TechGuide

Building an Ox Yoke

By David Kramer

Types of Yokes

Cattle have been domesticated and used as oxen for thousands of years. Throughout this time a variety of harnessing systems have been developed and used for oxen, the most common system being the yoke. There are two main types of yokes: The head yoke and the neck yoke.

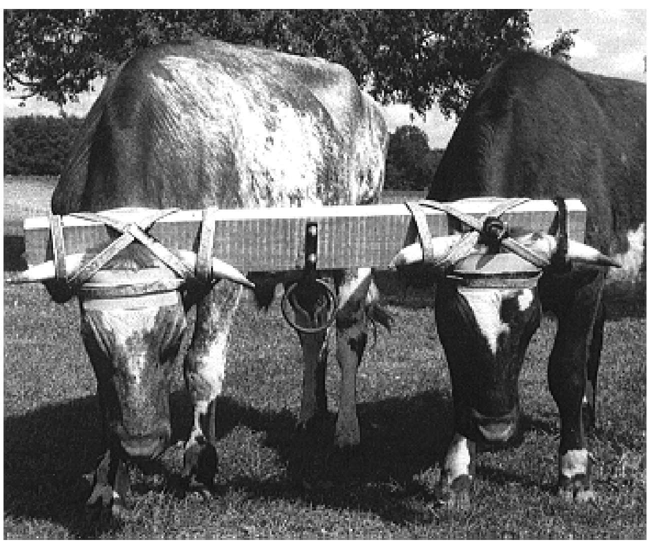


Figure 1: A Bolivian-style head yoke on a team of oxen.

A head yoke is secured directly behind the horns of the oxen. The animals transfer their power to the yoke beam by pushing on straps that wrap around their horns, behind the yoke, and across the front of their head. The beam is shaped to fit over the neck of the oxen. A leather pad is placed on their forehead where the straps cross. The head yoke is traditional to parts of mainland Europe and South America. (Fig. 1)

Figure 2: A North American-style traditional neck yoke.

A neck yoke rests directly on the necks of the oxen. It is carved and rounded to fit the animals' necks comfortably. Bows pass under the necks of the oxen and secure them in position. The oxen transfer their power to the yoke beam by pushing with the top of their neck directly against the beam, and by pushing with their shoulders against the upper part of the bows. Neck yokes are traditional to England and much of North America. (Fig. 2)

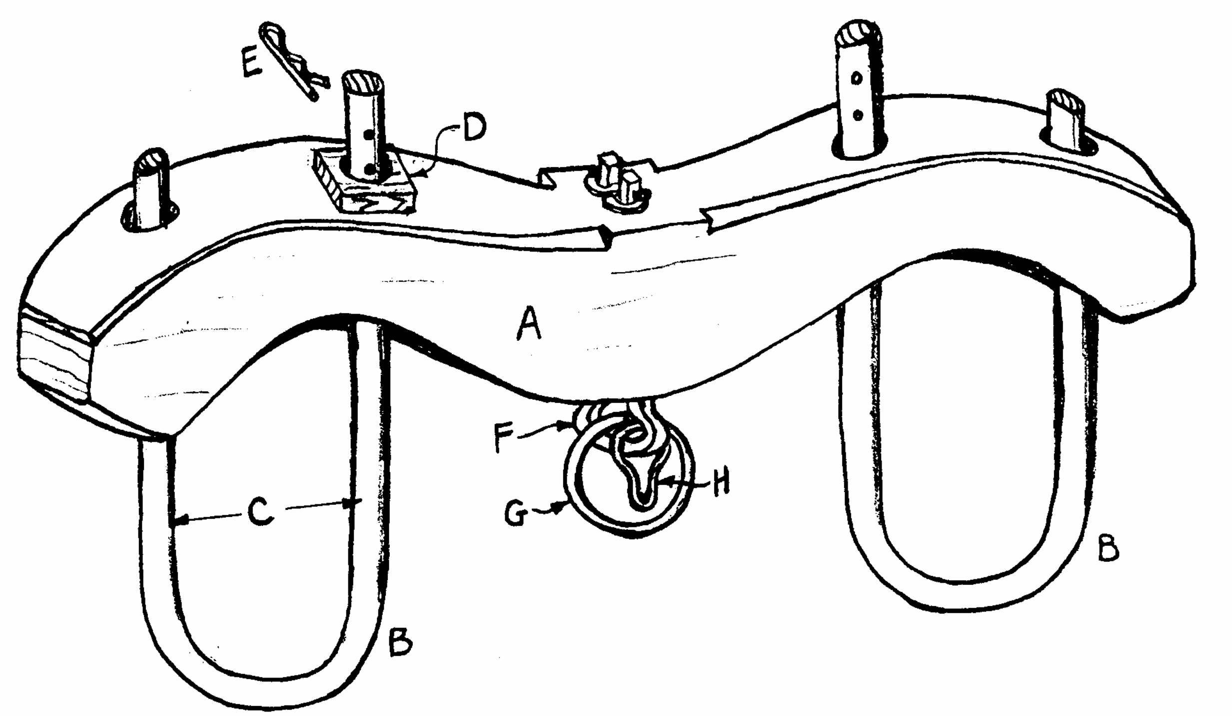
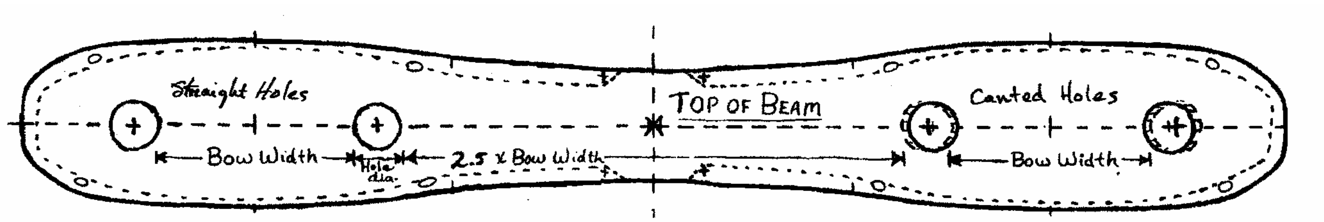


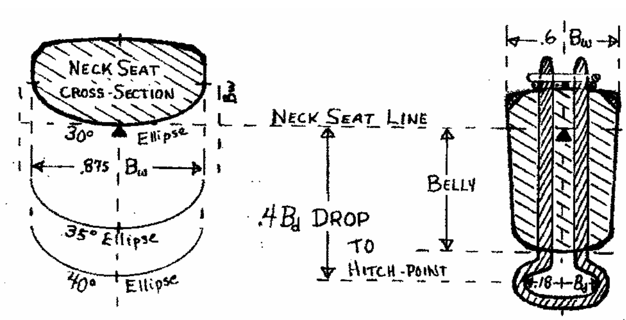
Figure 3: Parts of a traditional neck yoke: A – yoke beam; B – bows; C – bow width and size of yoke; D – spacer block; E – bow pin; F – staple; G – pole ring; H – chain hook.

Comparison of Yoke Styles

There are advantages and disadvantages to each of the yokes mentioned above. The head yoke limits the individual movement of each ox, and the team must learn to operate together. The force of draft from the head yoke is transferred through the neck of the ox. The hitch point of the yoke must be placed to prevent the head from being pulled up and back, or downwards under load. The head yoke cannot be used on animals without horns, and it cannot be used to train young calves whose horns are very small. An advantage of the head yoke is that it serves well for braking loads. Since the yoke is secured tightly to the horns it will not shift forward when the animals stop a moving load. Some teamsters see an advantage in the limited individual movement the head yoke forces upon the ox team, especially with an animal that likes to swing its head or tends to misbehave.

The neck yoke allows more freedom of individual movement for oxen, making sharp corners easier to turn. The force of draft from a neck yoke begins farther down the spine, and some of the force is taken through the shoulders by the bows. A neck yoke can be used on polled cattle and it can be used for training very young animals at an age when they respond quickly to training. When holding back a load, the neck yoke will ride forward on the necks of the oxen. This can be disturbing to the animals, and sometimes they get their ears pinched between the yoke beam and their horns. A brichen can be attached to the neck yoke to help solve the braking problem, but it is an added expense in equipment and time spent on preparing the animals for work. A brichen is a belt that wraps around an animal's rear quarters and permits it to hold back a load with its rump.





