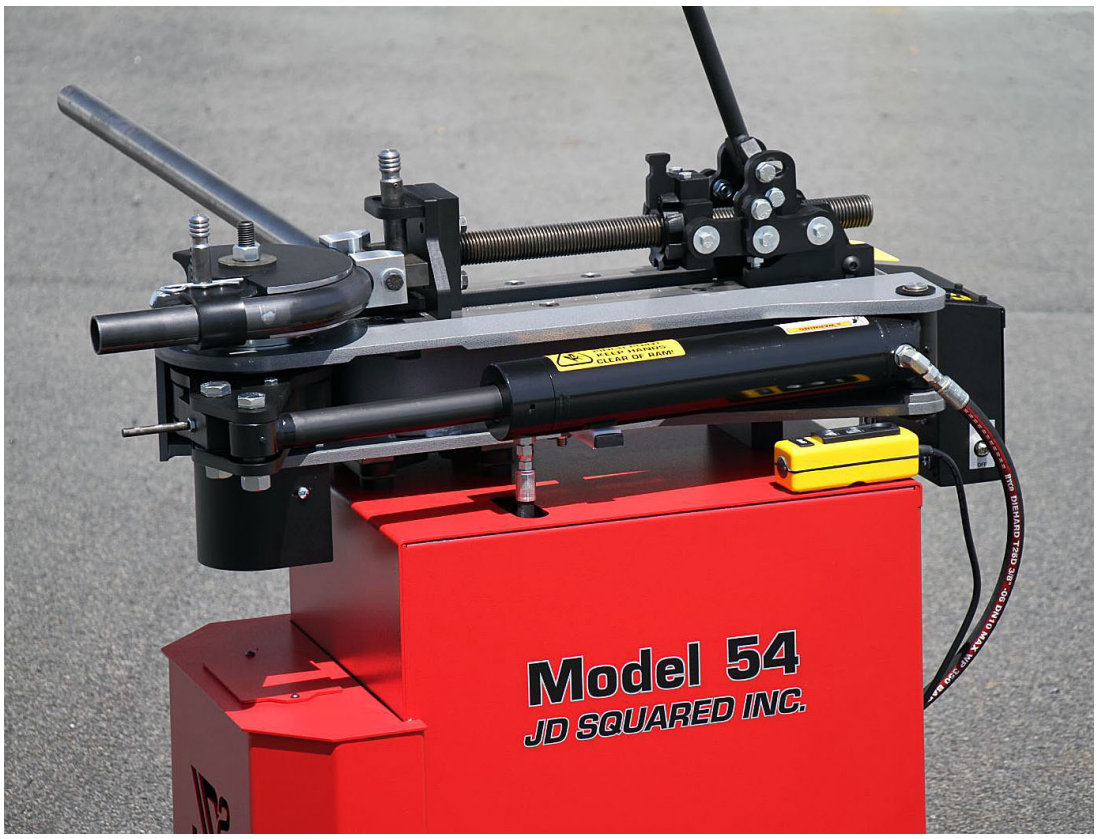
Model 54 Bender

Assembly and Operating Instruction Manual

Revision Date: 4/28/2015



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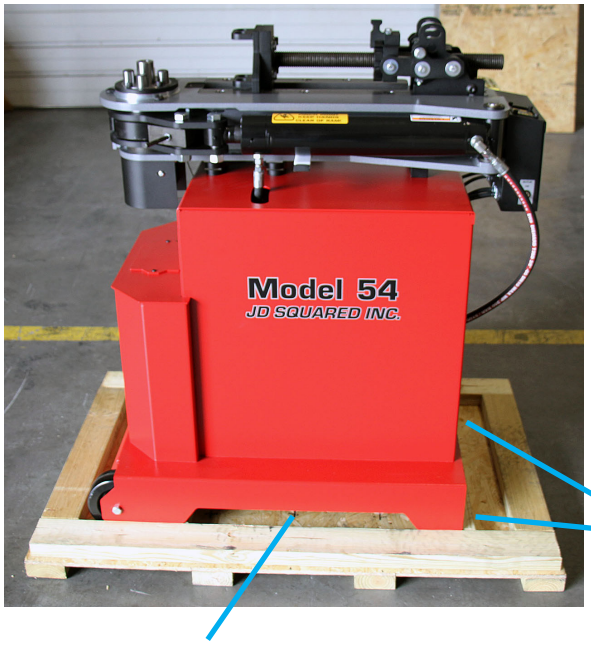
Uncrating

Bender's crate with sides and top removed.

