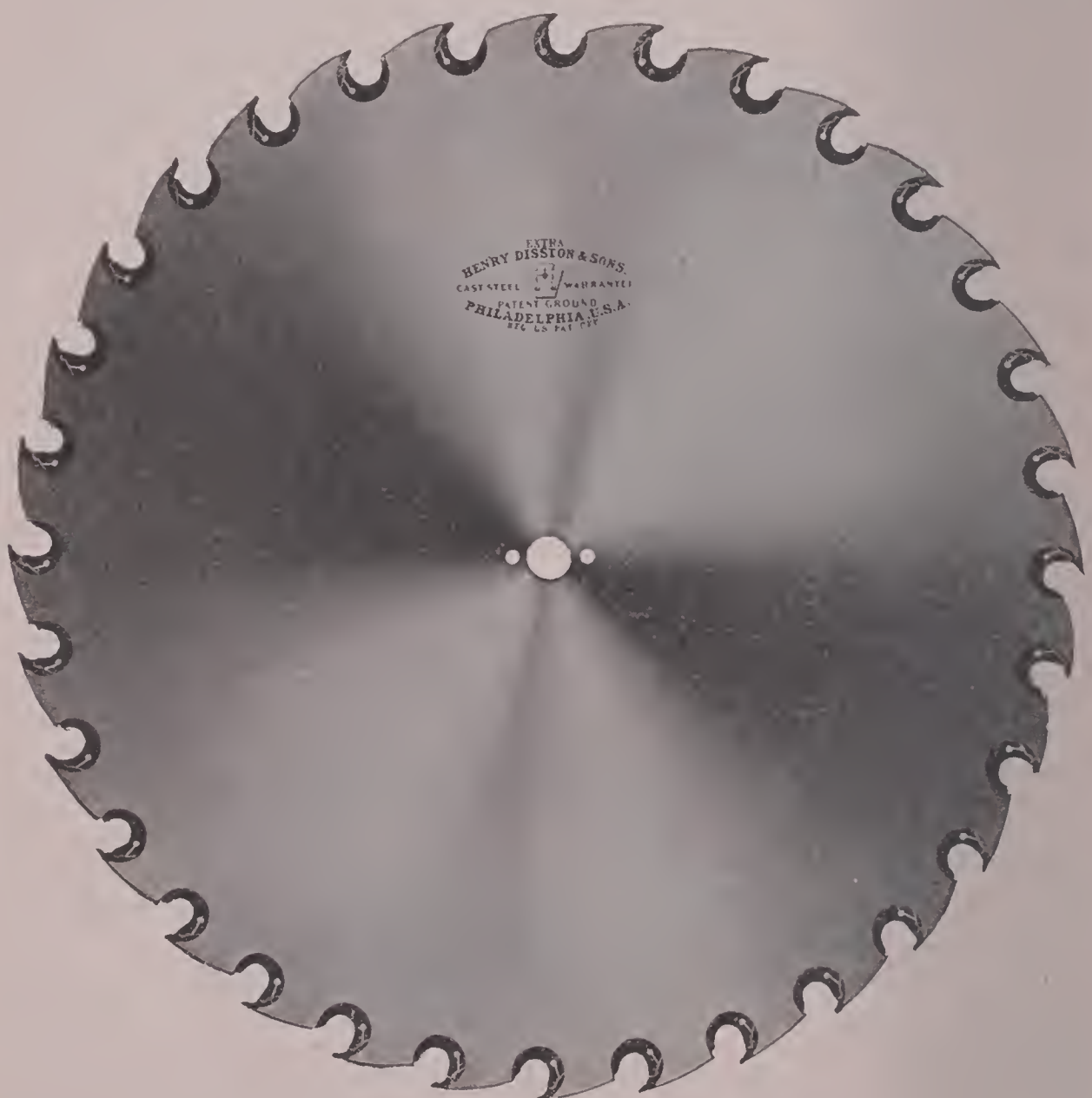
In this group of saws the first in importance and general use is the straight Cylinder Saw, which is used for making tight barrel staves for barrels that are to hold liquid. For cooperage work this is made with practically the same diameter as is desired in the finished barrel, and of sufficient length to cut the proper size staves. The straight form of Cylinder Saw has the walls of the drum, or cylinder, parallel with the mandrel for the entire length. Of course, this is used exclusively for cutting staves that are straight lengthwise, but are rounded crosswise to suit the circumference of barrel being made.

For cutting the familiar rounding, or bulging, staves, a Cylinder Saw called the Bilge Saw is used. The Bilge Saw has an outward bulge, beginning at the ends, and gradually increasing in diameter toward the center, which shape is imparted to the stave being cut. With the exception of its bulging form and smaller size, the Bilge Saw resembles the straight Cylinder Saw in every particular. It is used for making staves for small kegs, such as nail kegs; and, owing to the shape of the saw, leaves a bilge in the stave, thereby saving stock. Contrary to general belief, the Bilge Saw is not of recent origin. There was patented in 1832 or 1833 a Bilge Saw with inserted teeth.

Another form of the Cylinder Saw is the Bottom Cutting Saw. Though of the same type, it is much shorter, being constructed of a narrow, toothed cylinder, or band of steel. This steel band is formed to the diameter of the bottoms to be cut, and is screwed to a round cast iron head. The saw revolves on a vertical mandrel, the end of which is set in the center of the head, and in addition to the rotary motion has a sliding up-and-down movement. It is used

exclusively to cut bottoms for barrels, kegs and baskets. The stock to be sawn is held on a horizontal table, and the operator, pressing a lever, brings the saw in contact with it. The teeth cut at all points of the circle at the same time.

There are a number of saws of the Cylinder type manufactured for special purposes other than those of wood-working. For instance, Henry Disston & Sons, in the year 1908, made the largest Cylinder Saw ever constructed, and intended solely for cutting stone. This big Cylinder Saw was 8 feet 9 inches in diameter, and 30 inches wide. It had 68 teeth, each of which contained a



Inserted Tooth Circular Saw (see next page)

diamond. This saw cut large stones into curved shapes for arches, and saved an immense amount of hand labor.

Another variation of the Cylinder Saw on a small scale is the Button Saw. This saw goes to the other extreme, being quite small, and, as its name signifies, is used for cutting button blanks out of pearl and bone. While cylindrical in form, it is not joined. A long, thin, tapering wedge is inserted to retain the shape, the blank end being slightly larger than the toothed end, thus permitting the button blanks to pass freely through the cylinder and drop out. The

length is usually from 3½ to 4 inches, while the diameter depends upon the size of button to be cut. In use this saw is fastened in a lathe.

Surgeons use a similar small saw, revolved by hand, for removing portions of the human skull when it is necessary to relieve pressure on the brain. This form for surgeons' use is called the Trephine or Crown Saw. Trephining or Trepanning is one of the oldest surgical operations known. History tells us that Hippocrates used a Cylinder Saw of his own invention for this purpose over 400 years before the Christian era.

The foregoing closes the history of the general types of Solid Tooth Circular Saws.

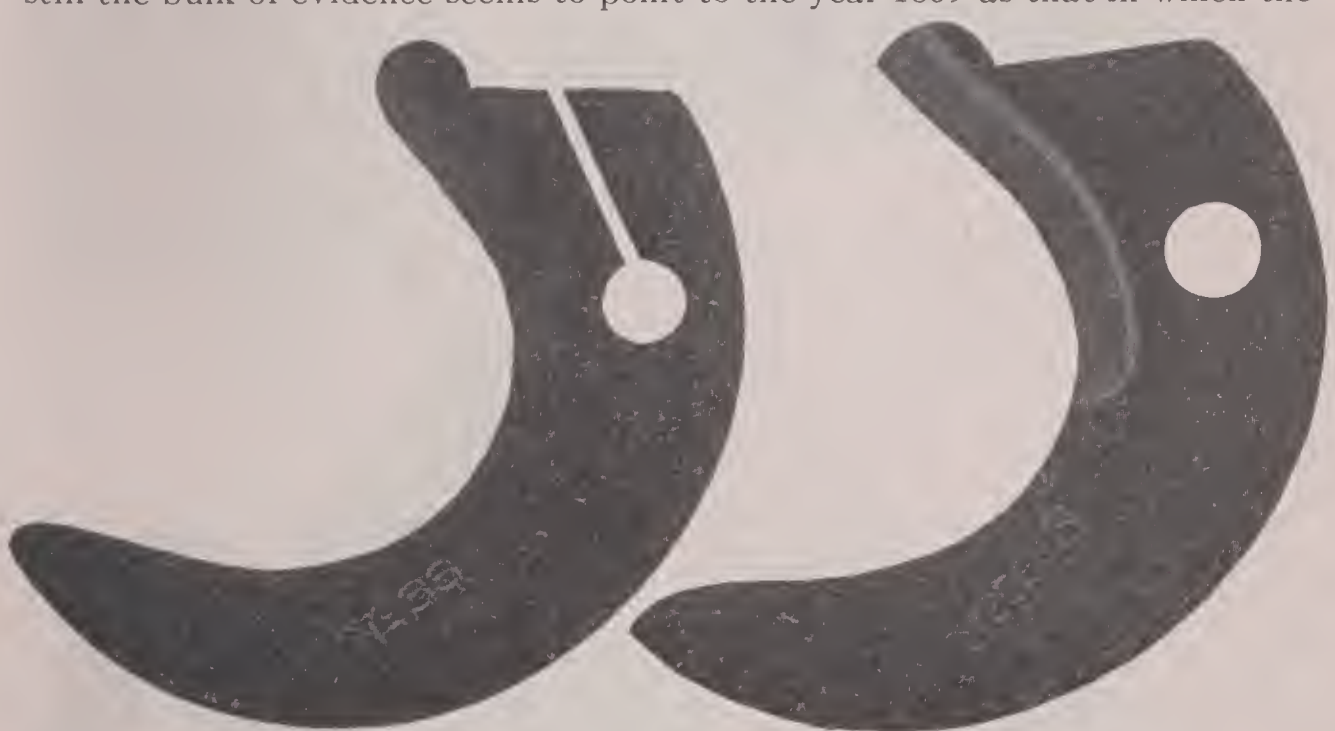
Continuing on Circular Saws, those with inserted teeth will be dealt with next.