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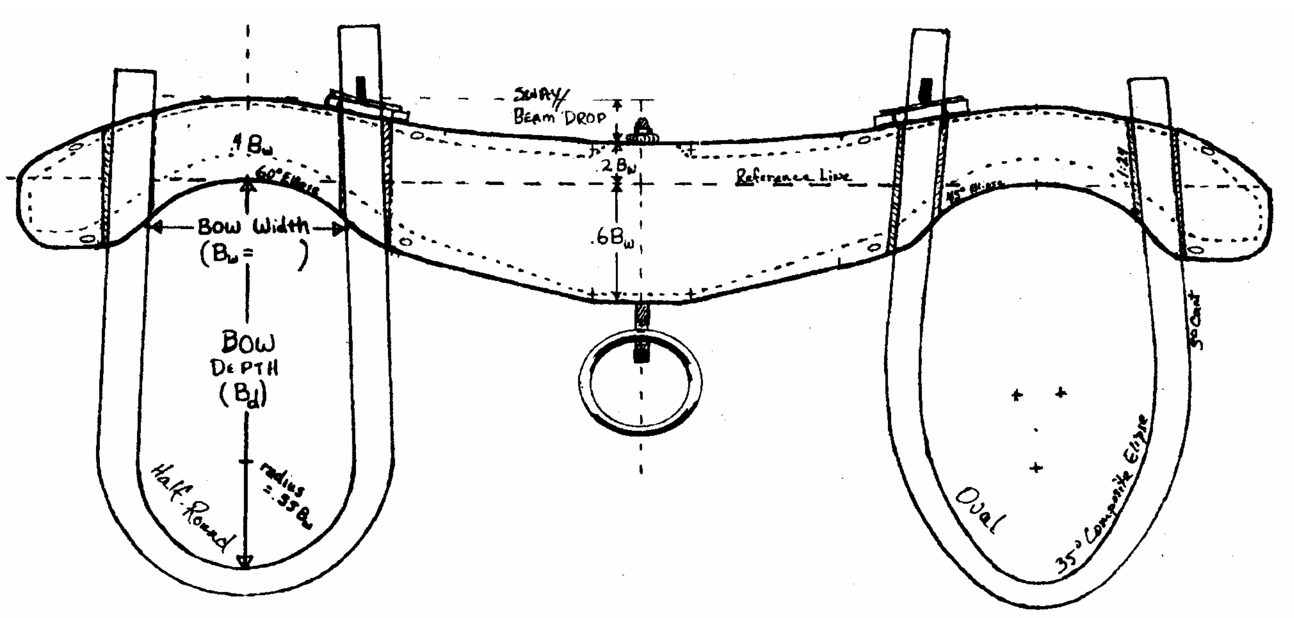

Figure 4: Tillers' Plans for a Traditional North American Neck Yoke.

In pulling contests there seems to be little difference in performance by yoke style. Teams of oxen with similar body weights will pull fairly equal loads provided each type of yoke is carefully fitted. Tillers does not recommend one yoke style over the other. As an ox driver you will need to consider the styles and choose the one that bests suits you and your team. It is possible to train a team to work in both styles of yokes.

We generally use neck yokes at Tillers. Neck yokes were traditional to this area, and they are suitable for our work because our land is flat and the oxen do not need to do much braking. We also use the neck yoke because we prefer to train our oxen at a young age before their horns have grown. The focus of this TechGuide will be on the construction of neck yokes.

Design and Fit of a Neck Yoke

Before construction begins it is important to understand the parts of a yoke, how the parts function, and how they should be sized to properly fit a team of oxen. This information is covered in detail in **Tillers Tech*Guide***, *Neck Yoke Design and Fit: Ideas from Dropped Hitch Point Traditions.* Yokes for oxen are like shoes for children. One size does not fit all. A young team may need as many as five or six yokes before it reaches maturity. A well-fitted yoke will allow an ox team to pull to its full potential. A poorly fitted yoke will cause discomfort, could injure the oxen, and will not allow the team to pull to its full potential. The parts of a neck yoke are shown in Fig. 3. The size of the bow, or **bow width**, is one of the most critical dimensions in fitting a yoke. Because this measurement is so critical, the size of a neck yoke is generally given by the width of its bows. A 7-inch yoke will have bows with a 7-inch space for the neck of the oxen. When the yoke is on the oxen you should be able to slide your hand between the neck and one side of the bow. The **Tillers Yoke Plan** (Fig. 4) is designed to give dimensions for a general-purpose yoke of any size. Once you have determined the correct bow width (**Bw**) and bow depth (**Bd**), all other dimensions of the yoke are factors of these dimensions. For example, if you are making a yoke with a 7-inch bow width, plug 7 into all of the equations on the plan where you see **Bw.** Full-scale yoke templates can be ordered from Tillers for yoke sizes ranging from 4 inches to 14 inches, while plans are available for yokes up to size 8.

TABLE 1:
Woods Commonly Used in Yokes

For Light Duty Yoke Beams

Common Name	Botanical Name
Pine	Pinus
Aspen	Populus tremuloides
Alder	Alnus glutinosa
Tulip Tree (also Yellow Poplar)	Liriodendron tulipifera
Sassafras	Sassafras

For Heavy Use Yoke Beams

Common Name	Botanical Name
Elm	Ulmus americana
Shagbark Hickory	Carya ovata
Hard Maple	Acer saccharum
Hornbeam	Carpinus caroliniana
Sycamore	Acer pseudoplatanus
Yellow Birch	Betula alleghaniensis

For Bending Ox Bows

Common Name	Botanical Name
Hackberry	Celtis occidentalis
Hickory	Carya
White Ash	Fraxinus americana
White Oak	Quercus alba
Red Oak	Quercus rubru
English Walnut	Juglans regia

The Yoke Beam

There are many types of woods that can be used to make the yoke beam. Softwoods can be used for small training yokes, or for larger yokes that are used for pulling carts and other light work. A yoke that is used for plowing sod, pulling stumps, or logging should be made of a harder stronger wood. Traditional woods used for yoke beams in North America are listed in Table 1, but do not limit yourself to this list. I have seen yokes made from a wide variety of soft and hardwoods. I believe old farmers often made yokes from what was on hand. Some teamsters may be concerned about the weight of a large yoke. This is really more of a problem for the person lifting the yoke up onto necks of the oxen than it is for the oxen. A 60 to 70 lb yoke is not too heavy for a full-grown team of animals that together may weigh two tons. The comfort of a larger surface area to push against makes a larger beam worth its extra weight.

The size of the yoke beam will vary with the size of the yoke needed. Table 2 gives rough dimensions of the stock needed for various yoke parts according to the bow width of the yoke. Sometimes a team may not be equal in size. One ox may require a 7-inch bow width, and its partner may need an 8-inch bow width. In a case like this I generally make the yoke beam according to the larger bow width, and drill the bow holes closer together on one side to fit the smaller ox.

TABLE 2: Dimensions of Yoke Parts in Inches

Bow Width	4	5	6	7	8	9	10	11	12
Rough Cut Beam									
length	28	35	42	49	56	63	70+	70+	70+
width	4	5	6	7	8	8	9	9	10
depth	4	5	6	7	8	9	10	11	11
Diameter of Bow Holes Bored									
in the Beam	1.25	1.5	1.75	1.75	2	2	2	2.25	2.25
Bow Stock									
length	32	40	48	56	62	66	68	70	72
thickness	1	1.25	1.5	1.5	1.75	1.75	1.75	2	2
Staple/ Mild Steel									
square bar	0.5	0.5	0.5	0.5	0.62	0.62	0.62	0.62	0.62
length	14	17	20	23	26	29	31	33	35
bulb width	2.5	2.75	3	3.5	4	4.5	5	5.5	6
Pole Ring/ Mild Steel									
round bar	0.37	0.37	0.5	0.5	0.62	0.62	0.62	0.62	0.62
length	14.5	14.5	15.5	15.5	16	16	16	16	16
(These lengths will make a ring with an inside diameter between 4 and 4.5 inches)									
Pear Shaped Chain Link/ Mild Steel									
square bar	0.375	0.375	0.375	0.375	0.5	0.5	0.5	0.5	0.5
length	12	12	12	12	13	13	13	13	13
Bow Pins/ Spring Steel									
round stock	0.187	0.187	0.187	0.187	0.25	0.25	0.25	0.25	0.25

