A HISTORY OF THE SAW
WITH SPECIAL REFERENCE TO APPLICATIONS
OF THIS TOOL FOR CUTTING WOOD

A Thesis Presented For The
Degree of Master of Arts

by

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CHAPTER I

INTRODUCTION

Throughout the ages, even to the present time, the glamour and romance of the hunt and of war have attracted and held the interest of man to a much greater extent than his every-day pursuits. Weapons and military machines of destruction win his attention, but tools of trades and crafts, which have been important factors in civilization's advance, have been too prosaic to arouse much more than a passing interest. This may account for the fact that the saw, a tool whose ultimate development was of prime necessity in converting towns and cities from forests, and therefore of more than average importance as a civilizing factor, has received so little attention from historians, ancient or modern. Generally speaking, craftsmen themselves prove more prolific as sources of information concerning the use and evolution of the saw than the so-called scholars of a particular period.

Purpose of the Study. A history of the evolution and use of the saw and its basic machine applications is a part of the heritage that belongs in a rich concept of industrial arts education. Modern industrial processes involving the use of saws and sawing machines cannot be fully appreciated unless the procedures that ante-date them are known. Many machines today were made possible by the application of power to hand tools then in use. Quite often this
application was in the beginning very crude, judging from present day accomplishments. But as time went on, the refinements of these applications crowded themselves upon the scene with ever increasing momentum. Some inventions had to wait on others before they became a benefit to mankind. For example, witness the statement of Roe (49 p.11)* in regards to steam engine:

... John Wilkinson, of Burhan, made the steam engine commercially possible by first boring Watt's cylinders with the degree of accuracy necessary...

A somewhat similar statement made by Wyatt if true is even more striking and to the point. He says (55 p.317):

By conquest of the club, the hammer was conquered;
by conquest of the hammer, the drill was conquered;
by conquest of the drill, the wheel was conquered;
by conquest of the wheel, the lathe was conquered;
by conquest of the lathe, the steam engine was conquered; by the conquest of the engine, the electrical age was achieved.

Following the intimations which have been made above, it is the purpose of this study to assemble evidence and data on the origin, use, and evolution of the saw as a hand tool and its later machine applications. More specifically the data so assembled include not only an account of pre-historic saws, the invention, use and evolution of the saw since history began, but attention is also called to men who seemingly have made important inventions and improvements. In addition the study is intended to bring to light such social and economic conditions resulting from the evolution as have been chronicled. Changes in the kind of power used

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*This form of notation is used throughout the study and refers to the position of the reference in the bibliography.
to operate the various machines have been noted as well as changes of material used in construction. The importance of this last point is made more clear by another statement from Hes (49 p.33):

We hardly realize the crudity of the tools available in the eighteenth century. In all machinery the principle parts were of wood, as that could be worked with the hand tools then in use. The fastenings and smaller parts only were of metal, and consisted of castings and fastenings fitted by hand.

The data gathered illustrate the fact that many of the changes from hand to machine processes are due to inventions which have come into use in but comparatively recent years.

Conflicting evidence and statements in the various sources have been noticed. These have been discussed and evidence presented in an attempt to reach logical, unbiased conclusions.

By such presentation of material it is the purpose of this study to add to the existing available heritage belonging in particular to the "Wood Industries" in the general range of industrial arts content.

Related Studies. Although most of the data in regards to the history of the saw are in documentary form, for the most part they are supplementary to some other topic. No one work found has attempted to cover all the particular aspects which have been set forth as the purposes of this study. H. C. Mercer in his "Ancient Carpenters Tools" (34) has collected more material in regards to saws and saw-mills than was found in any other work. And while he has made mention of saws and saw-mills dating from earliest times
and from many lands, his main attention is given to those tools and machines, some not of a basic nature, which actually were used during the early period of American history. Much of his work was done in connection with the Bucks County Historical Society at Doylestown, Pennsylvania, where quite large, and possibly the most complete collections of carpenter's tools in the United States have been made. The purpose of the Society is much the same as Mercer's; namely that of depicting tools and implements used and developed in the colonial and expansion periods of American History.

A booklet made by Henry Disston & Sons, for commercial purposes, and called "The Saw in History" is most interesting. The principal points are brought forward in a brief, high lighting manner. The work does not present a complete story and can be said to be only semi-scientific in form.

A third work of somewhat related nature is entitled "The Carpenter's Tool Chest" written by Thomas Hibben, whose main purpose has been to write an interesting account in the language of the adolescent boy. His purpose of writing an attractive account has been accomplished; however no particular emphasis was placed on the history of the saw, and therefore the treatment was more or less brief.

Techniques. The material presented in this study was obtained largely from existing, available documentary sources. Books containing information are generally of such nature that most libraries do not have them on their shelves, at least not a sufficient number of titles to permit study to be carried on smoothly. Because of this difficulty, the
Library of Congress at Washington, D. C. was selected as the chief place of study. Here beginning with such sources as were already known, the sources mentioned by Disston (16), by Wallace (53) and by Wyatt (55) (56), and by working backward many other books were discovered. Eventually many original sources were uncovered. Some of these latter; namely, Moxon (28), Besson (8), Bockler (12), Veranzio (52), and the American Museum (1) were included in the rare book collection of the Library of Congress which would indicate that but few volumes of these particular books remain in existence. Besson's and Veranzio's work remain in French untranslated, as does Bockler in German. All three books, however, contain plates which convey valuable information.

In addition to the sources found in the manner described above the indices were exhausted under such key words as saws, saw-mills, wind-mills, water-mills, tools, implements, wood machinery, mill machinery, carpentry and invention.

The following museums were visited in the hopes of locating specimens of early types:

5. Ohio State Archeological Museum, Columbus, Ohio.

Limitations of Study. It was the original intent of this study to cover the history of woodworking machinery. A preliminary survey indicated the magnitude of the task and resulted in a less ambitious undertaking for the following
reasons. First, this subject, besides being too ambitious for a study of this compass, would have necessitated explanations of improvements and refinements which were often of a technical nature and therefore outside the range of industrial arts content. Second, since many woodworking machines evolved from carpenter's and joiner's hand tools, a discussion excluding such evolution would have been incomplete. Therefore, as an alternative it was decided to select one tool and trace its present day use. The saw, companion of the axe in the conversion of lumber, appeared to be one of the most important of all woodworking tools and reason was fixed upon as the subject of this paper. As a further restriction only basic applications of this tool, as they apply to wood industries, have been considered. In the chapter following, the first crude implements, with which man began his long career as a sawyer, are described.
CHAPTER II

PRIMITIVE SAWs

Hundreds of years before man mastered the art of writing, he must have discovered that a blade with a serrated edge was more efficient as a tool for parting certain materials than a knife, no matter how keen its edge. Compared with a modern tool, this blade of savagery was an abrasive implement. Nevertheless this serrated knife was man's first saw. The origin of this saw long lost when history began is entirely open to conjecture. Hyatt (56) mentions one supposition and then goes on to discount the theory. He apparently discounts the fact that ancient man intentionally made saws, and would have us believe that the Egyptians were the inventors of the saw and that they first made it of bronze. He says (56 p.380):

An imaginative writer has opined that the scallop shell was man's first saw and his second a nicked stone. Primitive man probably used such crude tools, but if so, he probably thought of them as badly dulled knives. The saw probably developed from the knife, but from a bronze one and not a tool of the Stone Age. As far as we know, the Egyptians were the first users of the saw. They had these bronze tools as far back as 4500 B.C.

If primitive man thought of serrated blades as badly dulled knives, he surely would not have nicked intentionally the pieces of stone he used for cutting arrowshafts and bows as stated by Mackenzie (30 p.4) or for sawing bones as Neuberger speculates (40 p.68). The Egyptians may have reached the
stage of making saws and other tools from bronze before more primitive people in other parts of the world had discovered the uses and advantages of a serrated blade made of stone. Nevertheless it might be safe to hazard the assumption that at least in some parts of the world stone saws were the predecessors of the saw made of metal just as the stone axe led to the development of one made of metal.

**Stone Saws.** Excavations in various parts of the world have brought to light many tools and weapons of both palaeolithic and neolithic periods. Resulting collections of such implements only infrequently are completed with examples of stone age saws. Moorehead (36), in an illustrated catalogue describing eight hundred and fifty weapons and tools exhibited at Andover, Massachusetts, makes no mention of saws. Likewise in describing the stone age in North America (35) he fails to notice them, although in a work edited by the same author stone saws found in North America are described and illustrated (37 p. 236, 376). The chipped stone implements exhibited during the Columbian Exposition at Madrid did not, according to Mercer (34), include saws.

Evidence concerning the existence of stone saws assume a more positive tenor as Schliemann's report on the excavation of Troy is read. He says (50 p. 79):

**Knives were found in very great numbers; all are of flint, some in the form of knife blades, others—by far the greater majority are jagged on one or both edges like saws.**

From the illustration that Schliemann gives (50 p. 94), it would appear that the serrations were quite regular and
therefore intentionally made. If so these alleged knives might very well be saws despite the apparent hesitancy in classifying them as such. Neuberger is not so backward. Witness his description of these same blades (40 p. 68):

The little saws of silex and chalcedony from the excavation of Troy were only a few inches in length and were probably used to saw up bones, perhaps to smooth the surface of wood.

The age of these stone implements, always an interesting conjecture, cannot be definitely stated. It seems possible that these saws could be considerably older than the bronze tools mentioned by Wyatt (56). According to Disston, the oldest saws known are those fragments of obsidian found at Ur of the Chaldees and described as follows (16 p. 6):

- - - - the original saws found at Ur of the Chaldees, Mesopotamia, by the joint expedition of the University Museum, Philadelphia, and the British Museum, London. These blades are made from obsidian, a volcanic glass and are two inches in length. Archeologists agree that the age of these blades is between 6000 and 7000 years. They were at least 2000 years old when Abraham lived. They are the handiwork of the Sumerians, a race of ancient Babylon. - - - - These saws, undoubtedly the oldest in the world, are now in the University Museum, Philadelphia.

Stone saws were found also by Greenwell in Britain, who makes the following comments concerning a number found in a barrow near Hulsthorne, England (20 p. 262).

Amongst the implements must be numbered 79 saws. Many of the saws are very delicately serrated, some along both edges, and showing by the glaze along the edge that they have been in use. The number of saws was very surprising and far exceeded the aggregate of those obtained from all the barrows I have opened, and it is by no means easy to give any reasonable explanation of this phenomenon.

The above statement also seems to bring out the point that
stone saws were not generally found in any great abundance. Further description of these saws and conjecture as to their uses is given by Mackenzie (30 p. 4):

... his [primitive man] saws were small, but are still found to be quite serviceable for the purpose they were constructed for, such as the cutting of arrowshafts and bows, and the teeth are so minute and regular that it is necessary for us to use a magnifying glass in order to appreciate the workmanship. ... The flint workers must have had wonderfully keen and accurate eyesight to have produced for instance "little saws" with twenty-seven teeth to the inch.

Stone saws were also found in America despite the fact that the authorities mentioned in preceding paragraphs failed to list them. Dr. Ronald Steiner found specimens in Georgia which he describes as follows (37 p. 376):

This object [flint saw] is very rare, but few being found. They are usually small, in form, either triangular or quadrilateral, though we have one oval in outline closely resembling a circular saw. The serrations generally along one and the longest edge. Some of the long spearheads and arrowpoints could be used as saws. In the saw proper the serrations were very fine.

The use of such tools, must necessarily from the very nature of a stone blade, have been confined to the parting of small pieces, and no claim can be made, that at this stage of man's progress the saw was of basic importance to his well being. In speaking of the efficiency of these earlier saws and their use Disston says (16 p. 7):

The earliest prehistoric saws were simply small flakes of flint, notched by chipping. Rarely more than three 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.
Flint saws have also been uncovered in France in caves of the "Reindeer Period," as well as in the ancient stone heaps in Denmark (16 p.7). One saw found near Polada, Italy, was made of four separate flakes of flint cemented into a groove of a wooden handle with asphalt. (16 p.8)

Other Saws of Savagery. In addition to the stone saws mentioned above, primitive peoples have made tearing and abrading implements from other materials which they have had at hand. In California, bone saws have been found which have been attributed by Dr. L. G. Yates to the Mopan Indians (37 p.236). Other examples are described by Mason (31 p.47).

... the ancient Mexicans and some Polynesian islanders knew well how to make saws by inserting jagged stone and the teeth of sharks in a groove in a handle wood or by sewing them with sinnet upon the side of a thinner piece.

Examples of the latter implement may be seen displayed in the National Museum at Washington and the University Museum, Philadelphia. Larger, but similarly constructed objects are classified as swords, capable beyond doubt of inflicting serious wounds, but also capable if the occasion demanded of cutting pieces of small diameter.

All in all the saws made by savage peoples before the advent of metal was crude and pathetically impotent. This was due to several reasons. First of all the very nature of the material which the ancient tool maker had at his disposal prevented him from making a blade thin enough to pass through the kerf cut by the teeth. In that respect all the above described tools resembled the modern back saw,
except that the cutting depth was only a small fraction of that obtained by the back saw. Even though primitive man had had the tools at his disposal he probably would not have aspired to imposing architecture. When occasions did demand, he could manage by laborious processes to separate large pieces of material without the aid of a saw. One such method is described by Mason (31 p. 47):

He primitive man gets out puncheons and planks by means of unnumberable wedges distributed along a great log. Bone and harder substances he rips by boring a series of holes through the substance in a straight line and then breaking the pieces asunder with a blow.

Considering such methods it is not surprising that primitive peoples have sought shelter in caves and huts of poles and mud rather than more satisfactory dwellings of a latter day, which for their construction had to await development of suitable tools.