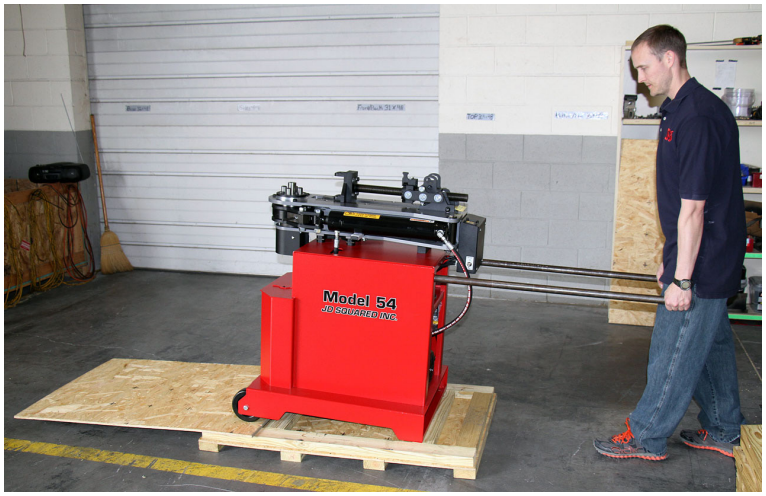


Parts included with bender:

1 Pressure screw pin (1" diameter)
1 U-strap pin and hitch pin clip (7/8" diameter with multiple drilled holes)
1 Die socket set screw (3/4"-10 x 3.5" long)
1 Die washer (3/4" hole)
1 Die nut (3/4"-10 hex)
2 1/2"-13 x 2 1/2" long leveling bolts
2 1/2"-13 hex nuts
4 1/2" washers

1) Remove the top and sides from the crate. Remove the 1/2" bolts attaching the bender to the crate's floor but do not discard them. They are used later to level the rear of the bender.

2) **Removing the bender with a forklift:** The bender may be lifted from the base using a forklift by inserting the forks into the forklift access slot as shown in the above picture. The forks should be spread out as far as they will go and still fit into the slot. The bender is very top heavy and you must be careful not to let it tip and possibly fall off the forks. We recommend you use tie downs and strap it to the forks. Also, make sure no one is around the bender that may be hurt if the bender falls off the forks. GO SLOW AND BE VERY CAREFUL. **Removing the bender without a forklift:** The bender may be rolled off the base using the procedure shown below. In order to do this you will need to obtain 2 handles and a some 9/16" or thicker plywood. See the section "**Installing the handles"** in the assembly section of these directions. Do not use the wood from the crate's side and top because it may not handle the bender's weight.
    1) Insert the handles and tilt the bender back. Place the plywood as shown below.
    2) Carefully and slowly roll the bender down the ramp.



Assembly

Moving the bender

In order to save you money, the bender is sold without the moving handles. Why? The 5 1/2 foot long handles will not fit into the bender's crate and therefore must be shipped separately at an average cost of over $40. The handle material itself however is less than $10.

Bender shown with handles and the two rear leveling bolts installed.

Installing the handles

Obtain 2 pieces of 1" pipe or 1 1/4" tubing at least 5 1/2 feet long. Insert both handles into the 2 outer holes as shown to the right and push them past the 2 inner holes until they bottom out. Now you can easily move the bender around.

Floor mount or wheeled?

In order to achieve best results, the spindle must always be as level as possible. To illustrate the problem, let's assume the bender is wheeled into position but the floor is 1^{o} off level from the horizon. The operator makes a 90^{o} bend. Now the operator repositions the tube for the second bend and carefully levels the tube to the horizon and makes the second bend. This repeats for a third bend. The result will be the first and the last bend are now 2^{o} off plane from each other. We refer to this as cork screwing. Therefore, the best way to setup up the bender is to mount it directly to the floor as described later.