That class used for cutting wood will be first described. Later on the Circular Saw of the inserted tooth type for cutting metal will be taken up.

The introduction of the Inserted Tooth Circular Saw was almost as great an advance over the Solid Tooth as the step from the reciprocating saws to those of continuous action.

It is for this reason that among distinctly modern saws the circular saw with *inserted* teeth occupies a prominent place. Reference to the illustration on page 15 will show the variety of ideas finding expression in the early types of teeth. The patent records show that the first generally known inserted teeth were those invented by Kendall, in 1826, as already referred to. These were very narrow strips of steel set in the edge of the saw plate, and held in place by hammering a burr on opposite sides of plate. A hole was cut in the saw plate in front of each tooth, to catch the sawdust and carry it out of the cut.

Although this is the earliest record of the detachable or removable tooth, still the bulk of evidence seems to point to the year 1839 as that in which the



Swaged and Slotted Holder

Ribbed Swaged Holder

inserted tooth had its real beginning. The greatest advance was not made, however, until 1859, when, as described previously, Spaulding, while experimenting at Sacramento, Cal., discovered the principle of inserting the teeth on curved lines.

The steady growth of the use of inserted tooth circular saws for lumber-making is due to its many advantages, the foremost of which is the fact that

the original diameter of the blade is always retained, whereas the repeated sharpening of the solid tooth saw gradually reduces its size and reduces its tension, necessitating more frequent hammering, until finally the blade becomes too small for use in sawing logs of the larger diameters.

With the inserted tooth, the amount of filing is reduced to a minimum, thus saving machinery, time, and files. When the teeth (frequently called "points" or "bits") become worn out or broken by accident they are replaced with new ones, an operation which consumes but little time, and can be done while the saw is on the mandrel.

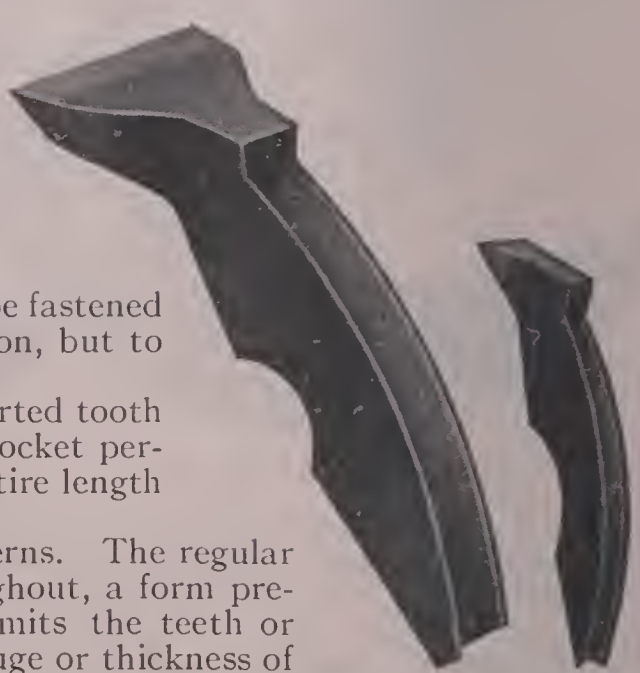
The gullet or throat room is also a vital point in large saws, for upon this depends the amount of "feed" which the saw can carry. If this dust chamber is not sufficiently large or properly formed the sawdust will not be carried out of the cut and the saw will "choke down." On this account it is highly important to have perfectly formed gullets, though it is not always an easy matter to form them—especially when proper tools are lacking—so it will be seen that the absence of the necessity for gumming an inserted tooth saw is another excellent feature.

Another important item in the inserted tooth saw is that the teeth being separate from the blade provides the opportunity of hardening them to a greater degree, thus insuring more durable and lasting cutting edges. The teeth are made in various patterns—certain forms being best adapted for sawing hard wood, and others for soft wood.

The chief difficulty experienced in the manufacture of inserted tooth circular saws was in the endeavor properly to secure the teeth in the saw plate, and to do so without interfering with the tension, or distorting the blade. The difficulty can readily be appreciated when it is remembered that the saw revolves at a high speed, and is subjected to great strain in the working; that not only must the teeth be fastened so they will not fly out while in motion, but to withstand side strain.

Improvements in the Disston inserted tooth saws provide a holder which fits the socket perfectly and rests on the blade for its entire length when the tooth is in place.

Holders are made in several patterns. The regular holder is of an even thickness throughout, a form preferred by many millmen, since it permits the teeth or bits to be worn down close to the gauge or thickness of the saw.



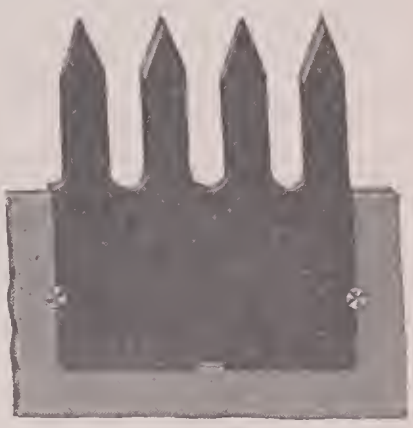
No. 1 No. 4½

Another style is swaged in the throat, a gauge and a half heavier than the saw plate proper. This style is serviceable for the cutting of frozen timber, as the swaged holder keeps the cut free from the dust which sometimes passes down the sides of the saw and freezes to the log. Still another pattern, much heavier at the throat, is termed the ribbed swaged holder, and is used quite largely on the Pacific Coast.

Holders of the slotted pattern are made for those who prefer that style—the purpose being to give them greater elasticity.

In these inserted tooth saws an inverted V-shoulder is milled in the socket which fits into a corresponding V-shaped groove in the holder and bit, which form of design, together with the spring of the holder itself, secures both firmly in place.

For the insertion, or removal, of the teeth and holders a special wrench is furnished, by means of which the work of exchanging worn or damaged teeth is performed in a few minutes.



Four-Prong

The Disston Chisel Tooth Saws (a type of inserted tooth) are made in the various gauges and ten different sizes of teeth, each having various widths of cutting edges; they are made suitable for a feed of ½ inch to the revolution of the saw, or for the heavy steam and shotgun feeds employed in cutting the largest timber.

The great variation in the size of circular saws with inserted teeth is well pictured in the illustration on the preceding page, which shows the largest and smallest types regularly made.

The small tooth is a No. 4½, which is 13 gauge, with 3/16-inch cutting edge, and the large tooth is a No. 1, 3 gauge, ⅞ inch on cutting edge—the latter being used only for removing the bark and gritty surface in advance of the saw doing the cutting.

The inserted tooth pattern is also adapted to gang edger saws, lath bolter saws, knee bolter saws, lath saws, clapboard saws, boxboard saws, bench saws, grooving saws, and for many other special purposes which thoroughly demonstrate its usefulness and popularity.

The Chisel Tooth Saws referred to in the foregoing are used only for ripping, or cutting *with* the grain. For cross-cutting, *i.e.*, cutting *across* the grain,

Method of Using Chisel Tooth Wrench

a different style of tooth is necessary by reason of the fact that in cutting *across* the grain the fibres of the wood must be severed, which requires a knife or shearing cut to be made.

The Disston spiral inserted tooth Cut-off Saw is the latest development in the way of a rapid smooth cutting and easy driving cut-off saw, and has proved superior to any other form of cut-off saw of inserted tooth type manufactured. The teeth are inserted in the blade on spiral lines, which not only gives full clearance to each individual tooth, but also gives the entire blade perfect clearance in the largest cuts.

The manner in which the teeth are inserted in the plate does away with the necessity of setting or springing the teeth for clearance. Sharpening is the only operation for keeping the saw in running order. As will be seen in the accompanying illustration, the inserted tooth circular cross-cut saws are fitted with sections containing two or four prongs, or teeth. These teeth are designed for use only in saws 36 inches and larger in diameter. They are made in 5, 6, 7, 8, and 9 gauge only.

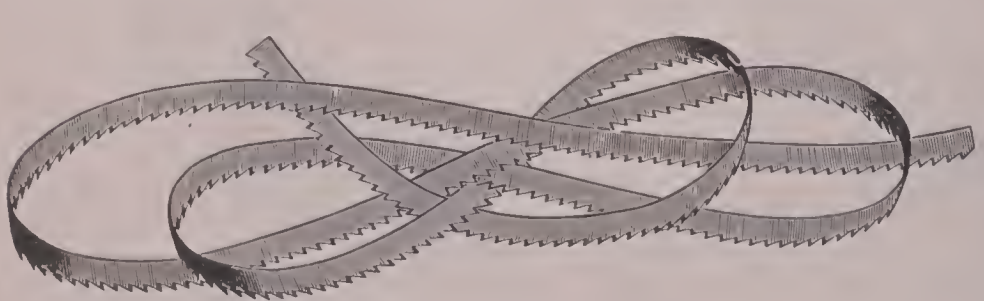
This style of saw is particularly adapted for use in stave mills; also for Slab and Slasher Saws, and for all mills where logs or cants are cut into short lengths or bolts.

In the line of special work, inserted tooth Circular Saws are also used for cutting slate, limestone, coral, ice, slots in corrugated paper, etc.

The leading type, however, as known today is the large inserted tooth Log Saw, the average being 60 inches in diameter, although made in various sizes from 12 to 72 inches and larger, and varying in thickness.

The latest development in this type of saw is known as the No. 33 and No. 44 Chisel Tooth Saw. This design embraces new ideas in the method of holding the bits in place, by which they always stay central; there is no lateral motion of the shank, consequently the saw runs better, cutting smoother lumber, while the possibility of the points starting forward in cutting frozen timber is entirely eliminated. There has been no change in the sockets of either the No. 3 or No. 4, the new Nos. 33 and 44 fitting same perfectly. Owing to the formation of the improved wrench for these new bits and holders they are under better control and can quickly be inserted in the plate.

