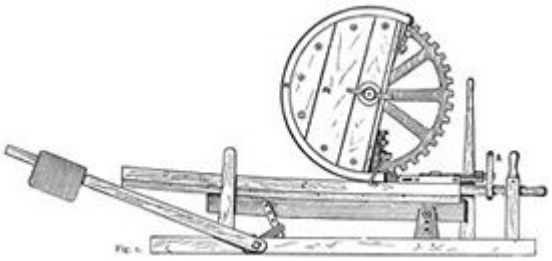
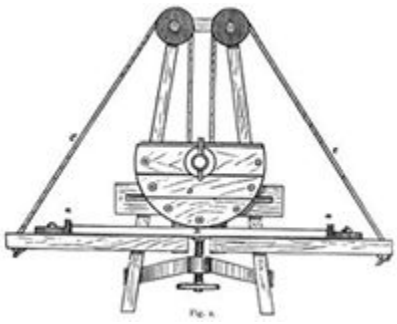
WOOD BENDING
Applied Mechanics in Wheel-Making
Hub November 1878 page 388-389
Chapter VI--Bent Timbers for Rims.

It is a singular fact that wheel-makers of this country own a lifelong debt to the warlike occupation of the gunsmiths, as the following preliminary sketch will demonstrate.

In the year 1838, Edward K. Reynolds, a gifted mechanics native of New-Jersey, resident of St. Georges, Delaware, and gunsmith by trade, after some years' experimenting, was granted a patent for a machine and process for bending timber ("preferably hickory") into felloes or rims for carriage-wheels. Mr. Reynolds, like all other inventors, met with very little encouragement in his first efforts to introduce his invention, and became disgusted with the indifference of those who should have been most interested in this great improvement. After many disappointments, he found in Geo. W. Watson, of Philadelphia, at that time becoming prominent as a builder of carriages, a patron and friend, who after repeated tests adopted the bent rim, and Reynolds was soon forced by increase of business to remove to Salem, New Jersey, where be secured increased facilities for obtaining timber and shipping the articles when manufactured, and to this beginning may be traced the era of the American wheel made possible by this invention. Unfortunately there was one difficulty: Reynolds' machine was not economical in its working, as nothing but the best timber would bend, the strain upon the fibers causing the inferior qualities to break. This, though limiting the profits of the business, was the means of introducing these rims more rapidly, as, bent in this manner, they possessed more elasticity and were free from any sinking at the joints.





The difficulty of breakage was overcome in the year 1849 by another inventor, the well-known Thos. Blanchard, also a gunsmith, who had already conferred an inestimable benefit upon the carriage trade through the invention of the "spoke turning lathe." Blanchard's improvement consisted in placing a "screw" upon the binding band of a bending machine, which was a perfect mechanical remedy for this wasting of good material, which amounted under the Reynolds system to about thirty per cent. As this improvement caused a revolution in the principles governing the working of the rim in making a wheel, we will consider it in detail, as it is of the greatest importance that it be understood.

If we examine a rim strip before bending, say of one and a half inch in size, the lines of the top and bottom are parallel or of equal length. Now, if we bend this (the rim strip) around a half circle, or"form," 42 inches diameter, the inside of the rim would measure in decimals 65,9736 inches for the one-half circle, while for the outside of the rim it would require 70,636 inches to the same point, leaving more than four and a half inches for the fibers to stretch in this old style of bending it; it is therefore plain that nothing but the most elastic material would endure this operation. With the "screw" used by Blanchard, the inside fibers are crushed together, or, to use tire technical term, "upset," so that the outer fibers retain their normal condition, with the