Seasoning The Wood

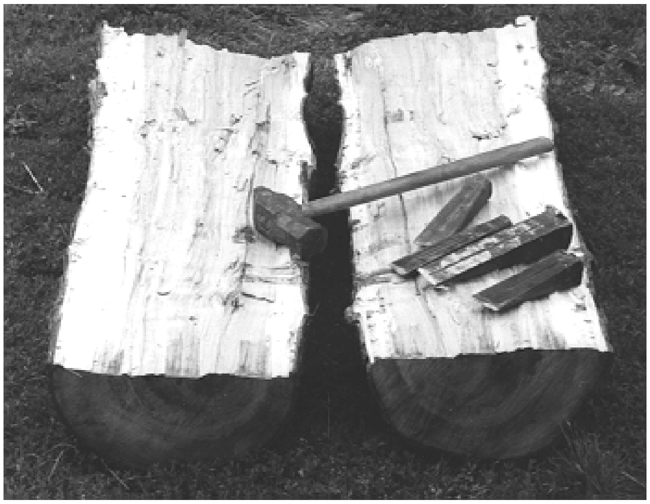

Figure 5: A yoke beam split from a large log is less likely to check when drying than one made from a smaller full log.

Construction on the yoke beam may begin with a rough log, or with a beam squared up at a sawmill. If you begin with a log you will need wedges to split out the yoke beam. Try to find a log large enough to halve or quarter, and build the yoke from one piece. (Fig. 5)

The circular grain structure left in beams made from a small log will cause more internal stress during drying, and will be more likely to develop checks and splits. (Fig. 6)

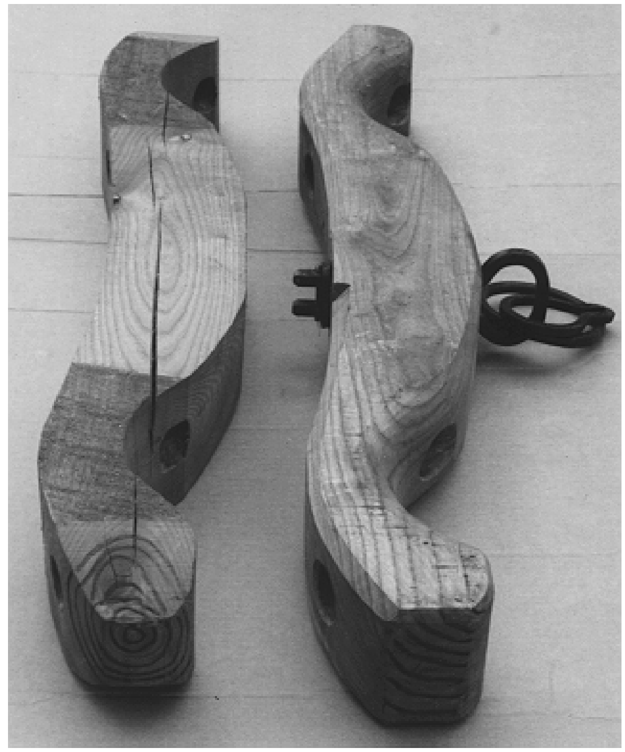

Figure 6: Two yoke beams made of sassafras wood and dried under similar conditions. The beam on the left with large cracks was made from an 8-inch diameter log. The beam on the right was made from a section of a 14-inch log. It dried without checking.

If you choose to begin with a beam from a sawmill you should check the end grain and look for a beam that was taken from one side of a large tree. (Fig. 7)

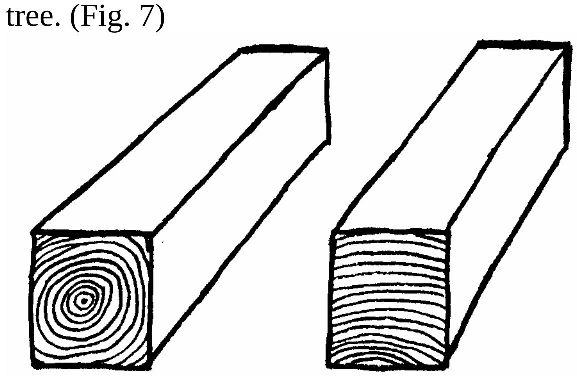

Figure 7: A beam with the grain pattern shown on the right is a better choice for yoke making.

Even a good piece of wood will split and check if it is not carefully seasoned. Slowing down the drying process is the key to avoiding checks. If you have a log it is best to split out the section you need for the yoke beam immediately. The smaller the piece of wood you have the easier it is to dry evenly without checking. If you do not have time to carve the beam right away store the beam in a cool shady place, off the ground so that it will not absorb ground moisture. Do not store the wood inside a heated or dehumidified building. Evaporation of moisture will occur more quickly at the ends of the beam. Old paint, engine oil, or linseed oil can be applied to the ends to slow the drying. Plastic can be draped loosely over the wood. Turn the plastic inside out daily to allow the condensed moisture to escape. If signs of mold appear on the wood it is drying too slowly and it may rot if the plastic is not removed. Some of the old time yoke makers recommend seasoning the yoke beam by burying it in loose hay. The hay will allow the beam to dry, but at a very slow rate. A large beam of wood can take several years to dry. We usually make our yokes from green wood, paint them with several coats of boiled linseed oil and turpentine (mixed in a 2:1 ratio), and begin using them immediately. At first they are quite heavy, but after some months of hanging in the barn they lose much of their moisture.

Some yoke builders may prefer to begin work on a beam that is already seasoned and dry. In this case any checks or splits will be evident before time is invested in shaping the beam. Power tools, especially sanders, work better on dry wood. Many of the traditional hand tools work better on green wood.

A good place to look for wood is at a tree trimming/tree removal business, or at a small sawmill. Small band saw mills are becoming popular and will saw small logs and uncommon woods that larger sawmills will not touch. Lumberyards usually do not carry hardwood beams, and if they make a special order the cost will be very high. Look for a piece of wood that is clear of large knots. Small knots are acceptable if they do not weaken the beam and if they do not occur in the neck seat area of the yoke. If possible, cut or purchase the stock long. If a defect is found inside the log, or the end of the beam develops checks, then the yoke pattern can be shifted to eliminate those defects or place them away from the neck seat.

Shaping the Yoke Beam

Figure 8: Mark the cross section of the beam on the end of the log and then split outside your lines.

When splitting the yoke beam from a log, mark the beam blank at the top of the log and use wedges to rough split outside your lines. (Fig. 8) Trees usually split better from the top end down.

Figure 9: Use care when adzing in the traditional method.

Use a foot adze to hew the beam down to size. Stakes driven into the ground will help to hold the beam stationary. Experienced workers like to hold their foot on the wood and slice chips away from under the toe of their boot. (Fig. 9) I feel safer straddling the work with my feet out of the way. Both methods have their dangers. With your foot on the work there is always the chance of slicing into your toes. With your feet to the side a glancing blow may strike your shin. I have a notch in one shin as proof that this can happen. When using the adze start with light strokes until you get the feel of how it cuts. I usually make chopping strokes with the blade cutting perpendicular into the wood, and follow these with lighter "planing" strokes parallel to the surface of the wood. With some practice you will find that the adze can be used to do some very nice finish work. When I plane or smooth the wood surface with the adze, I hold the upper part of my arms against the sides of my chest and swing the adze in a smooth arc with my lower arms. Keeping my upper arms rigid against my chest helps to give me better control and allows me to make fine adjustments in the arc as I cut.

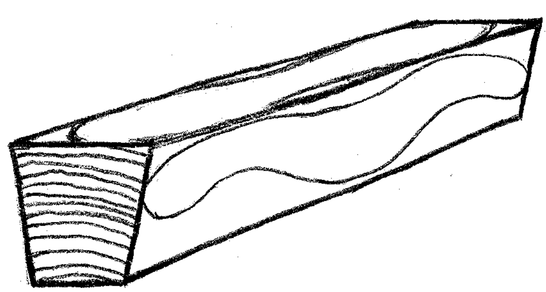

Figure 10: The roughed out yoke beam is a trapezoid in cross section.