To those not familiar with sawing, the modern inserted tooth and solid tooth Circular Saws seem ordinary looking implements. A more intimate acquaintance, however, brings out the fact that they are made on scientific lines, the speed and feed at which they are to run and their work being predetermined. For instance, there is a relation of the hook, pitch, or rake of the tooth to the periphery line, the clearance on the back if not sufficient would cause the saw to knuckle or rub in the cut (*i.e.*, top of plate would rub the log).



Narrow Band Saw

If the cutting edge of tooth stands too high it would have a tendency to tear the wood instead of cutting free, and this is likely to cause the teeth to break. Taking a 48-tooth saw, cutting 3-inch feed, at one revolution of the saw each tooth would cut 1/16 inch, while, if the same saw were running at 6-inch feed the saw would consequently be taking a bigger "bite" and each tooth would cut ⅛ inch per revolution, but on account of the heavier bite it is necessary that greater clear-

Double-edge Band Saw

ance be given the teeth; in other words, the teeth should be pitched slightly higher.

The inserted tooth Circular Saw today has reached a high state of efficiency. Given a proper equipment and sufficient power, skillfully controlled, it will never be supplanted in its line by any other type of saw.

The Band Saw stands pre-eminently at the head of modern Continuous Action Saws, both in size and usefulness. The great lumber industry, to which the world owes so much, places its dependence largely upon the capacity and efficiency of this type of saw.

Band Saws, which today range in size from ⅛ inch to 18 inches in width, are familiar to almost everyone. They consist of an endless band, or ribbon of steel, usually toothed on one edge. They are also made with both edges toothed. This is generally done in the case of large Band Saws, although double edge Band Saws are sometimes made in widths as narrow as 8 inches.

The band is run over two wheels, or pulleys, which, except in the case of horizontal Band Saw Machines, are set one above the other, and spaced some distance apart.

In using small Band Saws the work rests upon a tilting, or adjustable table, through the center of which the saw passes, the work being fed by hand.

For general work, the blades are made as narrow as ⅛ inch, and from that are graduated up by eighths to 1⅞ inches, saws up to this width being considered "Narrow Band Saws." The length is usually 18 feet, and longer, according to the size of the machines on which they are used.

The fact that with a narrow Band Saw circles or other curved lines can be cut in any desired direction, makes it available for use in cutting intricate and ornamental patterns. Where formerly scroll sawing was done entirely by the Reciprocating type—Web or Scroll Saws, working up or down, and Compass Saws—now the narrow Band Saw is being widely used with excellent and greater results. Its downward motion carries the sawdust away without the aid of a blower, leaving the lines drawn on the work perfectly clear to operator.

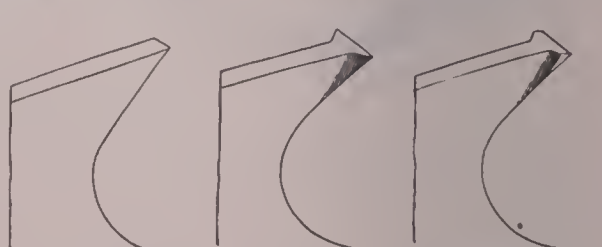
It is understood, of course, that Band Saws can be used in this connection only in cases where the pattern is begun on the edge of the stock; for interior designs it is necessary to use a Reciprocating Saw (Jig Saw), the end of which can be passed through the interior of the pattern.

The Band Saw has superseded the Circular Saw in several lines of work. It has many advantages over the Circular Saw—especially in that class of sawing where its very thin blade makes it desirable. Band Saws from 2 to 8 inches, in some cases 10 and 12 inches in width, are extensively used for ripping and resawing, for, compared with the Circular Saw, they save kerf, time, and power.

Log Band-Saw (coiled)

This leads us to the consideration of the Band Saw as related to the sawmill. Before its introduction there was a limit in the size of timber which could be sawn by Circular Saws, which could cut only logs of a size slightly less than half the diameter of the saw. The size of the saw itself was also limited; difficulties of management and running arose as soon as the saw diameter was increased beyond a certain point.

Double mills were used to a great extent in regions where large timber was being cut. By this arrangement, which consisted of two Circular Saws, one above the other, logs of an ordinary size were sawn with the larger, or "main" Circular Saw, while the smaller, or "Top Saw," was brought into action when a log exceeded the capacity of the main saw. The Band Saw obviated all this, for there is practically no limit to the size of logs which can be cut by Band Saws.



Spring Set

In large Band Mills, as a rule, the work is brought to the saw upon a carriage driven by feeding devices independent of the saw, although there is a rig being placed on the market where the saw travels to the log.

Compared with the Reciprocating Saws formerly used in sawmills, such as Mill, Gang, etc., the Band Saw has the advantage of steady and continuous cutting action, no time being lost in a return stroke. However, gangs of Reciprocating Saws, by reason of their ability to cut as many as 30 boards at one time, are still retained in numbers of large mills as an adjunct to the Bands.

When one considers the value of every 1/16 inch saved in kerf in the course of a day's sawing of several hundred thousand feet, the great economy in using the thin blade Band Saw over the Circular Saw can be more fully appreciated.

Large Band Saws for log sawing range from 8 to 18 inches in width. The general width for single-edged Bands is 12 inches, while double-edged Band Saws (*i.e.*, toothed on both edges) are made in a variety of sizes. The majority of these latter, however, are about 14 inches in width, although, as previously stated, some few are made as narrow as 8 inches.

The length of the standard log Band Saw varies, according to size and make of mill, from 40 to 60 feet.

Although the practise of toothing both edges of a Mill Saw blade (Reciprocating type) dates back to the sixteenth century, it is a feature that has never been extensively employed until quite recently. Double-edged Band Saws are now used frequently and the log can be cut as it moves in both directions—going and coming—thus adding materially to the output of the mill.

The swage set is principally used on Log Bands and Resaws. Swaging the teeth consists of spreading or widening the cutting edge of each tooth so that it extends slightly beyond each side of the blade, giving clearance to the body of the saw while cutting. Sufficient clearance prevents friction and insures free running. Then, too, with the swaged tooth both corners of the tooth cut, consequently it will not only do twice as much work as a spring-set tooth, which merely cuts half a kerf, but, in addition, it will stand more feed, thus greatly increasing the capacity of the mill. Small, narrow Band Saws, on the other hand, are always fitted with a spring-set. With the spring-set the point of one tooth is bent to the right, the next to the left, and so on alternately throughout the length of the saw. This effects the necessary clearance.

Some time ago Henry Disston & Sons made several inserted tooth Band Saws for sawing stone. One of these was 45 feet 6 inches long, 8 inches wide, and contained 273 inserted teeth, each with a diamond embedded in the point. The teeth of these saws were small—only ¾ inch in length—and cast around the diamond points. They were of a square form, fitting into square sockets in the saw plate.

These, however, have not been sufficiently tested to warrant an opinion as to their general adaptability in this line of work.

The Band Saw has reached its highest form of usefulness in its present employment in gangs. There are several mills in this country and Canada using gangs containing two or more machines. Two of the largest gangs today consist one of four and the other of five Band Saws, used in resawing.

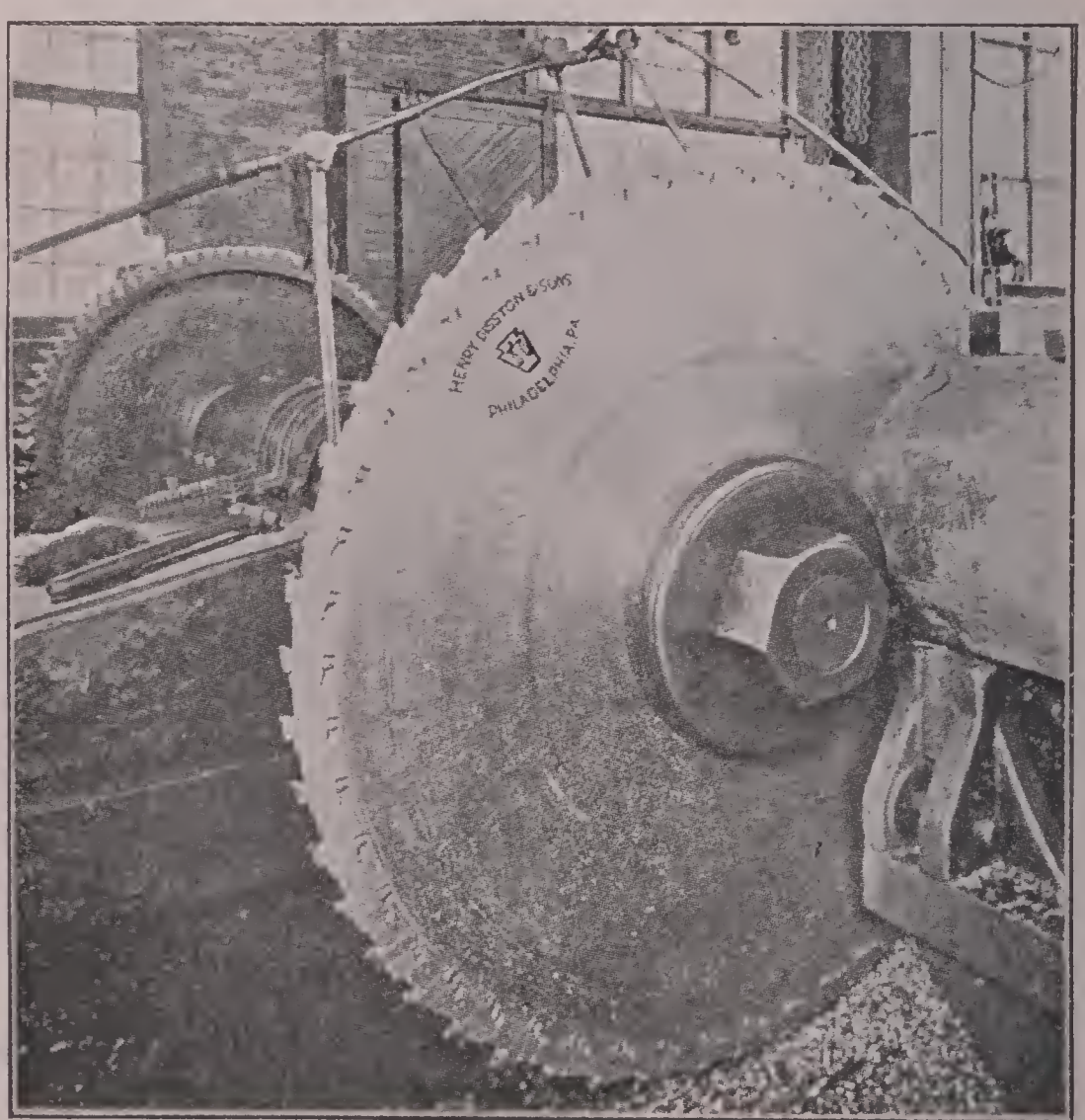
A feature of one of the mills is the band gang made up of five 6-foot band rigs, carrying 10-inch saws, cutting ⅛ inch kerf. These bands are set one back of the other, tandem, with their bases movable, permitting the sawing of any thickness of lumber desired. For instance, if 2-inch "stuff" is being sawn and the sawyer desires to change to 1-inch he does so by operating a lever con-