From the standpoint of effectiveness the statement of Wyatt (56 p. 380) is not so far wrong after all. Granting that a true saw should be made of metal, man's experience with the types described above, must have hastened its adoption. The more adequate saws of the early civilizations will be described in the next chapter.
CHAPTER III
ANCIENT SAWNS OF METAL

When and under what circumstances man made his first tools of copper and later of bronze is a matter of romantic supposition. In Egypt the wealth of records, both in writing and in relics from the burial chambers, prove that the use of copper and bronze must have reached heights previously unknown. With the rise of civilization and the establishment of society on a high plane arose the first great need for the saw. Wooden architecture, on a scale never before attempted, and the use of wooden coffins and furniture demanded an effective tool for converting timber into usable pieces. It seems safe to say that without such a tool the use of wood on a large scale would have been impossible, except, perhaps under circumstances where labor was extraordinarily cheap and plentiful. Such being the case, the importance of the saw, in the progress of man, begins to assume a new position.

Egyptian Saws. The minimum age of saws in Egypt is fixed by Petrie in the following statement (44 p. 42):

The saw is certainly as early as the beginning of the first dynasty. The large number of wooden coffins of that period must have been sawn . . . . the great amount of boards required for wooden architecture, also must have required much sawing.

Actual specimens which could be labeled the first Egyptian
saw apparently have never been found. Petrie, however, says (43 p. 567):

The carpenter's saw was at first merely a blade roughly hacked on the edge. By 4500 B.C. it had regular teeth sloping equally both ways. . . . .
No ancient saw, however, had a kerf, cutting a wider slit than the thickness of the blade. We do not know when that was invented in the Middle Ages. The Egyptians used a push saw as the earliest form; and the pull saw was the only one of the West and Roman World; the push saw came back into use in the last few centuries, though the pull saw in a frame is still used in the East.

Because of Petrie's eminence as an Egyptologist, the dates which he ascribed to the early saws of Egypt may be safely accepted. Not so, however, with his statement in regards his implication that the Romans did not set the teeth of their saws, as will be seen later in this chapter when Roman saws are discussed. Furthermore, his statement concerning the push saws of the Egyptians may be questioned. Be that as it may, early Egyptian saws do not appear to have had raked teeth so they might have scraped away—either, the push or the pull. Considering the nature of copper and bronze it seems reasonable to believe that saws made from either of these materials, unless crudely thick, were more apt to be made to cut on the pull motion in order to prevent buckling and bending. Not many specimens of these saws have been found. Disston estimates (16 p. 18) that not more than thirty copper or bronze saws have been found in all Europe. Whether these thirty included those found in Egypt or not was not determined; but, if not, it appears from the evidence studied that the total would not be greatly increased by "finds" made in parts of the world other than Egypt. Many
of these saws, on the advent of iron, were returned to the foundry to be remelted and recast into other objects. Still others thrown into the discard, eventually corroded or perhaps covered with the debris of centuries await the up-turning spade of excavators. The five figures on the blue print (page 17) represent the saws of the Egyptians. Figure 1 is an attempted copy of the saw found in a tomb at Thebes as pictured by Disston (16 p.4) and the "Penny Cyclopedia" (43 p.476). The latter describes this saw as follows (43 p.476):

The blade which appears to be of brass (bronze?) is ten inches and a half long, and one and a quarter inches broad at the widest part. The teeth are irregular and appear to have been formed by striking a blunt edged instrument against the edge of the plate. The bur or rough shoulder thus not being removed.

Figure 2 is similar to one of three saws illustrated by Forman (19 p.40) who describes them as being nearly a foot long including the tang for the handle at the end. Evidently there is not much difference between these saws, and accepting Petrie's statement above that regular teeth had appeared by 4500 B.C., these saws must be older than that; possibly the oldest of all metal saws. Figures 3 and 4 are pictured by Disston (16 p.4) who also reproduces a drawing from a tomb showing an Egyptian Sawyer ripping a board. The teeth of these three saws appear to be raked toward the handle indicating they were intended to cut on the pull. Differences are also noted in the way the handles are attached. The latter types cannot be said to be tanged as were the former, but instead the handles were attached to an extension
of the saw itself by means of thongs or perhaps rivets. Though Disston does not quote the source of these illustrations they appear to further contradict Petrie who says (44 p. 43) that saws of raked teeth were invented in Italy possibly as early as 900 B.C. Repeating logic previously used, that copper and bronze saws of efficient thickness would have bent easily if made to cut on the thrusting motion. Therefore, it would seem reasonable to believe that the Egyptians using saws which cut on the pull should have eventually raked the teeth of that saw toward the handle.

Figure 5 is a representation of the so-called Egyptian long-saw, as illustrated by Neuberger (40 p. 71). Since this saw has irregular and unraked teeth, further doubts are cast upon the conclusions implied in the preceding paragraph. Neuberger makes no attempt to fix the age of this saw, so that it may be of an earlier period than the ones pictured by Disston. Regardless of the correct answer these saws, sometimes as long as four and a half feet, were the principal board making tools of the Egyptians. Neuberger describes the laborious method by which the log was sawn into boards (40 p. 68):

... for dividing up the felled trunk the saw played an important part. These boards were made the following way in Egypt. A stake was stuck vertically in the ground. The trunk to be sawn was tied on this stake and also in a vertical position. Sawing was commenced downwards and was continued until ropes could be used to prevent the sawn parts pressing together and jamming the saw. The most commonly used saw had straight teeth and did not have its teeth set crosswise like those of our day. ... Hence with straight teeth, ropes which enabled the parts of the trunk to be held asunder were a useful adjunct in some circumstances.
Freehand Sketches of Egyptian Saws.
Despite the fact that the Egyptians had and used saws of metal very early in history, it seems apparent that they in reality made less progress than one might expect in refining this tool to make it a more efficient wood cutting instrument. No mention was found that the Egyptians had files with which to sharpen their saws. In fact the Romans are credited by Mercer (34 p.274) and Petrie (44 p.46) as being the first to use the file. This fact was probably the main reason why greater progress was not made, since without files the sharpness of the teeth must have depended on the accuracy with which they were hacked in the plate. A second reason may have been due to the abundance of cheap (slave) labor which the Egyptians had at their command. History tends to point out that under such labor conditions industrial processes suffer lack of progress.

In summation of the contributions which the Egyptians made to the development of the saw, while important, may be briefly stated. Their saws of copper and bronze, in all likelihood the oldest in the world, were all of the open hand one man type, first with a tanged handle and later with a handle, curved to fit the hand of the Sawyer, tied or riveted to the blade. They possibly deserve credit for raising the teeth of the saw, but this cannot be positively stated. No evidence was found to suggest that they had frame saws.

Other Bronze Saws. Probably one of the most interesting "finds" in connection with ancient bronze implements was that made at Bologna, Italy. These implements, supposedly collected about the year 900 B.C. by some founder for the purpose
of remelting, contained some saw fragments which bring forth the following comments from Petrie (44 p.43):

The true cutting saw is that in which the teeth all have a rake in one direction and are a series of cutters while in the back stroke they do not act. The first such saw appears in the fonderia group at Bologna, invented at the same mechanical outburst which produced the perfect tang and socket chisels ... from the thimness of these pieces it seems that they were framed saws, but there is nothing to show whether the true saw was pushed or pulled ...

Petrie also illustrates (44 pl. I) a bronze saw found at Knossos which had a very slightly notched blade. Holes for riveting the handle on are clearly visible. This saw, described by Petrie (44 p.44) as being the oldest bronze saw found in Europe, is clearly a one man, unframed saw considerably different from any of the illustrated Egyptian saws, thus hinting of a separate origin. On the same plate appears an illustration of a saw attributed to the lake dwellers of Switzerland which from the general description might possibly have been framed. The innovation of the framed saw will be discussed more fully under the heading of Roman Saws. According to Disston (16 p.3) bronze saws have also been found in France, Spain, Hungary and Sweden, and in the last named country was also found a stone mold in which four bronze saws complete with teeth could be cast at once.

**Bronze Age in America.** Though metals were not unknown to the natives of North and South America, record could not be found of their having made or used saws of bronze or copper. Nordenskiöld (41) describing the copper and bronze age in South and Central America makes no mention of metal saws,
nor does Moorehead in either of his books (35) (36). The original Americans did not build wooden buildings in great numbers or of any great size. In case they desired to fell trees or divide up the trunk, they made use of fire as a substitute for the cross-cut saw. The Mayas of Central America and Mexico, as well as the Inca of Peru, built some remarkable buildings of stone, but according to the method pictured in the National Museum, Washington, D. C., these stones were not sawn as were the blocks used by the Egyptians to build the pyramids, but were literally chopped out with a pick or adze then squared with the chisel and maul. It is altogether probable that among most of the Indian tribes metal of any kind had uses which they valued too highly to use it to make a saw—an instrument for which they had not a great need.

**Gold Saw.** A saw must have been highly desirable indeed, if it needs must be made of gold. Plate I is the picture of such a saw, which is now in possession of the University Museum, Philadelphia. Described by museum authorities as being made of gold with perhaps some base metal, it stirs the imagination more than any other ancient saw. It was found in the tomb of Queen Shub-Ad, Royal Cemetery at Ur. The date of this saw is 3000 B.C., as the picture shows that it has very fine but irregular teeth. It is about twelve inches long and perhaps two inches wide. The piece of metal hanging to the tang was supposedly a part of the handle. It is interesting to note that although the teeth are very much the same as those on the saw found at Krossos the shape
Plate I.

Gold Saw 3000 B.C.

Found in the Royal Cemetery at Ur. Exhibited by University Museum, Philadelphia.
more nearly resembles those of Egypt. Speculation as to the use of this saw seems futile.

Iron Saws. Perhaps the greatest single industrial advancement made by the ancients was the replacement of bronze by iron and steel in the making of tools and weapons. A discovery without which modern civilization as is now known would be impossible, yet as in the case of other comparable achievements of prehistoric or early historic times the origin of the use of iron is obscure and again as in the case of bronze a matter explained largely by romantic myths and suppositions. Many there are who have believed the first iron known to man was that which descended to the earth in the form of meteors. In support of this theory a romantic little sketch has been repeated by Atkins as to the origin of the first iron saw. It is as follows (3 p.3-11):

Long, long ago, so legend tells, far back thousands of years, in the Age of Bronze, there lived a cheif-ten on whom the gods had laished more than a usual amount of intelligence. This cheiften was a great wanderer. From place to place he and his dusky slaves traveled, through the deserts and forests--always on the go . . . .

In the Bronze Age the tools and implements, of which there were few, were made from the only metal they knew at the time--Bronze. . . . One of the most important tools of this roving band was a crude short one man cross cut saw fashioned from bronze. It was used principally to cut the limbs from fallen trees and thus firewood was obtained in meagre amounts as needed for their mighty camp fire. The cheiften found that through the daily use of the bronze saw it dulled easily--would not hold its edge. The slaves worked upon it almost constantly, sharpening the teeth by hand with flint and stones that they picked up in their travels.

One night during the course of their wanderings they were startled by a mysterious ball of fire which appeared in the heavens. Great was their consternation.
The slaves cast themselves on the ground face downward in abject terror, thinking that the gods were sending a terrible affliction on them. The cheiftan watch the ball of fire coming closer and closer with marvelous speed. It struck the earth with a thunderous boom and loud were the cries of the slaves. After a short silence the cheiftan said to his terror stricken followers: "Perhaps it was not intended for our destruction—mayhap it was a gift from the Gods.Tomorrow we will search for it."

With the coming of the dawn the cheiftan and slaves began searching for the object from the heavens which had so frightened them the night before. . . . suddenly one of the slaves indicated that he saw something which might be the object of their search, . . . . frantically he dug away and soon came upon a hard round ball; the composition of which was then unknown. It was a meteor! . . . . The cheiftan decided to have the meteor carried to a secluded spot, and then he directed the slaves to break it open.

The slaves, by using some large heavy stones, broke the shell of the meteor and the discovery was made that it was a new metal, (pure iron) a metal unknown to them at that time. The cheiftan obtained a rectangular piece of this pure iron, and under his direction, the slaves pounded it with hard stones until it resembled in form a cross cut saw blade. Teeth were shaped in it through the use of sharp flint rocks, and finally a crude saw, so legend tells us, was fashioned.

Immediately the band of wanderers repaired to the outskirts of the forest. In a ravine they found some fallen tree on which they proceeded to try this newly discovered saw. Great was the rejoicing when after repeated trials and tests they found that it performed its task in a much more satisfactory manner than the bronze saw they had been using. The news of the new saw quickly spread concludes the legend; and, when soon thereafter iron ore was discovered, a great step in the progress of the world had been made.

Fanciful as this account may seem, it is quite possible that through meteors man first became acquainted with iron for, despite the abundance of ore deposits throughout the world, iron in pure state rarely exists.

Another interesting story has been included in the
Greek mythology excerpts of which are quoted from Beckmann (6 p. 361-3).

The inventor of this instrument, the saw, has by the Greeks been inserted in their mythology. By some he is called Talus . . . . who having once found the jaw bone of a snake, he employed it to cut through a small piece of wood; and by this means was induced to make a like instrument of iron that is to make a saw.