A straight edge can be used to check that the planes being chopped out are straight and flat. When a flat plane has been established on one surface, the cross section of the beam can be marked out at the opposite end of the wood, and chalk lines can be used to keep the edges straight. The yoke beam is wider at the top than the bottom, so we usually use the adze to hew out a beam that is a trapezoid in cross section. (Fig. 10)

Figure 11: A "T"-handled auger bores the bow holes in the yoke beam.

The bow holes should be marked out and drilled in the beam when it has straight flat sides. Once the beam is carved there are no straight reference lines and it is very difficult to get the holes drilled straight. Marking the center of the yoke with a chalk line will ensure that all the bow holes are in a straight line. A large hand auger was the traditional tool used to bore the bow holes. (Fig. 11) The holes should be drilled 1/4 inch larger than the finished bow stock diameter. If you have access to a traditional barn builder's boring mill, it is an excellent tool for guiding the auger perpendicular to the surface. A strong electric hand drill and a variety of spade or forstner bits will also drill the bow holes. Assistants watching from different angles can help to make sure the holes are drilled straight. A drill press can also be used to bore the bow holes. The drill press table will ensure that the holes are drilled straight if the beam is square.

On some historical yokes we have found that the bow holes were drilled at a slight angle, making the holes closer together at the top of the yoke. This angle may have been used to fit the bows more closely to the neck. The top of the neck is sometimes tapered thinner than the bottom. This system limits the depth adjustment of the bows, making the taper of the bows critical to fitting the bow depth. Drilling angled holes and bending matching tapered bows can be difficult for a novice yoke maker. For starters I would recommend keeping bows and bow holes straight and parallel.

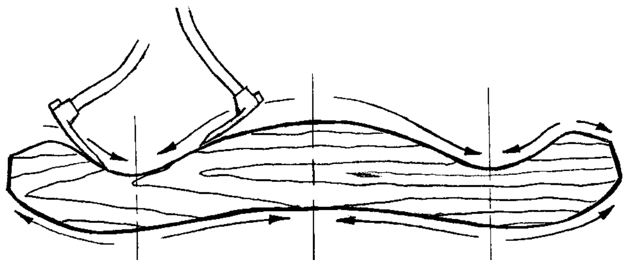

Figure 12: On a straight-grained beam, the direction of cut will move from high points to low points. Follow the arrows. If the tool is digging in or leaving a rough cut, try reversing and cutting from the opposite direction.

Cardboard or thin plywood templates of the yoke plan are useful to layout the profile on the beam. A black marking pen leaves an outline that can be easily seen during work. The adze is again used to rough out the profile of the yoke. When using the adze the grain of the wood must be considered. The cuts used to remove waste wood will start at the high points of the beam and work to the low points. The direction of cut will have to be changed many times to complete the profile. (Fig. 12) If the adze is making rough cuts, or is digging in too deep, try reversing the direction of the cut. Other hand tools that can be used to carve the yoke profile are a small hand adze, hatchet, or wide chisel and mallet. Power tools are also commonly used to make yokes. A band saw can be used to rough out many yokes in a production shop. (Fig. 13) A skilled operator with a chain saw can remove lots of waste wood quickly.

Figure 13: Yoke blanks cut out with a band saw in Tillers' production shop.

When the side and top profiles have been roughed out, finish work on the neck seats can begin. I usually use a large chisel and mallet to knock a 45-degree chamfer off the edge of the neck seat. (Fig. 14)

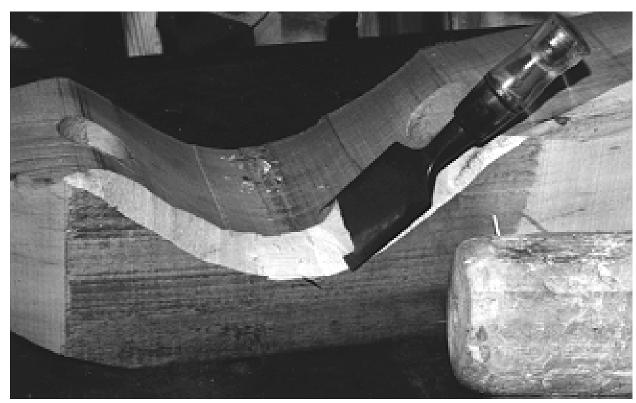

Figure 14: A large chisel and mallet being used to shape the neck seat of a yoke beam.

A drawknife and spoke shave can be used to round over the edges. (Fig. 15) Direction of the wood grain is again important for determining the direction of cut. Smoothing the surface of wood with a cutting tool is a lot like petting a cat with your hand. If you pet a cat from the head to the tail its fur will lay smooth and flat. If you pet backwards from the tail to the head the hair will stand up and be uneven. The grain of wood normally runs out one direction on the surface.

Figure 15: A spoke shave efficiently smoothes the neck seat of a yoke beam.

Like the fur on a cat, the wood grain can be smoothed down, or it can be roughened up depending on which direction you choose to cut it. In most cases you can follow the directions of the arrows in Fig. 12.

Figure 16: A shard of broken glass brings the surface to a hard smooth finish.

Note the cross section of the neck seat on the Tillers' Yoke Plan. (Fig. 5) It is a smooth flowing elliptical shape right from the center of the neck seat out to the edge. Cabinet scrapers and pieces of broken glass can be used to scrape and smooth the surface of the neck seat to a smooth hard finish. (Fig. 16)

It is a temptation to fix a pad onto the neck seat of the yoke beam to make it more comfortable for the oxen. Avoid this temptation. Soft pads added to the neck seat or bows of the yoke will rub and cause sores on the animals' necks and shoulders, much like a loose sock can cause a blister on your foot. A hard smooth surface is better for the oxen than a pad. A hand held grinder with a coarse sanding disc is a great tool for shaping the neck seat and the sides of the yoke. I use a 16-grit sanding disc for heavy stock removal. Finer sanding discs or belt sanders can be used for finish work. Sanding tools work better on dry wood than on green wood.

Figure 17: A hand plane is a good choice for quickly smoothing the sides of the beam. It removes stock quickly when pushed across the grain.

The neck seats must be carefully finished, smooth and evenly curved surfaces. The rest of the yoke can be left rough-hewn. For a more finished look a hand plane or spoke shave can be used to smooth the sides, top, and bottom of the yoke beam. (Fig. 17) The top edges of the yoke and the edges of the bow holes may be rounded or chamfered for decoration. Having sharp tools is very important to any type of woodworking.

Most hand tools ordered from catalogs do not get shipped honed and ready to use. Working with dull or poorly adjusted tools is very frustrating. A sharp spoke shave should cut like a potato peeler through green wood. If your tools are not cutting well invest in a good honing stone. Find someone who can teach you how to sharpen and adjust your tools.

At this point I would recommend sealing the beam with oil or whatever finish you prefer. This will slow the drying and help to prevent checks. Boiled linseed oil thinned with turpentine (2:1) is the finish we normally use at Tillers, but I have also seen some old painted yokes. Red and blue seem to have been traditional colors for painted yokes.

Laminated Yoke Beams

Figure 18: A saber saw can cut the layers for a laminated beam.

Laminating several boards together can create a strong yoke beam. Laminated yokes may not look very historical, but they have several advantages. Kiln dried lumber can be purchased to make the beam. Because the wood is already dry there is no need to worry about carefully seasoning the beam to prevent checks. A saber saw or small band saw can be used to cut out the yoke profile on each board before they are glued together. This will eliminate much of the shaping work with an adze. (Fig. 18) Laminated yokes can actually be stronger than a solid beam of wood. If a defect or check occurs in one layer of wood, it will be contained in that layer and will be surrounded by solid wood on either side. Grain directions will vary from one board to the next and the layers will help to strengthen and support each other much like a piece of plywood.

Wood used to make a laminated yoke beam should be thoroughly dry to ensure that the glue bonds properly. The boards do not all need to be the same thickness, but they should all be planed smooth and flat before gluing. A variety of woods can be used to give the yoke an interesting design. Yellow carpenter's glue (aliphatic resin) is water resistant, and I have had good success with it on several laminated yoke beams. Always do a trial clamp up without glue to make sure you have enough clamps. You may need as many as 10 clamps when gluing a large beam. If you are short of clamps, try drilling holes through the layers and using long bolts or threaded rod with nuts and washers to pull the layers together. When the glue has set the bolts can be removed and the holes plugged with dowels, or the heads of the bolts can be countersunk and left in the beam to add strength.

