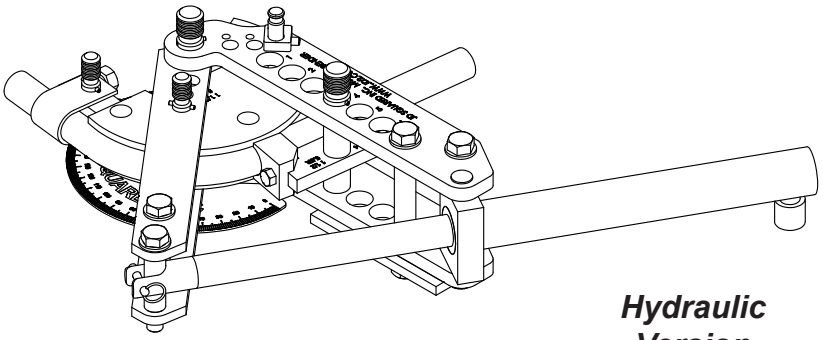
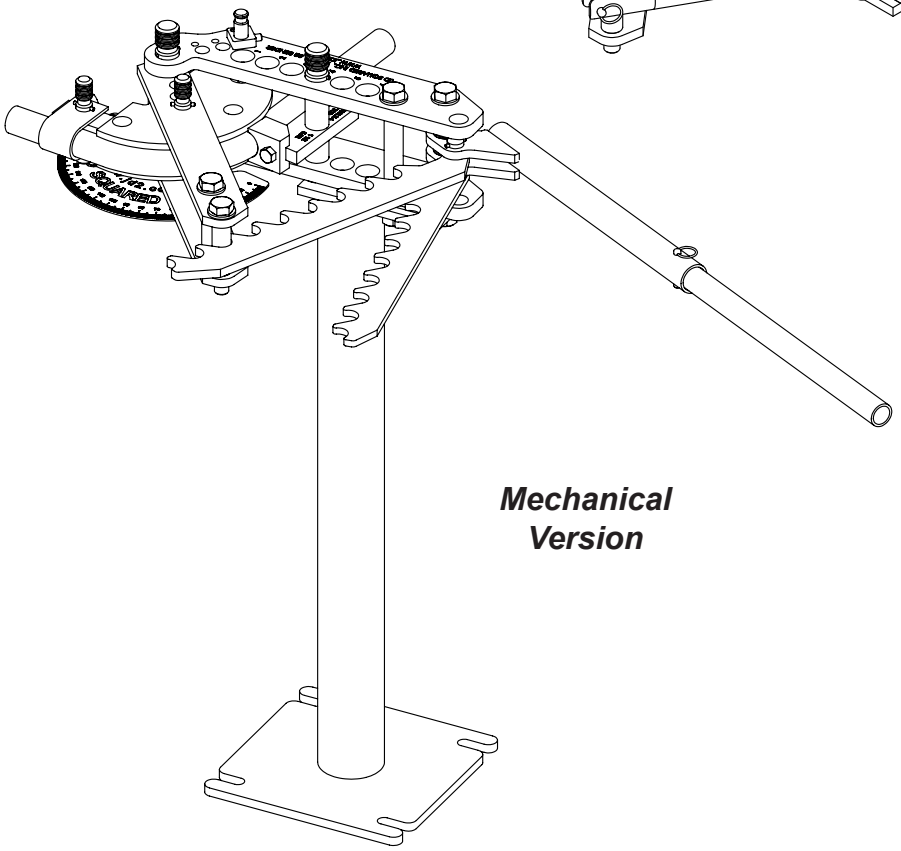
Model 32 Tube Bender

Assembly & Operating Instructions



Hydraulic Version



Mechanical Version

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http://www.jd2.com

ASSEMBLY

1) The bender may be mounted to anything rigid enough not to twist or move during the bending operation. Using the Base as a template, drill two 3/4" holes through your mounting surface. The front cover shows the bender mounted on the optional pedestal.
2) Assemble the bender's frame assembly as shown below.

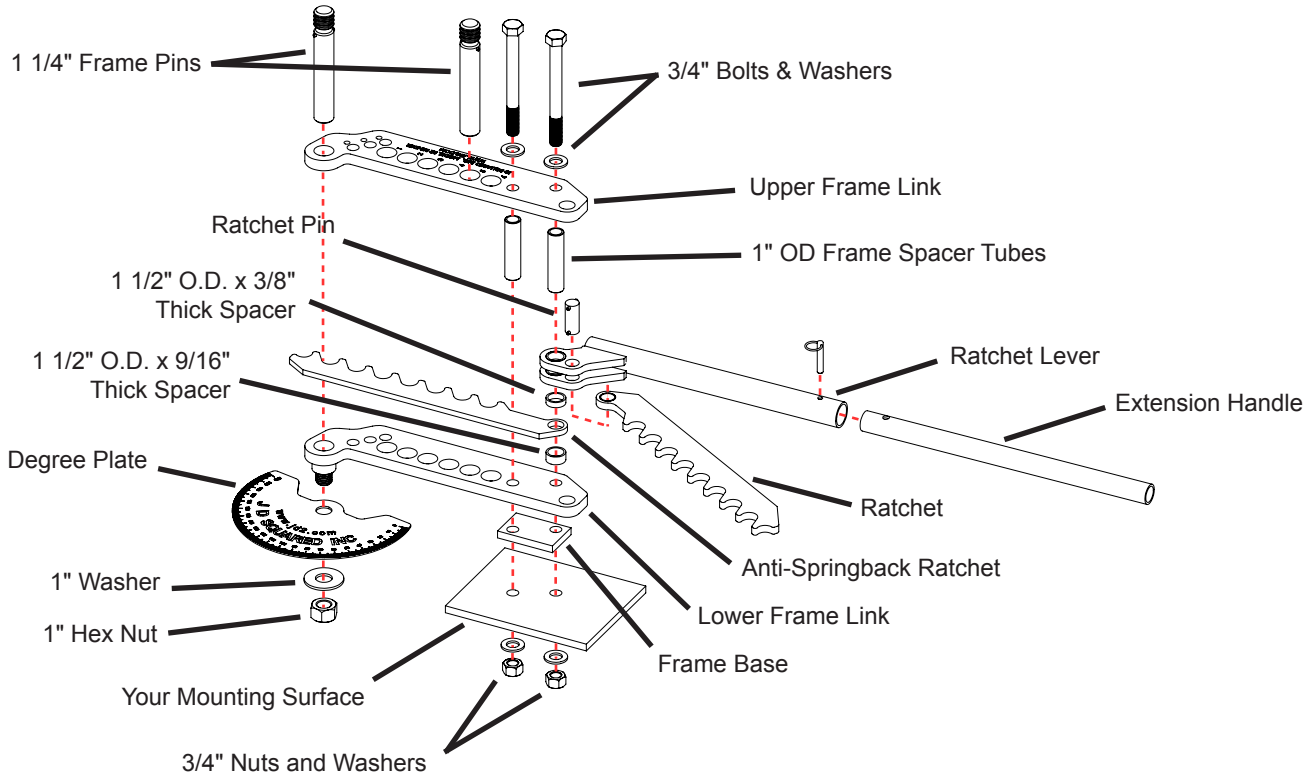


Figure 1 - Exploded view of the Frame Assembly with Degree Plate

A) Assemble the ratchet and ratchet lever as shown in figures 1 & 2 using the 7/8" ratchet pin and two 3/16" spring pins. For hydraulic adapter installation see page 3.
B) Notice the longer of the two 1 1/2" o.d. spacers goes under the anti-springback ratchet and the shorter one goes between the ratchet and anti-springback ratchet.
C) Assemble as shown above but only hand tighten the 3/4" bolts.
D) Insert the 1 1/4" Frame Pins in the holes shown above. Now, tighten the 3/4" nuts as tightly as possible, while insuring the two pins are perfectly vertical and slide easily through their respective holes.
E) Install Degree Plate as shown. Use only your hand to snug down the nut. This nut is never wrench tightened. This allows you to easily adjust the Degree Plate while bending.

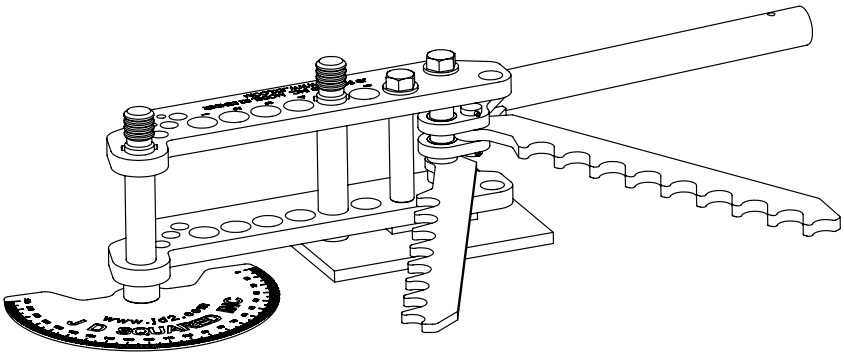


Figure 2 - Completed Frame Assembly with Degree Plate

3) Using the diagram to the right and hand tightening only, assemble the Drive Links as shown. The word 'TOP' must be face up on the upper link. This is very important because the three 7/8" drive holes are offset to the right. Insert the two pins into their respective holes to help alignment. Lay the assembly on its side to further help alignment and wrench tighten securely.