Wheeled installation

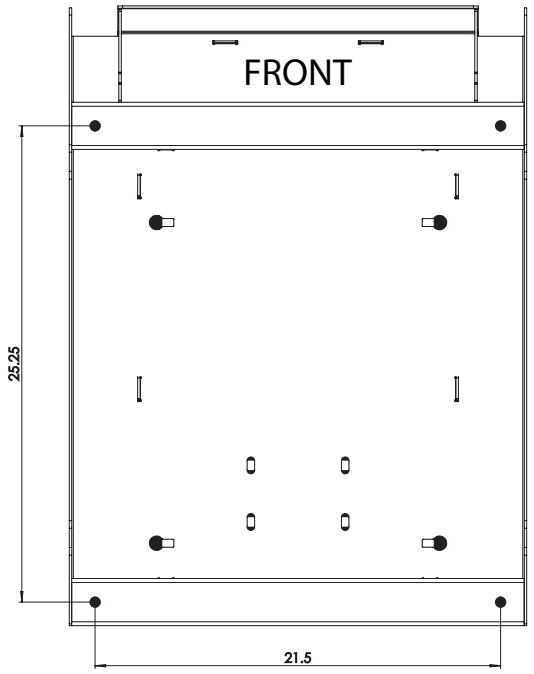
While floor mounting is definitely the best way to go sometimes the bender must be mobile. In this case, locate the 1/2" bolts, nuts and washers you removed when uncrating the machine. Refering to the photo above, install them back into the same holes in the base from where you previously removed them. The head of the bolt must face down. The two bolts can now be used to level the bender.

Floor mounted installation

Remove the front wheels. Using the holes in the stand or the measurements below, mark the floor at the 4 corners of the bender's stand. Now drill the holes and cement 1/2" threaded rods into the floor. Using 3 pairs of nuts and washers at each corner, level the spindle's top as described in the next section. Because the stand's welded dimensions may vary slightly from the drawing, verify the holes in the floor match the one's in the bender before cementing in the threaded rods.

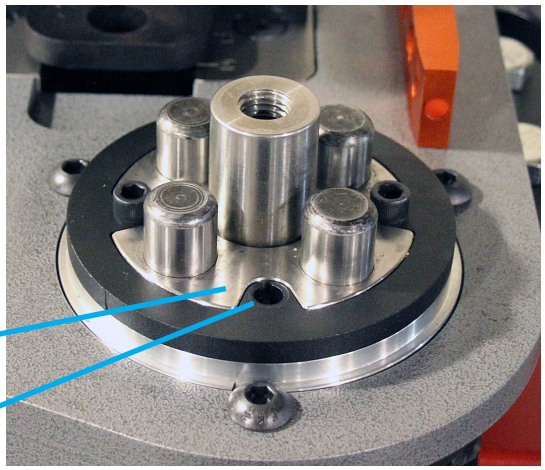
Bender mounted to floor

Front corner, wheel removed

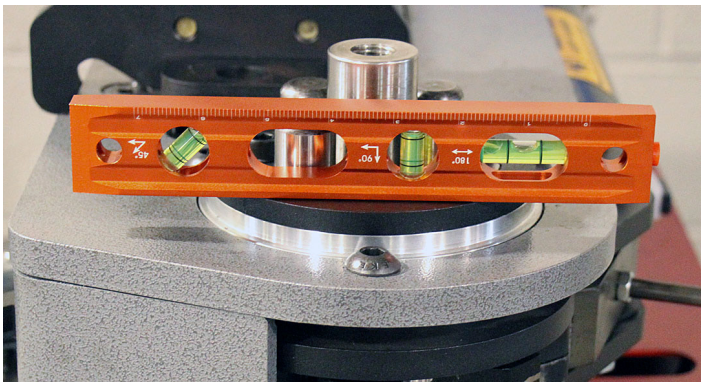


Leveling the spindle

1) Remove 1 of the 4 socket head cap screws from the top of the spindle as shown to the right.
2) Place a level on the spindle's upper surface. Do not place it anywhere else such as the top of the screws or dowel pins because they may not be level themselves.
3) By rotating the spindle 90^{o} from the front to the side and adjusting the nuts at the 4 corners, level the spindle as accurately as possible.