Making the Bows

Table 1 lists some woods that bend well without splitting. Bows were traditionally bent from the sapwood of a straight-grained tree. Choose a sapling 6 - 7 inches in diameter, growing deep in a forest with a high canopy. Small trees growing deep in the forest will shoot straight up with very few branches that cause knots and crooked grain. Split the sapling into pieces large enough for making bows (Fig.19). Use a drawknife to remove the heartwood. Leave the bark on the outside of the wood. Cutting the wood during the winter when the sap is not running will help to ensure a tight bond between the bark and the wood.

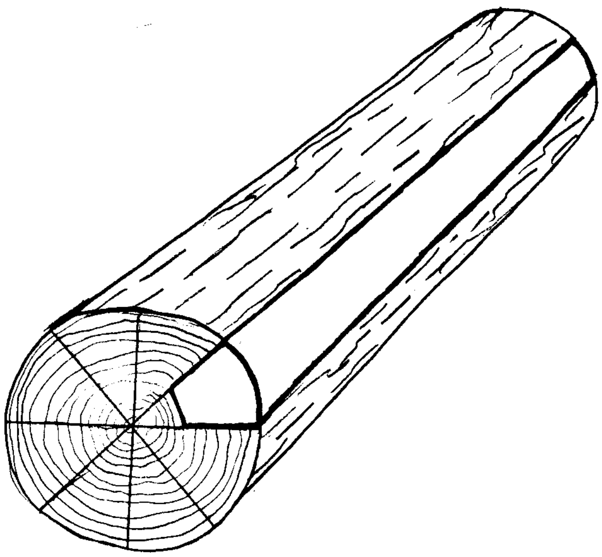

Figure 19: Bow stock should be split out of the outer section of a sapling.

The bow blank is slowly bent over several hours around a form or simply around a tree of the correct diameter. Ropes and pulleys are set up to help bend the bow. The bark is positioned on the outside of the curve, and helps to prevent the outside fibers of the wood from tearing out. The traditional method of bending described above was tried at Tillers and our success rate was not very high.

We normally use a steam box to heat the wooden bow stock before bending. Even with steam, the straightness of the grain and absence of any knots or defects in the bow stock are critical to a successful bend. Instead of splitting wood for bows, we saw out bow blanks from select straight-grained lumber. Kiln dried lumber does not bend well. Air-dried lumber cut in the last year or two works best when steamed. Soaking the wood in water for several days before steaming is helpful. Since the bark is removed from our bow blanks, we use a metal strap to support the outside of the bow during bending. The bow stock is steamed at least one hour before bending, and the steam should be plentiful. Larger bows should be steamed longer. One hour of steaming for each square inch of cross section is a good rule. We have a wood stove with a water tank built into it. The steam flows out of the tank through a water pipe into a wooden box. No part of our system is pressurized. There are plenty of cracks and holes in the box to prevent pressure from building up. If you make or adapt a tank for a steam box make sure you include a safety valve to prevent explosion. When the wood is removed from the steam box it should be too hot to handle with bare hands. The steam softens the resin that holds the wood fibers together, allowing them to slide past each other instead of shattering or breaking during bending.

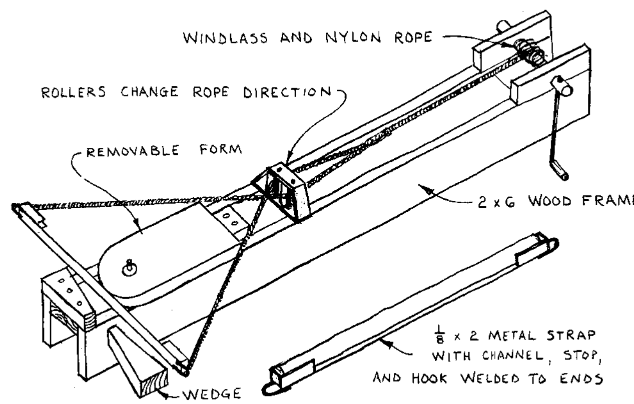

Figure 20a: Tillers bends bows on a simple jig with a windlass.

Before the wood cools it must be bent into the desired shape. We use a bending jig to hold the forms for any size of bow. (Fig. 20 & 21) A metal supporting strap made of 1/8-inch thick mild steel is placed behind the bow stock.

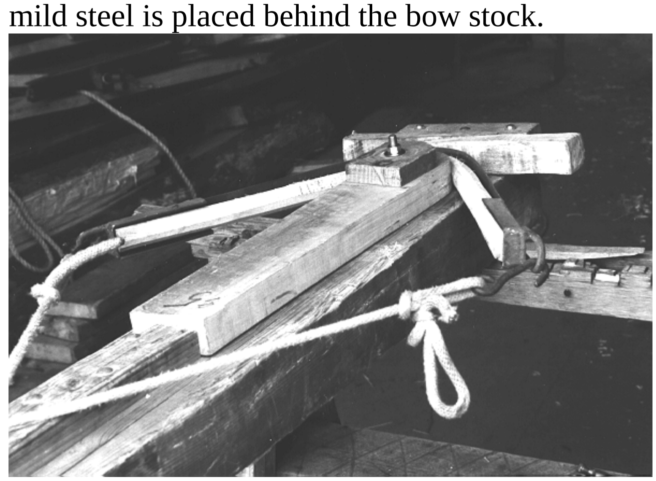

Figure 21: bending a bow on the jig.

Wedges are used to hold the strap and bow stock firmly against the form. Stops welded to the end of the straps compress the bow stock along its length during bending. Compression occurs along the inside of the curve. The outside is not allowed to stretch and tear out.(Fig. 22)

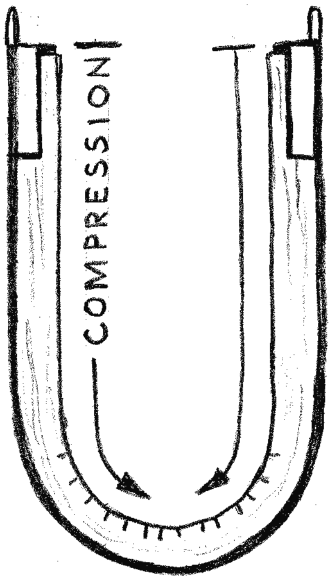

Figure 22: A metal band with end stops around the outside of the bending bow compresses the inside of the curve – keeping it from tearing on the outer edge.

Normally the bow stock is cut 3/8 to 1/2 inch shorter than the length between the stops on the bending strap. If the bow stock is left too long the compression during bending will be too great, causing the wood to rupture and deform on the inside of the curve. A simple windlass and ropes are used to pull the strap and bow around the form. With steamed wood the bending need only take 20 to 30 seconds. Bar clamps hold the finished bow tight to the form. Additional bows can be bent immediately by replacing the form on the jig. When we fire up the steam box we like to heat 8 -10 bows at one time, and we have enough clamps, metal straps, and forms on hand to do this. Finished bows should be left clamped for at least one day, preferably longer.

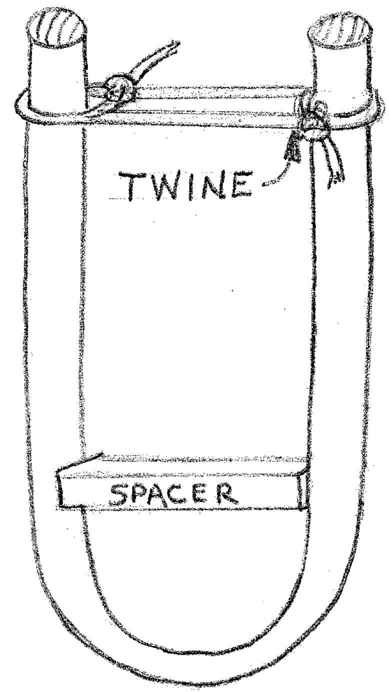

Figure 23: Tying newly bent bows with a spacer to help it keep its shape.

When the clamps are removed, tie a piece of string around the top of the bow to hold it in place, and use a stick cut to hold the bottom of the bow near the radius to its correct size. (Fig. 23) If the yoke beam is prepared, the bows can be rounded with a spoke shave to fit the bow holes, and the bows can be stored in the yoke beam. If the bows are not tied or stored in the yoke beam they will slowly begin to straighten out. I like to cut one end of the bow slightly shorter than the other. The longer end of the bow is placed in the hole nearest the center of the yoke. If the shafts of the bow are equal in length it can be difficult to get both ends started into the holes at the same time. Having one end longer allows the bow to be looped under the neck of the ox, started on the inside hole, and then pushed or pulled as needed to get the opposite end started in the outside hole. Rounding the tops of the bows will also make it easier to get them started in the bow holes.