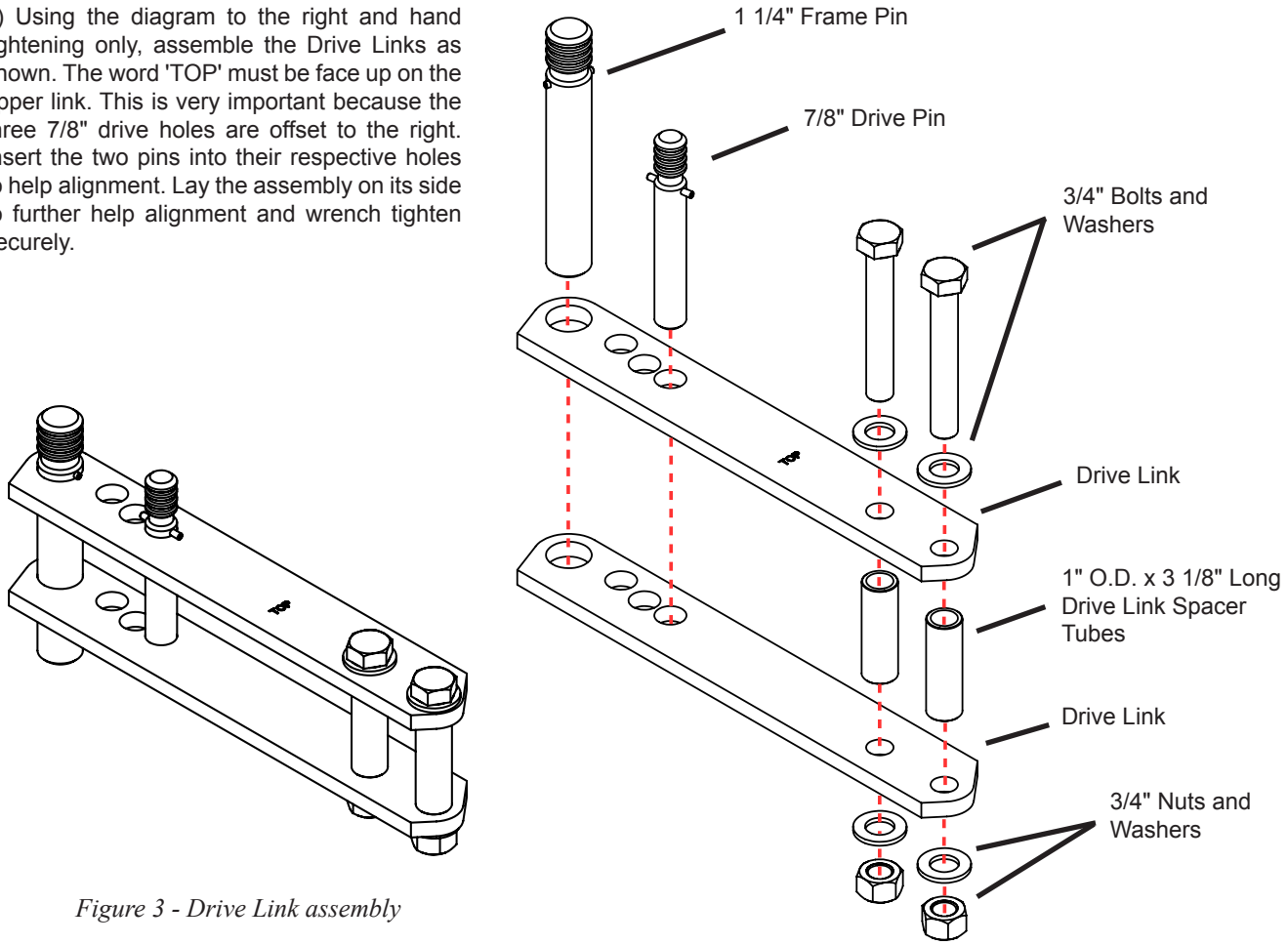


Figure 3 - Drive Link assembly

4) Remove all pins from the Drive Link assembly. With the word 'TOP' facing up, Install the Drive Link assembly into the Frame assembly using a 1 1/4" Frame Pin. See figure 4. The bender is now assembled and ready for the die set to be installed.

NOTE: A 19" extension handle is provided with the bender. Slide it into the ratchet lever and using the supplied 3/8" pull pin, secure in place. The combined handle will be approximately 36" long. This should allow the average user to bend 1 3/4" x .095" wall mild steel tubing using just one hand. If bending chromemoly, DOM or larger tubing and find you desire more leverage to reduce the bending effort required, simply obtain a length of 1" pipe (1.315" o.d.) and cut it to the desired length. You also need to drill a 7/16" hole near one end so the pull pin may be installed.

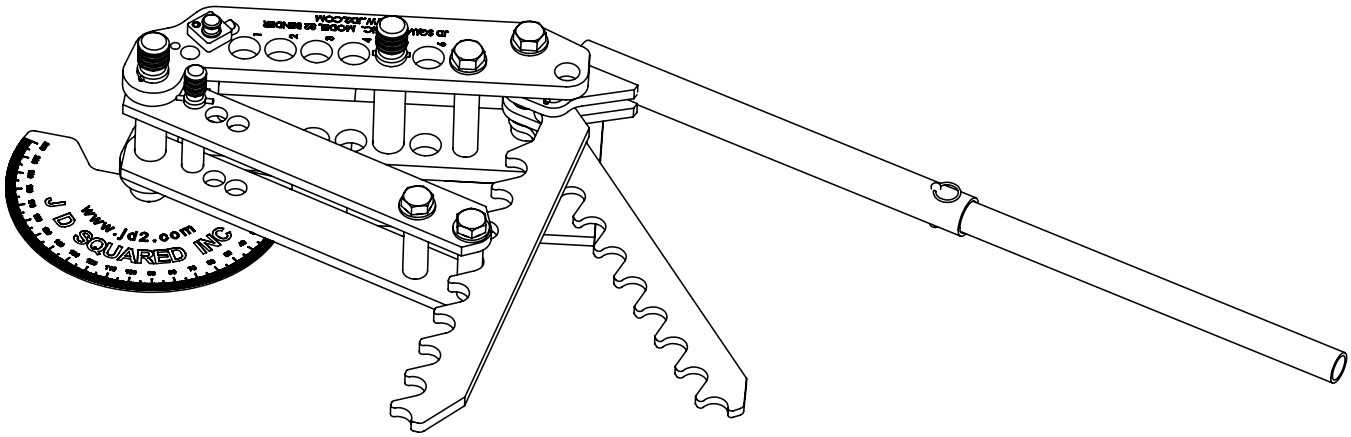


Figure 4 - Completed bender without die set installed
(Note: The die locking mechanism is also shown above, but at this stage of assembly it has not been installed)

Model 32 Bender Hydraulic Adapter Assembly

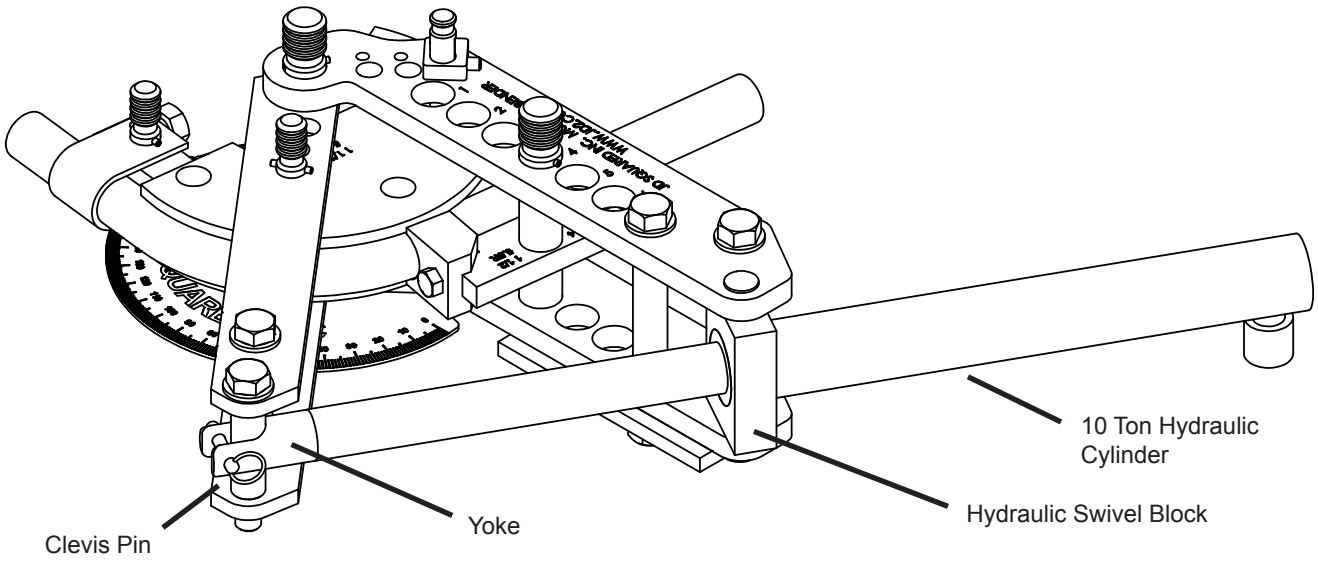


Figure 5 - Bender with hydraulics installed.

Adapter Components: Excluding the hydraulic cylinder:

Hydraulic Swivel Block
Yoke
Clevis Pin

Recommended Cylinder:

Power Team C1014C or Enerpac RC1014 or an equivalent cylinder. They are rated at 10 tons and have a 14" stroke. On the front of the cylinder is a 2 1/4" x 14 TPI thread.

Recommended Power Unit:

We offer several hydraulic pumps suitable for the Model 32 Bender. However, any power unit may be used that has an output of at least 1500-4000 PSI. The average bending pressure will generally be below 1300 PSI. Tested examples: 1 3/4" x .095" mild steel - 900 PSI, 1 5/8" x .083" 4130 chromemoly - 1400 PSI, 1 1/2" solid round bar stock - 3100 PSI. If the bender is operated at a pressure higher than 4000 PSI the drive links and drive link pin have been designed to fail first in order to protect the more expensive frame links and provide the operator with a warning of overload. For safe reliable operation never operate the bender at pressures above 4000 PSI.

Assembly:

Screw the hydraulic cylinder into the hydraulic swivel block as far as it will go or until its front surface is flush with the swivel block's front surface. The quick disconnect fitting on the rear of the cylinder should point down towards the ground to relieve stress on the hose. If it does not, unscrew the cylinder out of the swivel block until it does, but no further.

