HOW TO MAKE A BOW

Every field archer should make his own tackle. If he cannot make and repair it, he will never shoot very long, because it is in constant need of repair.

Target bows and arrows may be bought in sporting stores, here or in England, but hunting equipment must be made. Moreover, when a man manufactures his bow and arrows, he appreciates them more. But it will take many attempts before even the most mechanically gifted can expect to produce good artillery. After having made more than a hundred yew bows, I still feel that I am a novice. The beginner may expect his first two or three will be failures, but after that he can at least shoot them.

Since there are so many different kinds of bows and all so inferior to the English long-bow, we shall describe this alone.

Yew wood is the greatest bow timber in the world. That was proved thousands of years ago by experience. It is indeed a magic wood!

But yew wood is hard to get and hard to make into a bow once having got it. Nevertheless, I am going to tell you where you can get it and how to work it, and how to make hunting bows just as we use them today, and presumably just as our forefathers used them before us. Later on I shall tell you what substitutes may be used for yew.

The best yew wood in America grows in the Cascade Mountains of Oregon, in the Sierra Nevada and Coast Ranges of northern California. By addressing the Department of Forestry, doubtless one can get in communication with some one who will cut him a stave. Living in California, I cut my own.

A description of yew trees and their location may be had from Sudworth's "*Forest Trees of the Pacific Slope*," to be obtained from the Government Printing Office at Washington.

My own staves I cut near Branscomb, Mendocino County, and at Grizzly Creek on the Van Duzen River, Humboldt County, California. Splendid staves have been shipped to me from this latter county, coming from the neighborhood of Korbel.

Yew is an evergreen tree with a leaf looking a great deal like that of redwood, hemlock, or fir at a distance. It is found growing in the mountains, down narrow canyons, and along streams. It likes shade, water, and altitude. Its bark is reddish beneath and scaly or fuzzy on the surface. Its limbs stand straight out from the trunk at an acute angle, not drooping as those of the redwood and fir.

The sexes are separate in yew. The female tree has a bright red gelatinous berry in autumn, and the male a minute cone. It is interesting that in bear countries the female trees often have long wounds in the bark, or deep scratches made by the claws of these animals as they climb to get the yew berries. It is also stated by some authorities that the female yew has light yellow wood, is coarser grained, and does not make so good a bow. I have tried to verify this, but so far I have found some of my bear marked female yew to be the better staves.

The best wood is, of course, dark and close grained. This generally exists in trees that have one side decayed. It seems that the rot stains the rest of the wood and nature makes the grain more compact to compensate for the loss of structural strength. It is also apparent that yew grown at high altitudes, over three thousand feet, is superior to lowland yew.

In selecting a tree for a hunting bow, the stave must be at least six feet long, free from limbs, knots, twists, pitch pockets, rot, small sprouting twigs and corrugations. One will look over a hundred trees to find one good bow stave; then he may find a half dozen excellent staves in one tree.

There is no such thing as a perfect piece of yew, nor is there a perfect bow; at least, I have never seen it. But there is a bow in every yew tree if we but know how to get it out. That is the mystery of bowmaking. It takes an artist, not an artisan.

Before one ever fells a tree, he should weigh the moral right to do so. But yew trees are a gift from the gods, and grown only for bows. If you are sure you see one good bow in a tree, cut it. Having felled it and marked with your eye the best stave, cut it again so that your stave is seven feet long. Then split the trunk into halves or quarters with steel or wooden wedges so that your stave is from three to six inches wide. Cut out the heart wood so that the billet is about three inches thick. Be careful not to bruise the bark in any of these operations.

Now put your stave in the shade. If you are compelled to ship it by express, wrap it in burlap or canvas, and preferably saw the ends square and paint them to prevent checking. When you get it home put it in the cellar.

If you must make a bow right away, place the stave in running water for a month, then dry in a shady place for a month, and it is ready for use. It will not be so good as if seasoned three to seven years, but it will shoot; in fact, it will shoot the same day you cut it from the tree, only it will follow the string and not stand straight as it should. Of course, it will not have the cast of air-seasoned wood.

The old authorities say, cut your yew in the winter when the sap is down, or as Barnes, the famous bow-maker of Forest Grove, Oregon, used to say: "Yew cut in the summer contains the seeds of death." But this does not seem to have proved the case in my experience. I am

fully convinced that the sap can be washed out and the process of seasoning hastened very materially by proper treatment.

Kiln dried wood is never good as a bow. It is too brash; but after the first month of shade, the staves may be put in a hot attic to their advantage.