The reported findings of iron saws, that could be classified as among the first, are even more rare than those in regard to bronze saws. Iron oxidizes much more readily than bronze, and except in rare cases the early iron saws have disappeared due to this cause. Layard, however, reports the finding of an iron saw at Nimroud by saying (29 p. 165) "Amongst the iron instruments were the head of a pick, a double handled saw (about 3 feet 6 inches in length) . . . ." Judging from the illustration which Layard gives, the teeth are uneven in size and shape and without rake. This laconic comment and meager illustration fail to give a very clear concept of this saw. It could be assumed from the shape and placement of the handles that it was a cross cut saw and that the unraked teeth were intentional. Hibben says (22 p. 160) that such a saw was known to the Assyrians. It is quite reasonable to believe that this is the oldest iron saw in existence. The date by which saws had come to be made of iron and steel is fixed by Petrie (44 p. 43) as being as early as 666 B.C. Petrie also mentions (44 p. 43) the finding of three other iron saws of an Assyrian armourer, two of which had raked teeth and cut on the pulled stroke, the other was double edged and framed.
It is probably safe to assume that the use of iron saws dating several centuries before Christ was much more widespread than the evidence presented above would seem to indicate—the rapidity with which the thin metal plates rust away accounting for the lack of specimens found. Perhaps, too, lack of interest in this tool by excavators is also a reason.

**Evidence of Greek Saws.** Types of saws used by the Greeks were not found described. However, the assumption has been made that the saws of the Greeks were very similar to those of the Romans. This being the case, it is quite possible that some of the developments in the saw, with which the Romans will later be credited, might really have been due to the Greeks. The basis for this assumption is a statement by Beckman (6 p. 365) who said that the saws of the Grecian carpenter "had the same form, and were made in the like ingenious manner as ours are at present." Furthermore, due to the intermingling of Greek and Roman cultures, it seems possible that carpenter's tools, including the saw, might have been much the same in both countries.

**Roman Saws.** It remained for the Romans to make the greatest advances in the development of the saw. From them came the clearest evidence of the use of the bow or frame saw although, as has been seen, they were not the first to use it. The bow, quite generally associated with the arrow as a weapon of the hunt and the field of battle, has proved an indispensable adjunct in the early industrial processes of man. With the bow men revolved a stick inserted in wood
fast enough to produce the spark that would start his fire; he early learned to use the bow in revolving his crude drills and later used it as a means of applying power to his lathe. So it appears only natural that he should eventually substitute the saw blade for the string, making a bow saw. Indeed it is matter of wonder as to why the taut string did not give the idea sooner.

The blue print on page 27 has four sketches representing illustrations found of Roman saws. Figure 6 is copied from a similar representation of Disston (16 p.7) who says that it was originally drawn on a Roman tomb. An artist's conception undoubtedly, yet the similarity to the modern buck-saw is indisputable. Figure 7 is likewise supposed to be a drawing from a Roman tomb this reproduced by Petrie (44 pl.1). A comparison of these two sketches seems to indicate that the later type is cruder, and therefore of an earlier type since no discernible way is to be seen from increasing the tension of the blade. The former having a ridged piece between the blade and the cord could evidently be tightened by twisting and thereby shorten the cord. Figure 8 is a rough representation of bow saw photographed by Petrie (44 pl. 1). This saw had no provision for tightening the blade, and with this particular specimen the ancient workmen had removed one of the pins and bent the blade around the end of the bow to attain the required degree of tension. Figure 9 is still another type bow saw also photographed by Petrie (44 pl.1) and shown by Wyatt (56 p.380). The bow, or frame of this saw was made of iron, the tang on the frame
being for the handle. Similar to the two preceding sketches this saw had no apparent means of being tightened, though it is possible that the frame was sprung to insert the blade. It is assumed that the blades of these saws were made of iron or steel since by Roman times the age of Bronze was definitely past. That they cut on the pull seems logical since the blades were thin and the tension usually improper.

As to whether Roman saws were "set" is a question upon which authorities disagree. Petrie says in speaking of Roman saws (44 p.44) "There is no trace of setting the teeth alternately to one side and to the other so as to cut a wide kerf in an ancient saw." On the other hand Hibben makes this statement (22 p.131):

A great improvement that the Romans made in saws was to set the teeth out alternately so that the blade cut a wide kerf and slipped through easily without sticking on the sides. The Romans also had a tool for setting saw teeth and the shape of this instrument was almost exactly the same as that used for the same purpose until about a hundred years ago.

In support of this stand, Wyatt says (56 p.380):

The saw blades found at Bologna, and even some found as late as medieval times, had no set; hence it was commonly believed that Romans did not know how to set their saws. Saw sets . . . . and some blades with set found later on show they did set their saws. It is also known that the Romans had files for sharpening the iron and steel saws which came into use about the year 700 B.C.

Mercer also comes to the support of the contention that the Romans set their saws by showing (34 p. 295) saw wreaths or sets from Roman ruins at Herculaneum and Pompeii as well as files with a peculiar notch in one side which he thinks was used in setting the teeth.
The weight of the evidence on the question raised above seems to favor the latter contention. It is probable that blades which Wyatt says were "found later" never came to Petrie's attention, though Wyatt does not give any further information as to where and when these "blades" were found, although a final and conclusive bit of evidence is found in a statement from Neuberger (40 p. 4) who says, "An ancient Roman saw in the Antiquarium at Zurich shows the crossing of the teeth", and this saw may be one of those to which Wyatt referred.

Another great innovation of the Romans was the "saw pit" and the framed pit saw. Disston (16 p. 6), Knight (27 p. 2033) and Mercer (34 p. 155) all reproduce a painting discovered at Herculaneum depicting genii at the end of a plank, one above and the other below operating a saw very closely resembling the frame pit saw of the seventeenth, eighteenth and nineteenth centuries. Plate II is a similar picture which, according to Mercer (34 p. 155), was taken from a sixth century manuscript except that the saw instead of being taut in the middle of the frame is placed along the margin of the frame. Ribben makes these comments in describing this invention (22 p. 164).

In late Roman times there was invented a new method for sawing planks. This was done by digging a hole in the ground over which the logs were rolled. The saw was made with a long flat blade held tight in a frame, from which the saw gets its name. Then one man would go below and pull the long saw down, while his partner pulled it up again from above. It was called a frame pit saw, and these workmen, who had a guild of their own, were called pit sawyers.

The contributions which the Romans made to the devel-
opment of the saw may be stated as follows: They apparently were the first to "set" the teeth of the saw; to them belongs credit for making satisfactory files with which to sharpen saws; they developed the bow or frame saws and eventually found means of adjusting the tension, and last but not least they invented the frame pit saw. The fact that many of these saws remained in use for centuries, and that some types are still common, will be shown in the following chapter as well as a description of the newer innovations with some pertinent information relative to manufacturing methods and materials used.
CHAPTER IV
SAWS OF YESTERDAY AND TODAY

The stagnant period of the Dark Ages succeeded the cry and clamor hurley-burley of a faded Roman Empire and was in turn succeeded by a period of commercial growth bringing in its wake the building of towns and cities. That carpenter's tools and particularly the saw played an important part in this latter period is a foregone conclusion. But only an obscure illustration or an occasional chance comment survive to aid in building a satisfactory chronology of the saw's development. Such great gaps occur, that, though by comparison of Roman saws discussed in the last chapter with those known to have existed from the fourteenth century on, it is possible to relate the development of the intervening centuries, it is impossible to find out and fix accurately where and under what circumstances changes and innovations took place. Subsequent paragraphs will attempt to show the changes that took place before the rising of the curtain that dispersed the Dark Ages, as well as the more recent ones. However, all types of saws did not originate during or after the Dark Ages, but were continued through this period from Roman times up to and including the present.

Buck Saws. One of the types referred to above is the buck-saw. Still a somewhat familiar implement, this saw was a common farm necessity until the early twentieth century.
Plate II.

Genii Sawing.

Reproduced from a painting found in a 6th century manuscript. Courtesy Bucks County Historical Society.
Farm boys of many generations and in many lands might have had their imaginations stirred, when engaged in the commonplace and perhaps undesirable task of sawing wood for the family fire. They but known, that in all probabilities, Caesar's legions carried and used a very similar implement during the invasion of Gaul.

Mercer (34 p. 200) differentiates between a bow and buck saw by saying that the blade of the former may be turned in the frame, while the blade of the buck saw cannot. This classification can only be accepted in speaking of framed saws made after the Middle Ages. As shown in the preceding chapter, the framed saws quite clearly developed from the bow, in the early types of which the blade could not be turned. However, the classification may be accepted when thinking of those framed saws since the Middle Ages that have the blade strained along the margin of the frame. This being so, the buck saw has had some variation as to size and shape. One such saw, the blade strained in a homemade frame, may be seen in the Ohio State Archaeological Museum, Columbus, Ohio. From the size of this saw it is apparent that it was intended for the use of two men, though the more common type, as illustrated on Plate III, were one man saws. Because of its unturning blade, the buck-saw must of necessity be limited to cutting off comparatively small pieces. The three buck-saws, illustrated on Plate III, are owned and exhibited by the Bucks County Historical Society. The teeth of these three saws are unraked. This is a second
Plate III

Buck and Bow Saws

Courtesy Bucks County Historical Society
distinguishing feature of the buck-saw. Bow saws have teeth raked toward the handle so that they may cut on the pull stroke while buck saws cut on both the push and pull stroke. This tool though interesting, because of its widespread use and its ancestry of Roman bow saws, cannot be considered a fundamental tool of the sawyers, the carpenters, or the joiners.

Bow Saws. Many saws used for special purposes, such as the metal cutting hack-saw, the butcher's meat saw, and others, as well as certain saws used for cutting wood, come under the general classification of bow saws, thus each may be said to have originated, at least partially, from the bow saws of the Romans. Saws of this type, used for cutting wood, are also classed by Disston (16 p. 25) as the "tension" type saw. One such saw, illustrated by Disston (16 p. 25) showing a thin narrow blade stretched in a wooden frame, is called a "web saw", concerning which the following comments are made (16 p. 26):

In some foreign countries this saw is used almost entirely as a 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 general type of hand saw.

Figure 29, Plate IV, is a very much similar implement as taken from the illustration by Diderot (15 pl. 8). This eighteenth century drawing shows no apparent means of turning the blade, though perhaps this is due to the draftsman's inaccuracies. In any event the rake of the teeth disprove the notion that it might belong to the buck saw type. Petrie also shows a saw of this type (44 Pl. L) saying it was used by the Dutch as early as 1694. Though records could not be
Plate IV

Saws Illustrated by Diderot

Courtesy Bucks County Historical Society
found to show the development of this saw during the Middle Ages, it seems plausible to assume that carpenters in Europe have used such saws ever since Roman times without a great deal of change in appearance.

The lower left hand saw pictured in Plate III is a bow saw used for the same purpose as the now common coping saw; namely, curvilinear work. This specimen, now owned and exhibited by the Bucks County Historical Society, corresponds closely to the frame "turning" saw used today. Other saws of today used for curvilinear work, and closely related to the bow saws, are generally classed as "bracket" type saws. Disston differentiates between these various saws as follows (16 p.29):

As a matter of fact, fret, scroll and jig saws are very similar and used for practically the same purpose. The fret saw blade is extremely narrow, and made from 1/32 inch wide, up. The narrowest blades, while having teeth, appear to be merely wire. The fret saw is used almost entirely by hand. It is delicate in construction and used 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 used by hand, is also used in a machine run by foot or other power. The jig saw, though often confused with fret and scroll saws, is distinctly a machine saw and is used on all heavy work.

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

The most common form of scroll saw, used by hand, and in general use in school shops, is called the coping and is described by Disston (17 p.14) as having a blade six and one half inches long stretched in a frame four and one half inches
deep from tooth edge to inside of back.

A kind of fret saw with a most interesting history is the Buhl saw, concerning which Disston makes the following comments (16 p.20):

A species of fret saw is the Buhl saw. The name is derived from Andre 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 especially made for this class of work.

Beneer (34 p.155) also describes this saw saying it was named for Boule, an Italian, inlayer of brass and tortoise shell. Though differences appear in the spelling of the name, and materials with which he is supposed to have worked, they seem to be of small importance. The interesting points in connection with this saw are that it can be assumed that Andre Buhl was the originator of it, and, as such, stands out as the first instance found of a particular man being credited with making a specific innovation in saws. In addition to this, the Buhl saw was the only example found of a saw being named for a man. Buhl's distinction, if not otherwise important, is at least unique.

**Veneer Saws.** The art of veneering was known to craftsmen quite early in history; and, according to Wallace (53 p.3), was practiced in early times by the Greeks, then, the art having been forgotten was rediscovered during the Middle Ages by Filippo Brunelleschi, an Italian. Wallace also adds (53 p.3) that the first veneer mill was set up at Augsburg, Germany, in 1565. No description of this mill
Plate V

Veneer Saw

Courtesy Bucks County Historical Society
could be found, so it cannot be definitely stated as to whether veneers were "sawn" or "sliced" though it seems probable that the latter is too recent a method to have been begun at that time. Furthermore, a considerable percent of veneers were cut by hand as late as the nineteenth century with a saw similar to the one pictured in Plate V which Mercer (34 p.156) thinks originated in France. This frame saw, with fine teeth and the blade strained between the centers of the end pieces of the frame instead of along the margin, was according to an illustration reproduced by Mercer (34 p. 157) held horizontally and pushed backward and forward by two men, as indicated by the hand grips at each corner of the frame.