Alternative Bows

There are many people with the tools and skills to make a yoke beam. Bending bows is more difficult. Tillers has been experimenting with some optional materials for bows. A variety of metal and plastic pipes and conduit can be bent into bow shapes. Plastic pipe is easiest to bend. Look for a thick walled pipe section. Fill the pipe with **dry** sand and plug the ends with clay or wet soil. Heat the plastic pipe over a small bed of hot coals, or with a propane torch. Work outside or in a well ventilated area. Heated plastic can give off poisonous fumes. Keep the pipe moving to prevent burning it. When it becomes soft like a cooked noodle bend it around a wooden form and hold it in place until it cools. The sand will prevent the walls of the pipe from collapsing during bending. Use **dry** sand to prevent build up of steam pressure in the pipe. Remove the sand after bending. For small training yokes up to 5 or 6 inches, the plastic pipe alone may be strong enough. To increase the strength of the pipe, glue a wooden dowel in the straight sections of the bows. Tillers has used plastic bows at workshops in Africa with young calves being trained to pull small carts. We found them to be strong enough for this purpose. An ox driver in Wisconsin informed us he was using plastic bows with wooden inserts to pull small logs with his three-year-old team.

Electrical shops carry a variety of thin walled metal conduit, and they often have equipment to bend a variety of curves without heat. A wooden dowel should be glued in the straight bow section if any kind of a load is going to be pulled. Heavier walled metal pipe can also be bent into bows, but it must be heated red color first. A coal or gas forge, or acetylene torch can supply the heat. Do not use water pipe because it has a galvanized coating that will give off poisonous fumes when heated. Black pipe, which is used for gas lines, is not galvanized. Fill the pipe with **dry** sand, and bring the area to be bent up to a red heat. Have a metal form (brake drum, wheel rim, etc.) ready to bend the metal around. The metal will bend quickly where it is the hottest, so try to get an even heat. If the pipe is bending unevenly, stop and add more heat to the section that is not bending. I have had success using heavy walled pipe bows for plowing and hauling sleds loaded with bricks in Africa. Metal pipes could be a problem in cold climates. During winter months the oxen may not appreciate a cold piece of pipe wrapped around their necks.

I do not recommend plastic or metal pipe bows over wooden bows. These alternatives are offered for those who might have difficulty making or purchasing wooden bows. If you choose an alternative bow you will need to carefully experiment with the load limits of the plastic or metal tubing/pipe you select. Be aware that a bow which snaps under load, whether it is made of plastic, metal, or wood, has the potential of frightening and/or injuring your oxen.

Bow Pins and Spacers

Wooden pins can be made to hold the bows in position. The wooden pin shown below will require a rectangular slot to be chiseled in the bow. (Fig. 24) As the bow is pulled downward the pin is locked into position so that it cannot slide out.

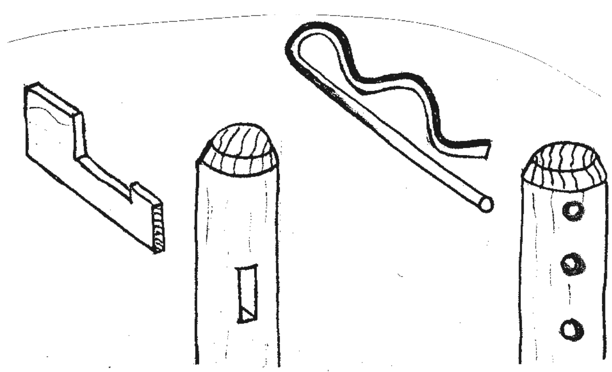

Figure 24: Wood or metal bow pins keep the bow in the yoke beam.

Metal pins are nice because several holes can be drilled in the top of the bow, giving lots of depth adjustment. The easiest way to get a metal pin is to buy one at a hardware store. Metal bow pins can also be hand forged. Small coil springs made of stock 3/16 to 1/4 inch in diameter can be used to make bow pins. Heat the spring in a forge, place the red hot spring over a pipe clamped in a vice, and pull on one end of the spring with a pliers. The spring will unwind into a straight wire. Use a hot chisel to cut off a piece 8 inches long. Flatten half the spring. The flat stock is bent into the curve and will be easier to flex than round stock. A bending fork in the anvil hardy can be used to form the pin into a shape that will clip around the side of the bow. (Fig. 25)

Figure 25: Bow pins are shaped on a bending fork set in the hardy hole of the anvil.

When the pin is finished it should be hardened and tempered to retain its spring qualities. To harden, heat to a red temperature and quench in a can of vegetable oil. Clean one side of the pin with a file or sandpaper so that you can see the tempering colors. Place the pin in your kitchen oven at 500 degrees and watch the temper colors run. It will be first straw, then purple, then blue. When the blue appears remove the pins from the oven. They should be hard enough to spring back to shape, yet soft enough not to be brittle. If you find the pins are breaking, heat them at a higher temperature in the tempering process.

Hardening and tempering can be tricky on small stock. At Tillers we often use mild steel stock to make bow pins, then quench the red hot finished pins in a hardening solution to give them some spring quality.

Quenching Solution To Harden Mild Steel

Ingredients

- 5 gallons water
- 5 lbs table salt
- 32 oz Dawn dishwashing liquid (blue)
- 8 oz Shaklee Basic “I” (wetting agent)

Quench at 1550 F (light cherry red)
Expect 43 to 45 Rockwell C
on 1018 mild steel

Spacers are made from blocks of wood and/or leather. They are placed under the bow pins and are used to give depth adjustment in the bow. Many teamsters like to at least put a leather spacer under the bow pins, as this keeps the bow pin from digging into the yoke beam.

Holes for the bow pins are usually drilled on the longer shaft of the bow, which is set in the hole closest to the center of the yoke. Normally only one shaft of the bow is pinned. When fitting a new pair of bows it is a good idea to put the yoke on the team of oxen, adjust the bows for depth, and mark the correct location for the bow pin. This will eliminate the need to drill many holes or use a lot of spacers.

Yoke Hardware: Staples and Rings

The hardware for a neck yoke consists of a staple, a round pole ring, and a grab hook or enclosed chain grab link. (Fig. 3 and Fig. 26) The sizes and lengths of stock for the yoke hardware are listed in table 2. All parts are made of mild steel. A form can be made to bend a staple, or the staple can be bent without a form following the steps in Fig. 27. The metal will need to be heated red hot to make the bends. When the staple is finished use a small piece of stock to form an “S” shaped washer that fits over the top of the staple.

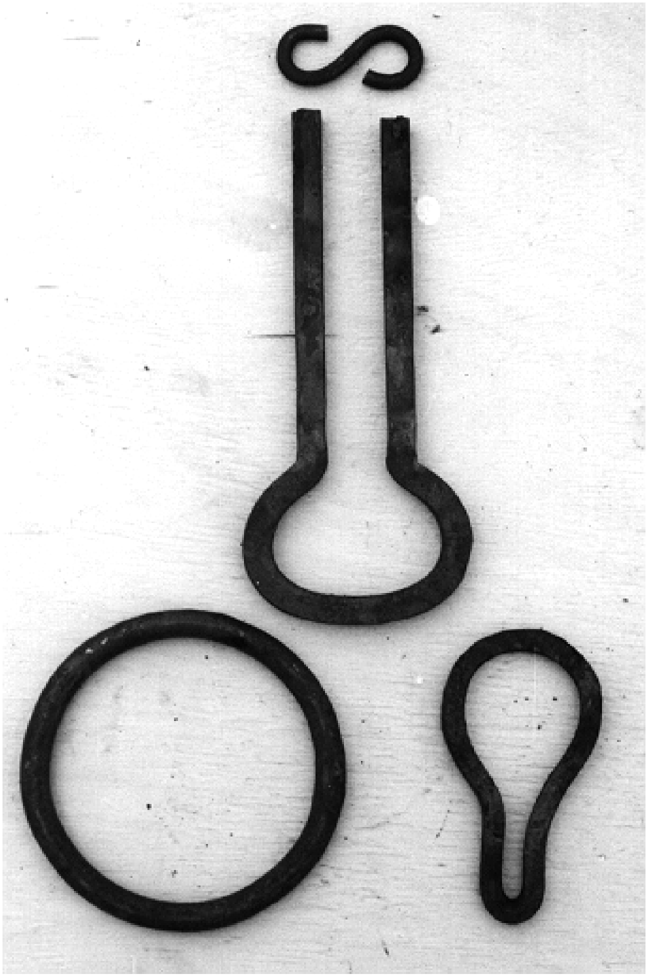

Figure 26: The hardware for a neck yoke: staple with "S" washer, pole ring (lower left), and pear shaped chain grab link (lower right).