In selecting the portion of the tree best suited for a bow, choose that part that when cut will cause the stave to bend backward toward the bark. Since your bow ultimately will bend in the opposite direction, this natural curve tends to form a straighter bow, or as an archer would say "set back a bit in the handle."

If it is impossible to get a stave six feet in length, then a wide stave three and a half feet long may be used. It is necessary in this case to split it and join the two pieces with a fishtail splice in the handle. Target bows are made this way, to advantage, but such a makeshift is to be deprecated in a hunting bow. The variations of temperature and moisture combined with hard usage in hunting demand a solid, single stave. It must not break. Your life may depend upon it.

Before engaging in any art, it is necessary to study the anatomy of your subject. The anatomical points of a bow have a time-honored nomenclature and are as follows: Bows may be single staves, or one-piece bows, those of one continuity and homogeneity; spliced bows consist of two pieces of wood united in the handle; backed bows have an added strip of wood glued on the back; and composite bows are made up of several different substances, such as wood, horn, sinew, and glue.

That surface of the bow which faces the string when drawn into action, that is, the concave arc, is called the belly of the bow. The opposite surface is the back. A bow should never be bent backwards, away from the belly; it will break.

The center of the bow is the handle or hand grip; the extremities are the tips, usually finished with notches cut in the wood or surmounted by horn, bone, sinew, wooden or metal caps called nocks. These are grooved to accommodate the string. The spaces between the nocks and the handle are called the limbs.

A bow that when unstrung bends back past the straight line is termed reflexed. One that continues to bend toward the belly is said to follow the string. A lateral deviation is called a cast in the bow.

The proper length of a yew bow should be the height of the man that shoots it, or a trifle less. Our hunting bows are from five feet six inches to five feet eight inches in length. The weight of a hunting bow should be from fifty to eighty pounds. One should start shooting with a bow not over fifty pounds, and preferably under that. At the end of a season's shooting he

can command a bow of sixty pounds if he is a strong man. Our average bows pull seventy-five pounds. Though it is possible for some of us to shoot an eighty-five pound bow, such a weapon is not under proper control for constant use.

Some pieces of yew will make a stronger bow at given dimensions than others. The finer the grain and the greater the specific gravity, the more resilient and active the wood, and stronger the bow.

Taking a yew stave having a dark red color and a layer of white sap wood about a quarter of an inch thick, covered with a thin maroon-colored bark, let us make a bow. Counting the rings in the wood at the upper end of the stave, you will find that they run over forty to the inch.

Ishi insisted that this end of the stave should always be the upper end of the weapon. It seems to me that this extremity having the most compact grain, and the strongest, should constitute the lower limb, because, as we shall see later on, this limb is shorter, bears the greater strain, and is the one that gives down the sooner.

We shall plan to make the bow as strong as is compatible with good shooting, and reduce its strength later to meet our requirements.

Look over the stave and estimate whether it is capable of yielding two bows instead of one. If it be over three inches wide, and straight throughout, then rip it down the center with a saw. Place one stave in a bench vise and carefully clean off the bark with a draw knife. Do not cut the sap wood in this process.

Cut your stave to six feet in length. Sight down it and see how the plane of the back twists. If it is fairly consistent, draw a straight line down the center of the sap wood. This is the back of your bow. Now draw on the back an outline which has a width of an inch and a quarter extending for a distance of a foot above and a foot below the center. Let this outline taper in a gentle curve to the extremities of the bow, where it has a width of three-quarters of an inch. This will serve as a rough working plan and is sufficiently large to insure that you will get a strong weapon.

With the draw knife, and later a jack plane, cut the lateral surfaces down to this outline. The back must stand a tremendous tensile strain and the grain of the wood should not be injured in any way. But you may smooth it off very judiciously with a spoke shave, and later with a file. The transverse contour of this part of the bow remains as it was in the tree, a long flat arc.

Shift the stave in the vise so that the sap wood is downward, and set it so that the average plane of the sap is level. With the raw knife shave the wood very carefully, avoiding cutting

too deeply or splitting off fragments, until the bow assumes the thickness of one and one-quarter inches in the center and this decreases as it approaches the tips, where it is half an inch thick.

The shape of a cross-section of the belly of the bow should be a full Roman arch. Many debates have centered on the shape of this part of the weapon. Some contend for a high-crested contour, or Gothic arch, what is termed "stacking a bow"; some have chosen a very flat curve as the best. The former makes for a quick, lively cast and may be desirable in a target implement, but it is liable to fracture; the latter makes a soft, pleasant, durable bow, but one that follows the string. Choose the happy medium.