exception of a slight elongation, caused by relaxing the screw during the revolution of the "form" or bender; then instead of having the back of the rim stretched to make up this four and a half inches, we have the inside of the rim driven together to that extent. This can be better understood by referring to Fig. 1, which shows a front view of the "Reynolds-Blanchard machine." The "screw" is seen at A ; B is the rim as it appears after the revolution of the form D ; C is a sliding bed, which supports the wood during the process of bending. It might naturally be supposed by those not informed, that a rim, after bending, would have a tendency to spring out or away from the circle to which it is bent; but this is the case only so long as the rim retains the moisture and sap left in the pores of the wood after steaming. This, in drying out, closes together the circle, caused by the inner circle of the rim containing more fibers in a given space than the outer; as shrinkage takes place, the inside exerts a force greater than the outside, drawing the rim in tire direction mentioned, which accounts for the "flattening " of the joints, so prevalent in wheels made with these rims, as the ends will retain this tendency to curve in. No matter how much the mechanic may open them out while preparing them for the wheel, tire fibers will eventually return to tire position received in the operation of bending, or a little beyond this point, if the "upsetting" has been severe. Fig. 3 gives an idea of the closing together mentioned. This, under the Reynolds\Blanchard system, and in the bands of a skillful operator, is rendered very regular and uniform. All that is necessary, then, to secure the best results and render these rims durable, is to remember that the manufacturer of these articles makes the "forms" upon which they are bent much smaller in diameter than the heights marked upon the bundles in which they are packed. This is done to facilitate packing, as when first bent they have the tendency to force outward; but tire wheel maker must wait till the rim dries before using, at which time they will return to the exact circle first beat, irrespective of the heights marked upon the bundles in which they were confined. We have often heard wheel-makers remark that it is more essential to have the spokes thoroughly dried or seasoned than the rims. There never was a more egregious error, as there is no such thing as durable work if any material used in the work is not thoroughly seasoned, and when the rim has reached this state, the distance between the spokes that support it upon the wheel is of little importance. In fact the wider the space allowed, to a reasonable extent, the easier the motion conveyed to the axle, always taking it for granted that the rims used are bent upon a "form" approximating to the circle of the wheel when finished. This brings the strain of the fibers against the tires, which prevents all flattening between the spokes or at the joints, which is inevitable if this natural law be disregarded.

There is another system of bending, in which the rim is confined in the center from which it is bent, each way (see Fig. 2). A A show the stops which are fastened rigidly, against the rims. B is the unbent rim. The differential windlass at the rear operates the ropes C C, which draw the levers around the form D, as shown. These stops A A being fastened rigidly, the "upsetting" takes place at the extreme ends, as there is no pressure when the levers first move; then for the same reasons mentioned in the first instance, the shrinkage will affect these ends to a greater extent than the center of the arch, which, drawing naturally, must flatten the rim at this point. It is an impossibility to make a rim of this kind stand the ordinary hard usage of city streets. The shape of the rim may be all that could be desired when first worked, but the draw of the tires and the jar of the pavement soon force the fibers to the position described.

It has become the custom among wheel-makers to have the rims bent with the growth rings perpendicular (see Fig. 4), and for no other reason than to prevent the splitting in boring the holes for the spokes. This is ingenious, but not correct; as the fault of the splitting lies in the auger-bits used, the "worm" or thread forcing the fibers of the wood apart like a wedge. It would

be better to make this tool to overcome the difficulty rather than use the timber edgewise. It is well-known in practice that the timber is less able to stand vibration when the edges of the growth rings are turned in this position; nature has placed them layer upon layer, and it is in this direction they exert the most resistance to strains and weight. The dowels generally used have also a tendency to split the rim when the growth is in this direction shown, and we contend that what is termed "bending the rim the right way," may be called right in the work-shop, but is radically wrong in service and point of durability.

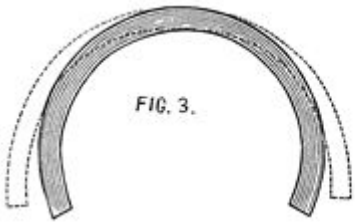


FIG. 3.


FIG. 4.