trolling a valve on the compressed-air cylinder. The cants are fed through the band gang on live rolls running vertically, those in the rear of the table being stationary and those on the opposite side movable to allow the admission of different-sized cants, an unique arrangement of press rolls. The rolls on the front side, in addition to feeding the cant through, hold it up tight to the vertical table or straight edge by air pressure.

The Band Slabber is made of two Band Saws, a right and left, through which the log is run, a screw mechanism being used to adjust the saws according to the size log to be cut. The log to be cut is dropped into a V-shaped trough, which automatically centers it, while an endless chain feeds it to the saw. As it passes between these two saws the two sides are taken off simultaneously.

Mills are known as Right or Left-hand Mills, according to the side from which the log is fed to the saw. In ordering a Band Saw it is always necessary to state whether it is for a Right or Left-hand Mill. In a Right-hand Band Saw the teeth run down to the right as you stand facing the teeth, and the reverse in a left-hand saw. This is accomplished in a very simple manner by turning the ends of the band either to the right or left before making the braze.

Band Saws, like Circular Saws, are employed to cut a great variety of materials in addition to wood. Among these are: Slate, Fibre-board, Paper, Bone, Meat, Hard Rubber, Ivory, Asbestos, Magnesia, Horn, Amber, Cloth, Bronze, Brass, Copper, Aluminum, Nickel, Iron, Steel, Carbon, Ice, Celluloid, Talc, Camphor, Mica, Pearl, Shell, and Cardboard.



26-inch Blade, Bar Cold-Saw Cutting-Off Machine for Cutting Metal

When you consider that the modern Band Saw travels at the speed of about 1½ miles per minute—or faster than the fastest express train—that in connection with its width it is extraordinarily thin, you will have some idea of the strain to which it is subjected, and a better conception of the wonderful quality of the steel that has made the production of these saws possible.

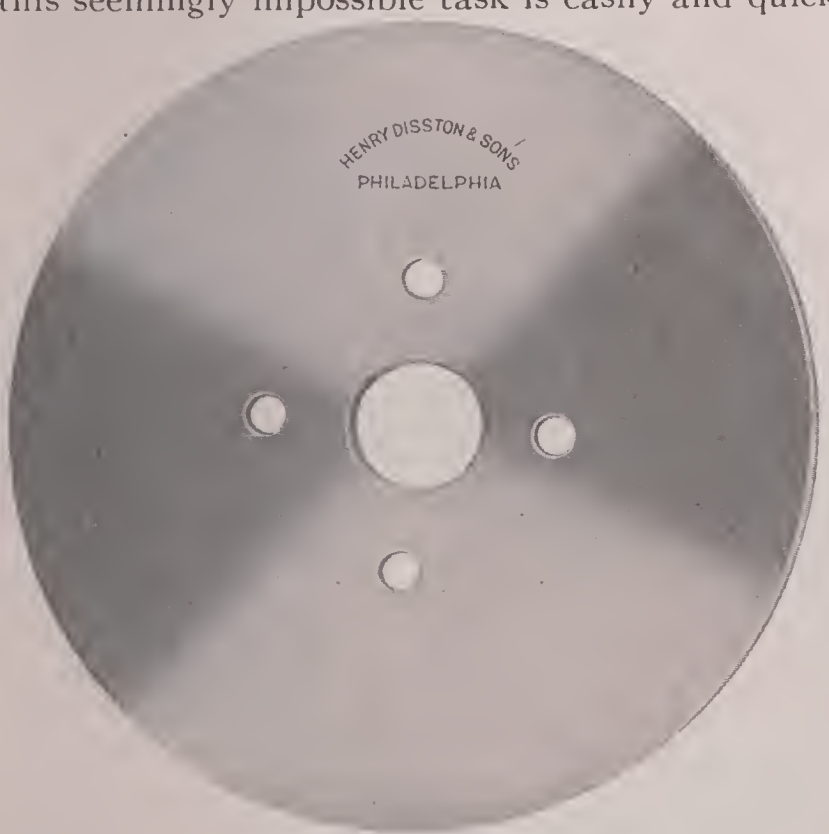
The Band Saw, which remains today in practically the same form as when invented, is still the last word in saw efficiency. It is in the perfecting of a suitable steel to withstand the successive bending and straightening while in operation, the making of a proper joint or "braze," and the improvement in the form of the teeth that modern advances have been made.

It is hardly safe to predict what may be developed in the way of improvements to the saws at present manufactured, but it is difficult to conceive of anything which will surpass the material, construction, and operation of the Band Saw as now used, and to Henry Disston & Sons is due, in no small measure, the final attainment of this high efficiency.

Previously were described those types of saws—both reciprocating and continuous action—employed in sawing wood; also certain reciprocating types for metal cutting, viz.: Hand Hack Saws.

The next in order and final group is that class of Metal-cutting Discs and Saws of continuous action, driven by power.

Powerful and rapid as may be the action of saws in severing wood, still it is not so strikingly wonderful nor so appealing to the mind mechanically inclined as is the cutting or dividing of hard metals by means of a saw blade. To the uninitiated it would seem an impossible feat for a revolving, comparatively thin blade to drive its way through a mass of iron or steel without being shattered or stripping off the teeth. But such has been the advancement in the construction of these saws and the steel used in their manufacture that this seemingly impossible task is easily and quickly performed.

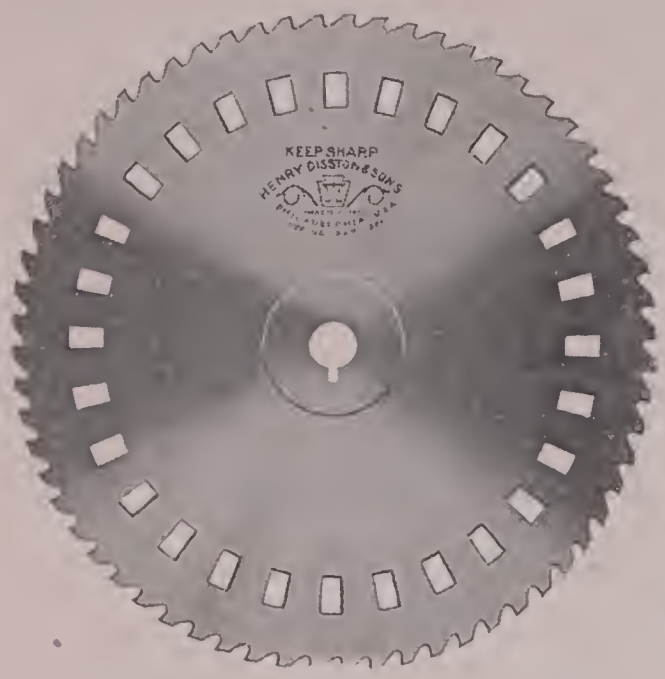


Circular (Friction) Disc

It is not so many years ago that the working of metal to size was done by what would now be considered a very crude, laborious, and expensive method. It was usually done in a blacksmith shop, the smaller work being forged to shape, the larger sheared off and dressed up with a file, while in such cases where joints or mitres were required on beams, girders, etc., the work was sheared to length, the required angle then cut on a planer or shaper. This method afterward gave way to the adoption of special shears, though this did not give an accurate angle and necessitated further work of dressing off. All of these methods consumed considerable time.

The use of the Circular, Band, and Hand Metal-cutting Saws has rendered possible to a greater extent the employment of metals in the trades, as modern

appliances for shaping and cutting with this class of tool have reduced to a nominal figure the hitherto prohibitive cost, the work now being done with comparative ease.

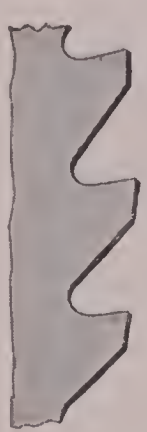


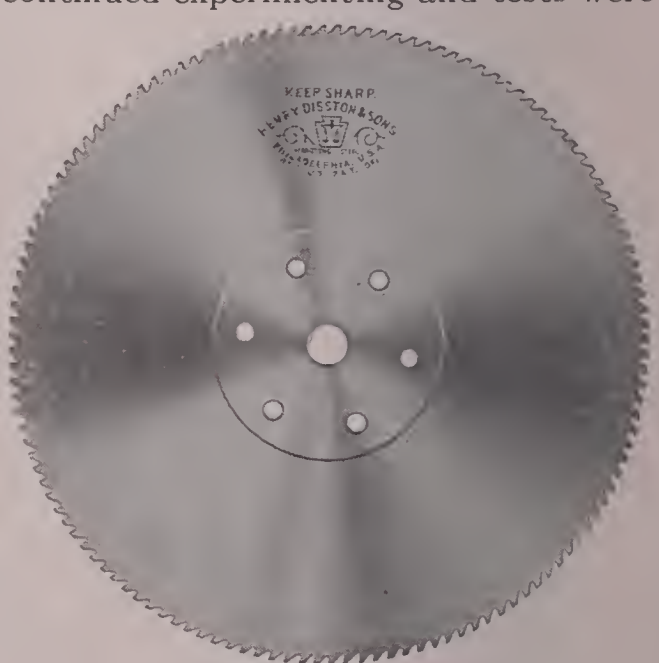
Special Milling Saw: Sprocket-drive

As iron and steel construction work, etc., increased, corresponding improvements were made in the manufacture of saws looking to greater efficiency and durability. This, in turn, necessitated the making of a steel which, when manufactured into saws, would withstand the tremenddous heat and shock of cutting metal, and still retain its temper and cutting qualities.