The process of shaping the belly is the most delicate and requires more skill than all the rest. In the first place you must follow the grain of the wood. If the back twists and undulates, your cut must do the same. The feather of the grain must never be reversed, but descend by perfect gradation from handle to tip.

Where a knot or pin occurs in the wood, here you must leave more substance because this is a weak spot. If the pin be large and you cannot avoid it, then it is best to drill it out carefully and fill the cavity with a solid piece of hard wood set in with glue. A pin crumbles while an inserted piece will stand the strain. If such a "Dutchman" be not too large nor too near the center of either limb, it will not materially jeopardize the bow. If, in your shaving, you come across a sharp dip in' the grain, such that will make a decided concavity, here leave a few more layers of grain than you would were the contour even; for a concave structure cannot stand strain as well as a straight one; the leverage is increased unduly.

The following measurements, with a caliper, are those of my favorite hunting bow, called "Old Horrible," and with which I've slain many a beast. The width just above the handle is 1-1/4 by 1-1/8 inches thick. Six inches up the limb the width is 1-1/4, thickness 11-1/16.

Twelve inches above the handle it is a trifle less than 1-1/4 wide by 1 inch thick. Eighteen inches above the handle it is 1-1/8 wide by 7/8 thick. Twenty-four inches above it is 15/16 wide by 3/4 thick. Thirty inches above it is 11/16 by 9/16 thick. At the nock it is practically 1/2 by 1/2 inches.

Having got the bow down to rough proportions, the next thing is to cut two temporary nocks on it, very near the ends. These consist in lateral cuts having a depth of an eighth of an inch and are best made with a rat tail file.

Now you can string your bow and test its curve.

Of course, you must have a string, and usually that employed in these early tests is very strong and roughly made of nearly ninety strands of Barbour's linen, No. 12. Directions for making strings will be given later on.

It is difficult to brace a new heavy bow and one will require assistance. In the absence of help he can place it in the vise, one of those revolving on a pivot, and having the string properly adjusted on the lower limb, pull on the upper end in such a way that the other presses against the wall or a stationary brace, thus bending the bow while you slip the expectant loop over the open nock. Or you can have an assistant pull on the upper nock, while you brace the bow yourself.

In ancient times, at this stage, the bow was tillered, or tested for its curve, or, as Sir Roger Ascham says, "brought round compass," which means to make it bend in a perfect arc when full drawn.

The tiller is a piece of board three feet long, two inches wide, and one inch thick, having a V-shaped notch at the lower end to fit on the handle and small notches on its side two inches apart, for a distance of twenty-eight inches. These are to hold the string.

Lay the braced bow on the floor, place the end of the tiller on the handle while you steady the tiller upright. Then put your foot on the bow next the tiller and draw the string up until it slips in the first notch, say twelve inches from the handle. If the curve of the bow is fairly symmetrical, draw the string a few inches more. If again it describes a perfect arc raise the string still farther. A perfect arc for a bow should be a trifle flat at the center. If, on the other hand, one limb or a part of it does not bend as it should, this must be reduced carefully by shaving it for a space of several inches over the spot and the bow tested again.

Proceeding very cautiously, at the same time not keeping the bow full drawn more than a second or two at a time, you ultimately get the two limbs so that they bend nearly the same and the general distribution of the curve is equal throughout.

As a matter of fact, a great deal of experience is needed here. By marking a correct form on the floor with chalk, a novice may fit his bow to this outline.

The perfect weapon is a trifle stiff at the center and the lower limb a shade stronger than the upper.

The real shooting center, the place where the arrow passes, is actually one and one-quarter inches above the geographic center, and the hand consequently is below this point. Your finished hand grip, being four inches long, will be one and a quarter inches above the center and two and three-quarters below the center. This makes the lower limb comparatively shorter, so it must be relatively stronger. Your bow, therefore, when full drawn should be

symmetrical, but when simply braced, the bend of the upper limb is perceptibly greater than the stronger lower limb.

You will find the bow we have made will pull over eighty pounds, even after it is thoroughly broken to the string. It is necessary, therefore, to reduce it further. This is done with a spoke shave, a very small hand plane or a file. Ultimately I use a pocket knife as a scraper, and sandpaper and steelwool to finish it.

Your effort must be to get every part of the wood to do its work, for every inch is under utmost strain, and one part doing more than the rest must ultimately break down, sustain a compression fracture, or, as an archer would say, "chrysal or fret."