There is some diversity of opinion respecting the amount of wood which can be displaced in boring for the spokes, and the rules of mechanics must be modified to suit the circumstances. We are taught in mechanical construction that not more than one-third of the substance should be removed in making a mortise, but to follow the rule in this particular would make the tenons upon the spokes too small for strength. Then of two evils chose the lesser, which we can do by making the holes displace one-half the amount contained in the width of the tread. This, in the cities where the tramway brings an additional strain upon this part of the spoke, will be none too much; but on this subject local experience is the best teacher, and it is our aim in these articles to present the general features of the art, leaving, the many minor points untouched, as the local wants of each district must vary with climate, roads, and taste. An old, broken-down wheel may teach more to an intelligent mechanic than much that can be written. Dissection and analysis are the means used in gaining knowledge in every art and science.--Why not in wheel-making? H. M. DuBois.

Carriage Monthly April 1908 page 4-6
HISTORY OF WOOD BENDING
By H. G. Shepard

Any one attempting to write the history of wood bending will find himself greatly handicapped on account of the absence of literature upon the subject.

Wood bending and the use of bent wood antedates the written history of mankind. Human progress has been divided into different eras, as the stone age, the bronze and the iron age. The age in which we live might be called the steel age (you can spell the word "steel" to suit yourself; it will be all right spelled either way). But the use of bent wood has come down to us through all the ages. Its primitive use we find to-day in the form of toboggan, and other means of transportation used by inhabitants of northern regions. One of the best and most interesting specimens of ancient times is the shepherd crook or staff.

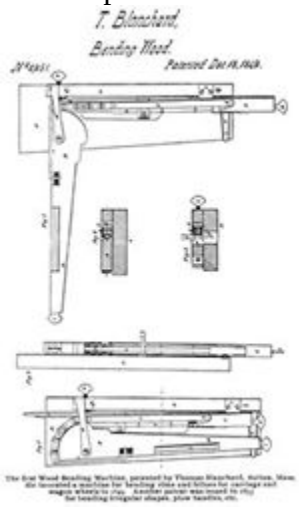

The Shepherd's Crook as has been and is used at present.

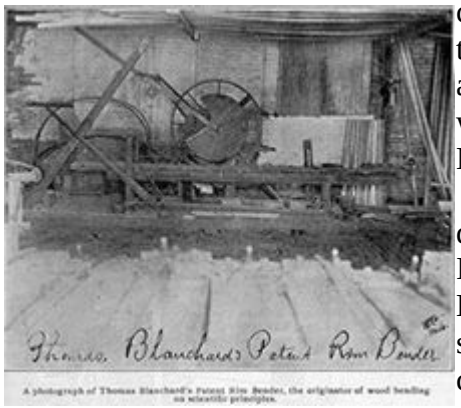

Early Wood Bending illustrated in a chair over 200 years old, showing one of the principal uses of bent wood in the 17th and 18th centuries.

That has come down to the present time, and is largely used in

the mountains of Scotland and Switzerland today. It was originally about 8 feet long, with one end bent in the shape of hooks such as women use on their dresses. It served as a staff to help the shepherd in climbing the mountains, and the bent end was used to catch sheep-by hooking it around their shanks. More modern bending limits come down to us in the shape of furniture, especially in chairs. Wood being of a perishable nature we could not expect to find much of it except in household furniture, and what little we have was evidently bent in a primitive way, and with very little knowledge of the art.