As an outcome of many careful and painstaking experiments, in which various rare and valuable alloys were used, a number of new grades of steel were obtained. The most important achievement is the grade termed "High-speed Steel," by reason of the fact that saws and tools made of this material can be run at a much higher rate of speed and a deeper cut taken, it being capable of withstanding the great frictional heat without losing its hardness.

It now lay with the saw-maker to devise various types of saws for metal-cutting particularly suited to the different purposes in the widening field of operation. And it was no easy task; long-continued experimenting and tests were necessary to determine the correct shape, pitch, and space of teeth; the speed at which the saw should run, and the amount of feed —each point mentioned being controlled by the kind of metal to be cut. That success has been achieved is attested by the many and varied purposes for which these saws are employed today.



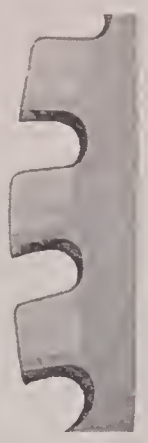


Circular Milling Saw

The general classes of circular metal cutters are: Circular Discs (plates without teeth), run at high speed for cutting cold metal; Circular Saws (toothed), for cutting hot or cold metal at high speed; Circular Milling Saws, for cutting metal at slow speed; Metal Slitting Saws; Screw Slotting Saws, and next, but constituting the most recent improvements and highest form, the Inserted Tooth Milling Saw; then follows the Band Saw for metal, each of these types being made of a quality of steel peculiarly adapted to the work to be done.

Taking them up in order named:

Discs (circular plates without teeth) are used for cutting cold iron or steel. They are run at a high speed, about 24,000 feet per minute, rim motion, and *cut by friction.* In size they vary from 14 inches, 10 gauge, to 50 inches in diameter, 3 gauge, or 17/64 inch thick. They are used in foundries, forges, and metal-working plants, to cut metal, such as rails, beams, bar stock, etc., to size.



Special Milling Saw

These Friction Discs, as they are sometimes called, eat their way through the metal by a process of fusing or melting the stock. The tremendous speed at which they run creates intense heat which melts away the stock in front of the disc edge. In Sheffield, England, some years ago, a Friction Disc measuring 9 feet in diameter was in use for some time. A speed of 86,000 feet per minute, rim motion, was attained with this in cutting 6-inch armor plate. So much heat was created by it that it was necessary to play a continuous and heavy stream of water on the edge of the disc to prevent its fusing with the stock being cut. Owing to the nature of the discs and the methods of cutting they must be run at exceedingly high speed or they will not work.

For cutting hot iron and steel at high speed, Solid Tooth Circular Saws (sometimes termed Hot Saws) are used, ranging in size from 14 inches in diameter, 10 gauge, or ⅛ inch thick, to 50 inches, 3 gauge, or 17/64 inch thick, having teeth varying from ⅜ to ⅞ inch space. Hot Saws are run at a slightly lower speed than Friction Discs, about 20,000 feet per minute, rim motion.

Similar saws, revolving at high speed, are also used for sawing cold iron and steel rapidly.

Both the above styles of saws are used in iron and steel works for cutting I-beams, girders, rails, etc., to merchantable lengths.

The most widely used type of solid tooth circular metal-cutting saw is the slow motion Milling Saw. It bears the same relation in the metal-working industry as the Circular and Band Saw do in lumber manufacturing. The principal sizes range from 8 inches in diameter, 16 gauge, or ¼ inch thick, to 60 inches, 000 gauge, or 7/16 inch thick. For clearance in the cut some are ground thin or slightly tapering toward centre, and others finished even in thickness from rim to centre, with the teeth swaged or set.

These saws are used in machine shops, foundries, forges, rolling mills, etc., on machines, some of which drive the saws from the centre in the ordinary manner, while others drive from the rim by means of a sprocket wheel engaging in perforations in the saw blade near the edge, as shown in illustration (page 52).

Saws of this class, intended for cutting hard and heavy stock, are made of a grade of steel especially adapted for the work to be done, and the blades left as hard as is practical to work.

The successful working of a Milling Saw does not rest entirely with the material of which it is made, for, as previously stated, a great deal depends upon its teeth—their shape, size, number, and space. The speed and feed at

which any circular saw can be run depends largely on the number and shape of teeth.

The proper styles of teeth for different classes of work have been determined on scientific lines and proved by actual demonstration. For instance, to saw metal tubing, fine teeth are required. The reason for this is quite

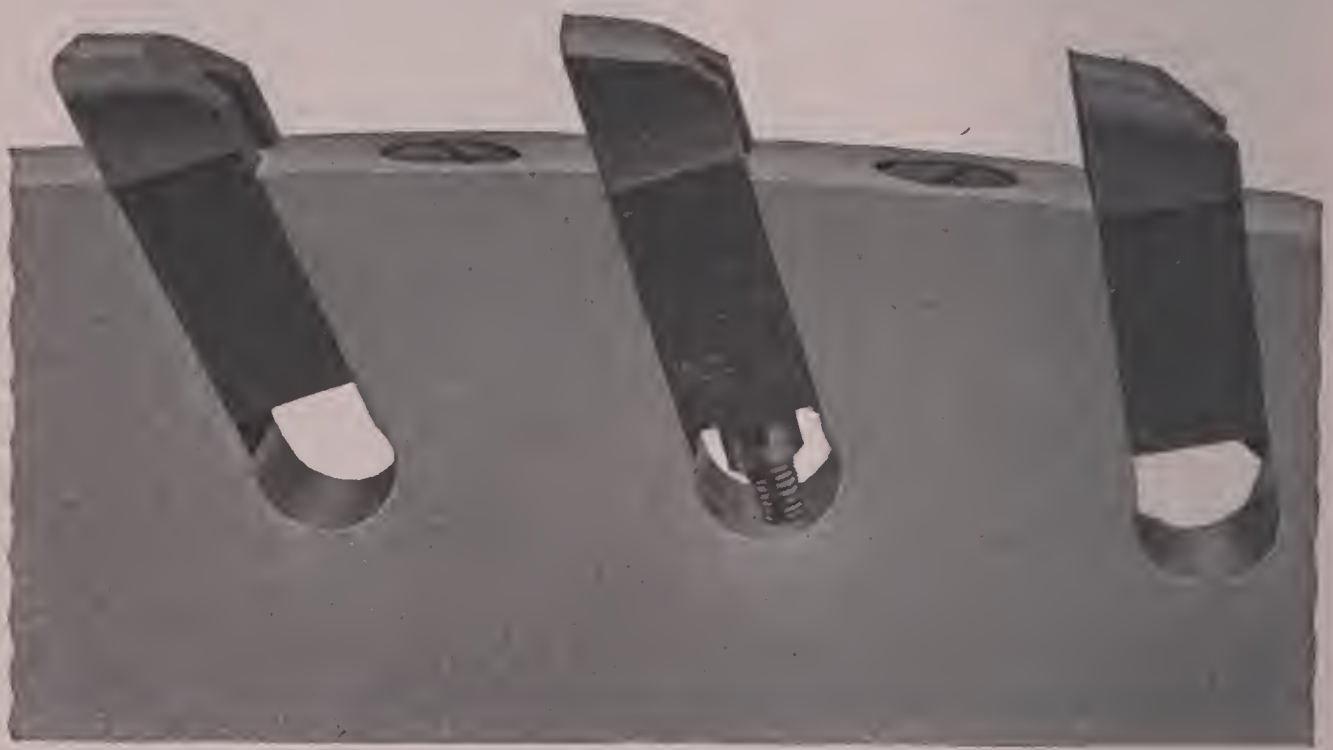


Fig. 24

obvious when attention is called to the fact that all metal-cutting saws must have a comparatively "straight front" or hook instead of a V-shaped tooth, consequently as soon as the points of the teeth penetrate the thickness of the metal tube, if too coarse, they engage or catch in the edge of the metal, and breakage is the result.

In cutting small sections of solid metal the space or pitch of teeth should be closer than for large work, and there should always be two or more teeth

Fig. 25

in the cut at the same time; while for cutting rails, beams, etc., 7/16 inch space of teeth in solid tooth saws, 24 to 30 inches in diameter, is considered right.

While ordinary solid tooth Milling Saws are run at slow speed, this, of course, varies according to the hardness or density and size of the stock to be cut. When sawing open-hearth steel rails they should run about 30 feet rim motion per minute, and at 45 feet for beams, etc.; for wrought iron, a speed of 60 feet rim motion per minute; and on brass or soft metals the speed can be increased to about five times that of cutting iron.

Small Circular Milling Saws are also used in portable machines for railroad construction work and repairs, etc. The machine is clamped to the rail, and the saw adjusted to cut either straight or diagonally, as may be required. While these machines are adapted for hand operation, they are also arranged to work by power. This constituted a great advance over the old hammer and chisel method of cutting, the work being done better and in considerably less time.

The next in order is the Metal Slitting Saw, which, in point of fact, is simply a small size milling saw.