"A bow full drawn is seven-eighths broken," said old Thomas Waring, the English bowmaker, and he was right. Draw your bow three inches more than the standard cloth yard of twenty-eight inches and you break it. It is more accurate to say that a full drawn bow is nine-tenths broken.

It is also essential that the bow be stiff in the handle so that it will be rigid in shooting and not jar or kick, which one weak at this point invariably does.

A bow should be light at the tips, say the last eight inches, which is accomplished by rounding the back slightly and reducing the width at this point. This gives an active recoil, or as it is described, "whip ended." This can be overdone, especially in hunting-bows, where a little more solidity and safety are preferable to a brilliant cast.

And so you must work and test your bow, and shoot it, and draw it up before a full length mirror and observe its outline, and get your friends to draw it up and pass judgment on it. In fact, while the actual work of making a bow takes about eight hours, it requires months to get one adjusted so that it is good. A bow, like a violin, is a work of art. The best in it can only be brought out by infinite care. Like a violin, it is all curved contours, there is not a straight line in it. Many of my bows have been built over completely three or four times. Old Horrible first pulled eighty-five pounds. It was reduced, shortened, whip ended, and worked over again and again so to tune the wood that all parts acted in harmony. Every good bow is a work of love.

Your bow is now ready to shoot, but let us weigh it first. Brace it and put it horizontally in the vise with the string facing you. Take a spring scale registering at least eighty pounds and catch the hook under the string. Draw it until the yardstick registers twenty-eight inches from the string to the back of the bow. Now read the scale; that is its weight.

As a matter of convenience I have devised a stick that facilitates the weighing. I take a dowel and attach to one end by glue and binding a bent piece of iron so fashioned that the extremity

serves as a hook to draw the string and the bent portion permits the attachment of the scale. The dowel is marked off in inches so that one can test different lengths of draw. With the bow in the bench vise, this measure hooked on the string and resting on the bow at the arrow plate, the scale is hooked in place, the dowel drawn down to the standard length and the registered weight read off on the scale.

If you still find that your bow is too strong for you, it must be further reduced. Begin all over again with the spoke shave and the file, trying to correct any inequalities that may have existed before and reducing it to what ultimately will be sixty-five pounds. Put on the string and weigh it again and again until you get the weight you want. If you have reduced it too much, cut it down two or four inches; it will be stronger and shoot better.

All yew bows tend to lose in strength after much use, and your new one should pull five pounds more than the required weight. If a bow is put away in a dry, warm place for several years it nearly always increases in strength. In our experience one in constant use lasts from three to five years. The longer the bow, the longer its life. Some, of course, break or come to grief after a short period, others live to honorable old age. Yew bows are in existence today that were made many thousands of years ago, but, of course, they would break if shot. Many bows over one hundred years old are still in use occasionally. I have estimated that the average life of a good bow should exceed one hundred thousand shots, after which time it begins to fret and show other signs of weakness.

Keeping in mind the idea of making your weapon as beautiful, as symmetrical and resilient as possible, free from dead or overstrained areas, work it down with utmost solicitude until it approaches your ideal. Smooth it with sandpaper; finish it with steelwool.