We have plenty of evidence to show that very little difficult bending was done previous to the middle of the last century. We believe the first wood bending done on a scientific basis was by Thomas Blanchard, Sutton, Massachusetts. He invented a machine for bending rims or felloes for carriage wheels and other things, and received a patent for it in 1849, and also another patent in 1853 for the bending of irregular shapes--plow handles, etc. He also invented lathes for turning wagon wheel spokes, shoe lasts, busts, etc., and while he did not fully grasp the scientific principles underlying the art, lie came near to it, and I believe we must give him credit for being the first to do wood bending by what may be called a scientific method, although an imperfect one. It is related of him that when he was before the United States Commissioner of Patents, engaged in obtaining a patent for a turning lathe, he made the assertion that by his new method he could turn out any given shape, however irregular it might be. The





commissioner turned upon him with the question, "Can you turn out a seventy-four man-of-warship?" Blanchard, without a moment's hesitation, replied, "Yes, if you will furnish me with the model." A statue has been erected to his memory in Mount Auburn Cemetery, near Boston.

Nearly all the progress made in wood bending has been done within the writer's memory, which dates back to 1849. In that year I entered the employ of Frederick A. Holcomb, Branford, Connecticut, who was bending shaft, poles, and some miscellaneous work for the carriage business. He claimed, and I believe truly, to be the first to bend buggy shafts, and I feel very confident he was the first to bend them for the general market. He commenced bending these things about 1840, and in 1849, the time I entered his employ he was doing quite a large business in these lines and soon after the Blanchard machine spoken of was patented and put on the market, and he added the bending of wheel rims to his other work, and a few of these machines are in use to-day, but are not considered up-to-date by any means.

In 1853 the firm of Smith & Barlow were formed in Bridgeport, Conn. The members of the firm were Daniel Barlow, Henry Barlow and Horace Smith. They bent perches, futchels, beds, rims, back bars, bows, shafts, and odd bendings to drawing. They were also the first to bend coach beds in this or any other country, and at that time, and many years after, they stood foremost as wood benders, and did much towards advancing the art. The same business is known today as the Wheel and Wood Bending Company, Bridgeport, Connecticut. They are the successors of Smith & Barlow. The business is now carried on by the descendants of Horace Smith.

In 1854 the writer fitted up an establishment for William Blush, Middlefield, Massachusetts,

for bending shafts, poles, bows for carriage tops, and some miscellaneous bending of wood for the general public. Previous to this, however, the carriage factories in the State had bent buggy shafts and bows for their own use. They also did other light bending in their own factories.

In 1856 Updegraff patented a machine for bending felloes, using a short rotary bed instead of the long bed used on the Blanchard. As it was no improvement upon the Blanchard it never became very popular.

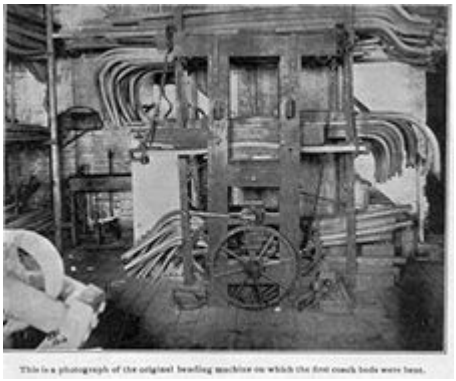
Dann Bros. & Co., New Haven, Connecticut, formed a partnership in 1858 for bending wood: They bought out two firms that were doing bending in a small way, mainly shafts and poles, one by the name of Scranton, and another by the name of Story. They did miscellaneous work in the early 60's, and advanced the art further than it had previously been. In 1880 they stood in the front ranks of wood benders in this country. They were the first to bend corner pillars by reducing the place where they were bent to about one-half the thickness, leaving just enough wood for the molding. This they did for Brewster & Co., New York, and under their instruction.

In 1862 John C. Morris, Cincinnati, Ohio, an employee of the Fay & Egan Co., patented a machine for bending felloes, which was manufactured by the Fay & Egan Co. This machine was very popular, and was much superior to the Blanchard rim bender.