If the cylinder has a stud installed into the end of its ram, it must be removed. This will expose a threaded hole in the end of the ram. Screw the Cylinder Yoke into the cylinder's ram until it bottoms out. Rotate the swivel clockwise (to prevent it from unscrewing off the threaded rod) until it may be slid onto the outer drive link sleeve as shown above in figure 5. Install the Clevis Pin through the Yoke.

Hook up the pump and hose. Extend and retract the cylinder several times to purge air from the system.

Die Set Components

A Die Set refers to the components that are used in the bender to hold the tubing or pipe during the bending operation. This section does not describe the operation of the bender. This section's purpose is to simply familiarize you with the different components that make up a 'Die Set'. Knowing how the different die set parts interact with each other is essential in operating the bender correctly. The die set must match the size of the tubing or pipe being bent. For example, never bend 1 1/2" tubing in a 1 5/8" die set. This may damage the followbar's inserts.

First, let's explain the difference between ***tubing*** and ***pipe***. Tubing is specified by its outside diameter and a wall thickness. For example, 1 1/2" x .095" ***tubing*** has an outside diameter of 1 1/2" and a wall thickness of .095". On the other hand, ***pipe*** is specified loosely on its inside diameter. We say loosely because the pipe's size may not actually be its inside diameter. Confused yet? Just remember pipe is commonly used for the purpose of transporting fluids. Fluid flow is only concerned with the inside area of the pipe and the outside makes no difference what so ever. Pipe wall thickness is specified as a schedule number and is obtained from a pipe chart. Another example, 1 1/2" schedule 40 ***pipe*** has an outside diameter of 1.900" (larger than 1 7/8") and a wall thickness of .145" and an inside diameter of 1.610" (near 1 5/8"). So, when ordering die sets be careful to specify whether it's a tube or pipe size die set.

ROUND GROOVE DIES:

A Round groove die set consists of three main elements:

1) Forming Die

This is the part that the tube or pipe actually bends around. It has a circular groove machined around its circumference. Please note that this groove is machined with a specially designed profile to help in reducing flattening of the bend's outside. If you lay a section of tubing into the forming die you will notice that it will NOT completely seat into the die's groove. This is normal for tube size dies and becomes very important as the tube's wall thickness gets thinner. However, forming dies that are machined for 'Pipe' instead of tubing are generally not manufactured with this profile and the pipe may completely seat in the groove. Pipe is much more forgiving when it comes to bending because of its thicker wall. Stamped into the top is the outside diameter of the tube or pipe and the centerline radius (CLR) of the forming die. Above is pictured a 3/4" die with a 2 1/4" CLR and a 1 1/2" die with a 4 1/2" CLR.

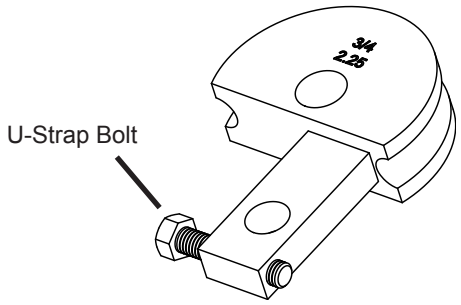


Figure 6 - Forming Die without drive holes

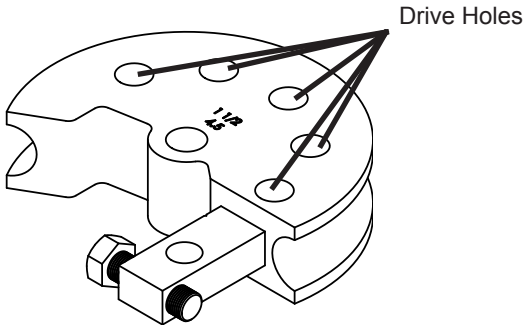


Figure 7 - Forming Die with drive holes

Drive holes are drilled into most dies with a radius of 3" or larger. When the 7/8" drive pin is inserted into the drive links, it will pass through these holes. This is how the drive links rotate the forming die. The 1" drive holes are drilled oversize to permit easy insertion of the 7/8" drive pin.

Die sets with a radius smaller than 3" will generally not have drive holes because there is no room to drill them. As explained in the following section on how to operate the bender, the diameter of the tubing or pipe is so small the bender can be operated without the use of the ratchet mechanism.

2) U-Strap

U-straps are sized to the OD of the pipe or tubing being bent. The size is stamped onto them.

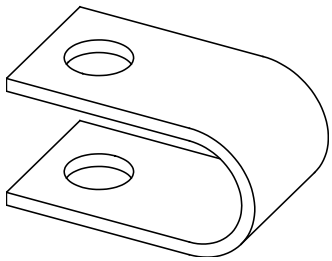


Figure 8 - U-Strap for round groove dies

3) Followbar (Also referred to as the Pressure Die)

The Followbar is the component that presses the tubing into the forming die to create the bend. Shown in the illustration below, it consists of three main parts: a backing block and two inserts. This multipart design allows the inserts, if damaged or worn out, to be inexpensively replaced without having to purchase a whole followbar assembly. The Inserts are permanent mold cast from a special bearing grade anti-galling material to protect the tubing from scratching during the bending process and then CNC machined to size. They are silverish in color but are NOT aluminum.

Notice that one insert is slightly angled. This angle is calculated and machined into the backing block to 1/1000 of a degree from theoretically perfect for the tube size and bend radius. This angle helps to support the tube or pipe after the point of bend, greatly reducing flattening. When bending, the angled insert will always be closer to the forming die, and the U-strap for that matter, than the straight insert.

A 5/16" diameter roll pin is installed to hold the followbar in position while loading. When the followbar is in the bender, the insert grooves must ride slightly lower than the forming die's groove. This allows the followbar to RISE under pressure. If the pin extended too far, the followbar would bind under pressure.

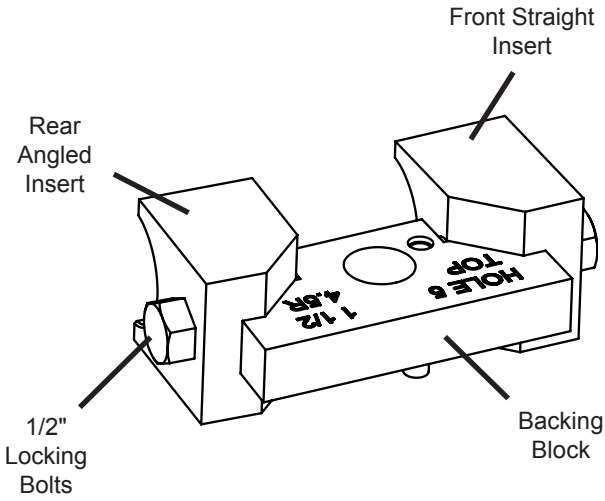


Figure 9 - 1 1/2" OD Followbar Assembly

COMPLETE ROUND GROOVE DIE SET

Below is pictured all of the components which make up a complete die set for round tubing or pipe. You can see two red lines drawn at 90 degrees apart. These lines are marked as 1 and 2. Line 1 runs from the center of the forming die's center hole to approximately the middle of the angled rear insert. Line 2 runs from that point parallel to the tubing. This illustrates the basic principle of how the components relate to each other. It is vital that when bending the rear insert is positioned as shown. For example, suppose the followbar in engraved with hole 6 as shown, but you install it in hole 7. The rear insert will be shifted to the right of line 1 and the angle machined into it will have no effect during bending. This will generally cause flattening of the tubing's outer side and may also cause wrinkling. If you experience this problem and you have the followbar installed in the correct hole, the rear insert's bending position can be easily checked. Simply place a short piece of tubing into the bender as if your were actually going to bent it. Apply enough bending force to remove any play but not actually bend the tubing. Now hold a 90 degree carpenter's square above the bender so that its outside edges are positioned similar to the red lines shown. The center of the angled rear insert should be roughly at the corner of the square. I say roughly because some dies are designed to shift the insert slightly to the left or right of center to improve bend quality. However, this will generally be less than 1/4". If as in the example above, you placed the followbar in the wrong hole, the insert will be very noticably off center and almost always to the right of red line 1.

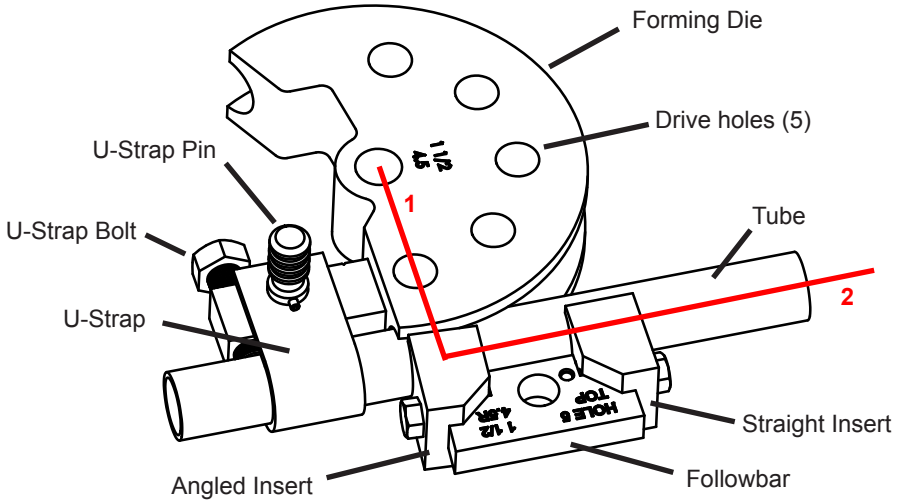


Figure 10 - Die set components

SQUARE AND RECTANGULAR GROOVE DIES:

Square groove dies operate similar to the round groove dies explained earlier with these exceptions:

1) The bottom of the groove has a raised crown machined into it. This starts the depression in the bottom side of the tubing during bending to prevent the tube from kinking and helps keep the sides reasonably straight. Note that square tubing will always sink in on the outside and inside of the bend.
2) The U-strap clamp uses a bolt to tightly secure the tubing to the die block. This bolt presses against a H shaped steel plate to prevent the bolt from marring the tubing. To the right is an illustration of the tubing installed in the forming die.
3) The followbar does not utilize inserts. It is machined from one solid piece.
4) You must lubricate both the outside of the tubing and the COMPLETE groove in the forming die before bending. Square tubing tends to wedge itself into the forming die while bending and generally requires a large rubber mallet to tap it out when finished. The bigger the tubing, the worse the problem. Without lubricant it can be very difficult to remove the tubing from the die. This problem is not specific to the Model 32 Bender, but to ALL benders utilizing a one piece die.