Socket head cap screw removed


Spindle rotated in order to level side to side


Spindle rotated in order to level front to back

Filling the hydraulic oil tank

The bender is shipped without hydraulic oil as per transportation regulations. Remove the front oil tank access cover. Using commonly available ISO-32 or ISO-68 hydraulic oil such as used in agricultural equipment, fill the oil tank to approximately 1" from the top. The tank's oil level may be seen easily through the JD2 logo using a flashlight. A rubber hose attached to a funnel makes this job fairly easy.

Oil tank viewed through the JD2 logo

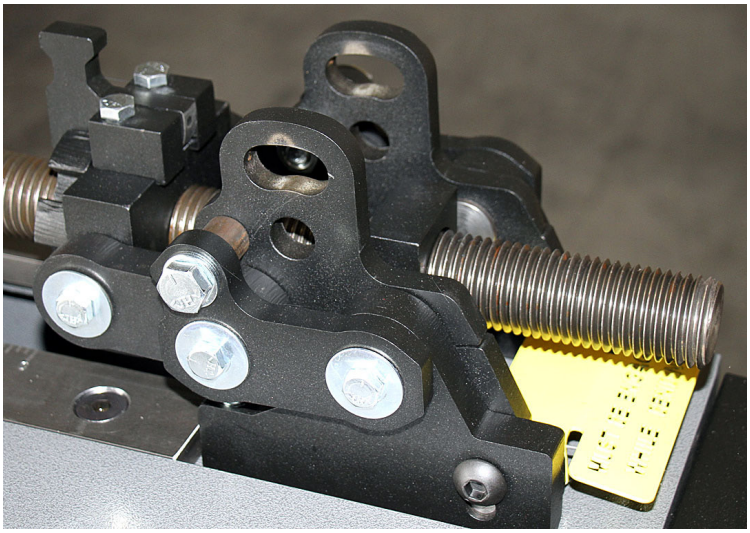
Electrical connection

AC SUPPLY VOLTAGE: The bender may be configured to operate on an AC supply voltage of either 110-120v or 220-240v. The solenoid installed in the bender must match the supply voltage to the bender. The standard motor may be wired for either voltage.

EXTENSION CORD: If you plug the bender into an extension cord, we recommend you use the shortest 10 gauge cable possible. If you use a long cable, such as 50 feet or more, or a smaller gauge cable, the power drop through the cable may be significant enough to trip the breaker in your building's fuse box. The pump may also not receive enough power to develop full pressure.

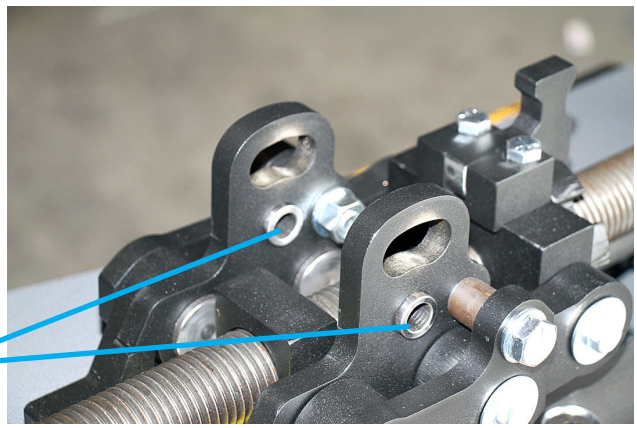
Assembling the toggle mechanism

1) Remove the bolts, washers and sleeves from the handle.
2) Refering to the photo to the right, locate the 2 empty slots and holes. Place a sleeve in each one of the 2 lower holes as shown.
3) Install the handle with the welded block to the rear of the bender using the 2 bolts and washers.
4) Install a sleeve in each slot. Install the remaining 2 bolts and washers into these sleeves.
5) Tighten all the bolts in the entire mechanism very securely.
6) Verify the toggle moves freely and the safety bar engages and disengages smoothly.