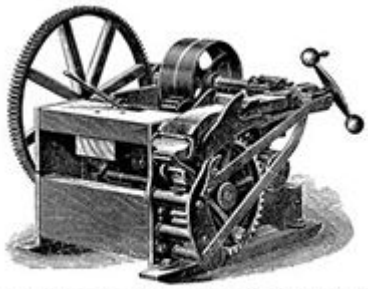
Between 60 and 70 the Austrians did some very fine bent work in the manufacture of chairs and other household furniture, and in the art of fine artistic bending of small sized pieces they have never been excelled up to the present time, but some of their most important machinery was invented and made for them by S. R. Bailey, Amesbury, Massachusetts.

Wood bending is not done very extensively in Europe to-day; although at the present time and for some years past the French have been doing very good work int he line of bent wood for carriages, but I think I can truly say that American is ahead of any other country int he art of heavy and difficult bending, and there is nothing done in any part of the world that we cannot do in America, and we bend some things here that other countries have not been able to do at the present time, and in some lines of wood bending we are very near perfection. As regards rims, bows and shafts, there is but little room for improvement in speed or perfection of work.

The firm of H. G. Shepard & Sons, New Haven, Connecticut, were established in 1880, making a specialty of heavy and difficult bending, making their own machinery and adopting entirely new methods, and are very successful in that line, doing heavier and more difficult bending than had been done before. They were the first to bend corner pillars for landaus without first reducing them in size at the bends, but their history is too well known at the present time to be of interest to the public.



This is a photograph of the original bending machine on which the first coach bods were bent.

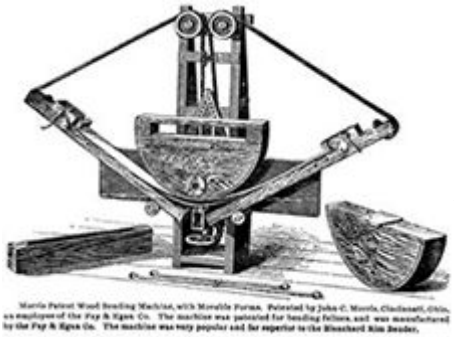


A modern, compact wood-bending machine, showing the progress made over the early, unimproved attempt in wood bending, furnished by Dann Bros., New Haven, Conn., who advanced the art of wood bending, and in 1880 stood in the front ranks of wood benders in this country.

Although prophecy is not history, it becomes so when verified by time, and I am inclined to predict that the rise of bent wood will be very greatly increased in the future, for it is quite evident that a piece of beat wood is far stronger than the same shape would leave been if sawed from a plank, and adds to whatever construction it is a part of a very desirable element of strength and durability, often permitting the use of Cheaper materials in connection therewith on

this account.
There is a limit also to practical shapes in sawed out stock on account of its lack of strength if too cross grained, which has to be taken into account by the architect, the draftsman, and the designer. This limitation is largely removed by the introduction of bent wood, and will open-up a wide field for new designs that will supersede those now in use for many purposes, as its utility in this direction becomes more fully recognized.

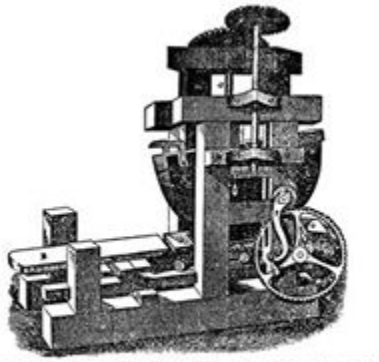
The art of bending wood is yet in its infancy, as every manufacturer of bent wood knows. I care not how skillful he may be, he knows there are possibilities in the art that have never been developed, but will in time be brought out, and what is now very difficult or impossible to do will be easily done.



Morris Patent Wood Bending Machine, with Movable Forms. Patented by John C. Morris, Cincinnati, Ohio, as employee of the Pay & Egan Co. The machine was patented for bending fellies, and was manufactured by the Pay & Egan Co. The machine was very popular and far superior to the Blanchard Rim Bender.