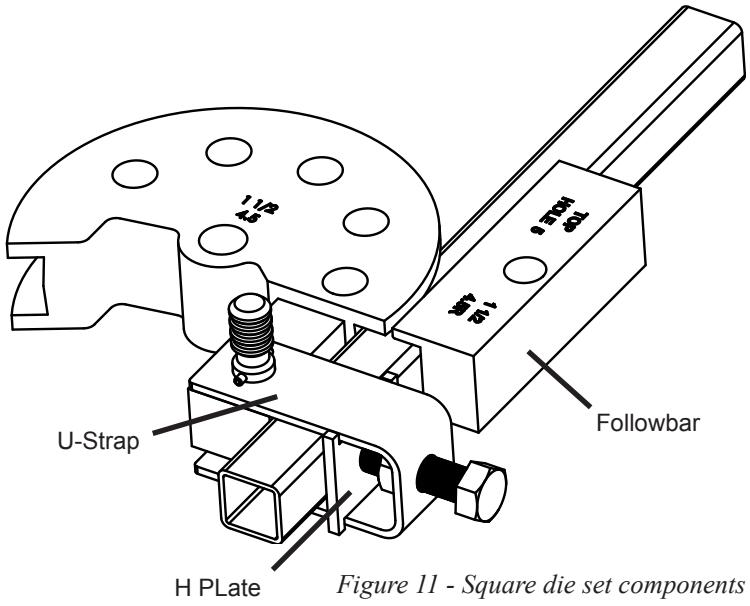


Figure 11 - Square die set components

DEGREE POINTER INSTALLATION

Current production forming dies are made to accept a degree pointer. This is supplied as a straight piece of 3/32" copper coated steel rod. The illustration below shows the pointer installed on the forming die. You will need pliers and a wire cutter to fit the pointer. First install the die set into the bender, preferably with a length of tubing installed also. On the backside of the forming die's die block, you will see a thin groove with a washer and bolt installed next to it. Using the illustration below as a guide, bend the wire pointer to fit, making sure it clears the U-strap and drive links. Allow approximately 1/16" clearance above the degree markings. Notice we've placed a small bend in the pointer's lower end so that it aligns with the degree markings. This makes it easier to read when bending. When you are happy with the fit, tighten the pointer lock bolt to secure the pointer onto the forming die. The pointer should be left on the die even after the die is removed from the bender. When storing the die set be careful not to bend up the pointer. However, this is just common 3/32" copper coated TIG welding rod, so if you do manage to *mangle, damage, decimate, disfigure, batter, hurt, mutilate, warp, destroy, lose, smash, wreck, maim, ravage, sabotage, trash, demolish, vandalize, incapacitate, ruin, obliterate, cripple, (... deep breath ...) spoil, break, annihilate, brutalize, make inoperable, or otherwise extinguish its very existence,* just visit your local welding supply to get a new one.

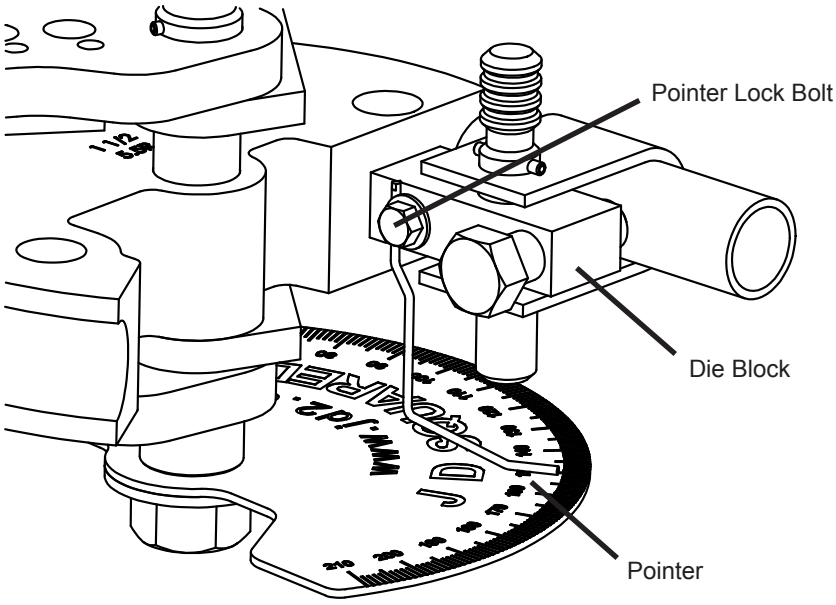


Figure 12 - Pointer installed on the backside of the Die Block

Die Set Installation and Bending Procedure

There are two types of forming dies provided for the Model 32 Bender. Those with drive holes and those without. The drive holes are the five 1" holes drilled in a circular pattern around the forming die's center hole. A 7/8" diameter pin inserts through the drive links and through the forming die's drive holes when in operation. The drive holes are drilled 1/8" oversize to provide easier pin installation. To prepare for bending, follow the steps below depending on the type of die set.

WITH DRIVE HOLES:

Place the forming die into the bender using the 1 1/4" frame pin. If bending square tubing, thoroughly lubricate the forming die's groove. However, if bending round tubing or pipe, NEVER lubricate the forming die's groove. If you do, the tube will tend to slip backwards in the die while bending, which in turn causes the tubing to kink or wrinkle. Place the tube into the forming Die. Install the U-Strap with the shorter 7/8" U-strap pin. If necessary, tighten the U-strap bolt to prevent the tube from slipping through the die will bending. It's a good idea to cut a slice out of a bigger piece of tubing place it between the bolt and tubing to prevent the bolt from dimpling the tubing. If bending thin wall tubing (.065" or thinner) you must always use the U-strap bolt.

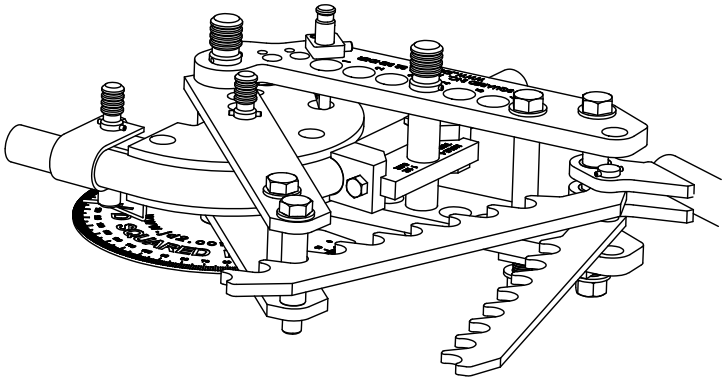


Figure 13 - Bending with drive holes and ratchet

Next, using 1 1/4" diameter pin, place the Followbar into the bender. See page 5 for the correct way to install the Followbar. Lightly spray some lubricant on the outside of the tubing so that the tubing will slide through the Followbar easily. Any spray lubricant works well. If you are bending tubing with a wall thickness of .065" or thinner you may want to skip the lube entirely. This will help the followbar stick to the tubing during ratchet repositioning and generally helps prevent wrinkling. **Make sure all pins are completely seated in their holes. Failure to do this may cause damage to the bender links or worse yet the operator may slip and fall.**

Rotate the Ratchet Lever fully counter-clockwise. Engage the Ratchet onto the outer drive link spacer tube. Lightly pull on the handle to preload the tubing. Do not pull hard enough to actually bend the tubing. Using a free hand, loosen the degree plate nut. Rotate the degree plate until the die's pointer is at 0 degrees and then hand tighten the nut to secure it into position. Now you're ready to bend. Pull on the handle in a clockwise direction until the Anti-Springback Ratchet just barely can engage the drive link's outer sleeve, but no further. The idea is to limit the spring back of the tubing to a minimum. Return the Ratchet Lever to the starting position. Reengage the ratchet and pull again. As per the previous section regarding the Die Locking Pin, continue bending until the Die Lock Pin drops into the die's drive hole. Disengage both ratchets. Remove the 7/8" Drive Pin and rotate the Drive Links counter-clockwise until the Drive Pin may be reinstalled through another hole in the Bending Die. Now repeat the above bending sequence until the desired degree of bend is obtained. Lift and slightly rotate the die locking pin so that its roll pin now rest on top of the bender's frame. This will keep it from interfering while you remove the bent tube. If after bending, the tubing doesn't release freely from the die, remove the extension handle from the ratchet lever, insert it diagonally through the drive link's spacer tubes and pull counter-clockwise. The followbar will release its grip and the tubing may be removed.

WITHOUT DRIVE HOLES:

These dies typically have a center line radius of less than 3". Because the radius of the die is so small, drive holes cannot be drilled into the die. This does not present a problem as the tube sizes for these dies is of relatively small diameter and is easily bent. The ratchet is not used.