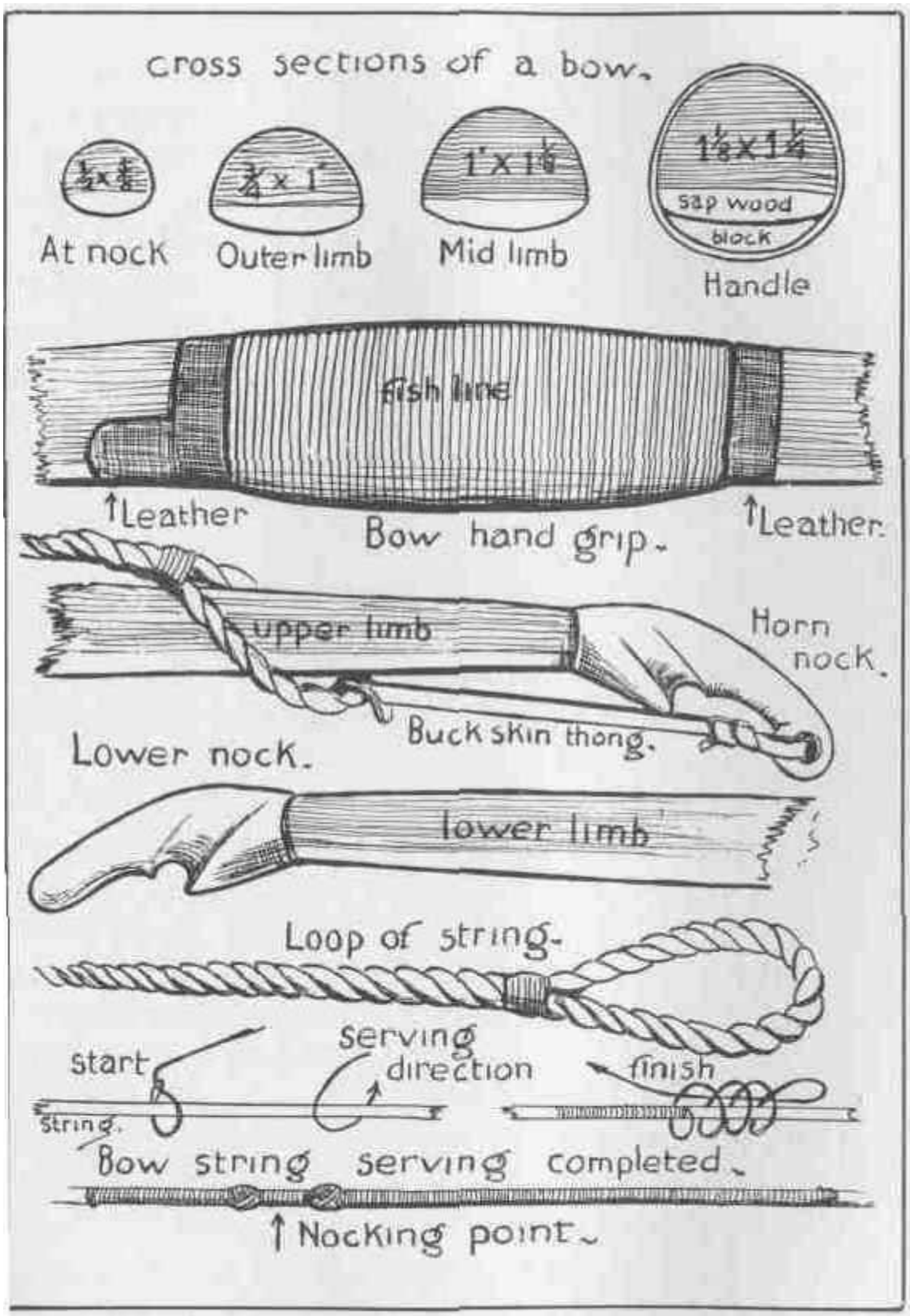
Now comes the process of putting on the nocks. A bow shoots well without them, but is safer with them.

From time immemorial, horn tips have been put on the ends of the limbs to hold the string. We have used rawhide, hardwood, aluminum, bone, elk horn, deer horn, buffalo horn, paper fiber or composition, and cow's horn. The last seems best of all. From your butcher secure a number of horns. With a saw cut off three or four inches of the tip. Place one in a vise and drill a conical hole in it an inch and a quarter deep and half an inch wide. This can be done by using a half-inch drill which has been ground on a carborundum stone to a conical point the proper length. In this hole set a stout piece of wood with glue. This permits you to hold the horn in the vise while you work it.

After the glue has set, take a coarse file and shape the horn nock to the classical shape, which is hard to describe but easy to illustrate. It must have diagonal grooves to hold the string. The nock for the upper limb has also a hole at its extremity to receive the buckskin thong which keeps the upper loop of the string from slipping too far down the bow when unbraced.

The nocks for hunting bows should be short and stout, not over one and a half inches long, for they get a lot of hard usage in their travels. They should also be broader and thicker than those used on target bows.

Two nocks having been roughly finished, they are loosened from their wooden handles by being soaked in boiling water, and are ready for use. Cut the ends of the bow to fit the nocks in such a way that they tip slightly backward when in place, but do not attach them yet.



DETAILS OF BOW CONSTRUCTION

At this point we back the bow with rawhide. Ordinarily a yew bow properly protected by sapwood requires no backing; but having had many bows break in our hands, we at last took the advice of Ishi and backed them. Since then no bow legitimately used has broken.

The rawhide utilized for this purpose is known to tanners as clarified calfskin. Its principal use is in the manufacture of artificial limbs, drum heads and parchment. Its thickness is not much more than that of writing paper.

Having secured two pieces about three feet in length and two inches wide, soak them in warm water for an hour.