Then, again, the high price of timber and the prospect of its being still higher in the future, favors the use of bent wood as a matter of economy, where it is now sawed from plank in a very wasteful manner. As a matter of fact, much of the stock left after sawing out the sweeps called for is of little use to the manufacturer who has produced it, on account of its shape and size; and the expense of further manufacture to fit it for the use of other lines of work is usually too great on the relatively small amount to be a paying proposition. Hence, a large quantity of the finest material finds its way to the wood pile and an enormous aggregate of waste results.

The ship building industry also presents an almost unlimited field for its use. This field has hardly been entered at all, but enough has been done to show its practicability and its superiority to the usual method of framing a vessel. The American yachts which have won the international races on the great lakes between this country and Canada have for several years been constructed of bent timbers throughout, which, it is claimed by their owners, gives life and elasticity to a boat, not otherwise obtainable.



Updegraff's Patent Wood Bending Machine. Patented in 1876 by H. J. Updegraff, York, Pa. The invention was a machine for bending fellies, using a short, rotary bed instead of the long bed as used on the Blanchard. As it was no improvement on the Blanchard, it never became very popular.

In the field of architecture there is also a wide usefulness for bent wood, which is only just beginning to be appreciated. Curved lines have been studiously avoided by the architect on account of the excessive cost as compared with flat, straight surfaces. With the better understanding of the adaptability of bent wood for this purpose, a greater freedom of design in the way of curved lines, round corners, arches, etc., will result with better and more pleasing homes, with no added expense.
Household furniture is also a field that is but partly occupied, for, while light artistic furniture has reached a degree of perfection and beauty that compels our admiration, the heavier and richer designs have not been touched, on account of the difficulty in bending, which is far beyond the ordinary bending equipment.

It will, no doubt, be of interest to the readers of the CARRIAGE MONTHLY to know that, because of the early appreciation of the value of bent wood in the construction of carriages, the carriage industry is far better served in this respect than any other. In fact, very difficult bending is only done by this accessory to the carriage trade, which is very frequently called on to furnish bent wood to many other lines, the case often being of a very serious nature, as a recent instance of a $1,000,000 furniture order which would have had to be canceled except for the assistance

mentioned above.

History of Wood Bending
By S. R. Bailey, Amesbury, Massachusetts
continued from the April 1908 Carriage Monthly
Carriage Monthly October 1908 page 184-185

The following is a continuation of H. G. Shepard's interesting article, published in the April number of the Carriage Monthly, on "The History of Wood Bending." On account of Mr. Bailey's familiarity with the early development of wood bending in the united States, Mr. Shepard urged him to write something concerning the subject, and we are pleased now to present Mr. Bailey's interesting contribution in the form of a letter addressed to Mr. Shepard. It was our intention to publish this second article in the May number of the Carriage Monthly, but we were disappointed, owing to Mr. Bailey's illness, which prevented his earlier attention to the matter.

From: S. R. Bailey & Co., Inc.
Manufacturers of Carriages and Electric Vehicles.
Amesbury, Massachusetts August 27, 1908.

To: H. G. Shepard, New Haven, Connecticut.

Dear Sir: I have never been very prompt in my correspondence, and quite often negligent, and I think, perhaps, I have lost good friends by not answering letters. It has punished me more than it has them, for no one values his friends more than I, and in this case, in negligence, morbidness and dreading the thought of picking up this wood-bending history, I have even exceeded myself. This, to , I think, is the climax of all my previous doings in this respect, but I certainly hope you will forgive. I know it was more as a favor to me than what I could contribute. I felt flattered by it, and certainly meant to have reciprocated by being prompt. I will write you a rambling letter, just as it comes to me, and if you can pick out anything that is of any use for your history, I shall be surprised and pleased.