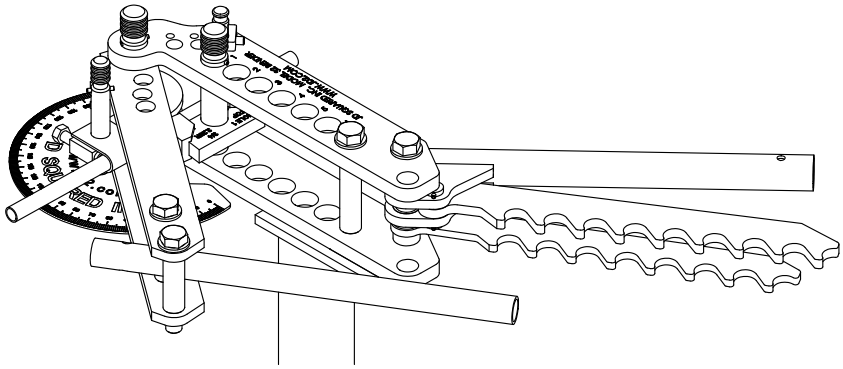
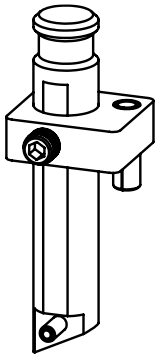


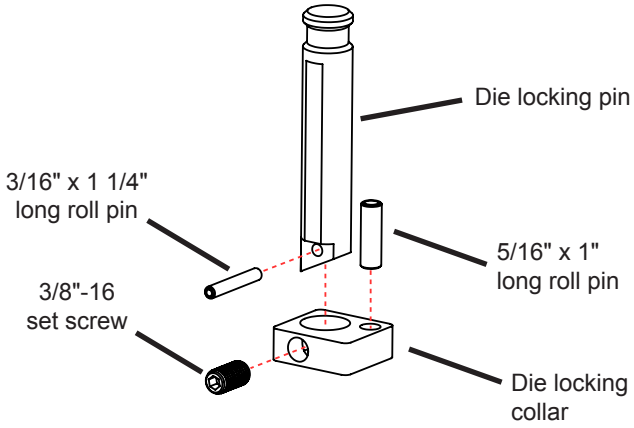
Figure 14 - Handle installed and ready to bend without drive holes

Die installation procedure:

Swing the ratchet assembly out of the way as shown below. Place the forming die into the bender. Place the tubing to be bent in the bender and using the 6 1/4" long drive pin (not the shorter U-Strap pin that is usually used) install the U-strap. If desired, tighten the U-strap bolt to secure the tubing to the die. This is not mandatory and may be omitted if the tubing shows no signs of slipping through the die while bending. Now install the followbar being sure the word 'TOP' is facing up. Rotate the drive links until their front edge pushes directly on the U-strap pin as shown in figure 6. Place the handle diagonally through the drive links' two 3/4" spacer tubes. Lightly pull on the handle to preload the tubing. Do not pull hard enough to actually bend the tubing. Using a free hand, loosen the degree plate nut. Rotate the degree plate until the die's pointer is at 0 degrees and then hand tighten the nut to secure it into position. Now, simply pull the handle and observe the pointer until the desired degree is reached.

Die Locking Mechanism - Installation and Operation





The purpose of the die locking pin, as it's name suggest, is to lock the forming die in a set position to prevent the tubing from springing back. This is critical for bending thin wall tubing to help prevent wrinkling and also very strong, heavy wall tubing to limit spring back.

ASSEMBLY:

Press the 3/16" x 1 1/4" long roll pin into the locking pin as shown so that both sides extend equally. Install the 5/16" roll pin into the collar flush with the top as shown. From the bottom of the upper frame link, slide the locking pin into the 3/4" hole that matches the drive holes in the bending die. Pull the pin upwards until it's roll pin contacts the bottom of the upper frame link. Place the collar on the locking pin and align the 5/16" roll pin with the corresponding hole in the frame. With the collar's lower surface on the frame link's upper surface, tighten the set screw.

INSTALLATION:

As assembled above, the lock pin is in a position where the forming die may be loaded into the bender. Place the forming die in the bender. Loosen the set screw and drop the locking pin into one of the forming die's drive holes. The collar should still be on the frame link upper surface. Tighten the set screw. The result should resemble figure 16. This is the locked position of the pin.

Lift the pin up and rotate it slightly so that the 5/16" roll pin now rest on top of the frame link as shown in figure 17. In this position the forming die may be freely rotated.

OPERATION:

Install the tubing or pipe as described previously. Rotate the collar until the 5/16" roll pin drops into it's matching frame hole. The collar will be approviamately 1/4" - 3/8" above the frame link but the 5/16" roll pin should still be in it's hole. Note that the purpose of this pin is to keep the ramp aligned with the forming die's drive holes circular path. If it's not set correctly and the pin rotates on it's own, the bender may be damaged.

Start bending and you will see that the pin is sliding along the upper surface of the forming die as shown in figure 15. Keep going until you see the lock pin drop into the drive hole as shown in figure 16. Immediately stop bending. The die is now locked. You can now reset the drive links to the next drive hole without the tubing coming loose in the bender. Once you have done this, continue bending. The lock pin will automatically rise out of the drive hole.

Repeat the above process until you have reached the desired degree of bend. When finished bending, raise the lock pin as shown in figure 17 and remove your tubing.

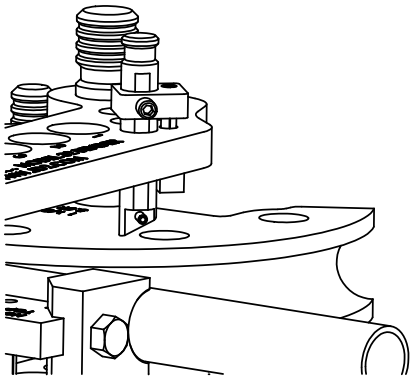


Figure 15 - Sliding along die's upper surface

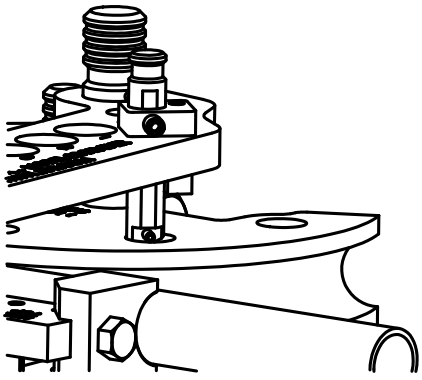


Figure 16 - Locked in position

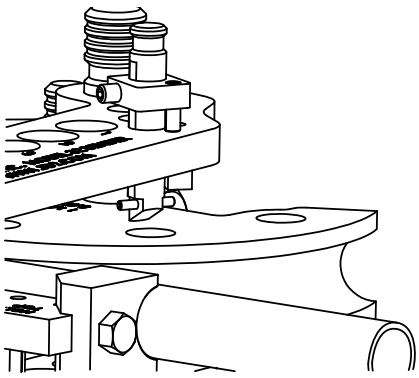


Figure 17 - Raised position

Bending Method #1 - Using Template Bends

The Easy Way To Position Bends

Learning the operation of a bender is fairly easy. The real challenge is accurately placing the tubing into the bender so that the bend comes out in the right position. This short tutorial explains the simple process of template bending.

Make a sample bend called the *Template* as shown in Figure 15. A permanent mark scribed on the template allows you to measure and visualize where the bend should be placed in the tubing. Once bent the tubing will spring out to a larger radius than the forming die's size indicates. The larger the O.D. or the stronger the tubing, the greater the springback. For instance, chromemoly tubing will springback roughly twice as far as the exact same size and wall thickness of welded seam mild steel tubing. By using a template bend with the same kind of tubing you are going to bend, you do not have to worry about this springback because the template has already sprung out to its finished size.

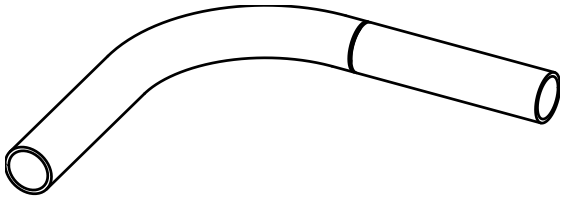


Figure 15 - Sample Template Bend

You may ask if buying bending software is a good idea. I believe bending software can only justified for two reasons: Creating part drawings if the software supports that function and for setting up a fully automatic CNC bender for the initial test of a part with multiple bends. Even using the software the bend locations usually need to be hand tweaked for accuracy before going into production. Most professional fabricators use a method similar to what is described here. It is extremely easy, accurate and fast. However, what if you need to bend 500 pieces. How would you use this process? Don't worry, it's a simple technique that I will explain later but first let's just complete a single piece job. To do this I'm going to go through the whole process that I use to make a four bend rollbar for a racecar as shown in Figure 16. This is a great example because it's a common request, there are no simple 90 degree bends, and it is generally a one-off piece. So hold on to your lug nuts, here we go.

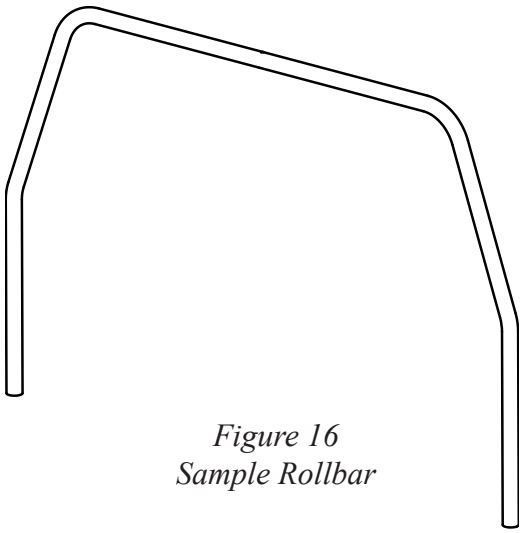


Figure 16
Sample Rollbar

Let's Make A Bend Template...

First, you need to make a template. For our example, we are going to use 1 1/2" o.d. x .120" wall welded seam mild steel tubing. As shown in Figure 15, the template is a piece of tubing bent to 90 degrees with approximately 6" of straight tubing on each side of the bend. Cut a piece of tubing roughly 30" long. Next, scribe an accurate line all the way around this tubing 6" from the end. An accurate and easy way to do this is to use an inexpensive pipe cutter. Your local home supply store should carry them in the plumbing department. A small lathe with a sharp cutter also does a good job. Scribe the line deep enough, roughly .015", so that when you paint the template, the line is still clearly visible. Hand scribing this line is difficult and not recommended. The tube should now resemble Figure 17.