While this is being done, slightly roughen the back of your bow with a file. Place it in the vise and size the back with thin, hot carpenter's glue. When the hide is soft, lay the pieces smooth side down on a board and wipe off the excess water. Quickly size them with hot glue, remove the excess with your finger, turn the pieces over and apply them to the bow. Overlap them at the hand grip for a distance of two or three inches. Smooth them out toward the tips by stroking and expressing all air bubbles and excess glue. Wrap the handle roughly with string to keep the strips from slipping; also bind the tips for a short distance to secure them in place. Remove the bow from the vise and bandage it carefully from tip to tip with a gauze surgical bandage. Set it aside to dry over night. When dry, remove the bandage and string binding, cut off the overlapping edges of the hide and scrape it smooth. Having got it to the required finish, size the exterior again with very thin glue, and it is ready for the final stage.

The tips of the bow having been cut to a conical point and the nocks fitted prior to the backing process the horn nocks are now set on with glue; the ordinary liquid variety will do.

Glue a thin strip of wood on the back of the bow to round out the handle. This should be about one-eighth of an inch thick, one inch wide and three inches long and rounded at the edges.

Bind the center of your bow with heavy fish line to make the handgrip, carefully overlapping the start and finish. A little liquid glue or shellac can be placed on the wood to fix the serving. Some prefer leather or pigskin for a handgrip, but a cord binding keeps the hand from sweating and has an honest feel.

The handle occupies a space of four inches with one and a quarter inches above the center and two and three-quarters below it. Finish off the edges of the cord binding with a band of thin leather half an inch wide. This should be soaked in water, beveled at the edge, sized with glue, put around the bow, and overlapped at the back. I also glue a small piece of leather on the left-hand side of the bow above the handle to prevent the arrow chafing the wood at this spot. This is called the arrow plate and usually is made of mother-of-pearl or

bone; leather is better. These finishing pieces are wrapped temporarily with string until they dry.

The bow is then given a final treatment with scraper and steelwool and is ready for the varnish.

The best protection for bows seems to be spar varnish. This keeps out moisture. It has two disadvantages, however; it cracks after much bending, and it is too shiny. The glint or flash of a hunting bow will frighten game. I have often seen rabbits or deer stand until the bow goes off, then jump in time to escape the arrow. At first we believed they saw the arrow; later we found that they saw the flash. Bows really should be painted a dull green or drab color. But we love to see the natural grain of the wood.

The finish I prefer is first of all to give a coat of shellac to the backing, leather trimmings and cord handle. After it is dry, give the wood a good soaking with boiled linseed oil. Using the same oiled cloth place in its center a small wad of cotton saturated with an alcoholic solution of shellac. Rub this quickly over the bow. By repeated oiling and shellacking one produces a French polish that is very durable and elastic.

Permit this to dry and after several days rub the whole weapon with floor wax, giving a final polish with a woolen cloth.

When on a hunt one should carry a small quantity of linseed oil and anoint his bow every day or so with it. Personally I add one part of light cedar oil to two parts of linseed. The fragrance of the former adds to the pleasure of using the latter.

When not in use hang your bow on a peg or nail slipped beneath the upper loop of the string; do not stand it in a corner, this tends to bend the lower limb. Keep it in a warm, dry room; preserve it from bruises and scratches. Wax it and the string often. Care for it as you would a friend; it is your companion in arms.

SUBSTITUTES FOR YEW

Where it is impossible to obtain yew, the amateur bowyer has a large variety of substitutes. Probably the easiest to obtain is hickory, although it is a poor alternative. I believe the pig-nut or smooth bark is the best variety. One should endeavor to get a piece of second growth, white sapwood, and split it so as to get straight grain.

This can be worked on the same general dimensions as yew, but the resulting bow will be found slow and heavy in cast and to have an incurable tendency to follow the string. It will need no rawhide back and will never break.

Osage orange, mulberry, locust, black walnut with the sap wood, red cedar, juniper, tan oak, apple wood, ash, eucalyptus, lancewood, washaba, palma brava, elm, birch, and bamboo are among the many woods from which bows have been made.

With the exception of lancewood, lemon wood, or osage orange, which are hard to get, the next best wood to yew is red Tennessee cedar backed with hickory.

Go to a lumber yard and select a plank of cedar having the fewest knots and the straightest grain. Saw or split a piece out of it six feet long, two inches wide, and about an inch thick. Plane it straight and roughen its two-inch surface with a file. Obtain a strip of white straight-grained hickory six feet long, two inches wide, and a quarter inch thick.

Roughen one surface, spread these two rough surfaces with a good liquid glue and place them together. With a series of clamps compress them tightly. In the absence of clamps, a pile of bricks or weights may be used. After several days it will be dry enough to work.

From this point on it may be treated the same as yew. The hickory backing takes the place of the sap wood.