Frame Pit Saws. It will be remembered that credit has been given to the Romans for inventing the frame pit saw. Last of the saws of Roman origin to be discussed, it is perhaps by far the most important. For centuries the only competitor of this implement in making boards was the axe and the wedge. It continued in widespread use in both Europe and America until displaced by the greedy saw-mill. Its importance can hardly be overstated and the following statements by Mercer are at times almost poetical in stressing this importance (34 p.16-17):

... this all important saw as a master tool of the wood worker has outrivaled the axe and out classed the wedge from the beginning of history... the two men "pit saw" in the eighteenth century produced (until 1720 in Pennsylvania) the chief raw material for carpentry; namely, boards, sawed directly from the log, and so out ranks in historic interest and importance all other saws... this tool inherited from the Romans was continually used to make boards in historic Europe; and tenaciously and tyrannically held
to as a breadwinner, by the sawyers, who kept on hand sawing boards in England until about 1620... Saw mills and saw factories, old and new, big and little, fade into the light of centuries as we look at this thin narrow flexible blade, stretched in a rectangular frame—this ancestor of all carpenter work, this most interesting of all saws... Plate VI is a picture of a frame pit saw now in possession of the Bucks County Historical Society. The two projecting pegs at the top are parts remaining of the "top man's" handle, and the holes in the bottom cross piece clearly indicate the location of the "pit man's" handle. A comparison of this saw with Diderot's drawing of a frame pit saw, Plate IV, figure 28, show that for all practical purposes these two saws are identical. The former appears more crude and gives rise to the supposition that the blade probably imported from England was stretched in a home made frame.

In these saws the teeth were raked toward the "pitman" so that cutting was accomplished on the down stroke. The "top man's" principal duties were to draw the saw back into position for the downward cutting stroke and to guide the saw in its descent.

Mercer (34 p.20) quoting from the "New English Dictionary" says that the frame pit saw was in use in England as early as 1350. Moxon (38 p.93) describes this tool during the seventeenth century in England. No difference can be noted in this saw and the ones already described. Holtzapffel's description and inclusion of this saw in a list of saws (24 p.693) show that at least this saw was not a forgotten, nor entirely unused implement, even as late as the middle of the...
Plate VI
Frame Pit Saw

Courtesy Bucks County Historical Society
nineteenth century. Taking into consideration these facts, it seems fairly safe to assume that this saw was used continuously in Europe from the time of its inception by the Romans, and although its use in Europe and America is now forgotten a very similar saw is, according to Mercer (34 p.25), still used in China and Korea. Whether or not this latter tool had a separate origin could not be determined.

The frame saws, described in the preceding paragraphs, seem definitely to have come down from Roman times, but at the close of the Dark Ages when records of saws were to be found again, carpenters, joiners and sawyers were using types of saws which had been unknown to the Romans; namely, unframed saws of the Egyptians, but unlike the saws of the Egyptians they were generally made to cut with the push motion. Exceptions to this rule were the still familiar cross-cut or "thwart saw" which has teeth raked in neither direction and the open pit saw, which like the framed pit saw, was made to cut on the pull of the "pitman." No evidence was found to indicate that any of the open one man varieties have been constructed to cut on a pull motion. A description of some of this variety of saws follows.

Open Pit Saw. The "open" pit saw, sometimes called the "long" pit saw, and at other times apparently referred to as the "whip" saw. A glance at Plate VII reveals the reasons for the diversity of names. Appearances show this saw to be much longer than the old frame type, and Holtzapffel's table describing various saws (24 p.698) prove that the open pit saw was the longer by two feet on the average. A
Plate VII
Open Pit Saw

Courtesy Bucks County Historical Society
slightly vivid imagination could easily picture the trembling, quivering qualities of this long, narrow blade. Attention is also called to the handles; the one at the top was called the "tiller" and hence the "topman" in a pit using a frame pit saw became the "tillerman"—an appropriate title since his principal job was to guide or steer the saw; the adjustable lower handle was, because of its appearance, called the "box", while the "bitman" remained unchanged.

Just when, during the Middle Ages, this saw had its inception is of course unknown. The oldest evidence found by Mercer (34 p. 21) was in the form of an engraving by Antonio Tempesta, 1555-1630, showing a pit saw of this variety and proving that the use of these saws began some time before 1630 and quite possibly during the sixteenth century.

From reference found by Mercer (34 p. 23) in the Essex County (Mass.) Court records, to "whip" saw and "tiller" it appears that this type of saw was sold and used as early as 1654. Though again evidence is lacking to prove the point, it seems probable that both framed and unframed saws were brought to America with the first colonists. A later chapter will show that the first colony in America at Jamestown in 1607, preceded the first saw mill in America by less than twenty years, and though houses on the frontiers continued, as long as a frontier existed, to be built of "hewn" timbers, the older and more firmly established colonists were ready enough for planks and clap boards from the "pit" or "mill."

The blade of the open pit saw was quite thick in com-
parison to the blade of the framed saw. Because of this, more of the log was wasted in the process of sawing. This was not considered a particular disadvantage in America where timber was exceedingly cheap due to its abundance. In addition, larger logs found in America could be ripped up without interference of a frame, so that this type of saw was generally more popular in America than in Europe where lumber was more valuable and logs generally smaller in diameter. However, the impression must not be given that pit saws of either type were the chief reliance of the lumberman in producing boards. In regard to this point Mercer says (34 p. 24):

... throughout the colonial period these two man saws ... whether framed or open were by no means universal tools, but rather superannuated survivals, used for odd work, such as making special ship or bridge timbers or furniture boards, and at odd occasions or places, by slave labor or where water power had failed; and that ever since the first settlement of the American colonies the great demand for boards, planks, rafters, etc. was supplied by another apparatus which had been doing the same work in Europe before the discovery of America.

Mercer is, of course, referring to the saw-mill, and since, as will be shown in the next chapter, the saw-mill was little known in England until the eighteenth century, and general use of the saw-mill in Europe did not take place until the seventeenth century, the above statement might be a little misleading. The development of the saw-mill in America did, however, keep pace with a similar development in Europe. Despite this encroachment, the open pit continued to be used, to some small extent, almost up to the present time. Mercer found (34 p. 25) that as late as 1916
one of these saws was still in use in a Baltimore shipyard and that as late as 1929 Disston was still making these saws for export to Russia.

The Hand Saw. Probably the most common tool to be found in the carpenter's tool chest is the carpenter's hand saw. Like the unframed types of tools described in preceding paragraphs, this saw was brought into use at some unknown time during the Middle Ages. Though in shape this saw closely resembles early Egyptian saws, no other connection between them can be traced, and perhaps origin of these later push type saws owe but little of their origin to the earlier pull saws of the Egyptians.

The second saw on Plate VIII is an almost exact duplicate of the oldest hand saw of this class that could be found. Note particularly the tanged open handle and the curious notched "nib" at the end of the saw, more about which will be said later. This particular saw is now in possession of the Bucks County Historical Society and has a rather interesting history, which is told by Mercer as follows (34 p. 136-7):

... a rare tool found in a grave digger's shed at the old (1763) Buckingham Friends Meeting House, near Doylestown, Pa., shows the earliest type of this wide bladed unframed Anglo-American hand saw.

... In construction it resembles the carpenter's hand saw of today, except in the shape and set of the handle, which lacks the now invariable hollow grasp, and is not riveted on a blade through a slot, but set on a tang . . . . In no other resting place, excepting the secluded and rarely visited out house of the dead, where this relic was found, can we reasonably suppose that a saw would so long escape the imnumerable changes which elsewhere would have destroyed or lost it. One hundred and eighty years ago, or about 1740, when the original meeting house was
built, we may reasonably suppose that the first grave
digger used this tool to saw off obstructing roots
in the freshly cleared graveyard which is still
surrounded by woods. But the once omnipresent
roots have long since rotted away, generations
have come and gone since the old meeting house
burned down, in 1768, to be replaced with the pre-
sent building, while the saw, never lost, broken,
worn out, or rusted away, remains.

Saws similar to the one described above date as early as 1693.
Moxon illustrates a saw which is identical (38 pl.4) except
for the little notched "nib" or ornamental knob at the end,
which is to be found on all subsequent saws of this type
until recently discontinued by modern saw makers. This knob
is clearly seen on the two lower specimens on Plate VIII.
Petrie illustrates an identical saw (44 pl.l) which he says
is a Dutch saw of 1694, and Mercer found a copper engraving
dated 1718 (34 p.136) which likewise portrays a saw of this
kind. The hollow grasp handle, universal in hand saws today,
must have soon replaced the more clumsy tanged handle. The
lower two specimens on Plate VIII already mentioned are fair-
ly representative of the early hollow grasps. Mercer (34
p.137) mentions the find of an illustration of a hand saw
with a hollow grasp which was dated 1756. He believes this
to be the oldest record of this type handle. In 1769 Diderot
illustrates the same type handle indicating it was in common
use at that time.

Since the developments recorded above have been made,
the outward appearances of hand saws have changed but little.
The blades of saws made today are not all the same shape, as
will be seen by glancing at our manufacturer's catalogue—
for example, Disston's (16), some are straight backed and
Plate VIII

Hand Saws

Courtesy Bucks County Historical Society
some are skew backed. The handles are of course smoother, more harmonious in design, and the entire saw is better balanced. Great changes have of course taken place in the methods of making saws and, if commercial advertisements may be believed, changes in steel formulas have been of still greater importance. Witness the "Silver Steel" of Atkins (3) and the "Crucible Steel" of Disston (16).

The topic of hand saws can hardly be abandoned without the allotment of space to some comments on the little ornamental knob, which appears almost without exception on saws of the eighteenth and nineteenth centuries. Several sources have expressed curiosity concerning and have sought an explanation for this knob or notch, whatever it may be called. Petrie comments as follows (44 p.44):

The Dutch saw of 1694 shows the earlier forms of the curious little notch on the back which is still continued in modern saws without meaning. It seems originally to have been a tapering of the blade to the end, interrupted by a projection with a hole in it for hanging up the saw.

This may well be a logical explanation, since the tanged handle could not have provided an easy means of hanging as did the later hollow handles. Furthermore, though saws of this type found by Mercer, Plate VIII, seem to be partially rusted at this particular point, it looks as if it might have had a hole there. However, no other saws found did have such a hole.

Hibben has an entirely different explanation. He says (22 p.202):

It may well be that the little nipple that we see on the top of our saws has survived from the days when saws were pulled. Such a mark would serve to
catch the carpenter's eye as he pulled back on the saw so that he stopped his pull before the blade came out of the cut.

This explanation is not particularly satisfying since evidence is lacking to show that the unframed saws as known in Europe were ever any other than push saws—it does not seem plausible. No trace of any such mark was found on any Egyptian saws. More romantic explanations might be had by trying to identify this mark as belonging to some particular guild of talented saw makers, but Disston asserts (16 p.32) that it has no practical value, merely serving to break the monotony of the straight back line and as such is purely an ornamental design.

Other Unframed Saws. Among the common unframed saws of the seventeenth century was, according to Moxon (38 p.99), the "tenant" or what commonly is called a back saw today, though the more authentic name is tenon saw. This saw, from illustrations by Moxon (38 pl.4), was very similar to the tenon saws of today. The teeth were fine and the blade very thin so that the back was reinforced to keep it from buckling. Also, listed by Moxon is the compass saw. Moxon does not describe this saw. The following description is from Martin (32 p.522):

The compass-saw, which is very small and its teeth usually not set; its use is to cut a round or any other compass kerf; hence the edge is made broad, and the back thin, that it may have a compass to turn in.

It is probable that by Moxon's time there were more varieties of saws used than he has mentioned. Certain it is that Holtzapffel, about a century and a half later, lists
over thirty saws practically all used by various crafts that work primarily in wood. Some of these differ only in the angle that the teeth are filed and the degree to which they are set. For example, witness, hand-saw, rip-saw and half-rip-saw. One other saw used extensively during the Middle Ages, and now used extensively by the lumberman in felling trees and dividing the trunks, is the so-called cross-cut or "thwart" saw. The three specimens, shown on Plate IX, are two man saws of this type, while the top specimen, Plate VIII, is a cross-cut saw of the one man variety.

A very satisfactory discussion concerning this species of saw is reproduced as follows from Mercer (34 p. 31-32):

Far less important and fundamental than the pit saw because it did not make boards, this long tremulous tool, was, nevertheless sometimes used by the carpenters for crosscutting heavy timber and instead of the axe by the farmer or lumberman, for cross-cutting the trunks or butts of axe-felled trees, and gradually after 1880 for felling trees. Besides its general construction, one of its most important and conspicuous characteristics is the shape of its teeth, which, though greatly diversified by recent factory patents, are here shown (plate 9) only in their old inherited European form. In most saws, the angles of the teeth are never made at right angles, but always at acute angles, and always raked away from the hand; hence cut on the thrust, and not on the pull of the sawyer. But in this horizontal, two-man saw, where both sawyers should do equal work, the teeth were not raked at all, so that they could cut both ways. We further learn that in order to check the clogging of saw-dust in a wide back and forth cut through heavy timber, the teeth of the cross-cut saw are extra wide spaced, and unlike those of any other saw, show jagged or rude shaped intervals between the teeth, as if every other tooth had been broken off or filed down . . . . In some, the teeth are single and equisided. In others, the teeth are double and appear in close set pairs, raked contrariwise, which latter device, though frequently used in modern factory saws, is
Plate IX
Cross Cut Saws

Courtesy Bucks County Historical Society
no modern idea, since it appears in all old
German engraving by Vort Stoss of the fifteenth
century in the Dresden Print Collection. The
New English Dictionary proves that the "thwart
saw" was in use in England between 1404 and 1612,
and the Essex County (Mass.) Probate Records show
by numerous entries that the early New England
settlers employed it between 1631 and 1686.

Reference has previously been made to the resemblance of
the two handled iron saw found at Nimmrud to the above
described implement, and since Hibben says (22 p.160)
"cross-cut saws with long blades worked by two men setting
opposite the timber have been known since the time of the
Assyrians," it is possible that this saw has been continu-
ously used ever since the beginning of history. If this is
ture, the cross-cut saw without great change in form has
been employed over a longer period of time than any other
variety of saw. Offsetting this somewhat is the fact that
no trace was found of the Romans having used such a saw.