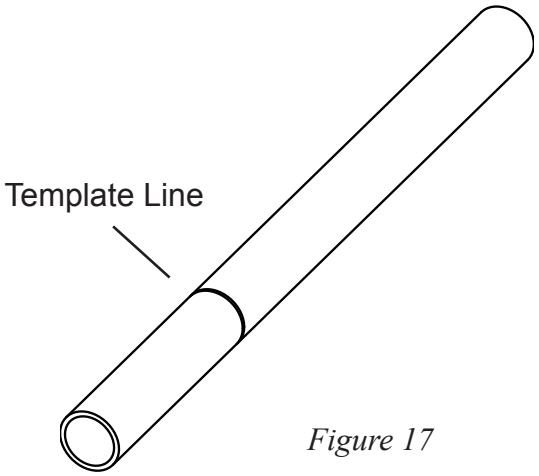


Figure 17

Load this tube into your bender as shown in Figure 18. Note that only the die set and tubing are visible in the figure. The actual bender and the die set's u-strap are not shown so that you can see what we're trying to achieve. Place the scribed line at the flat edge of the forming die. Never use the followbar as a reference. If the forming die has a lock bolt on it, use it to securely tighten the tubing in place. It's very important that this mark stays in line with the die's flat edge during the bending process or template will not give you accurate results later.

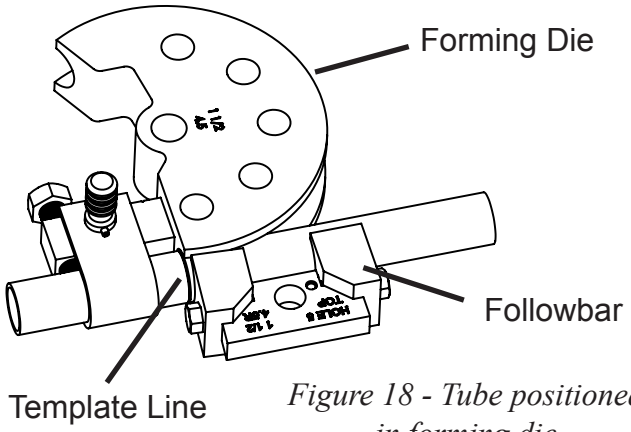


Figure 18 - Tube positioned in forming die

Bend the tube to a finished bend of exactly 90 degrees. On this example, I had to bend to 94 degrees to achieve a true 90 degree bend after the tubing relaxed. Cut the straight length of tubing that is not scribed to 6" long so that it matches the scribed side. This is not really necessary but it does look nice. Debur both ends and then paint the template an easily visible color. Why does it need paint? It doesn't. But after losing this thing a few times you'll get the idea. The template is finished.

If you work with different types of tubing that are of the same size but differ in the amount of springback they produce, possibly because of a different material or wall thickness, you may need to make a separate template for each one. You can decide later if this necessary depending on the accuracy that you require.

Figure 19 shows a finished template bend still in the die. Note the position of the scribed line on the tube.

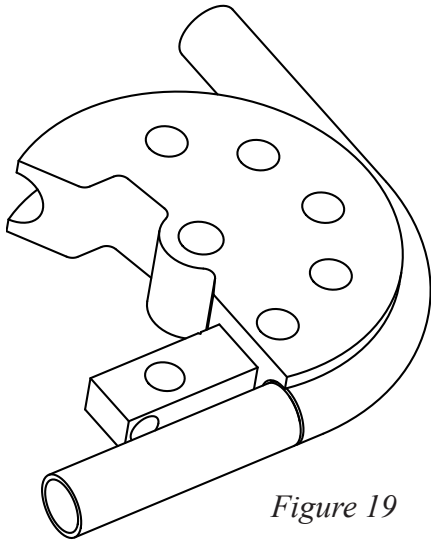


Figure 19

Time To Start Bending...

As shown in Figure 20, the rollbar will be 40" tall from the floor to its UPPER side. It will be 62" wide outside to outside. The top two bends are 70^{O} each and the two lower bends are 20^{O} each. I recommend that you purchase an adjustable carpenter's protractor to help determine the degree of bend for your specific job. They are made of clear plastic and have legs approximately 12" long.

To determine the total length of tubing needed, you could sit down and calculate it. This is described in the next section "Bending Method #2" which presents a more mathematical method to bend tubing. However, for this application, I think it's a waste of time. Time usually cost more than tubing, so here's the fast way: Take the total width of the rollbar (62") and add it to twice the height (40") which gives us a length of 142" (62" + 40" + 40"). This is slightly too long, maybe a foot are so, but there's a popular rule in fabricating: It is easier to remove material then to add it. Through experience you will learn how much extra tubing you must leave to complete the part.

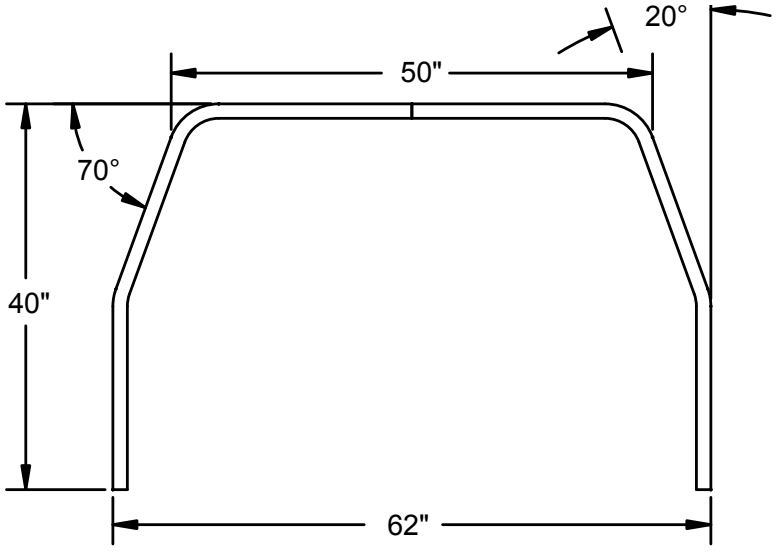


Figure 20

An important rule of bending is to, if possible, always make the bends closest to the center first and work your way out. This allows you to make measurement corrections between bends. Based on this rule, place a mark at the center of the rollbar tube. This is shown Figure 21.

BEND 1:

The first bend will be the upper right side bend. Referring to Figure 20, the upper dimension of the rollbar is 50". From the center of the rollbar to the outside of the bend is 25" (50" divided by 2). Lay the tubing to be bent on the floor and hold the template with the scribed side parallel to the rollbar tubing and directly above it, as shown in Figure 21 . The scribed side of the template will always face towards the center of the tubing being bent. Using a tape measure, slide the template left or right until it is 25" from its outside edge, shown by the right arrow in Figure 21, to the rollbar's center mark. Using a marker, draw a small line on the rollbar directly below the scribed line. Take note of what side of this mark the bend needs to be and draw an 'X' there so that when you load the tube into the bender you'll be bending on the correct side. Since the desired bend is only 70° and the template is 90°, you will have to use your best judgement of when the template is 25" out. This gets easier with experience. Now, load the tube into the bender and make the first bend. Don't forget to over bend a little to account for tube springback. For this material 3 to 4 degrees should be sufficient. Since all J D Squared benders are equipped with degree of bend indicators this is easily accomplished. Once you know the correct over bend required, you may want to record it for future reference.

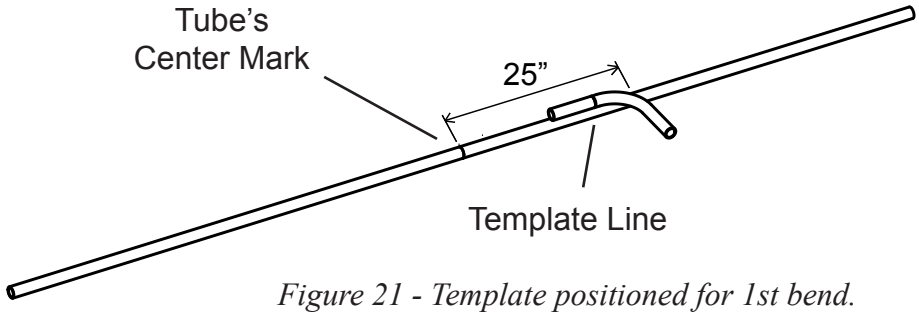


Figure 21 - Template positioned for 1st bend.

BEND 2:

Place the template above the rollbar tube with the template line facing bend 1 as shown in figure 22. Using a tape measure, position it for the desired 50" outside to outside of the two top rollbar bends. DO NOT use the tube's center mark as a reference and place the template 25" left of center. The reason for this is that if the first bend was not made at the exact right spot to achieve 25" from center you can correct for the error in the second bend's position. Once again, since the bend will be 70° and the template is 90° you must use your judgement as to where to position the template. Place a mark on the rollbar tube exactly underneath the template line. Load the tube in the bender so that the bend will be made on the CORRECT side of the tube and make the 70° bend.