The round pole ring can be formed on the horn of the anvil. Scarf the ends of the stock and forge weld the ring shut (Fig. 28), or leave the ends flat and use an arc welder to close the ring. Final shaping of the ring is done on a floor mandrel, or on the anvil horn after the weld is made. (Fig. 29)

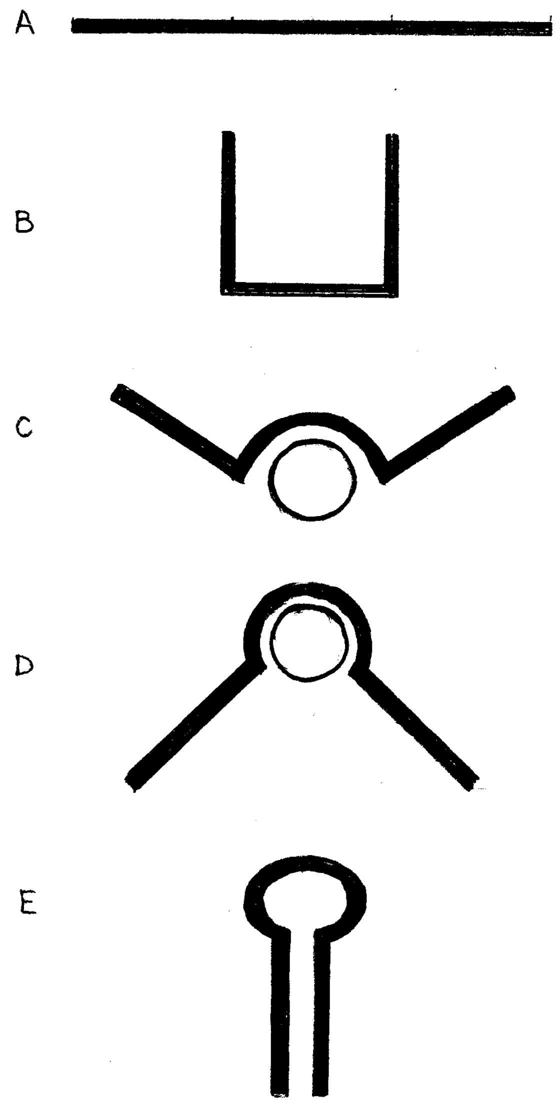

Figure 27: A staple can be formed in these steps: A-Cut bar to length, B-bend into sharp cornered U-shape over anvil corners, C & D-bend over anvil horn with pipe extensions over each end, E-adjust stems to parallel by clamping in a vise with a 1 inch spacer between.

Figure 28: The lap pattern for a scarf weld on the rings.

A pole ring with an inside diameter of 4 to 4.5 inches is large enough to hold most implement and cart tongues. I make rings on training yokes slightly smaller to keep them in proportion.

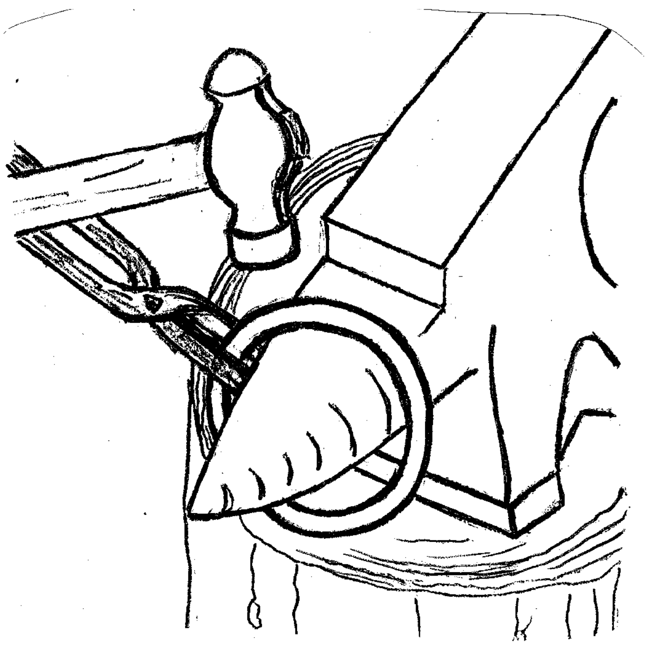

Figure 29: Finish shaping the pole ring on the horn of the anvil or on a mandrel.

The formula for calculating straight stock length for a ring is :

3.14 x (inside diameter of ring + stock thickness)

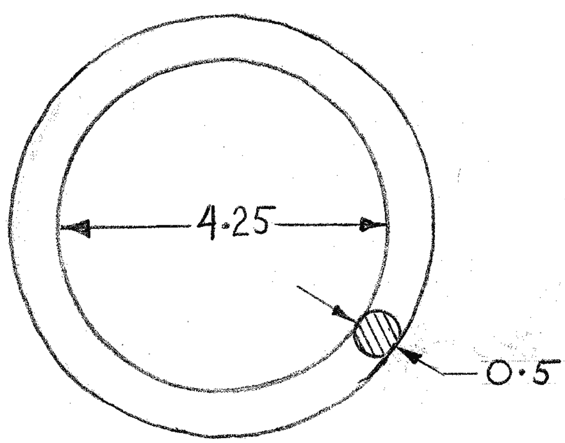

Figure 30: Calculate the length of stock from its diameter plus its thickness.

EXAMPLE

Calculate the length of straight 0.5-inch thick stock needed to make a ring with a 4.25-inch inside diameter.

3.14 (4.25 + 0.5) =

3.14 x 4.75 =

14.92 inches

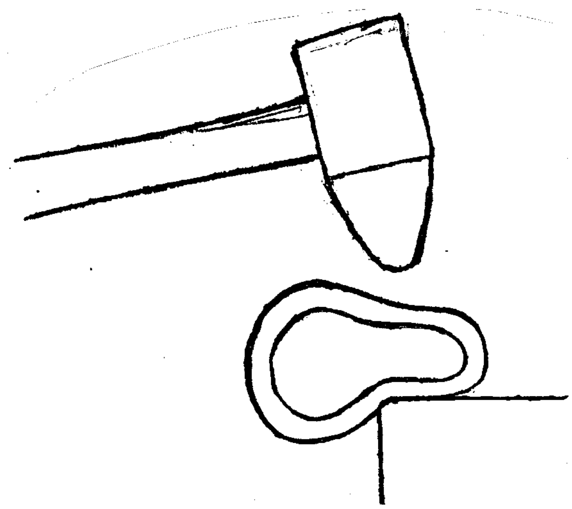

Figure 31: Form the pear shape of the grab ring on the edge of the anvil. Only heat the half of the ring that is being bent at the moment.

To make the chain grab link first form and weld a round ring. Then heat one side of the ring, hold it on the edge of the anvil, and crush it into a pear shape. (Fig. 31) The chain handy that will be held in this link should be at hand to test whether it fits the link too loosely or too tightly.

Mounting Hardware in the Yoke Beam

Holes for the staple should be marked and drilled in the yoke beam. I like to mark the holes at the top and the bottom of the yoke, and drill halfway from both sides. Drilling from both sides ensures that the ends of the staple will be in line on both top and bottom of the yoke. A hand brace and auger bit, or an electric drill can be used to bore the staple holes. As with the bow holes, it helps to have someone watching to see that the holes remain straight.

Figure 32: Holes for the staple are squared with a heated square bar of steel.