Supplementary Information. Some indications as to
craft conditions, dating from the seventeenth century, as
well as some explanation as to the quality and materials
used in making saws, may be had from the following extracts
which have been quoted from some of the more important sources.
The first is from Moxon who explains how to choose a saw as
follows (38 p.92-4):

All sorts of saws for Joyner's use are to be
found at most iron-monger's shops . . . .
choose those that are made of steel (for some
are made of iron) for steel of itself is hard-
er and stronger than iron. You may know the
steel-saws from the iron-saws thus; the steel-
saws are generally ground smooth and bright, and
are (the thickness of the blade considered)
stronger than iron-saws. But the iron-saws are
only hammer-hardened and therefore if they could
be so hard, yet they cannot be so smooth, as if
the irregularities of the hammer were well taken off with the grindstone. See it be free from flaws and well hammered, and smoothly ground, (that is evenly ground). You may know if it be well hammered by the stiff bending of it, and if it be well ground it will not bend in one part of it more than in another; for if it do, it is a sign that that part where it bend most is, either too much ground away, or too thin forged in that place. But if it bend in a regular bow all the way and be stiff the blade is good. It cannot be too stiff because they are but hammer hardened and therefore often bow when they fall under unskilful hands, but never break unless they have been often bowed in that place... The edge whereon the teeth are is always made thicker than the back, because the back follows the edge, and the edge should make a pretty wide kerf, if the back do not stick in the kerf, yet by ever so little irregular bearing or twisting of the hand away, it might so stop as to bow the saw, and with often bowing it will break at last. When workmen light a good blade thus qualified, they matter not much whether the teeth be sharp or deep, or set to their mind—for to make them so is a task they take unto themselves, and thus do they perform it:—They wedge the blade of the saw hard into the setting-block with handle toward their left hand and the end of the saw to the right, then with a three-square file they begin at the left end, learing harder upon the side of the file on the right hand than on the side to the left hand, so that they file the upper side of the tooth a little aslope toward the right hand and the under side of the tooth a little aslope toward the left or almost downright. Having filed one tooth thus, all the rest must be so filed. Then with the saw-wrest they set the teeth of the saw.

Although little is to be learned concerning manufacturing conditions from the above excerpt, a vivid imagination can picture the iron monger's shop perhaps in connection with a forge where manufacturing processes were undoubtedly all performed by hand. That these conditions did not change much in the following period of over a century is shown by the fact that Martin writing in 1813 could use many of
Norton's phrases in commenting on saws of his period. Martin's comments follow (32 p.522-3):

The saw is an instrument that serves to cut into pieces, several solid matters; as wood, stone, ivory, etc. The best saws are of tempered steel, ground bright and smooth; those of iron are only hammer hardened, hence, the first, besides their being stiffer, are likewise found smoother than the last. They are known to be well hammered by the stiff bending of the blade and to be well and equally ground by their bending equally on a bow. The edge, in which are the teeth, is always thicker than the back, because the back is to follow the edge. The teeth are cut and sharpened with a triangular file, the blade of the saw being first fixed in the whetting-block. After the teeth have been filed they are set, that is, turned out of the right line that they may make the kerf or fessure, the wider that the back may follow the better. The teeth are always set ranker for coarse cheap stuff than for hard and fine, because the ranker the teeth are set the more stuff is lost in the kerf . . . . of all mechanics none have so many saws as the joiners. The chief are as follows:

This pit-saw which is a large two handed saw used to saw timber in the pits is chiefly used by the sawyers. The whip-saw which is also two handed, used to saw such large pieces of stuff, as the hand saw will not reach easily. The hand saw which is made for a single man's use of which there are various kinds, as the bow or frame saw, which is furnished with cheeks. By the twisted cords that pass from the upper part of these cheeks and the tongue in the middle of them, the upper ends are drawn closer together, and the lower part set farther apart. The tenon saw which being very thin has a back to keep it from bending . . . . The surgeons use a saw to cut off bones; this should be very small and light, in order to be managed with greater ease and freedom, the blade exceedingly fine and the teeth exquisitely sharpened. Saws are now generally used by butchers in separating the bones from the meat; the divisions by the saw are neater than those by the chopper, and there is a certain saving, as the chopper splinters the bones, the parts of which cannot be included in the weight. . . .

While, as previously suggested, the authorities quoted above do not indicate changes in methods of making saws it seems probable that by Martin's time rolled sheets or plates may
have been used, instead of cast sheets which it is likely were used in Roxor's day.

An indication that men were striving to accomplish more efficient procedures in hardening the blades from which saws were made is shown by a description of a proposed hardening process and the apparatus to be used. This description written about 1808 by Fessenden follows (18 p. 253–4):

Our said invention of making and manufacturing all kinds of saws . . . made of iron and steel united, or of iron, or of steel, is particularly described (as follows) . . . the steel or iron is bored or cut into proper shape, the saws . . . are put in a frame of metal. . . . they may be heated red hot in the said frame, and stretched by screw or weight or any other proper power . . . and so formed in a straight direction. They are then immersed in water or a composition of oils and grease to be hardened in the frame in the direction wanted.

Whether or not the above method proved satisfactory was not determined definitely, but the assumption is that it did not, since the following description, of how saws were hardened, written by Holtzappfel about the middle of the eighteenth century does not resemble the one above (24 p. 683):

The blade of the rectilinear saw is usually as thin plate of steel, which in the first instance is rolled of equal thickness throughout, the teeth are then punched along the edge previously to the blade being hardened and tempered, after which it is smitted and hammered to make the saw quite flat. The blade is then ground on a grindstone of considerable diameter, and principally crossways, so as to reduce the thickness of the metal from the teeth to the back. When, by means of the hammer, the blade has been rendered of uniform tension or elasticity, the teeth are sharpened with a file, and slightly bent to the right and left alternately in order that they may cut a groove so much wider than the general thickness, as to allow the blade to pass freely through the groove made by itself . . . .
Though many of the various processes in this procedure, such as hammering, grinding, and filing would be classed as hand labor; a similar excerpt from the Penny Cyclopaedia of this time shows some machine processes being practiced (43 p.476-7):

... the very commonest kind of saws are made of iron plates, hammer hardened, and planished upon the anvil to give some degree of stiffness and elasticity ... the more useful saws are made either of sheer or cast steel, of which the latter is preferred on account of its greater uniformity of structure. The steel is cast in the form of a small slab about an inch and a half thick. This slab is extended by rolling to the required degree of tenacity, and then cut with shears into pieces of suitable form and size. The edges are next perfected by filing and holding the flat sides of the plates against the grindstones, which process prepares them for the cutting of the teeth. This operation is usually performed by a die cutter in a fly press, the motion of the saw being duly regulated ... the wire edges left on the teeth by the cutting out process are removed by filing, after which the plates undergo the process of hardening and tempering. After tempering they are hammerd, ground, re-hammered and polished, teeth set and filed.

Further details concerning the hardening of saws is supplied by Holtzapffel as follows (23 p.249-50):

Saws and springs are generally hardened in various compositions of oil, suet, wax and other ingredients ... the saws are heated in long furnaces, and then immersed horizontally and edgeways in a long trough containing the composition ... Part of the composition is wiped off the saws with a piece of leather, when they are removed from the trough, and then heated one by one a clear cake fire until the grease inflames—this is called "blazing off." When the saws are wanted to be rather hard, but little of the grease is burned off; when mild a large portion; and for a spring temper, the whole is allowed to burn away ... Springs and saws appear to lose their elasticity, after hardening and tempering, from the reduction and friction they
undergo in grinding and polishing. Toward the conclusion of the manufacture, the elasticity of the saw is restored principally by hammering and partly by heating it over a clear coke fire to a straw colour; the tint is removed by very diluted muriatic acid; after which the saws are well washed in plain water and dried.

The various processes which have been described in the several preceding paragraphs would for the most part be termed old fashioned and out of date. In modern manufacture, hand processes have generally been replaced by factory production methods. Electric furnaces with heat automatically controlled, grindstones especially and precisely made for the exact reduction of the various types of saws, as well as automatic presses, shears, dies, etc., are to be found in every saw factory today.

It has been a more or less general idea that in the early history of this country every blacksmith was capable of making and did make saws even as late as the middle nineteenth century, but this supposition could not be substantiated. Mercer (34 p.35) could not find a blacksmith who had ever made a saw or remembered of any saws being made by blacksmiths. Bushon says (11 p.300) "previous to 1830 we were almost entirely dependent on imported saws." From the phrasing of this sentence, it seems possible that in isolated instances saws may have been hand forged by the blacksmiths. In 1830 the manufacturing of large circular, mill, pit and cross-cut cast steel saws was begun in Boston (11 p.349). Soon after this, in 1840, the Disston Company was begun at Philadelphia (16 p.2). That hand labor prevailed in these earlier factories in America is shown by the state-
ment (3 p.1) that the saw and tool factory of the E. G. Atkins Company got its start in 1857 when Elias Atkins set up his anvil in Indianapolis and started making saws by hand. In view of the statements and dates set forth above, it seems probable that, though hand methods have only been replaced recently, the manufacturing of saws has long been carried on in plants built for that particular purpose.

Concurrent with the period which this chapter has covered in describing the developments in connection with handsaws, was the development of the saw-mill. This development will be described and discussed in the chapter which follows.
CHAPTER V

SAW MILLS

Probably the first as well as the most interesting machine application of the saw was the saw mill, used in cutting the log into deals, planks, clap boards, etc., for the use of the joiner and carpenter. Like the saw itself, its first use is somewhat obscure and evidence, which seems to be rumor or hearsay, has placed the invention of this device much earlier in history than can safely be accepted. Be that as it may, the development of the saw mill can be shown to have progressed by easy stages from a crude machine that worked by some power other than man, moved the previously described pit saw up and down as the log was moved toward it to the present gang of band saws devouring logs at a dizzy pace. As the awed gaze is cast on these modern mills, appreciation will surely be enhanced by a knowledge of the times and places of the earlier saw mills as well as the steps which eventually brought the modern mills into existence. Saw mills generally have been of three classes: namely, reciprocating, circular and band, and appeared in the order named, the last two being but comparatively modern innovations as will be shown in succeeding paragraphs.

Saw Mill in Europe. As mentioned above, what almost might be classed as a legend, and certainly little better
than rumor, places the first saw mill as having been established in Germany during the fourth century. As near as was ascertained, Martin (32 p. 524) and Beckman (6 p. 368), both mention reports of a saw mill having been built on the River Ruhr in Germany, at the time mentioned, are responsible for the continuance of this assumption, which Knight (27 p. 2041) and Bishop (9 p. 93) seem to accept as fact. Disston (16) and Mercer (34) ignore this evidence altogether arousing suspicion that they did not think it plausible for it seems certain that both had access to the above sources. Mercer (34 p. 25) does mention, however, that the early grist-mills were often confused with saw mills. Grist mills run with water wheels were in more or less general use at a time considerably earlier than the general adoption of the saw mill so that it is possible that the mill in question might have been of the earlier kind. Beckman, who is somewhat responsible for the existence of this report, goes on to create more doubt as to its truth by saying (6 p. 36) "I have, however, found no account in any Greek or Roman writers of a mill for sawing wood." Historians commonly give the impression that the Germany of this time was inhabited by the semi-barbaric Teutons while an enlightened Rome was the embodiment of the highest civilization known to that time. Logic indicates that the engineers, for which Rome was famous, would surely have produced a saw mill in advance of the Germanic tribes, or at least have seized upon the invention and developed it. Furthermore, the absence of any great number of towns and cities
in Central Europe at this time, indicate a lack of need for such a machine. The final reason for discarding this report as myth, or merely rumor, is the fact that no other mention of a saw mill was found for the succeeding period of almost a thousand years, and from the drawings and descriptions of these early mills it seems that crude applications of power to saw would first have been made. Of course, there is the possibility that such a mill having been built remained in use for a short while was not adopted because of the absence of need for it. Whatever may be the case the real beginning of the saw mill safely can be dated from a period not earlier than the fourteenth century.

In spite of the above logic, the first saw mill seem to have been built in Germany; but, by the fourteenth century great changes had taken place creating a need for as well as developing people with enough knowledge to build a saw mill. Disston (16 p.13) and Mumford (39 p.114) both state that saw mills run by water power were built at Augsburg, Germany, in 1322. Beckman, however, presents the most convincing evidence found concerning the early establishment of such a mill. He quotes Mr. Stretten, (6 p.370), who discovered from the town books of Augsburg that a saw mill was in operation there as early as the year 1337 and states further that some entries in the books might indicate a saw mill had been in use there as early as the year 1322. The actual year at this point seems of no particular importance, more than to definitely fix the time as early as the early fourteenth century.
Slowly, but with an increasing rate, these saw mills commenced to appear at various locations throughout the western world. The time and place, as well as other interesting facts, concerning the establishment of some of these early mills may be seen in the following quotation from Beckmann (6 p. 371):

When the Infant Henry sent settlers to the island of Maderia, which was discovered in 1420 . . . he ordered saw mills to be erected also for the purpose of sawing into deals the various species of excellent timber with which the island abounded. . . . About the year 1427 the city of Breslau had a saw mill . . . and in 1490 the magistrates of Erfurt purchased a forest in which they caused a saw mill to be erected, and they rented another mill in the neighborhood besides. Norway . . . had its first saw mills about the year 1530. This mode of manufacturing was called the new art; and because the exportation of deals was by this means increased, that circumstances gave occasion to the deal-tyths, introduced by Christian III in the year 1545. Soon after the celebrated Henry Hanzen caused the first mill to be built in Holland. In 1552 there was a saw mill at Joachimsthal, which we are told belonged to Jacob Gensen, mathematician.