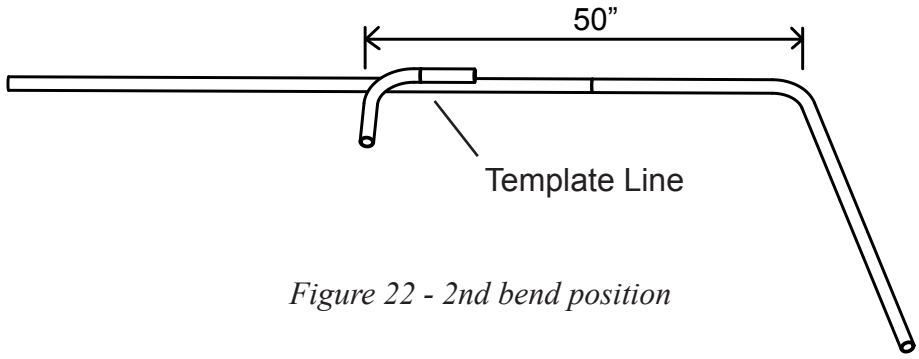


Figure 22 - 2nd bend position

Erase the center mark on the rollbar tube. Using the tape measure, place a new center mark exactly midway between the outside of the two bends. Why? Let's say your measurement shows the two top bends are really 50 1/4" wide instead of the desired 50". In that case, your old center mark could be off by as much as a 1/4". The NEW center mark corrects this error. That's the cool part about template bending. Your errors can generally be fixed with the next bend. Also note that if you had not started your bending from the center of the rollbar you would not have been able to make the correction. Every bend adds a little more error and you end up with a rollbar that does not fit.

BEND 3:

At this step you may want to use a large 90° square to help position the template. Position the template above the rollbar tube with the template line facing up towards the top of the rollbar as shown in figure 23. Slide the template up or down the rollbar tube until its outside is 31" from the rollbar's center. Mark your tube and make the bend.

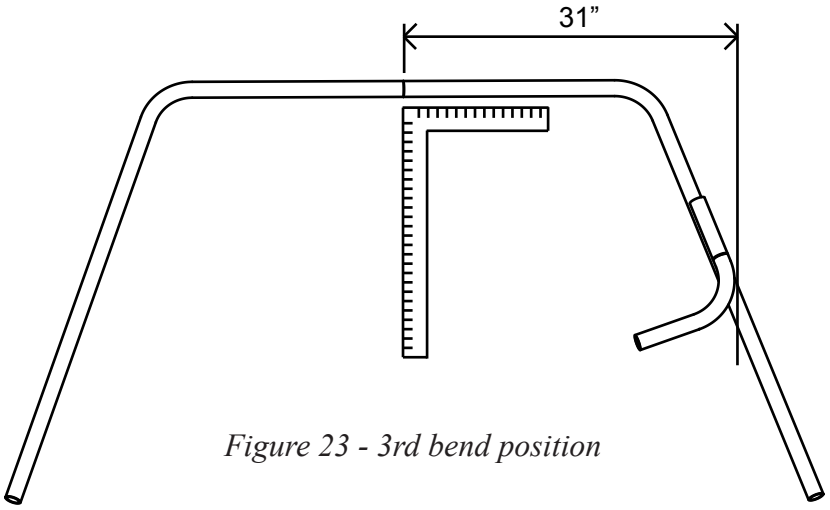


Figure 23 - 3rd bend position

BEND 4:

Position the template with the template line facing up towards the top of the rollbar as shown in figure 24. Slide the template up or down the rollbar tube until its outside is 62" from the outside of the 3rd bend. Also, verify the bend is the same distance down the tube from the top of the rollbar. If all is correct mark the tube and make the bend.

Lastly, cut the ends of the tube to make the rollbar 40" tall and your done.

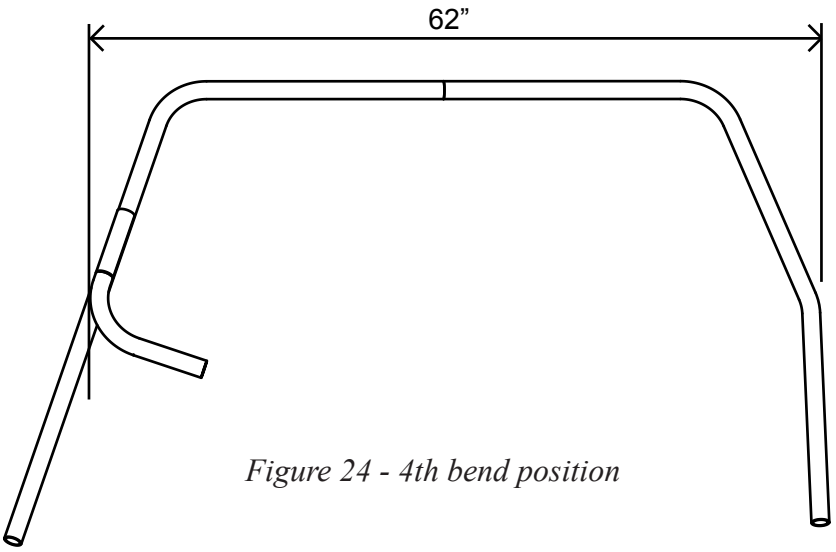


Figure 24 - 4th bend position

Finished!

PROCEDURE FOR SETTING UP A PRODUCTION BENDER USING THE TEMPLATE METHOD

As I stated earlier, this method can be used for production bending. The idea of making the bends from the center out doesn't usually work well in production. Most production bending is done by feeding the tube through the bender and making each bend as needed, thereby eliminating the need to remove the tube from the bender and flip it around. For this you would want a setup sheet with the locations of where to place the marks on the tubing for each bend location. The problem with template bending is that the template has the tube stretch and springback already in it. Since the tubing will grow in length as you make bends in it, how can you measure it accurately once it's bent? Unfortunately, you can't. What you must do is place marks down the tube, for example 10" apart, starting at the one end before you start bending. Now whenever you transfer the mark from the template to the tube being bent you can easily measure the distance from one of the 10" marks to determine where the mark would of been placed on an unbent piece of tube.

Bending Method #2 - Using Math Formulas

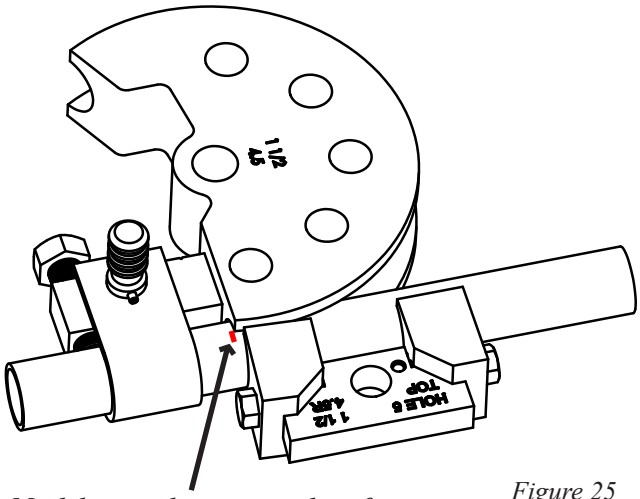
The first thing you need to do is to determine the actual starting location of a bend produced by the Bending Die you installed in the bender. This can vary between die sets and must be checked for every die set purchased. In the below example we are using 1 1/2" O.D. tubing and a Bending Die with a Center Line Radius of 6 1/2".
Here's the procedure:

A) Place a piece of tubing (app. 2 1/2' long) into the bender so that exactly 12" extends out from the edge of the die to the end of the tubing when the tubing is fully seated in the Bending Die's groove. Place a little bending pressure on the tube so as to seat the tubing in the Bending Die. Not enough to start bending the tubing just enough to seat it in the groove. *NOTE: If you lay a small length of tubing in the groove of a Bending Die you will notice the tubing does not seat to the bottom of the groove. The Bending Dies are deliberately machined this way so that during the bending operation a side force is developed in the tubing. This helps to reduce flat spotting and wrinkles.*

B) Using a Black Magic Marker mark a line on the tubing precisely at the edge of the die. See figure 25.

C) Bend the tube to an exact 90 degrees. Use a carpenters square to check the angle. You will have to overbend the tube a little to account for springback. How much to overbend will come with practice. If you overbend the tube a little don't worry. Because cold worked steel has memory, you can place the tube in a vise or anything else that will retain it, and simply unbend it. Obviously this only works for small amounts of overbend. If the tubing is under bent, it will be necessary to put it back into the bender.

D) With the tube bent correctly to 90 degrees locate the actual start of the bend. To do this, measure from the end of the tube to the far end of the 90 degree bend. In the example in figure 26 this came out at 20 1/4". Subtract 6 1/2" for the centerline radius (CLR) of the Bending Die, another 3/4" for the radius of the tubing not seated in the die, and 1/8" for springback. (Substitute the CLR and tube radius to match your die set). The 1/8" figure for springback is an approximation, not an exact figure. However it is usually very close to the real thing and may be used without worry to determine the actual starting location of the bend. So:



Mark here at the saw cut edge of die (not at the followbar's insert)

Figure 25

20 1/4" - 6 1/2" - 3/4" - 1/8" = 12 7/8"

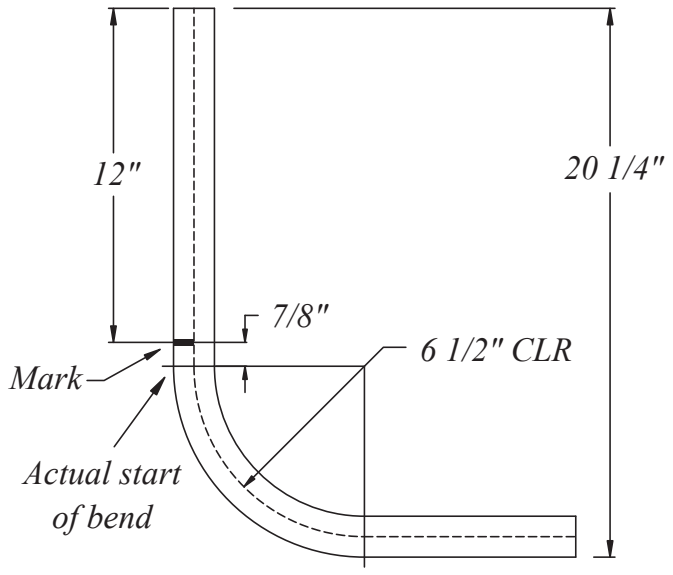


Figure 26

Now subtract from the 12 7/8" the original 12" we had marked earlier and you find that the bend will actually start 7/8" in from the edge of the bending die. Now we know for example, if we want 40" from the end of the tubing to the start of the bend, we must subtract 7/8" from 40" and set the tubing 39 1/8" from the edge of the Bending Die.