These saws, as the name indicates, are used for the purpose of making a narrow or thin groove or slit in metals, particularly where accuracy is required. For instance, the ends of some patterns of Butcher Saw Frames are slit to receive the blade; in many gas stoves the slots in the burners are sawn, these giving a better flame than cast or drilled holes. They are also used for various kinds of general machine shop work.

These saws are adapted to many other lines of work. For example, a very thin saw, about $\frac{5}{8}$ inch diameter, is used for cutting a slot in the ends of certain knitting needles, used in a machine, the thread being held in the slot instead of in the usual eye, which is commonly associated with a needle. A similar very fine saw is employed for slitting the nibs of the coarser styles of pens, this saw being about 6/1000 of an inch thick. Then again there are special sizes used by jewelers for cutting chain-links, etc. These are made of cold-rolled steel and are not ground.

Metal Slitting Saws generally range in size from $2\frac{1}{2}$ to 7 inches in diameter, and from 1/32 to $\frac{1}{8}$ inch in thickness. Owing to the nature of their work they are made of a particular quality of steel, with teeth of a character making them strong and effective cutters. They are specially hardened and tempered, accurately ground to gauge, and tapering thinner toward centre for clearance.

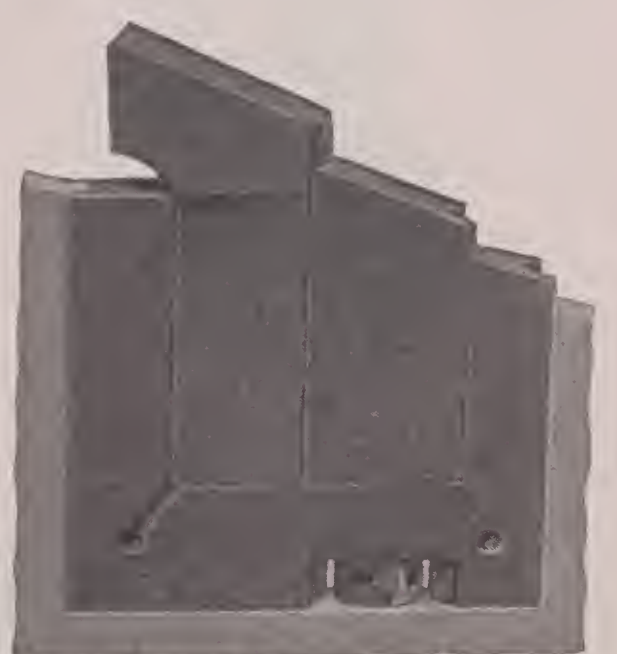


Fig. 26

For particular work, where a definite and positive width of cut is to be made, they are ground to micrometer gauge, so strict are the specifications as to thickness.

Somewhat smaller in size are the Screw Slotting Saws, their name also implying their use—cutting the slots in screws. These are generally used in machines which do the work automatically. Screw Slotting Saws range in diameter from $1\frac{3}{4}$ inches, .006 gauge thick, to $2\frac{3}{4}$ inches, .182 thick. While hardened and tempered, they are not ground or polished.

There are, of course, other sizes and thicknesses of Slotting Saws for

different kinds of mechanical work requiring the cutting of slots, but the dimensions mentioned above are stock sizes.

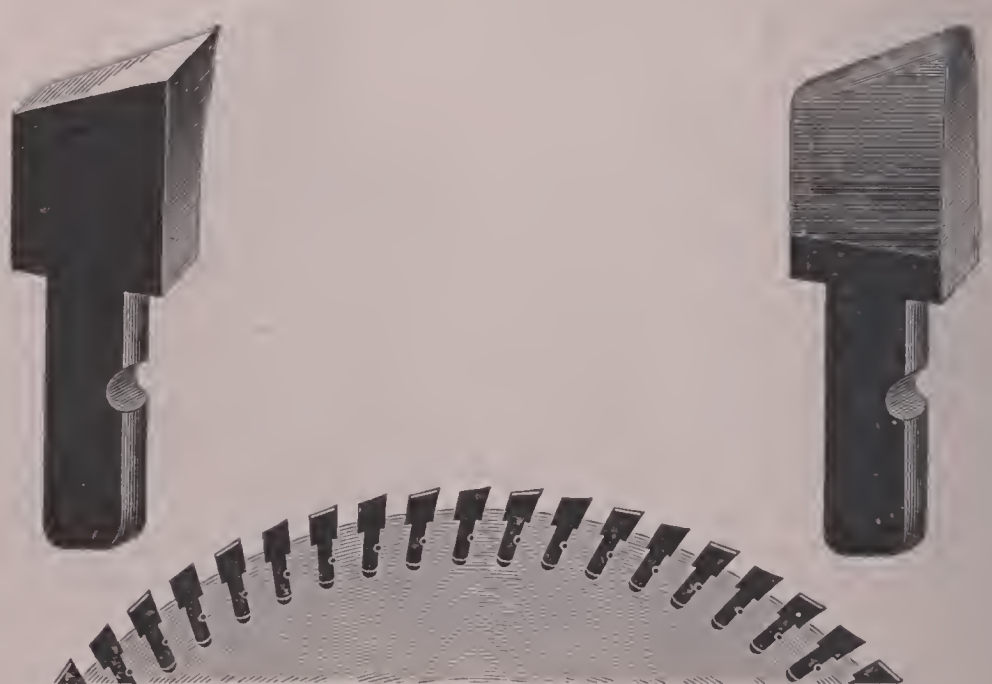
Times and methods change, progress, being ever the keynote, and while the regular solid tooth milling saws were improved, and their efficiency increased, still the cry came for "More work in less time." This naturally led to experiment in the direction of Inserted Tooth Saws for cutting metal, for the reason that in this pattern of saw the teeth, being separate from the blade, could be made of a different quality of steel and hardened to a much higher degree than is practicable in a solid tooth blade, and greater working results achieved thereby.

Inserted Tooth Circular Saws for sawing metal are of comparatively recent origin; in fact, so far as can be ascertained, the first saw of the kind made and used in the United States was that manufactured by Henry Disston & Sons in 1893 for a large steel works, to be used in cutting armor plate. This saw (Fig. 24) was 86 inches in diameter, the blade 1 inch thick, and cut a kerf 1 3/16 inches wide. The teeth in this saw were made of Mushet steel, the forerunner of the present High-speed Steel referred to previously. Several saws of this pattern were successfully operated for some time, but were finally discarded owing to improvements in the manner of inserting and holding the teeth in place.

Many and varied were the suggestions and designs looking to the improvement of this class of saw. The time and expense consumed in making and testing each of the patterns, as well as in making numerous changes and variations proved necessary by service, amounted to considerable, particularly as the experiments extended over some years.

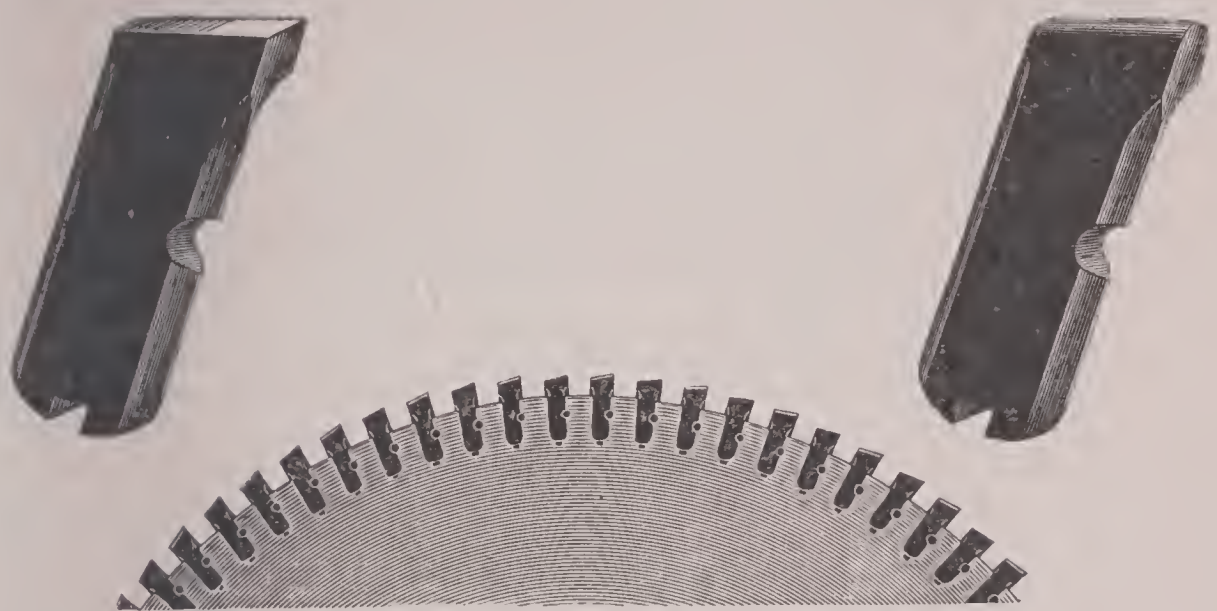
To illustrate some of the stages in the evolution of the Inserted Tooth Circular Saw for cutting metal, Fig. 24 represents a section of the pattern submitted to Disston by the steel works for the 86-inch saw referred to. This was followed by the Monarch type. Then from time to time, came in the order named, Regal, Royal, and Fig. 25.