Supplementing the above, Disston states (16 p. 13) that saw mills were built at Holstein in 1547, Lyons, France, in 1555 and in Sweden about the year 1658. Commenting on the early rapid development of the saw mill Disston also says (16 p. 13) that a gang saw mill, in which a log could be cut into a number of boards in one operation, was built on the Danube, near Ratesbon, in 1575. Beckman also mentions gang saw mills with the following comments (6 p. 373-5):

In the sixteenth century, however, these mills with different saw blades, by which a plank could be cut into several deals at the same
time. The first mill of this kind in Sweden was erected in the year 1657. At present (1817) that kingdom possesses the largest perhaps ever constructed in Europe, where a large water wheel, 12 feet in diameter, drives at the same time 72 saws.

There is no reason to believe that the dates and places mentioned comprise anything even approaching a complete list. On the other hand, it seems too safe to assume, since the wide spread geographical distribution is apparent, that the list is only a partial one.

**Saw Mill in England.** The absence of any mention of saw mills in England, might appear as somewhat curious, for a nation which ranks today among the most progressive of the world. It appears actually to be the case, however, that England was among the last to adopt this labor saving device. The reason for this cannot be blamed on England’s separation from the mainland of Europe or because of fancied isolation for according to Beckman (6 p.373) the Bishop of Ely wrote a letter in 1555 describing a saw mill he had seen in France. More than a hundred years after this, saw mills were still very uncommon in England as is shown by the following comment by Powell (46 p.34) made in 1661:

> At Danzick, a city of Prussia, Mr. Morrison, an ingenious traveler of this nation, saw a mill which, (without help of hands) did sawe boards, having an iron wheel, which did not only sawe, but did hook in and turn the boards into the sawe... We heard of the like device set up in Kent, here in England, and some other places.

This is the first report of a saw mill in England, and it is just that—a report. Since no confirming evidence could be found, and in view of later developments which prevented
the general adoption of the saw mill in England for some years after, this particular statement by Powell has little value as evidence.

The real reason why England lagged behind other nations in building saw mills may be seen in an excerpt from a letter dated August 2, 1700 as written by Houghton (25 p.44):

... Why should we not have a great many saw mills, and yet I do not understand there is any law against them, but I think the people are afraid of the mob.

Houghton's fears were likely prompted by attempt to start a saw mill in 1663. This attempt is mentioned by Andersen (2 p.354) as follows:

In this same year a Dutchman erected a wind saw mill or engine for sawing of timber on the river Thames, opposite Durham yard in the Strand, London; by which machine, with the sole assistance of one man and one boy, as much work was sawed as twenty men can perform in the usual way. But this method was afterward put down, lest our laboring people should want employment.

It is interesting to note in passing some of Andersen's comments on this prohibition. His arguments ring, surprisingly modern. He says (2 p.354):

How just such sort of reasoning seem is submitted to the public; since by parity of reasoning all wheels, carriages, etc., should be suppressed. There is one such saw mill in being at the town of Teet, (1763) near Edinburgh, which also goes by wind; and, as there is no legal restraint against so useful an engine, it is somewhat strange that in times, when useful hands were so much wanted elsewhere, it has never since been attempted; possibly the danger of popular clamor may have deterred men from pursuing it.

That the fears in regard to public opinion of both Houghton
and Andersen were not groundless is shown by the following excerpt from Beckman (6 p.375-6):

That he (Houghton) dreaded was actually the case in 1767 or 1768, when an opulent timber merchant, by the desire and approbation of the society of Arts, caused a saw mill, driven by wind, to be erected at Limehouse under the direction of James Stansfield, who had learned in Holland and Norway the art of constructing and managing machines of that kind. A mob assembled and pulled the mill to pieces. . . . A new mill was after erected which was suffered to work without molestation.

Although a definite date is not fixed to this latter mill, the evidence presented by both Andersen and Beckman seems to establish fairly well the time when saw mills finally were permitted to operate in England, that is sometime after the middle of the eighteenth century. They did not, however, completely supplant the pit sawyers, who according to Holtzapfel (24 p.698), until after 1820. It is possible that these first saw mills built generally on the Dutch pattern, and depending on wind for their operation, were not particularly successful, and not until this Dutch influence was overcome were satisfactory saw mills erected in England.

Saw Mills in America. As might be expected where labor was scarce and resources plentiful, the colonists in America were not long in seeing the advantages of a saw mill.

According to Disston (16 p.13) the first saw mill in America was built in 1634 at the Falls of Piscatauque on the line between Maine and New Hampshire. Bishop (9 p.95) says of this same mill that it was certainly there in 1635
and that it may have been there as early as 1631. Bishop further states that the Dutch had erected wind saw mills on Manhattan Island as early as 1633. It is quite probable that the Massachusetts Bay Company caused saw mills to be established in their colony almost simultaneously with the founding of the colony. In the Company's second letter of instructions, Bishop (9 p. 94) found that Governor Endicott was directed "to give approbation and furtherance to Francis Webb in setting up his saw mill" which was to be sent over to America in the "Iyon's Whelpe". This was in 1629 or 1630, and though these directions may have been carried out no record could be found of the FE having done so. Similar circumstances are found in connection with the Virginia colony. Bishop (9 p. 112) found that artisans were supposedly sent in the spring of 1609 to Virginia with the express order of setting up saw mills, but no record was found of their having done so. At any rate, the saw mill was to be found in America shortly after the first colonies were established and long before America could be considered anything but a wilderness.

The year 1656 saw a mill set up near a town in Massachusetts under the following conditions (9 p. 97):

. . . . that in case any of the townsmen do bring any timber to the mill to be sawed, the owners of the mill shall saw it; whether it be for boards or plank, before they saw any of their own timber, and they are to have one half for sawing the other half.

Other saw mills were established throughout the colonies. According to Mercer (34 p. 26) some of these were at Plymouth, Massachusetts, in 1654, in Connecticut in 1661,
in Pennsylvania in 1662 and near Montreal, Canada, in 1706. The first saw mill in Ohio was built at Marietta in the year 1789 (9 p. 104). Mercer throws more light on this growing industry in America when he says (34 p. 26):

It (the saw mill) was in frequent use in New England and the middle states throughout the seventeenth century, and in 1790 a hundred to two hundred and fifty mill saw blades were manufactured per year at Canton, Massachusetts.

... A man and a boy in New England in 1750 could saw in ten hours, four thousand feet of white pine boards, fifteen to twenty feet long and one inch thick.

In 1688 the price of a saw mill is reported by Weeden (54 p. 337) as having been one hundred pounds or nearly five hundred dollars. As the drawings of these early mills are examined, or the descriptions read, it is indeed hard to see why such a crude piece of machinery should be worth so much.

Descriptions of Early Mills. Because of the fact that many of the parts of saw mills are "homemade", because streams varied in width and velocity, and for other reasons unnoted, there are to be noticed many differences in saw mills. The following rather lengthy quotation from Mercer (34 p. 25-6) will bring out these differences and make the above point more clear in regards to saw mills found in both Europe and America.

... The saw mill, in which a frame saw, with one or more blades, was worked vertically up and down by a crank revolving on the end of the horizontal axle of a water wheel. Old pictures, imperfect descriptions, obscure hints in old books, and the writer's personal observations, show a considerable difference in the style and manipulation of this ancient apparatus, namely; in its old log carriage, whether moving on rollers,
impelled by cogwheels, or on greased channels or by windless ropes or suspended weights; and we find further that owing to variations in the force and volume of the water and in order to get the required velocity, the water-wheels ("overshot", "undershot", "tubwheel", "flutter-wheel", etc.) varied in size, construction and name; and in the gear, direct or indirect, of the axled crank above mentioned. Both the principle of construction of the machine, whether working in Europe in the middle ages, or in the American forests in the seventeenth, eighteenth and nineteenth centuries, was always the same. It is not necessary to confuse the mind by examining the modern log carriage or power application of recent circular or hand saw mills, where the gearing has changed and where the log if often clumped or clogged so as to overhang the side of the carriage; or to climb down into damp ruinous cellars and wonder at rotting water wheels; or to lose ourselves in the picturesque maze of ancient wooden machinery which often confuses this masterful device with flour mills. The important point always was to be kept in mind is that until the early nineteenth century, a framed pit saw was moved ... not by men, but by water, and that the moving carriage took the place of the long strips and cross pieces laid over the hand sawyer's pit; and that the log moved against the saw, and not the saw against the log.

Granting that Mercer's point, that fundamentally all early saw mills were the same, is the principal one to be considered in connection with early saw mill construction, there are other things of interest to be brought out by descriptions of early mills. These descriptions will show the easy stages mentioned in the early part of this chapter, by which the saw mill developed from the frame pit saw and the saw pit to the complicated piece of machinery illustrated by Plate X. Despite Mercer's statement to the contrary, and as has already been seen on page 56, these mills were not always run by water power but also
Plate X

Saw Mill

Courtesy Bucks County Historical Society
by wind, and some were devised for use of man power or the use of oxen.

What could easily have been the first step away from the hard method of sawing boards and toward the development of a saw mill is shown in an illustration by Veranzio (52 pl. 44). This drawing, which is really an interesting variation of the pit saw, shows a rectangular frame, somewhat higher than a man's head, on which the log to be sawed is placed. Two men are in the pit and the top of the frame saw is attached to two spring bars. There are two saws in the frame. The men in the pit pull the frame down causing the saws to cut into the log; when the frame is released the spring bars return the saw so that it is in position for another downward cutting stroke.

Probably the oldest drawing of a saw mill in existence is that reproduced by Usher (51 p. 144) from the album of Villard de Honnecourt, an ecclesiastical architect of the thirteenth century. This drawing shows the ordinary frame pit saw set in grooves in vertical timbers. The upper end of the saw frame is fixed to a spring pole, and the lower end fastened to moveable crosspieces which are periodically depressed by short bars protruding from the axle of the water wheel. The down stroke of these bars bring the saw down, while the return motion is accomplished by the elasticity of the pole. The log is held on a frame, similar to the one described in the previous paragraph, and moved into the saw on rollers. No reason was found to warrant conclusion that such a mill was ever put in operation and there-
fore may be considered as little more than an architect's dream. It may have been such ideas as this, however, that eventually brought the saw mill into reality.

Beckman quotes from a letter written by the Bishop of Ely, ambassador from Mary, Queen of England to the Count of Rome, who having seen a saw mill in the neighborhood of Lyons, France, in the year 1555 writes of it as follows (6 p.373):

The saw is driven with an upright wheel; and the water that maketh it go, is gathered whole into a narrow trough, which delivereth the same water to the wheels. This wheel has a piece of timber put to the axle tree end, like the handle of a brooch, and fastened to the end of the saw, which being turned with the force of the water, hoisteth up and down the saw, that it continually cateth in, and the handle of the same is kept in a rigall of wood from swerving. Also the teeth as it were upon a ladder which is brought little by little to the saw with another vice.

The account by Queen Mary's ambassador is quite obviously non-technical, and throws but little light on actual appearance, capacity or efficiency of this particular mill. The last sentence indicates that this mill could not be classed among the very earliest since the carriage was forced along at a predetermined speed by the action of gears connected to the water wheel. Early types of log carriages were moved by less satisfactory methods, such as weights and pulleys, windlasses or rollers over which the log was advanced by hand. Examples of these earlier types are shown by the drawings of Besson (8 pl.13-14). Although these drawings are of a more recent date (1571) than the mill described it is quite clear that Besson did not incorporate
the improvements in his drawings which this mill must have had. The assumption is that he followed types of machines with which he was familiar in making his designs. The principal differences in Benson saw mills were in the log carriage, which provided only that the log should be advanced to the saw on rollers with the assistance of the bar. Another unusual feature in regard to these designs was the fact that the crank was to be turned by man power. One of the designs (8 pl.13) provided for a gang of four saws to be strained in the frame. The other design (8 pl.14) provided for but two saws in the frame.

Bockler (12 pl.60-63) pictures four saw mills. Two of these mills have been reproduced by Disston (16 p.11). One of these is run by water power and has a windlass, which moves a certain distance with each stroke of the saw, thereby drawing the log into the saw, which is strained in a frame. The other picture by Disston (16 p.11) has been designed to utilize the power of beasts, oxen or horses, walking round and round in a circle. In this machine the log was pushed to the saw by man power.

In Bishop is found an interesting passage concerning the first patent under the New England code in reference to saw mills. The patent specifications have been reproduced by Bishop as follows (9 p.96):

In answer to the petition of Joseph Jenokes, for liberty to make experience of his abilities and inventions for ye making of Engines for mills to goe with water for ye more speedy dispatch of worke than formerly, and mills for making sithes and other edged tooles, with
a new invented sawe-mill, that things may be afforded cheaper than formerly and that for fourteen years without disturbance by any others setting up the like inventions that so his study and cost may not be in vain or lost; this petition is granted so as power is left to restrain ye exportation of such manufactures, and to moderate ye prizes thereof if occasion so require.

While the above specifications throw no light whatsoever on the saw mill invented, the wording of the decision and patent does throw some possible light on reasons why machinery monopolies were sometimes so easily gotten and were so hard to break. With indefinite specifications, a patent sometimes might have been used to the unfair advantage of the holder. However, the following description reproduced by Bishop (9 p.112-3) might very well have been the mill mentioned in the patent above:

... this hear is not altogether like those of norway, for they make the piece of timber approach the sawes on certaine wheels with teeth; but because of reparations which this toothed wheels are often subject unto, I will omit that use, and instead thereof put two waits, about two or three hundred pounds apiece .... the cords wherewith the sayd waits doe hange, to be fastened at the end of the two pieces of moving wood, which slide on two other pieces of fixed wood, by means of certain small pulleys, which should always draw the sayd pieces of moving wood, which advancing always toward the sawes rising and falling, shall quickly be cut in 4, 5 or 6 pieces, as you please to put on sawes, and placed at distance you will have for thickness of the blank or boards ye will cut, and when a piece is cut, then let one with a lever turn a rowler whereunto shall be fastened a strong cord, which shall bringe back the sayd piece of wood and lift again the waits; and after put aside the piece of wood already cut to take again the sawes against another piece of wood.