Another example, you want 36" from the bottom to the top of a rollbar. Tube size is 1 3/4" and you have an actual bend start 1/2" inside of the Bending Die's edge. The CLR of the Bending Die is 7 1/2". So: 36" - 1/2" (Actual Bend start) - 7 1/2" (CLR of die) - 7/8" (Half of the tubing diameter) - 1/8" (Springback) = 27". Set the tube 27" from the edge of the Bending Die and make the bend.

Example hoop :
Preparation is the key to making accurate bends. To make multiple bends in one section of tubing you will need a universal protractor. The protractor is then clamped, using a machinist v-block and a radiator hose clamp, to the tube. Make sure the pointer indicates '0' before making your first bend. Also using a carpenter's level, make sure the tube is entering the bender level. On the second bend if you turn the tube so that the pointer again reads '0' and the carpenter's level indicates the tube is level, both bends will be on the same plane with no noticeable twist.

First step is to draw a sketch of the intended shape and all measurements. Figure 27 below is the desired hoop. The Bending Die has a centerline radius (CLR) of 6 1/2". The tube O.D. is 1 1/2". We determined earlier, using the method described on page 4, that the Bend Start measurement is 3/4" behind the edge of this particular Bending Die set.

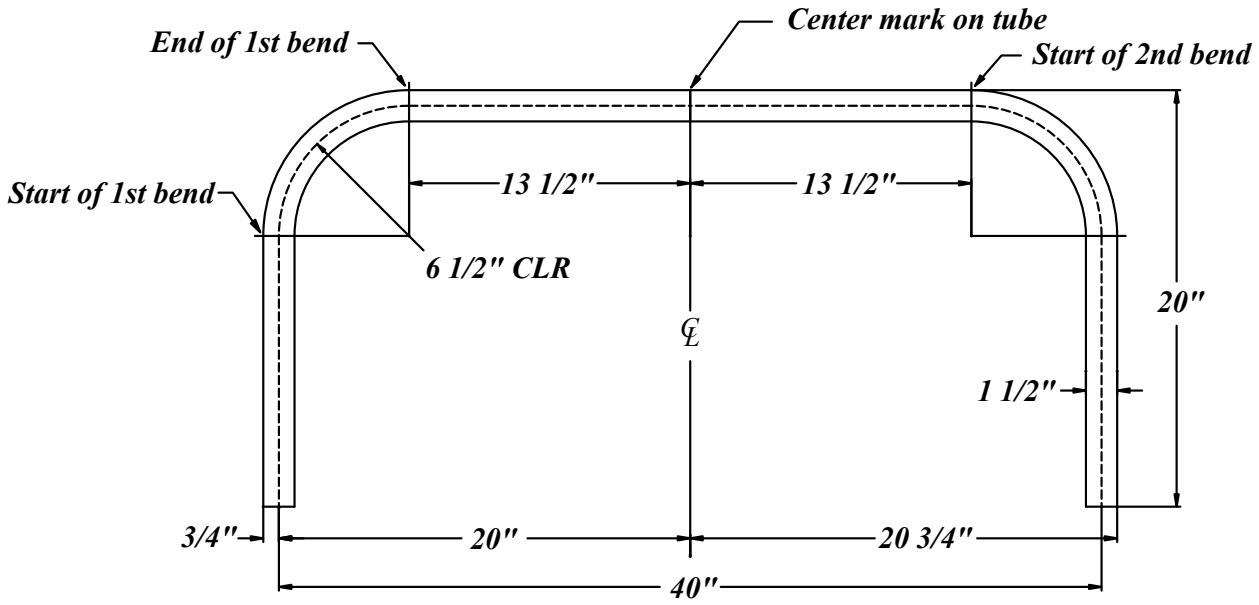


Figure 27- Example hoop.

1) Determine the total length of tubing needed. Using a calculator and the formula below let's add it all up.

6 1/2" (CLR of bend) x 90 (Number of degrees of bend) x .0175 = ***Length of tubing used in a bend.***

Using the formula above we get 6 1/2" (CLR of bend) x 90 (Degrees of bend) x .0175 = 10.2375. Let's round this off to 10 1/4" inches (10.250"). This is the amount of tubing used in the bend. We have two bends so we double this and get 20 1/2". Add to this the straight sections and we get 20 1/2" (tubing in bends) + 27 (the center section) + 13 1/2" for the left upright + 13 1/2" for the right upright = 74 1/2" of tubing needed. It's usually a good idea to leave a couple of inches extra on the end. Remember, it's easier to remove tubing then to add it. So let's add 2" to 74 1/2".

2) We cut our tube to 76 1/2". It's generally easier to work from the center out when making two bends in a tube. Divide 74 1/2" by 2 and our center point is 37 1/4" from the end of the tube. Place a mark on the tubing 37 1/4" in from one edge and mark the tubing so you will know which side is the 37 1/4 side and which side is 39 1/4". Notice we didn't use the 76 1/2" measurement that we cut our tubing to. This way we only have to cut 2" off one end of the finished tube instead of 1" off each end. The first bend is made on the short 37 1/4" side.

3) Using the method described on page 4 we determine that the tube should extend 12 5/8" from the edge of the Bending Die. Below is the equation from page 13.

20" (Height of hoop) - 6 1/2" (CLR of die) - 3/4" (1/2 of tube's dia.) - 1/8" (Springback) - 3/4" (Bend Start) = 11 7/8".

After making the bend we have half our hoop completed. The top of the bend is 20" from the bottom of the tube.

4) Now for the other bend. First we need to determine how much the tube stretched in the bend area. From figure 9 we see that the tube should be 20 3/4" from the outside edge to our 37 1/4" center mark. However after measuring from our center mark to the outside edge of the bend we now have 21" and not the planned 20 3/4". This 1/4" increase is due to springback and the tube stretching in the area of the bend.

If we now repeated the second bend, using the same 12 5/8" from the end of the tubing + 2" for the extra tubing we allowed, we would end up with a hoop 1/2" too wide. This is because the 1/4" stretch developed in the first bend will also be developed in the second bend, giving us 1/2" total increase in width. Not a good deal if you only want a 40" wide hoop. So what's the solution. Actually there is two ways to do it.

FIRST METHOD:
Look at figure 27 and notice the second bend starts at the top of the hoop and not at the top of the upright as the first bend did. Also the start of the second bend is drawn as 13 1/2" from the center mark. If you take the 13 1/2" measurement and subtract the 1/4" of growth that was developed in the first bend and another 1/4" to compensate for the second bend's growth you end up with 13". Subtract another 3/4" to account for the 3/4" Bend Start location on the Bending Die set and we have a final setting of 12 1/4". Notice we did not subtract an 1/8" for springback. This is accounted for already in the 1/4" we added for the second bend's growth. Set the tube so that the Bending Dies edge is exactly 12 1/4" from the center mark. Make sure the universal protractor reads '0' and the carpenter's level is centered. As one final check you can also measure from the far side of the completed bend to the edge of the bending die. See figure 28. This measurement should read:

40" (width of hoop) - 3/4" (radius of tube not in bending die) - 1/8" (springback allowance) = 39 1/8"

Make the second bend. Measure the height of the second upright and cut off the extra tubing we allowed for earlier.

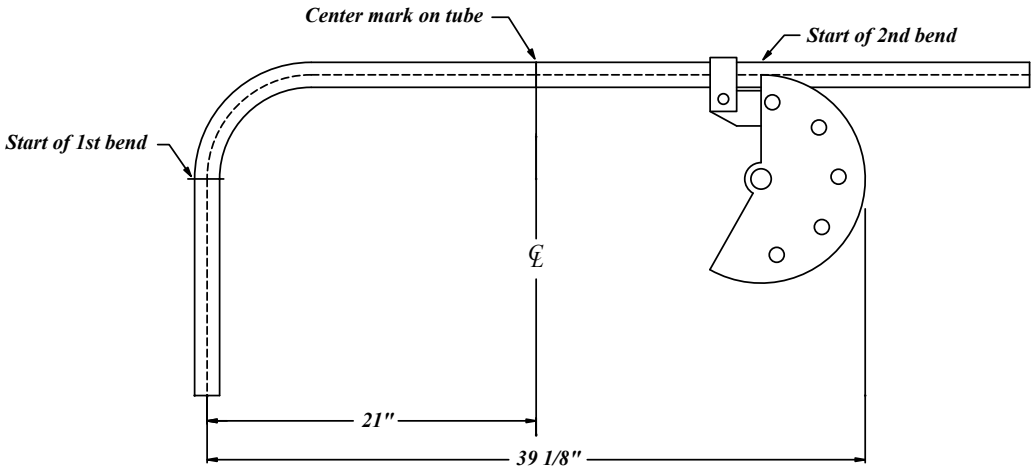


Figure 28

SECOND METHOD:
The second method is basically the opposite of the first method. The second bend will start at the bottom of the upright and *NOT* at the top of the hoop as in the first method and as shown in figure 28. We use the same method as used to bend the first bend with a few exceptions. First calculate the starting point for the second bend as shown below:

20" (total height of hoop) - 6 1/2" (CLR of bending die) - 3/4" (Bend Start) = 12 3/4"

Add 2" to account for the extra tubing we allowed earlier. Also add the 1/4" growth developed in the first bend and another 1/4" for the second bend. DO NOT ADD 1/8" SPRINGBACK. Once again this is already accounted for in the 1/4" growth of the second bend. We end up with:

12 3/4" + 2" (extra tubing) + 1/2" (growth for both bends) = 15 1/4"

Set the tube's end at 15 1/4" from the Bending Die's edge. Make sure the universal protractor reads '0' and the carpenter's level is centered. Make the second bend. Measure the height of the second upright and cut off the extra tubing we allowed for earlier.

Thank you for purchasing a JD Squared bender. Any further questions please contact us.