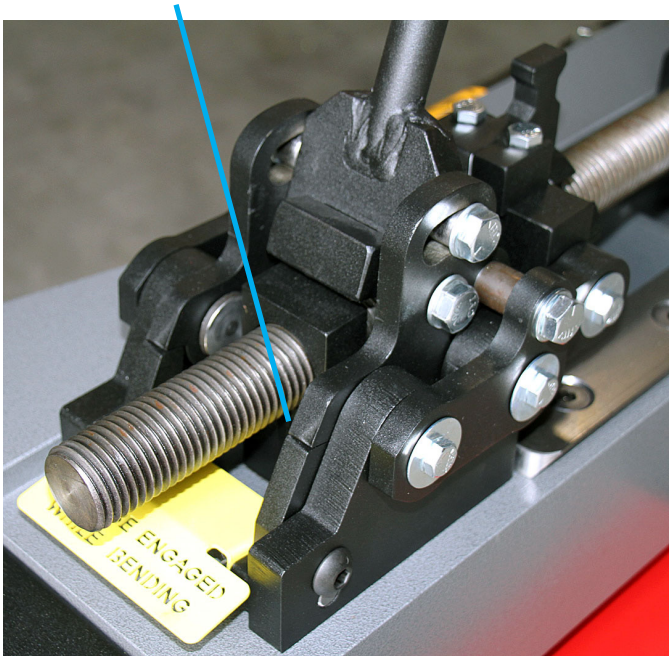


Toggle mechanism as shipped without the handle installed

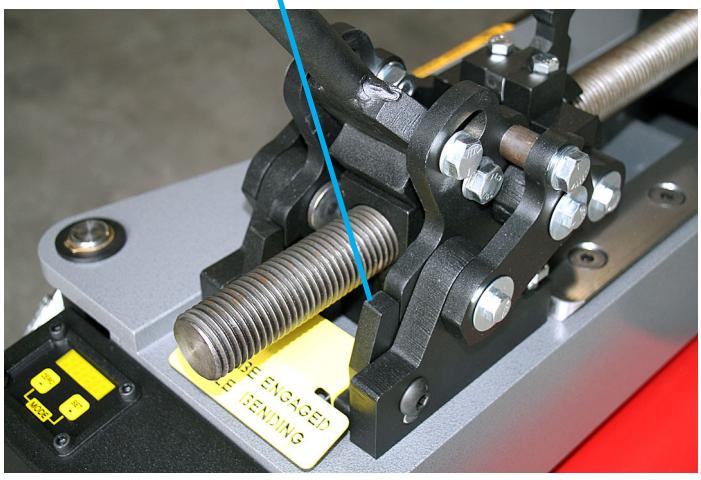
Handle as shipped with bolts,washers and sleeves