Cedar has a soft, lively cast and the hickory backing makes it almost unbreakable.

This bow should be bound with linen or silk every few inches like a fishing rod. Several coats of varnish will keep the glue from being affected by moisture or rain.

Since both woods are usually obtainable at any lumber yard, there should be no difficulty in the matter save the mechanical factors involved. These only add zest to the problem. A true archer must be a craftsman.

MAKING A BOWSTRING

A bow without a string is dead; therefore, we must set to work to make one.

Sinew, catgut, and rawhide strings were used by the early archers, but have been abandoned by the more modern. Animal tissue stretches when it is put under strain or subjected to heat and moisture. Silk makes a good string, but it is short-lived and is not so strong as linen.

A comparative test of various strings was made to determine which material is the strongest for bows. Number 3 surgical catgut is apparently a D string on the violin. Taking this as a standard diameter, a series of waxed strings of various substances were made and tested on a spring scale for their breaking point. The results are as follows:

Horsehair	breaks at 15 pounds.
Cotton	breaks at 18 pounds.

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Catgut               breaks at 20 pounds.
Silk                 breaks at 22 pounds.
Irish linen          breaks at 28 pounds.
Chinese grass fiber  breaks at 32 pounds.
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This latter, with similar unusual fibers, is not on the market in the form of thread, so is of no practical use to us.

We use Irish linen or shoemakers' thread. It is Barbour's Number 12. Each thread will stand a strain of six pounds; therefore, a bowstring of fifty strands will suspend a weight of 300 pounds.

A target bow may have a proportionately lighter string than a hunting bow because here a quick cast is desired; but in hunting, security is necessary. We therefore allow one strand of linen for every pound of the bow.

This is the method of manufacturing a bowstring as devised by the late Mr. Maxson and described in *American Archery*. Some few alterations have been introduced to simplify the technique.

It is advisable to take the threads in your hands as you follow the directions.

If you propose making a string for a sixty-five-pound bow, it should have about sixty threads in it, and these are divided into three strands of twenty threads each. Start making the first of these strands by measuring off on the bow a length eight inches beyond each end--that is, sixteen inches longer than your bow. Double your thread back, drawing it through your hand until you reach the beginning. Now repeat the process of laying one thread with another, back and forth, until twenty are in the strand. But these must be so arranged that each is about half an inch shorter than the preceding, thus making the end of the strand tapered.

When twenty are thus stroked into one cord, they are heavily waxed by drawing the strand through the hand and wax, from center to the ends, each way. Now roll the greater part of this strand about your fingers and make a little coil which you compress, but allow about twenty-four inches to remain free and uncoiled. Thus abbreviated it is easier to handle in the subsequent process of twisting it into a cord.

Make two other strands exactly like this, roll them into a compressed coil and lay them aside. Now to form the loop or eye it is necessary to thicken the string at this point with an additional splice. So lay out another strand of twenty threads six feet long. Cut this into six pieces, each twelve inches in length. Take one of these and so pull the ends of the threads that they are made of uneven length, or that the ends become tapered. Wax this splice thoroughly; do this to each one in turn.

Now pick up one of your original strands and apply to its tapered end and lying along the last foot of its length one of the above described splices. Wax the two together. So treat the two other strands.

Grasp the three cords together in your left hand at a point nine inches from the end. With the right hand pick up one strand near this point and twist it between the thumb and finger, away from you, rolling it tight, at the same time pulling it toward you. Seize another strand, twist it from you and pull it toward you. Continue this process with each in succession, and you will find that you are making a rope. By the time the rope is three inches in length, it is long enough to fold on itself and constitute a loop. Proceed to double it back so that the loose ends of the strands are mated and waxed into cohesion with the three main strands of the string. Arrange them nicely so that they interlace properly and are evenly applied.

Now while being seated, slip the upper limb of your bow under your right knee and over the left, and drop the new formed loop of your string over the horn nock. Begin again the process of twisting each strand away from you while you pull it toward you. Continue the motion until you have run down the string a distance of eight inches. During the process you will see the wisdom of having rolled the excess string up into little skeins to keep them from being tangled. Thus the upper eye is formed. At this stage unwind your skeins and stretch the string down the bow, untwisting and drawing straight the three strands.

Seize them now three inches below the lower nock of your bow. At this point apply the short splices for the lower loop. They should be so laid on that three inches extends up the string from this point and the rest lies along the tapered extremity. Wax them tight. Hold the three long strands together while you give them final equalizing traction. Start here and twist your second loop, drawing each strand toward you as you twist it away from you until a rope of three inches is formed again. This you double back on itself, mate its tapered extremities with the three long strands of the string and wax them together.