Still another description of saw mills is reproduced by Bale (5 p.36-7):
The common saw mill, which is generally employed in cutting lumber into planks, consists of a wooden frame in which a number of saws are stretched; this frame rises and falls in another wooden frame, secured to the foundation of the mill, in the same manner as a window sash rises and falls. The timber to be cut is placed in a horizontal carriage sliding upon the floor of the mill .. . which will carry the tree through and subject it to the action of the saws. The carriage is provided with a rack which is engaged by the teeth of a pinion, and this gives the means of advancing the carriage. The pinion is turned by means of a large ratchet wheel, with a click moved by levers connected with the saw frame; when the saw rises the click slips over a certain number of teeth of the ratchet wheel around and advances the wood forward just as much as the saw cuts during its descent.

While Dule does not give the actual source of this description, nor attempt to fix the date, it may be assumed, from the language and phrasing of the description, that it is of comparatively recent times, and in all probabilities corresponds closely to small reciprocating mills which frequently were in use in the nineteenth century.

Before leaving this topic, it appears that at least one description should be attempted of a wind mill, since several early saw mills were operated by wind power. One such mill is described by Anderson (2 p. 707):

A horizontal wind mill. The simplicity of this invention is now pretty well known to the mechanical world. It consists of an upright shaft, on top of which is a cap, familiar to an umbrella; in the sides of which are 5 cocks at equal distances, in each is placed an ear; the axes at the end of the ear turns in an upright shaft; the cap supports the ears by means of the cocks. On that part of the ear, under the cap, is fixed two crosspieces, called striking pins; on the edge of any building is fixed a round traversing board, with a hole in the center, to contain the upright shaft; in the hold of this board is fixed a tube, or socket, round.
which vane and vane board move as the wind directs. Under the vane board are three rollers, at equal distances which run on the traversing board, at the pleasure of the wind; on the upper side of the vane board is fixed two half hoops, or circles, against the ends of which the pins of the oars strike, to turn them to take the wind.

The form of power just described proved unsatisfactory in most localities, because of the inconsistency and irregularity of the wind. From its widespread use and general adoption, the most satisfactory power applied to the saw was that derived by the water wheel from a swiftly flowing stream. Wind, man power or power from beasts of burden were make-shifts to be used only where water power was not available. The water wheel remained supreme until the advent of steam.

One of the earliest attempts to operate a saw mill by steam occurred at New Orleans in 1803. An early experiment with a steam boat on the Mississippi River found the boat at New Orleans at the beginning of the winter. It was decided to use the engine to run a saw mill, but operations were barely started when the mill and engine were destroyed by fire started by a mob of hand sawyers (9 p.99-100). This was the only instance found in America of opposition to the saw mill. The first record of a steam saw mill in America is the patent issued to Robert McKeen in 1798 (9 p.80) (1 p.43).

The Muley Saw. It is to be remembered that all of the reciprocating type consisting of one or more blades strained tight in a frame which slide up and down in grooves similarly to a window sliding in its frame, so that it was
also called a sash saw (5 p.36). Just how the "muley saw" differed from this, and its peculiar advantages seem to be explained in the following quotation from Richards (48 p.125-7):

The "muley saw mill" as it is termed in America, for what reasons no one knows, is an invention that has been confined mainly to the western states and has not, as far as we know, been built or even heard of to any great extent in Europe. In fact, there is some characteristic about the bold idea of operating an unstained saw that indicates American origin; and, although somewhat out of place, we will note a marked difference placed upon old customers in America in many matters connected with manufactures. The very same reasons that are adduced in England or on the continent for continuing a plan of construction are presented in America as a sufficient reason for changing it. In England it is said, a custom so old "must be right," in America, a custom so old "must be wrong" and need revolution or change. This spirit has led to many bold innovations in machinery. Among other things the idea of an unstained saw for cutting lumber.

It has been assumed that cutting speed or movement of the teeth of saws is the exponent of their performance; the muley mill is simply an expedient to increase the rate of the teeth movement in a reciprocating saw, by dispensing with the tension frame and all possible weight in the reciprocating parts. There is at the lower end of the saw a light cross-head mounted in guides, to which the end of the saw and the connecting rod are attached. The upper end of the saw carries another still lighter cross-head working in guides mounted on a pendant support. Immediately above and below the log the saw is held and guided by lateral supports of wood, with its end bearing against the blade. The lower guides are stationary, the top ones are moved to suit the diameter of the logs. Now it is easily seen that the wood on each side of the saw blade, the lateral guides above and below the log, and those to which the ends of the saw are attached, leave but little of the saw exposed, and no chance for it to deviate from its path nor to bend, and the result is that lumber so cut is more true, as to dimension, than that cut on mills of any other kind; just the opposite of what would be expected from the plan of operating a saw without tension. In fact, muley sawed lumber commands in the market a superior price, on account of its regular dimensions, and smoothness, which is the result
of light cutting with slow feed. Muley saw plates, when new are, as a rule, about twelve inches wide, and one fourth inch thick; the stroke is from twenty to twenty-four inches; the number of revolutions from three to four hundred a minute. Such mills, when first introduced into America about twenty-five years ago (1845), were in some instances made on a plan termed "single geared" that is, the engine, when steam power was used, was hitched directly to the same shaft with the saw connection, and made the same number of revolutions; the stroke was short, the steam parts free; for a time the machinery would work well, but such rapid motion soon destroyed the engine, so that in late years the plan has been abandoned.

Richards leaves little to be desired in his description of the "muley mill" even his philosophizing throws light on the state of mind in which the pioneer American lumberman must have been held. Only one thing apparently escaped his notice: namely, that the thickness of the blade, which he states as one quarter inch, is such that considerable of the piece sawed must have been turned to saw dust instead of plank, and for that reason more raw material was wasted, than with the earlier frame type, which employed a thinner blade.

Saw mills of the above type are still in use in this country as shown by the fact that mill, gang and muley saws are still manufactured by Disston (18 p. 28). Of these saws, Disston says (18 p. 30):

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 still they are used extensively—especially on tough timber. The gang saw is shorter and lighter in thickness than the mill and muley saws. 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 muley.

Circular Saw Mills. Continuous cutting saws have quite generally taken the place of the slower reciprocating blade types, except in the more or less rare instances mentioned above. The first of these continuous cutting saws was the circular saw. The following statements by Bale (5 p.6-7) give many important facts concerning the origin of the circular saw:

The circular saw is said to have originated in Holland in the 16th or 17th century, but there is nothing to show who was the inventor. One of the earliest records of its use in this country is contained in the patent specifications of Samuel Millar, of South Hampton, granted in the year 1777, in which he claims an entirely new machine for expeditiously sawing all kinds of wood ... and the saws used are of circular figure ... in 1805 ... Brumel ... fitted up the government dockyard at Portsmouth with sawing machinery, including both reciprocating and circular saws.

Richards (48 p.9) also states that Millar's patent is the oldest record of a circular saw in England and goes on to quote from the original patent specifications, part of which is reproduced here as follows (48 p.9):

... the machine that gives the power is a horizontal windmill. The shaft of this mill stands vertical, with four levers fixed to it at right angles with the shaft. This shaft
hath a large wheel on it, round which goes a rope or chain which in continued to a smaller, through the small wheel goes a square bar of iron, that receives the saws, which are circular in figure. Those saws being in motion the matter or substance they are to cut through is brought forward as follows:—The horizontal shaft, as mentioned before, has a small wheel on it, to receive a rope, the rope is continued to a smaller that hath a pinion on it, connected to a straight bar under the chariot which hath teeth to match the pinion. The chariot moves on a groove likewise on a centre; it hath two motions, one to advance forward and the other sideways, which is performed by a screw annexed to the chariot. This screw is turned by hand to direct the pieces against the saws agreeable to any line wanted to be cut.

quite naturally the adoption of circular saw mills, as described above, awaited further improvements one of the biggest drawbacks being the diameter of logs which could be handled at that time with a circular saw. However, improvements did appear as shown by the following statements by Dale (5 p. 8-9):

In the year 1824 letters of patent were granted to Messrs. Gaynor and Greenwood for "improvements in sawing machinery", the chief of which was the use of two circular saws of small diameter placed one above the other, but with peripheries revolving in the same line, in lieu of one saw of large diameter for breaking down heavy timber... They also claimed the use of saws of several circular saws on one spindle divided by suitable collars for cutting planks into scantlings at the same time.

The above "idea" originated in America according to Richards (48 p. 1331), and at least nothing was found to dispute his statements, which follow, concerning the development of the circular saw mill:

The circular saw mill... may be termed an American "idea" for the elements of the mill are all old... yet the bold idea of cutting large timber and using two saws in the
same kerf, originated in the United States, where such mills built in portable form have almost entirely superseded the reciprocating mills, except at lumber centers, where a large amount of manufacturing is done at a fixed plant.

Richards goes on to say that the capacity of these portable mills was from fifteen to twenty thousand board feet a day, and that the power was supplied by a steam engine developing forty horse power. He also includes the following interesting figures concerning the manufacturing of circular saw mills (48 p. 131):

The manufacture of these mills has become, in the middle and western states of America, a vast business, not less than two thousand workmen are in the state of Ohio alone, engaged exclusively on portable circular saw mills, with steam engines to drive them.

These small portable mills are at the present time still common in Ohio as well as other states, though the ability of the manufacturers to make saws of large diameter had generally done away with the need for using two saws running in the same kerf. Disston now builds circular wood cutting saws as large as one hundred and ten inches in diameter (16 p. 3).

As hinted in the opening paragraph of this chapter, the band saw working in gangs has quite generally replaced the other types of saw mills in the large lumber centers; and, as the band saw was first invented and developed as a small resawing machine, rather than one to convert logs into more suitable sizes, a discussion of this machine will be included in the chapter on re-sawing machinery which follows.
CHAPTER VI

RE-SAWING MACHINES

The history of re-sawing machines is comparatively recent. In fact, the development of all wood working machinery exclusive of the saw mill, dates from the latter part of the eighteenth century. Re-sawing machines are of three general types, corresponding in that respect to the saw mill. They are: reciprocating, usually with a vertical motion, but sometimes with horizontal action, circular and band. As previously mentioned, the circular saw was not invented by Samuel Miller until 1777. This was the first invention of importance to the development of re-sawing machines that had been made since the unnamed sawyer had first managed to harness water or wind power to his frame pit saw. Although this latter application had been known for some centuries, it was not until the coming of the industrial revolution that re-sawing machines of this type were built and used. In regard to this fact Wallace says (53 p. 5):

All this time, until the end of the eighteenth century, the action of the drama had been rising to a climax which came with the industrial revolution, when inventions of modern machinery were made in rapid succession.

The tool, removed from the hand of the craftsman and guided instead by some mechanism having pre-arranged motion, ceased to be a tool and became a machine. The modern machine is threefold; it
consists of the motor mechanism, the transmitting mechanism, and the tool or working element. Such machinery makes possible the use of greater motive force and greater exactitude in its application.

Up to that time inventive progress in woodworking machinery was comparatively slow, but at the end of the eighteenth century there arose a remarkable man, Sir Samuel Bentham, who within a few years invented and patented almost every known variety of woodworking machine.

While the above quotation was made in regard to woodworking machinery, including planers, mortigers, etc., it also is applicable to saws alone. As to Sir Samuel Bentham, his name is sure to be encountered in any source dealing with the re-sawing machines as well as those of woodworking machinery. Richards says of him (48 p.1):

... no art seems to have been so fully developed, or so nearly perfected, at one time and by one man, as that of wood cutting machines, by Sir Samuel Bentham, of England. ... Bentham's inventions constitute nearly all that is known of wood cutting machinery in the eighteenth century.

**Bentham's Patent.** Bentham's patent specifications, of 1793, for the various wood working machines were entirely written descriptions, no drawings being submitted. (53 p.7) For this reason the exact nature of the machines, and the appearances, which undoubtedly Bentham pictured cannot be accurately determined. According to Wallace (53 p.7) the patent was in eleven sections, two of which makes reference to saws. One section describes a vertically reciprocating saw, with means to handle stock for straight cuts and curves as well—the first jig saw. Another section is described in the words of Wallace (53 p.7):

This is a notable section covering every circular saw table, molder or shaper in use today. Bentham
describes saw tables with either blade or table tilting; describes the present day cross-cut and rip fences; specifies driving the saw spindle by either belt or gear; gives method cutting wedges with a circular saw, describes the use of wide cutters instead of a saw blade . . .

About the time that Bentham was granted his patent, he was made inspector-general of the naval works of England (53 p.6). At the same time his brother, Jeremy Bentham, was in charge of a number of industrial prisons and faced with the necessity of putting unskilled and unintelligent convicts to work profitably. The two brothers decided to experiment by having the convicts operate woodworking machines, and if this were to be done it became necessary to build the machines and so the first factory for the manufacture of woodworking machines was established. Some of these machines were used in the prisons while others were manufactured for and used in the naval yards. Among re-sawing machines, which according to Knight (27 p.2033), Bentham invented and built for use at this latter place were: a circular saw, segmented circular saw, crown saw, cylinder saw, bevel saw, curvilinear saw, double grooving saw and a segmented sawing machine with radius arm. Detailed descriptions of these various applications would have indeed been interesting, but none was found.