Saws of these types were made up and used, but continued experimenting brought out the pattern shown by Fig. 26, which was designed by the Master Mechanic of Henry Disston & Sons. This pattern, however, while never used,



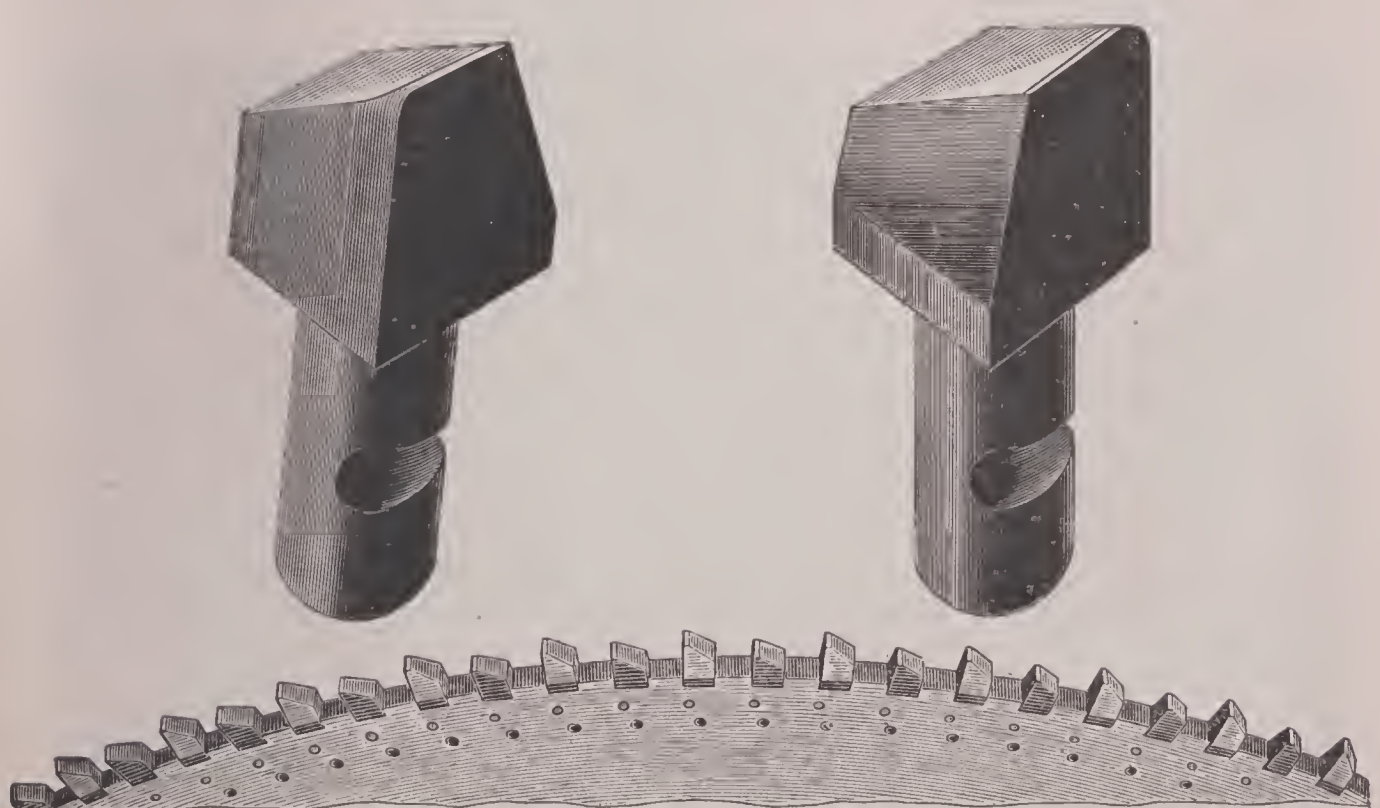
Regal Teeth and Section of Saw

nevertheless served its purpose by leading to a modification from which the Premier type was evolved at the Disston Works. The Premier was patented March 5, 1907, and, by comparison, will easily be seen to represent the highest and most efficient type.



Royal Teeth and Section of Saw

Prior to this time the question of steel for the teeth was satisfactorily settled by the invention of High-speed Steel; the form of teeth best suited was also determined, but there still remained the perfecting of a sure and positive method of fastening the teeth in the blade to prevent chattering and



Monarch Teeth and Section of Saw

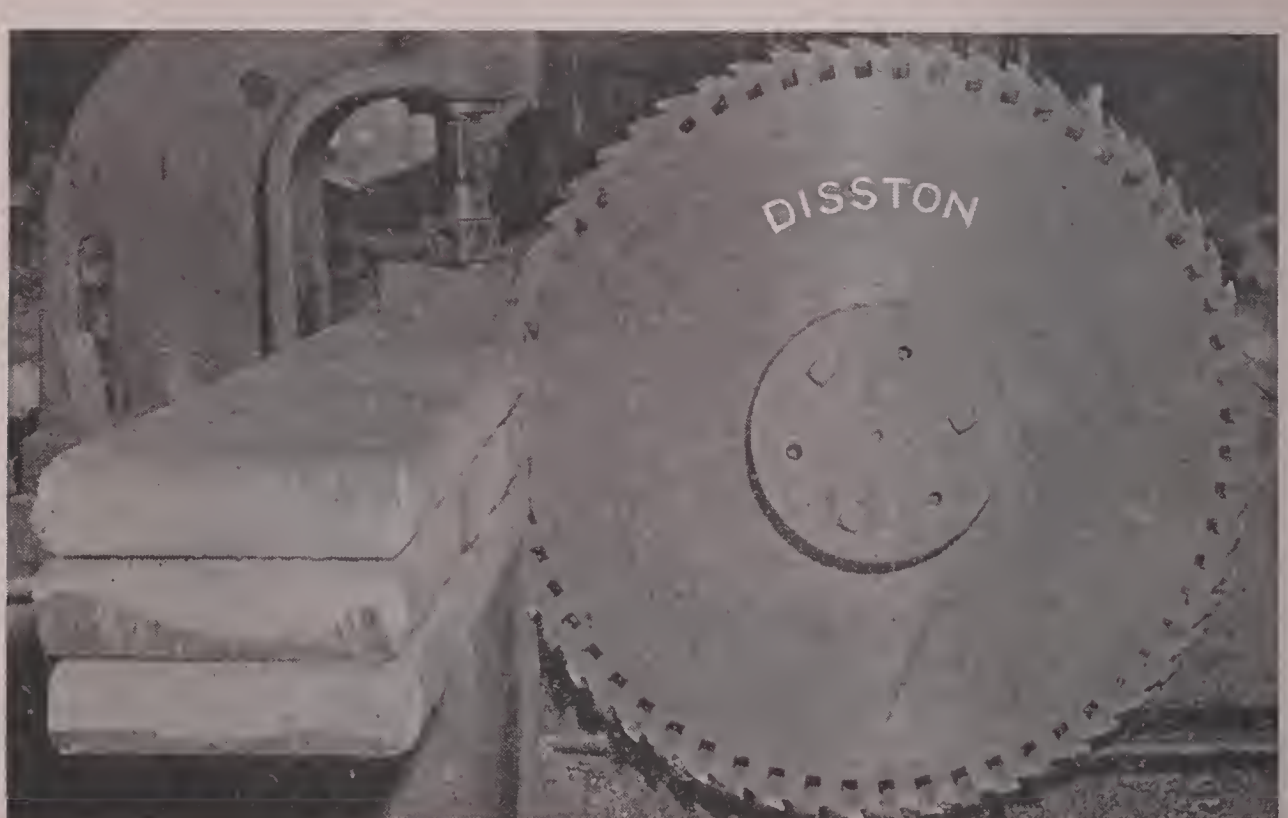
coming loose, and this was attained in the Premier Saw. Therefore, standing as the improved type of metal-cutting saw, a brief description of the make-up of the "Premier" is worthy of note.

The sockets in the blade are accurately milled to shape, and are made wider across the bottom than at the top on account of the inverted wedge. This wedge, as will be noted, is placed in reverse position to wedges in other saws. Thus, when adjusted by screw shown, even if the screw is removed, and the saw placed in operation, it has been ascertained that the teeth will not come loose. In the working, the force of inserted teeth naturally being outward, in the Premier, as the teeth are tapered slightly larger at the bottom and the wedge inverted, the tendency of the force mentioned is to make the teeth still tighter. Then, again, the wedge, instead of being driven down, is forced upwards in the tightening, thus backing up and strengthening that part of the tooth doing the cutting. This method of fastening the teeth in the Premier permits of easy adjustment or removal.

The teeth are of Disston High-speed Self-hardening Steel, milled from a solid bar, and toughened by a special process. They are of two types, as shown in illustrations. The round top tooth, which is narrow and projects slightly beyond the oval tooth, breaking the way by cutting a groove, and the other, an oval top tooth, following along, cuts out the remaining sides or full width of kerf or channel, and gives sufficient clearance for the blade. This manner of cutting gives three narrow chips instead of a single wide one. The hook on the fronts of teeth is formed to give the greatest rapidity of cutting, and rolls the chips clear of the cut. These teeth are accurately adjusted to the height desired by the adjusting screw inserted in plate beneath them.

The Premier Saws are run at a speed governed, to a great extent, of course, by the kind of material to be cut, varying from 40 to 60 feet per minute, rim motion, with a feed up to 1¾ inches per minute.

From the very first the actual working of the Premier demonstrated that it was an ideal saw for steel foundries, steel forges, railroad work, structural



work, locomotive works, and all heavy metal cutting, performing the work more rapidly and with greater accuracy than Solid Tooth Saws.

The picture on page 50 shows one of these saws in operation, giving a very clear idea of its appearance, and the powerful work it performs.

Before leaving the Premier Saw it may be interesting to state that a special saw was made, 72 inches in diameter, containing 56 teeth, each tooth being made of High-speed Steel and weighing 1 pound; the wedge weighed ½ pound, thus making a total weight for the teeth and wedges alone of 84 pounds.

The New Disston Spiral Inserted Tooth Saw for cutting all but the heaviest metals is another step toward efficiency and economy. As a thin blade is used, first cost is lower, and as less metal is cut in the kerf this saw is economical of power.