Slip the upper loop down your bow and nock the lower loop on the lower horn. Swing your right knee over the bow below the string and set the loop on this horn while you work. Give the string plenty of slack.

Start again the twisting and pulling operation, keeping the strands from tangles while you form the lower splice of the string. When it is eight inches long, take off the loop and unroll the twist in the main body of the string. Replace the loop and brace your bow. This will take the kinks from the cord. Wax it thoroughly and, removing the lower loop, twist the entire bowstring in the direction of the previous maneuver until it is shortened to the proper length to fit the bow. Nock the string again and, taking a thick piece of paper, fold it into a little pad and rub the bowstring vigorously until it assumes a round, well-waxed condition.

If the loops are properly placed, the final twisting should make one complete rotation of the string in a distance of one or two inches. A closer twist tends to cut itself.

If, by mistake, the string is too short or too long, and adjusting the twist does not correct it, then you must undo the last loop to overcome the error. The fork of these loops is often bound with waxed carpet thread to reduce their size and strengthen them. The whole structure at this point may be served with the same thread to protect it from becoming chafed and worn.

The center of the string and the nocking point for the arrow must now be served with waxed silk, linen, or cotton thread to protect it from becoming worn.

Ordinarily we take a piece of red carpet thread or shoe button thread, about two yards in length, wax it thoroughly and double it. Start with the doubled end, threading the free end through it around the string, and wind it over, from right to left. The point of starting this serving is two and one-half inches above the center of the bowstring.

When you come to the nocking point, or that at which an arrow stands perpendicular to the string while crossing the bow at the top of the handle, make a series of overlapping threads or clove hitches. This will form a little lump or knot on the string at this point. Continue serving for half an inch and repeat this maneuver; again continue the serving down the string for a distance of four or five inches, finishing with a fixed lashing by drawing the thread under the last two or three wraps.

A nocking point of this character has two advantages: the first is that you can feel it readily while nocking an arrow in the dark or while keeping your eye on the game, and the other point is that the knots prevent the arrow being dislodged while walking through the brush.

We have found that by heating our beeswax and adding about one-quarter rosin, it makes it more adhesive.

In hot or wet weather it is of some advantage to rub the string with an alcoholic solution of shellac. Compounds containing glue or any hard drying substance seem to cause the strings to break more readily. Paraffin, talcum powder, or a bit of tallow candle rubbed on the serving and nocking point is useful in making a clean release of the string.

So far as dampness and rain go, these never interfere with the action of the string. A well-greased bow will stand considerable water, though arrows suffer considerably.

Wax your string every few days if in use; you should always carry an extra one with you.

Strings break most commonly at the nocking point beneath the serving. Here they sustain the greatest strain and are subject to most bending. An inspection at this point frequently should be done. An impending break is indicated by an uneven contour of the strands beneath the serving. Discard it before it actually breaks.

By putting a spring scale between one of the bow nocks and the end of the string, the unexpected phenomenon is demonstrated that there is greater tension on a string when the bow is braced but not drawn up. A fifty-six pound bow registers a sixty-four pound tension on the string. As the arrow is drawn up the tension decreases gradually until twenty-six inches are drawn, when it registers sixty-four pounds again.

At the moment of recoil, when the bow springs back into position, this strain must rise tremendously, for if the arrow be not in place the string frequently will be broken.

The tension on the string at the center or nocking point during the process of drawing a bow--that is, the accumulated weight--rises quite differently in different bows. The arrow being nocked on the string, it is ordinarily already six inches drawn across the bow. Now in the same fifty-six pound bow for every inch of draw past this, the weight rises between two and three pounds. As the arrow nears full draw, the weight increases to such a degree that the last few inches will register five or six pounds to the inch, depending on many variable factors in the bow.

The gradient thus formed dictates the character of a bow to a great extent. One that pulls softly at first and in the last part of the draw is very stiff, will require more careful shooting to get the exact length of flight than one whose tension is evenly distributed.

Reflexed bows are harder on strings than those that follow the string. A breaking cord may fracture your bow. I saw Wallace Bryant lose a beautiful specimen this way. One of Aldred's most perfect make, dark Spanish yew and more than fifty years old, flew to splinters just because a treacherous string parted in the center. Sturdy hunting bows are not so liable to this catastrophe, but be sure you are not caught out in a game country with a broken string and no second. You will see endless opportunities to shoot. Wax is to an archer what tar is to a sailor; use it often, and always have two strings to your bow.