You ask me, in the beginning, to tell you something about the wood bending in the 1850's. I was born in 1838, consequently I was quite young, in the early 1850's at least. As we lived six miles from railroad and telegraph, I was pretty well buried in the country until I was twenty-seven or eight years old and I didn't have much chance to see what was being done. In our town, we hd no factory of any kind or machinery, except a grist mill and an old up and down saw mill and one carriage maker, by the name of Boynton. I used to loaf around his shop when I was young, and I remember seeing him try to bend carriage rims and sleigh runners without straps, and other kinds of bending, and you know the result.

The consequence of my hanging around Mr. Boynton's shop and what I saw there shaped my career, and father provided me with a shop before I was seventeen, fitting it up out of an old church. My struggles trying to bend sleigh runners without straps very soon set me to studying on the double-bend problem, the difficulties of which no one knows better than you, although it seems very simple to us now. I moved from this small village, est Pittston, Maine, to Bath, Maine, where I fitted up another church into a carriage shop (and perhaps it might have been the influence which hung around those buildings which accounts, in a measure, for my churchly tendencies since), the city of Bath discounting one-half its value to encourage the enterprise,

which is more than I have ever had done for me since by any town and almost, I think, more than by any individual. But, as is usual in the case of carriage business, I was soon short of money and was glad to take a partner in, who hd plenty of cash and cussedness, but nothing else. While there, I conceived the idea of bending timber over steam-heated forms. I succeeded so well, after many trials, that I concluded to go into the shaft-bending business, and went West and found a man to get out strips for carriage shafts and send them to Bath. The most of our timber came green and I found hot moulds almost indispensable, as I could remove the stock twice a day, instead of twice a week, as was the case with the cold mould in winter with green stock.

Passing over the details of the trouble which I had to encounter in perfecting the arrangement, I finally succeeded in producing moulds for the heel and the side bend, all on steam-heated forms, by the use of which I could set the timber three times a day with the green, and every forty-five minutes with the dry. This innovation almost controlled the shaft business. On account of disagreement with my partner in the matter of demands made upon me, we dissolved the partnership, and I found employment with E. A. & O. S. Gillett, in Boston, at a salary of $2,000 a year, which seemed to me then a princely sum for a countryman. I moved to Boston and remained with them tow years and a half. On account of the hot moulds and other devices which I introduced, I became valuable to them, as these revolutionized their process so far as shaft and wood bending was concerned, they being manufacturers and dealers in bent carriage wood work, with a very large business. They increased my salary and afterwards bought my patents, paying me well for them, s I thought at the time. They have continued in their use since, being very successful in their business and collecting large sums in royalties on the patent.

The first good timber bending that I ever saw was wagon rims, especially the heavy ones, which were an amazement to me, and I didn't have the mystery solved until I saw a Blanchard rim bender, which was made by James Blanchard, whom we all are glad to acknowledge as the father of wood bending in this and, I think, in all other countries. The second wood-work bending was a t Dann Bros., New Haven, which was then far in advance of anything done before, so far as I knew. The next was the wonderful, unexcelled work done by yourselves, H. G. Shepard & Son, which in my opinion, has never been excelled, if equaled.

Soon after coming to Boston, the Gilletts had a great demand for double-bent express wagon shafts and poles and, up to that time, they had never been bent commercially, except by splitting them up in the center, to prevent their breaking, not knowing how to use straps on the double bend, owing to the difficulties in the process. Mr. Gillett wanted me to see if I could study up some way to bend them solid, in one piece, and I didn't know any better way than to attempt it. Having once undertaken the job, I was determined to carry it through, and no one knows better than you the difficulties I had to encounter. James White, a wealthy gentleman and one of the partners of Gillett U Co., like all other moneyed men, was discouraged because I didn't "get there" quick enough, and came to me with the doleful consolation that smarter men than myself had failed in that, mentioning James Blanchard, and that it was no use for me to try and that it was a waste of money. I don't think that James Blanchard ever tried it persistently, or he certainly would have accomplished it, but, at any rate, it was a cooler for me, coming from one of my employers. However, I was successful, and the process was immediately adopted and is, to this time, almost universally used in most of its principles.