Sleeves placed in the lower 2 holes



Safety bar engaged and all bolts have been installed



Safety Bar Disengaged

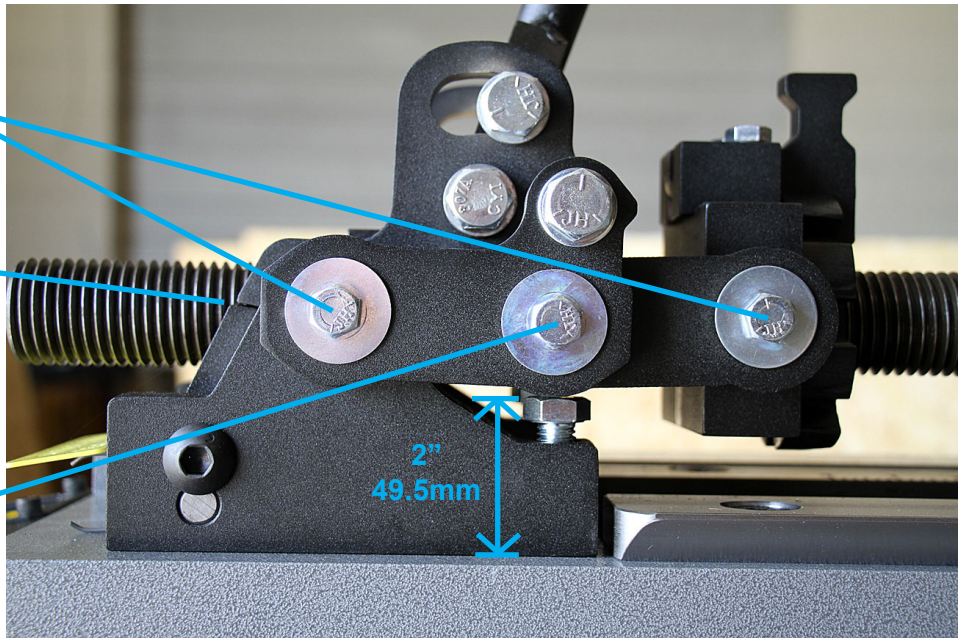
Adjusting the toggle mechanism's over-center distance

The proper adjustment of the toggle mechanism is critical for the safe operation of the bender. The principle of the toggle mechanism is that when engaged the middle pin will be slightly below the outer pins when the bender is under load. This creates an over-center condition thereby preventing the toggle from disengaging when in use. The distance that the middle pin is adjusted below the outer pins when engaged determines how difficult it will be to disengage the toggle mechanism after the bend is complete. The dimension of 2" at the top of the adjuster bolt is the factory setting. This will position the middle pin .050" below the outer pins when fully engaged. If the toggle is ever disassembled, upon reassembly it must be readjusted to these values on both sides.

Outer toggle link pins

A small gap must be present when the toggle is fully engaged. Typically around .015-.030". This allows the safety bar to be disengaged easily.