Brunel's Machinery. Brunel's machinery in some respects seems hardly to fall in the classification of re-sawing machinery, and neither could it have been called a saw mill. Regardless of its classification, the fact that the saw was mechanized, in a manner previously unemployed,
earns it some recognition. Bale gives the pertinent facts concerning this machinery as follows (5 p.6-7):

In the year 1805, Brunel took out a patent for "improvements in machinery for sawing timber" . . . he also about this time fitted up the government dockyard, at Portsmouth, with sawing machinery, including both reciprocating and circular saws. It was considered at that time the most complete machinery in the country. The tree subjected to the action of the cross-cutting reciprocating saw is placed in a long frame. . . . The end of the timber projects as much beyond the front of the frame as the part intended to be cut . . . . The saw is a straight blade, fixed in a wooden handle at each end to lengthen it. One of these handles is connected by a joint to the upper end of a lever bent at right angles and having the center beneath the floor. The horizontal arm of the lever is connected by a spear rod with the crank on the end of a spindle near the ceiling of the room. The motion of which is regulated by a flywheel. By this means the saw has a reciprocating motion from right to left nearly in a horizontal position, and exactly across the log that is to be cut, resembling in its action the carpenter's hand saw . . . . and it acts entirely on its own weight . . . . and slides up and down, to reach any height according to the thickness of the log.

The circular cross-cutting saw is more novel in its construction. The spindle is so mounted to move in any direction parallel to itself, the saw continuing in the same plane. By these means, it can be applied to any part, so that it will divide trees much larger than could otherwise be done.

It is doubtful if the reciprocating cross-cutting saw just described is widely used today, if at all, for cutting wood, though there is some faint resemblance in this application to the modern power hack saw. The circular sawing machinery apparently was the early counterpart of the present circular cut-off saw.

The Band Saw. Probably the re-sawing machine with
the most interesting known history is the band saw, which was invented by William Newberry and patented in 1808 (53 p.7) (16 p.16). Though not always used as a re-sawing machine, as has previously been noted in the chapter on saw mills, it was invented and brought into general and practical use as such. Plate XI is a drawing reproduced from Wallace (53 p.7) which was copied from the original English patent.

The parts referred to by the letters are as follows (53 p.7):

A, cast iron frame to carry on wheels; BB, wheels with iron plate screwed on behind to prevent saw from running off backwards; CC, blade of saw; D, bench for piece being cut; EE, two semicircles of iron, fixed to D whose centers are parallel to part of saw blade which is even with top of bench, one marked with divisions of circle by which, turning on slides, bench may be placed at any angle; G, guide to keep saw line; HH, wedges to force down lower wheel to give saw tension; I, piece to be cut.

For sometime nothing seems to have come of Newberry's patent beyond the submission of the drawings to the patent office. Perhaps this was due, as Disston says (16 p.16), to the great difficulty in making a strong smooth joint in the steel band. Richards points out another defect, at the same time commenting on the lack of development which followed the original invention, as follows (49 p.15):

Disregarding the trouble that would occur in removing and replacing blades the saw blade, the machine is good and operative; and as the drawing is only from a model, we can hardly claim to have made, during the sixty years past, so great an improvement in band saws as should naturally follow if compared with other machines.

The credit for the development of the band saw seems to belong jointly to M. Perin and Mlle Crepin of France. Disston
Plate XI

Newberry's Bandsaw

From a reproduction by Wallace (53 p.7).
is responsible for the following statements (16 p.16):

To Perin, of Paris, is due the credit for the improvements which made the general use of the band saw possible. The old difficulty in driving 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. The patent was later obtained by Perin, and the saw greatly improved by him—a suitable joint was perfected and the band saw became a practical reality.

Evidence substantiating the assertions of Disston, and also bringing to light the fact that though this machine was not brought into practical use, others were experimenting with the idea and patenting machines similar to Newberry's, is found in the following statements by Bate (5 p.120):

It seems the band saw machine was patented in France in the year 1815 and again in the year 1845 by M. Thouard; but, owing to the constant breakage of the saws, they were only used on a very limited scale.

There is no record of many machines being constructed on Newberry's plan till 1855, when M. Perin, of Paris, exhibited at the French International Exhibition a much improved machine, on which he employed saws of French manufacture. From the mode of tempering the saws, they were enabled to stand the tension . . . and to run considerable time without breaking . . . and after that date they gradually came into use.

According to Clark (10 p.211-3), there were two band saws exhibited at the Machinery Exposition at South Kensington in 1862. These he said were "a comparatively novel class of machine."

Generally speaking, the band saw had two great advantages over reciprocating and circular type machines. Band saw machines using narrow blades can be used at high rates
of speed for scroll work, while the wider ones (Disston makes band saws as wide as eighteen inches) cutting continuously at high speeds are used in mills to rip up logs with a minimum amount of waste in saw dust.

**Fret Cutting Machine.** It has been noted that Sir Samuel Bentham has been credited with the invention of the jig-saw. Undoubtedly his patent covered this type machine, but it seems possible that similar machines, possibly worked by foot power, had been known before his time. Bale says (5 p.138):

> The origin of fret-cutting machine, which is also called the scroll or jigger saw, is obscure, but it was in general use long before the band saw, both in this country and in America. For tracery, fret work, and other internal cutting . . . . the fret saw is of considerable value. Hand power fret cutting, by means of a bow saw, had been practiced a great number of years . . . .

A rather recent patent in regard to this type of machine is described by Bale (5 p.120):

> . . . . a flexible, self-adjusting, bow saw patented by Mr. Cotter in 1872. In the bow saw frame the stretcher is made of steam bent beech wood which forms a spring, the stretcher ends are jointed to the side bars; the top of the side bars are connected with the stretcher by two tension rods, fitted with thumb nuts at their outer ends; the other ends pass into female screws fitted in the stretcher.

The rest of the machine is not clearly described, but it is assumed that it was a machine which could be worked with a treadle or a belt.

**Interesting Inventions.** Not all the developments and experiments with re-sawing machines, which were tried and made during the nineteenth century, can be traced in detail
though a few examples can be pointed out and described. One of these was a traversing cross-cut saw bench built about 1836 in the Arsenal of Woolwich, by John McDowell, is particularly interesting because of the size of the blade employed and because of the method used in transmitting the power. This machine is described as follows by Eale (5 p.10):

... the saw itself was about 7 feet in diameter, the largest yet made from one solid piece of cast steel. The driving gear was a great novelty, the saw spindle being totally unconnected with the actuating power; the motion was communicated to the saw through two frictional cones of buff leather embracing the saw on either side and running at a high rate of speed ... The saw ran at 300 R.P.M., and could be made to travel the length of the mill some 70 feet; and being placed below the level of the ground could also be raised or depressed below the floorline at pleasure ...

In 1863 an invention was made which brought circular re-sawing benches up to about the present basis of mechanical perfection. Previous reference has been found to practically all manipulative features which are known to this type of saw today, including the tilting table, rip and cross-cut fences, direct or belt drive, etc. The invention referred to is described by Eale as follows (5 p.16):

Mr. W. B. Haigh, of Oldham, introduced ... a mode of operating saw benches in which instead of making the bearings stationary, which carry the spindle of the saw, they are made moveable, so that the saw can be raised or lowered as desired.

One of the most common types of machines, as shown by the machine exhibited in 1862, (13 p.211) and in 1880, (5 p.138) (26) was the deal frame. This machine employed from four to twenty-four reciprocating blades, and except for the apparent refinements in construction closely resembled
the reciprocating saw mills described in the preceding chapter.

Illustration in Hatton (26), Clarke (13), and Bale (5) prove quite conclusively that these re-sawing machines of the early nineteenth century were very similar and very hard to distinguish from present day machines. Particularly is this so after the old wooden frames of the machines were replaced with more suitable ones of iron and steel castings. Naturally, this type of improvement was not only a benefit to sawing machines, but of all machines regardless of their application. Bale fixes the date of this development, as far as woodworking machines are concerned, as 1863, and comments as follows (5 p.15):

... one of the greatest improvements ever introduced in connection with woodworking machinery was brought out by Mr. Henry Wilson. This was what is known as the solid or "box" framing—that is instead of ... being bolted together in pieces, they were cast in one solid mass, thus securing greater rigidity.

Among other inventions were found the following: An invention by Robert Eastman, of Brunswick, Maine, for the introduction of a limited number of sectional or false teeth in the periphery of the circular saw was patented in 1824. In the same year, a machine was patented by Messrs. Sayner and Greenwood, which employed two circular saws of small diameter, with peripheries revolving in the same plane to be used in lieu of one saw of large diameter.

Although not nearly a complete list of the inventions patented have been mentioned, the principal ones found have
been at least lightly touched upon. In regard to many of these patents of the nineteenth century, no evidence is found in present day counterparts to indicate they had ever come into general practical use.
CHAPTER VII
CONCLUSIONS AND SUMMARY

From the preceding chapters it has been seen that implements classed as saws were known to man before history dawned. Saw-like tools of obsidian, flint, and chalcedony, of limited cutting capacity, have been found among the remains of ancient peoples in various localities, including parts of North America, England, Denmark, France and Asia Minor.

With the advent of bronze, the stone saws of savagery were replaced by more effective implements, though still extremely crude with irregular, unraked and unset teeth. Improvements increasing the efficiency of this crude tool were gradually made. By 4500 B.C., according to Petrie (43 p.587), the saw had regular teeth capable of some cutting on either push or pull stroke. Implements similar to this continued to be used for hundreds of years. Then about 900 B.C., as stated by Petrie (44 p.43) the true cutting saw, that is one with raked teeth, appeared. These features, present in most types of saws today, enabled the teeth of the saw to act as a series of cutters, instead of the abrasive tearing implement it had previously been. It has been assumed, that since bronze lacking tensile strength, buckles easily, the true cutting saw was intended to cut on the pull stroke. The above developments in connection with bronze
saws, have been credited generally to the Egyptians, although saws of this metal have been found in Asia Minor, Switzerland, France, Scandinavia and Italy as well. No records were found of the occurrence of bronze saws in either North or South America.

At some obscure date, iron and steel replaced bronze in the making of tools and weapons. Saws of iron, according to Petrie (44 p.43) were made as early as 666 B.C. Such saws were more easily sharpened, stayed sharp longer, and could be forged thinner. Few ancient saws of this material seem to have been found, due possibly to the fact that iron and steel rust and deteriorate rapidly. The Assyrians are known to have had iron saws, and likewise perhaps the Greeks, but the most important ancient records concerning such saws are found in the Roman cities of Herculaneum and Pompeii. To the Romans, therefore, must go most of the credit for the progress made in developing the saw from the time of the Egyptians to the Middle Ages. It seems that they were the ones to adopt the bow as a frame to hold the saw, which increased its general utility and made possible types of cutting hitherto unknown. To the Romans, also is due credit for setting the teeth of the saw, which made it possible for the saw to easily pass through the kerf cut by itself. Since the saws of the Romans were framed types, including the frame pit saw, the bow or turning saw, and one resembling the modern buck saw employing thin blades and usually without satisfactory means of increasing the tension of the blades in the frame, it
has been assumed that they, too, were intended to cut on the pull stroke.

The period of the Dark Ages left a gap in the history of the saw. At the close of this period the saws of the Romans were found to be supplemented by the use of unframed saws, many made to cut on the push stroke, similar to those used today in Europe and America. The greatest improvements in hand saws, since that time, seem to have been the improvement in the quality of materials used in their construction and in manufacturing methods. Modern saw factories have developed apparently within the last one hundred years.

Machine applications of the saw, seemingly, had their beginnings with the first saw-mill which legend says was built in Germany in the fourth century, but which could not be definitely established as having been earlier than the fourteenth century—specifically at Augsburg in 1322. It is assumed that the saw-mill developed directly from the frame pit saw and saw pit and was developed by more or less easy stages. Various sorts of power were used, including that of oxen, wind, water, and eventually steam. Water, being the most successful type of power, was used until the advent of steam. Other improvements in this early type of mill were largely concerned with the advancement of the log. In the earlier instances the log was dragged over the "carriage" with windlass or weights or perhaps pushed by hand over rollers. The ultimate in this respect seems to be the
moving carriage which was regularly advanced by gears connected to the water wheel. More recent developments, such as the "muley" mill, the circular saw-mill, and the hand saw-mill, particularly the latter two, have almost entirely replaced the earlier types. Practically all advancements in style, mobility, accuracy, durability, adaptability and productivity have been made in the last hundred years, and in the majority of these, in the last fifty or sixty years. For over four hundred years the saw-mill was employed to saw up logs, with but few appreciable innovations. These old "up and down" saws are remembered by the older residents of every rural community, and the timbers of many barns still solidly standing are proof, from the marks of the up and down motion, that the reciprocating saw-mill was an important factor in the growth of rural sections.

Following the saw-mill came other applications generally known as re-sawing machines. The patenting of the circular saw in 1777 by Samuel Miller made many of these machines possible. This invention was supplemented by the invention and introduction of the jig saw, cylinder saw and other circular saws by Sir Samuel Bentham in 1795. Another important invention was made in 1808—the bandsaw by William Newberry. This machine was not put into immediate use, however, probably due to ineffective methods of brazing the broken bands. By the last half of the nineteenth century, the bandsaw came into general use. Although invented and introduced
as a re-sawing machine, band saws are used extensively today for sawing up logs in lumber dents.

Aside from the saw-mill, machine applications of the saw are generally recent and except for the fact that iron and steel castings have replaced the earlier wooden machine frame, modern machinery closely resembles their earlier counterparts.

Suggestions for Further Study. Great gaps are apparent in this particular paper. It seems probable that given a sufficient period of time the existing body of data could be added to appreciably. Perhaps other works undiscovered, written in French or German which have never been translated, would bring to light new facts; particularly of the period known in history as the Dark Ages.

Study of topics similar to the one dealt with in this paper, but considering the plane or the drill and the applications of each, would be interesting and possible. Source materials would, of course, be very much the same as the ones used in the development of this paper.
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