About this time, which was just before the Centennial Exhibition, Mr. Gillett brought John W. Griffiths into the shop, who claimed that I was infringing on his patents, and notified Mr. Gillett to stop using the invention. Griffiths was the man who sold to the Unites States Government, for a large amount, the process of bending ship timber, which, in my opinion, was one of the biggest

of the grafts in those days. He used for rotary work a Blanchard rim bender, laid down, and without its best features, that of a track on which the timber was drawn forward toward the mould and without any devices for raising or moving this track toward the center of the revolving mould to accommodate it to different sizes of forms. It was entirely incomplete and useless and proved an entire failure, so far as rotating moulds are employed. This machine was set up and a building built for it by the Government in Charlestown Navy Yard. Griffiths so terrified my employers that they allowed him to come in with an artist and make a drawing of my machine in every detail. (By the way, I was never able to find any patents that in any way conflicted with mine, in my subsequent patent application.) He afterward had cuts from the drawing, produced a machine exactly like mine, and exhibited it at the Centennial Exhibition, in Philadelphia, as his own. This appears on the circular reproduced below, which shows it with double-bend forms in position, but is made for universal timber bending. Of curse, I made some trouble for him in Philadelphia and said what I would be apt to say in such a case, and he never seemed inclined to take it up.

One day during the Exhibition period, a Mr. Lowe, a manufacturer of scientific instruments and a commissioner to one of the earlier Paris expositions, brought in four gentlemen, three of whom were introduced as the Thornet Bros., Austrians and proprietors of the Austrian Bent Wood Furniture Co., Austria. They wanted a machine to bend heavy pieces into a scroll double bend, which they had not been able to do satisfactorily at home, nor had they found anyone in this country who was willing to undertake it. We made, or changed, our machine so as to suit their requirements and to their satisfaction. When they witnessed the operation of putting on the first piece, they wouldn't let us remove it, but said to ship it right away, just as it was, to Austria. Since then I have had some correspondence with different parties in Austria, with them and others, in reference to the "wood-bending engine," as they called it, but it did not result in selling more than one more, as I had no patents in that country. In order to accomplish this business, I had to devise a swinging adjustable abutment, which I patented and have since made much use of in my own work. The Austrians, while they did very wonderful work with their cheap labor by hand, were not able to do heavy work by power, which accounted for their coming to Yankeedom in their troubles. Later on I made a large wood-bending machine, weighing 6 tons and of great capacity, with 125 tons power, which I have used in my work and in heavy timber 6 inches thick, on a short radius, which is particularly useful in the boat-building business.
On this machine we are able to bend twelve ordinary-sized buggy rims on one form in one minute's time and continue the operation of putting on the timber, bending and removing the moulds every three minutes, as long as the moulds last.
Of course, the experience which we gained from those difficult problems has been useful to us in various ways since, as you can understand, but never of great importance to the general public. I am sorry to say that I have not been able to get a cut of any machine, which I certainly meant to have had, or of anything that would assist you if you wanted to use it in your history. All I can furnish is the cut which Griffiths made and which he stole from me and the Gilletts with threats.

I very soon resigned from Gillett & Co., who, by the way, in their judgment, treated me fairly, and even with consideration, but I never got over the disappointment and injustice of what they allowed Griffiths to do by me, and I made up my mind that I would never let myself to anyone in

any capacity where I could not control products of my endeavor, and, so far, I have been able to hold out. I think, on the whole, it proved a useful lesson.

I won't attempt to show any of the advantages of the hot moulds or any other device, but I would say that some of them have been generally adopted and, on the whole, I have been tolerably well paid, although it has been said that "inventors get little for their trouble."

I owe you and the Ware Bros. An apology for the delays and the trouble I have caused you and them, and regret that I had so little of value to impart.

Thanking you for your patience, I am, Yours very truly, S. R. Bailey.