Middle toggle link pin

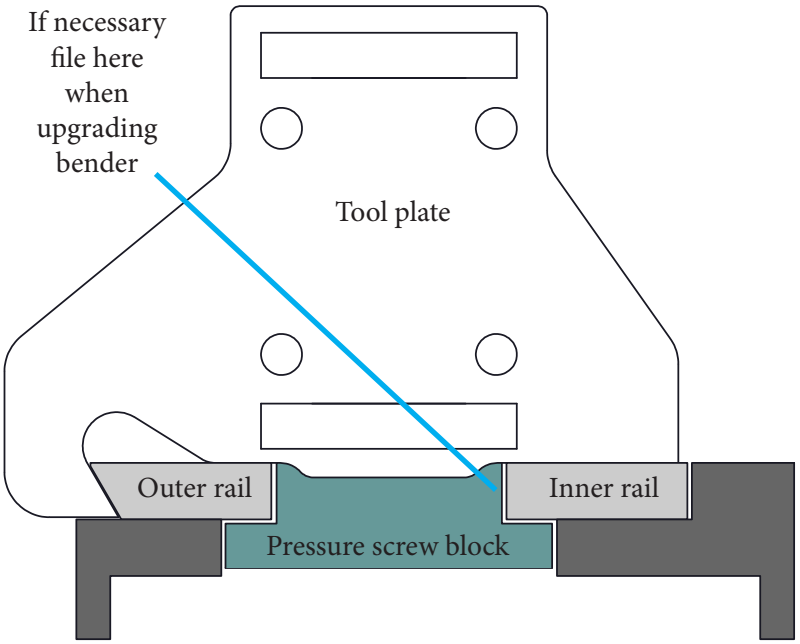


Toggle mechanism's side view

Tool Plate Installation

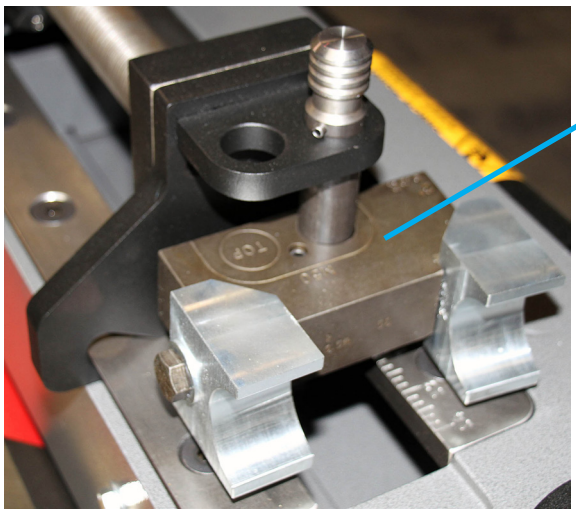
The Model 54 has been designed to allow new tooling to be easily added in the future. This is accomplished by using a tool plate that bolts to the pressure screw block. Various tool plate's are available depending upon the application. The majority of die sets use the standard 2 hole tool plate that is included with the bender. This plate accommodates dies for up to 2.5" tube and 2" pipe. However, a die set such as 3" o.d. tube may require a different tool plate. The correct tool plate for a particular die set can usually be determined by examining the tooling and looking for the engraved markings such as shown below.

The dovetailed tool plate design was added to the Model 54 in April of 2014. Therefore, if the bender was purchased before that date it may not have the upgrade installed. If this is the case, please call our sales deptartment. We feel this is a significant improvement to the bender and therefore offer this as a FREE upgrade.

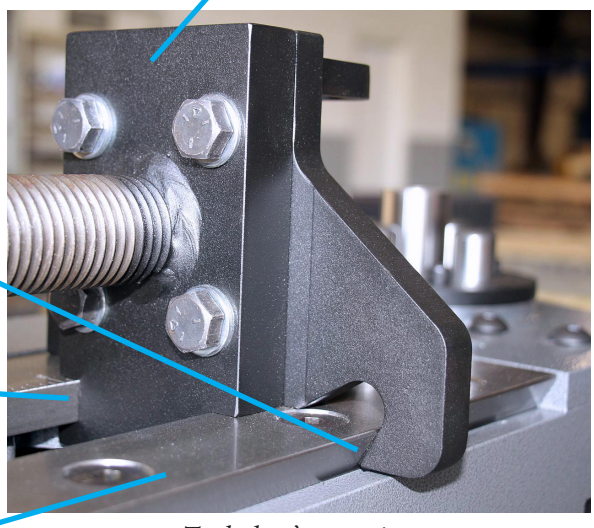


When the bender is under load, the dovetail in the tool plate will suck down onto the outer rail's dovetail and lay flat. This ensures the tool plate's pin holes are vertical and are not tilted. It is CRITICAL that the tool plate and the outer rail's dovetailed surfaces are in full contact under load.

To verify this, use the following procedure. Without any tooling in the bender, push the tool plate to the left towards the cylinder and try to raise the right side nearest the outer rail. If it does not tilt towards the cylinder or try to lift then everything is fine. If this is not the case, there is not enough clearance between the inner rail and the pressure screw block's left side slot. This should only happen when a older bender is being upgraded. To remedy this you can remove the pressure screw and using the edge of a file, remove material from the bottom of the left slot until a clearance of .010" or slightly more is obtained. This can be seen in the lower right photo. The amount of material to remove is usually only about .020-.030". If you wish you may also send the pressure screw to the factory and we will be happy to mill the slot deeper for free.