If the staple is made from square stock the round holes should be burned out square. Take a piece of square stock the same size as the staple, heat and taper it at one end. Then bring it to a bright heat and force it through the round hole. (Fig. 32) Remove the hot metal from the yoke beam immediately so that it does not burn the hole too large. Options to burning square holes are to chisel out the corners square, or use round stock for the staple and leave the holes round. Using a file or grinder to taper the top ends of the staple will help to prevent the staple from tearing out wood on the top of the yoke beam when it is driven into position. Place the rings on the staple, and use a hammer to drive the staple into the yoke beam.

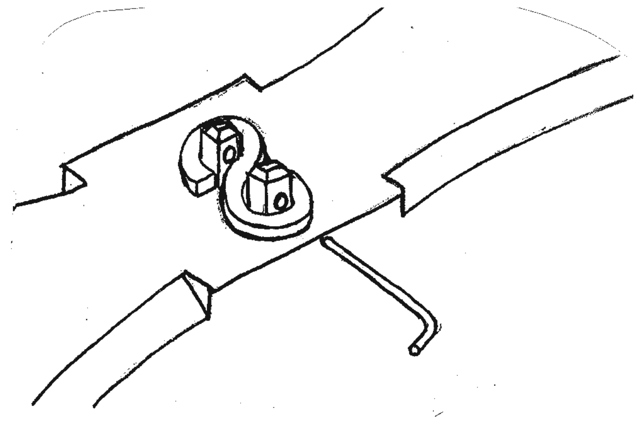

Figure 33: A pin is placed through the top of the staple and bent over the "S" washer to secure the staple.

The "**S**" washer is then placed on top of the staple, a hole is drilled above the washer, and a pin or heavy nail is secured in the hole to lock the staple in position. (Fig. 33)

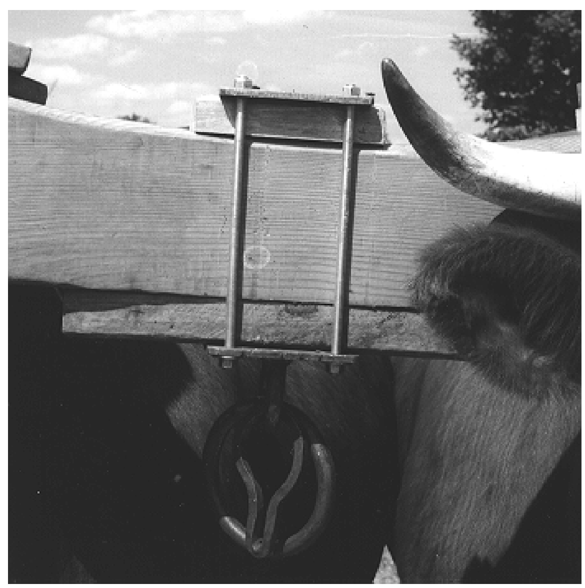

Figure 34: This adjustable staple can be slid to either side or lowered by moving the vertical spacers.

A variety of other staples can be made for yokes. Some staples can be adjusted to give a weaker animal an advantage, or the staple can be dropped/raised to change the hitch point of the yoke. (Fig. 34 & 35) Staples are sometimes secured in the yoke beam by means of threads and a nut. (Fig. 36)

Figure 35: The bottom plate of an adjustable staple can be fabricated in most metal shops.

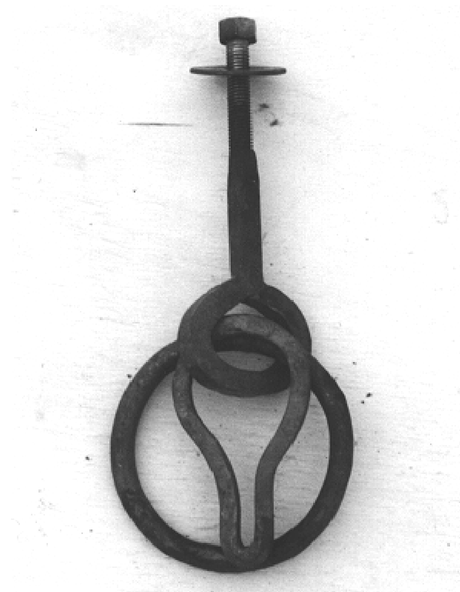

Figure 36: For small yokes a staple with a single threaded stem and a closed bulb works well.

If you are not a metal worker, stop in at your nearest hardware store and see what they have for sale. Most will carry a selection of eye-bolts, rings, and grab hooks that could be adapted for hardware on small or light duty yokes.

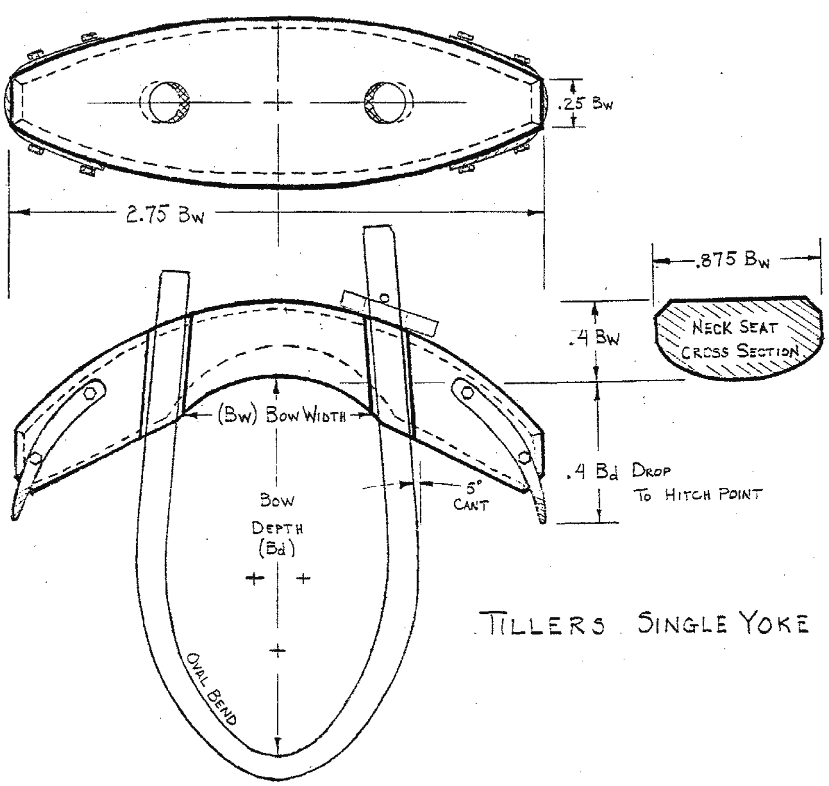

Figure 37: Tillers' Plan for making a single ox yoke.

Single Yokes

Most of the construction techniques given above can also be used to make a single yoke. The Tillers single yoke plan is again based on factors of the bow width. (Fig. 37)

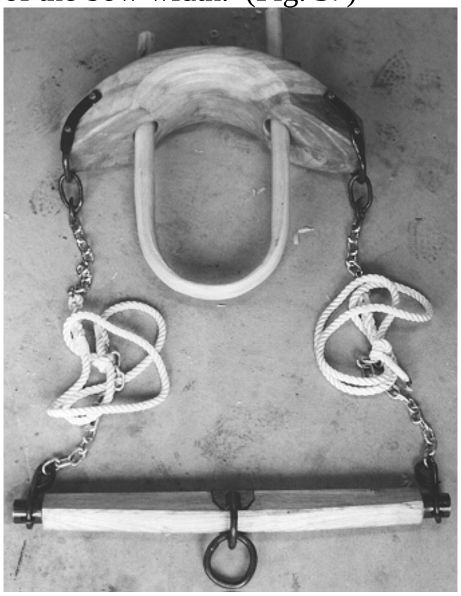

Figure 38: A single yoke laid out with rope traces to a singletree.

Single yokes differ from a team yoke in that they have two hitching points. Leather or nylon tugs or even light chains or ropes are attached to each end of the single yoke. These hook into a single tree behind the ox and the implement is hooked onto the center of the single tree. Hardware for the single yoke can consist of metal straps that wrap around the end of the yoke, (Fig. 38) or an eyebolt or "U" shaped pin secured in the yoke beam. (Fig. 39)

Figure 39: This single yoke has U-shaped irons for attaching the traces and straps running back to a brichen to stabilize the yoke.

Single yoke beams can be carved from a curved trunk or large curved branch of a tree. The grain following the curve of the yoke will give it more strength.

Books and Articles for Further Reading

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