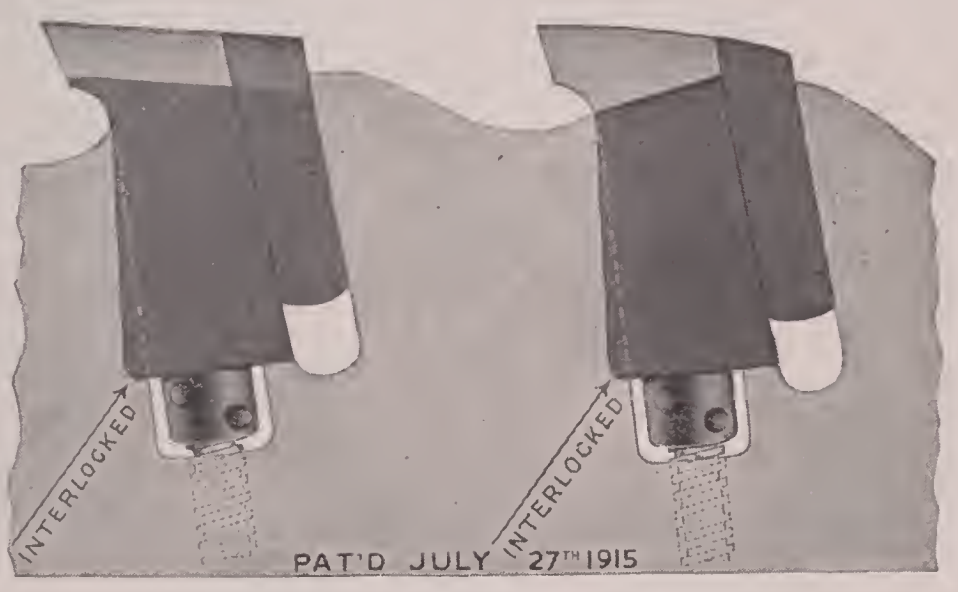
This new saw is of a high Carbon Crucible Steel, hardened and tempered plate, with High-speed Steel teeth, all of Disston manufacture.

The teeth are adjusted and set in place on a spiral to secure necessary amount of clearance in cut. The combinations of teeth are formed to give the best results in cutting various kinds, sizes, and shapes of stock.

The teeth are held in place with wedges. The teeth can be dressed easily without removing from saw. It is only necessary to dress fronts of teeth to secure desired results.

While the Disston "Premier" Inserted Tooth Circular Milling Saw held its place as "The Premier" for some years, the Interlocking Saw, as illustrated, has superseded it. This new saw is chiefly a modification of the "Premier" and represents the latest and highest type of Inserted Tooth Milling Saws for rapid cutting of large, heavy work.

For the cutting of hard steel, rails, gates, and risers of steel castings, general construction work, and the cutting of irregular shapes, the Sectional Interlocked has been designed.



Interlocking Tooth

The teeth of the "Sectional" can be ground while in place, practically the same as a solid tooth saw. Blade always retains its diameter, which means full cutting surface on the rim and can be operated with fully 50 per cent. less power than a solid tooth blade. The teeth are held in place by one wedge or key tightening and retaining four to six teeth. This means a saw with sixty teeth requires ten wedges only.

In the lighter work of metal sawing Band Saws are used for the reason that small pieces can be fed by hand instead of being clamped, and thus the work is quickly accomplished.

For some years the Band Saws used for this work were hardened throughout, but this did not permit making them as hard as was required for cutting metal, owing to the fact that extremely hard bands would not stand the

bending and straightening in going over the wheels.

Early in the eighties the first so-called Flexible or Soft-back Band Saws were made. These were extremely hard on the tooth-edge and from there to the back were not hardened, but left in the soft state. Thus was overcome the difficulty in the running, and not only that, but they cost less to make, and the user profits by this as well as the fact that the saws last longer and accomplish more work.

The Soft-back Band Saws, of course, are toothed, sharpened, and set before being hardened.

They are usually made of narrow width, from ¼ to ¾ inch, and from 23 gauge, or .025, to 21 gauge, or .032, in thickness. In length they vary according to requirements.

This type of saw was first used to cut shapes and forms out of sheet iron, but is now used by manufacturers of castings, machines, and bronze castings; ship and engine builders; foundries, etc.

In closing this description of Metal-cutting Saws, referring particularly to the larger saws, it is fitting to remark that the advance of modern methods has been great in the working and use of iron and steel. While the saw has contributed its share in no small measure toward this advancement, still due credit must be given the manufacturers of the machines, in which many improvements have been effected, making possible the attainment of highest efficiency and results.

The description of metal-cutting saws brings to a close the story of the modern types of saws—that is, the saws we see in use about us today—and concludes the history of the saw.

Sectional Interlocking Tooth

If, in the light of what we have been reading, we look backward again to those crude, roughened stones which primal man used before history was written, it is amazing to see the wonderful advances saws have made in a comparatively short span of time. When we observe the ease with which the teeth of a modern saw cut through a log or plank, the mind is inevitably led to make comparisons, and it seems almost inconceivable to us that a man armed only with one of the primitive stone saws of antiquity could even dent a piece of wood—much less cut it off.

But great as is the variety, and wonderful the construction of modern saws, there are none which better illustrate the vast advances made, nor draw a stronger contrast between the saw as it was and as it is today, than the modern mill saw.

The present-day Band Saw, ranging from 40 to 60 feet in length, and 12 to 18 inches in width, slipping through massive logs with a speed greater than

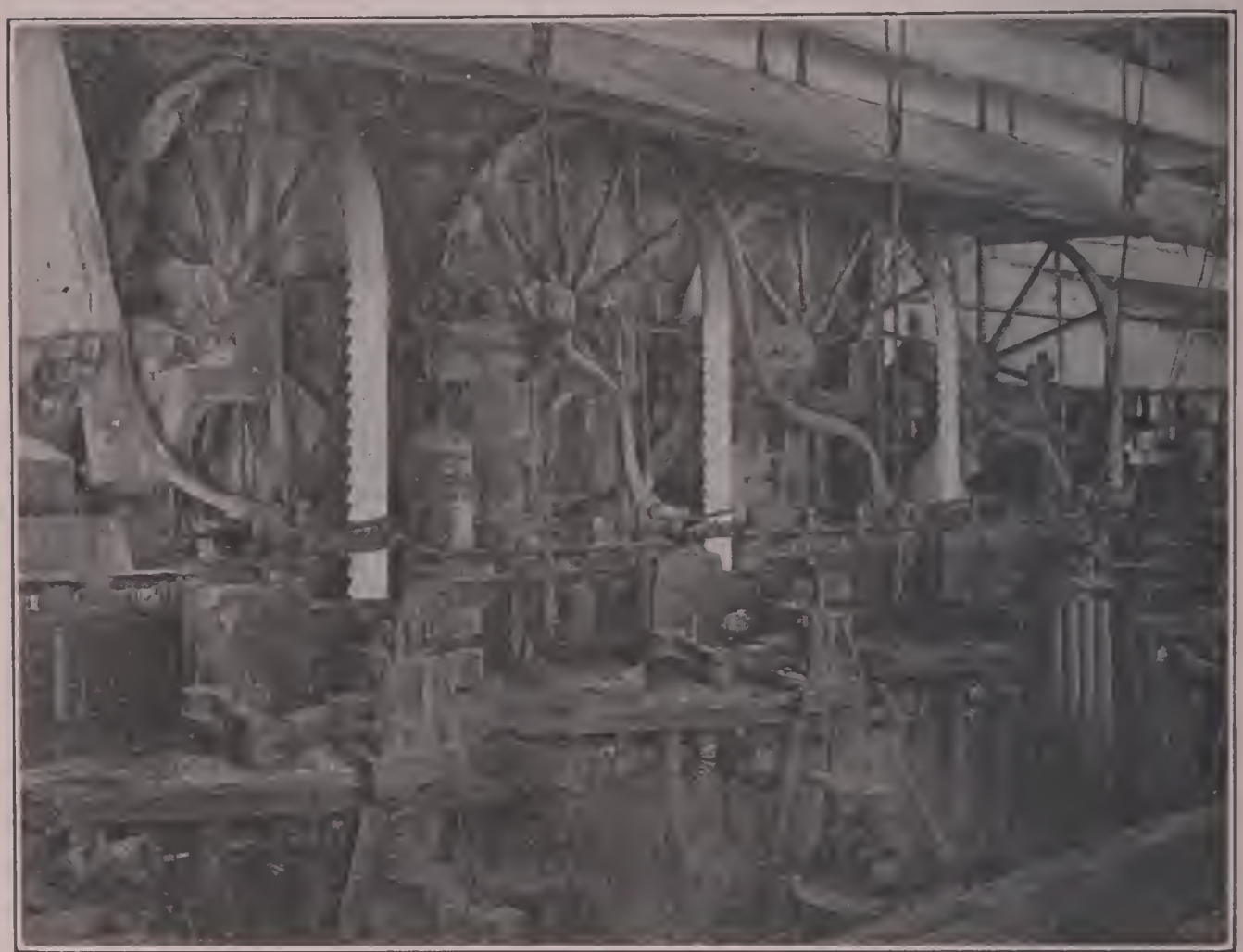
that of an express train, has become such an every-day matter that few realize what it means to the world, or what the saw-maker has done for humanity.

It is to the lumber mills, then, that one must look for the highest and greatest development of the saw. While Hand Saws, and the many other special forms of saws have increased in variety, efficiency, and appropriateness, the advances have been made chiefly in slight alterations in design, and the improvement of materials and processes. With the Band and Circular Mill Saws, on the other hand, we find a steady advance in size and efficiency, as well as in all the other attributes.

Could the millman of other days who struggled with his up-and-down saw, and his crude Circular Saw of improper tension and limited diameter, return today to witness the sawing operations of the big modern mills with their gangs of Band and Circular Saws, he would be astounded.

These mills of today, employing huge Band and Circular Saws, should be compared in your mind's eye to the prehistoric man seated under a forest tree, and devoting many hours of arduous labor to the severing of a piece of wood that would appear to modern eyes ridiculously small in contrast to the effort required

These great plants represent the final development of the saw as known today. What the future may bring forth it is hardly safe to predict, but with our present knowledge of materials and mechanical stresses it seems as if we were approaching the limit, and that these mills, and the saws they run, will stand for all time as among the greatest achievements of the saw-makers' art.



Four Band Gang Saw in a Modern Mill

Japanese Sawyer at Work

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