Two hole tool plate's front view

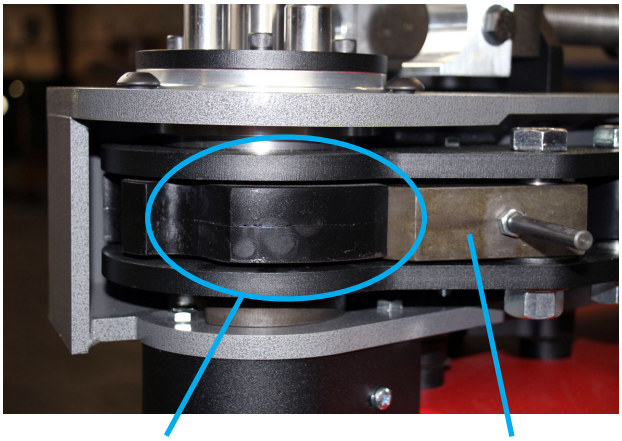


Tool plate's rear view

Loading a Round Tube/Pipe Die Set

Rotate spindle to its start position

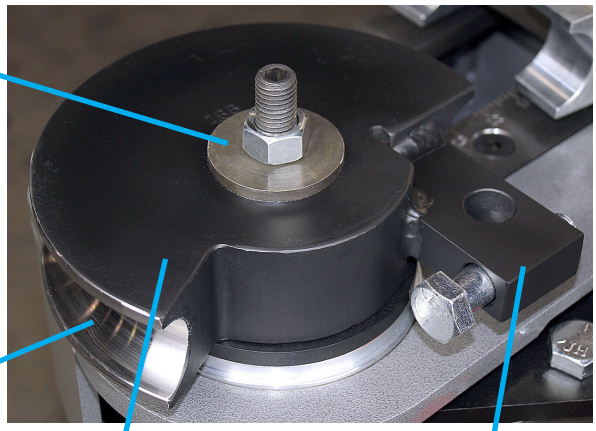
1) Retract the ram until it stops moving and then move it forward slightly. If left fully retracted, the ram will pull the spindle to the rear and lock it up. This does not harm anything, it just won't let you rotate the spindle by hand.
2) The drive hub has 7 teeth. One of them is much larger than the others. This is the first tooth. Pull the spring loaded drive pawl's handle out and rotate the spindle until the drive pawl engages this tooth. This is shown to the right.



Installing the forming die onto the spindle

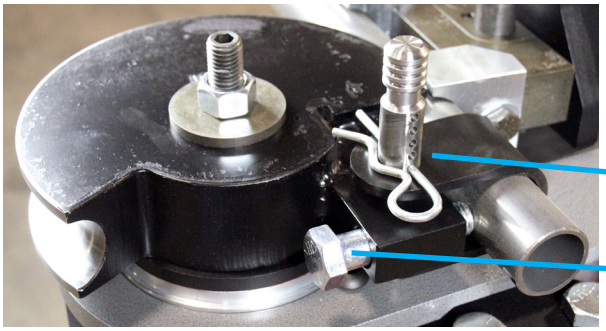
1) Examine the spindles upper surface and remove any debris that may not allow the forming die to sit flat. Also make sure the four large 1" dowel pins are seated completely.
2) Install the forming die with it's u-strap towards the cylinder. Install the die washer and nut. Tighten securely.

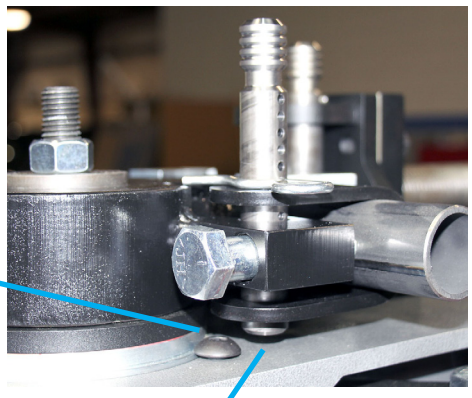
Spindle top view.



Installing the round tube/pipe U-strap

1) Wipe the forming die's groove clean. Never lubricate the groove as this would allow the tube to easily slip during bending. Place the tube into the groove's die.
2) Install the u-strap and insert the u-strap pin. The u-strap uses a clip pin to limit how far down the pin goes into the u-strap. It is very IMPORTANT that you place the clip pin into a u-strap hole that allows the u-strap pin to protrude past the u-strap's lower surface by a 1/4" or more without the possibility of the pin hitting the spindle button head bolts or the frame while rotating. This is shown in the picture to the lower right.
3) If bending thin wall tubing (.065" or less) you may need to tighten the u-strap lock bolt to help prevent the tube from slipping backwards into the die while bending. If the bolt tries to mar the tube, make a small piece of curved metal and place it between the bolt and the tube.





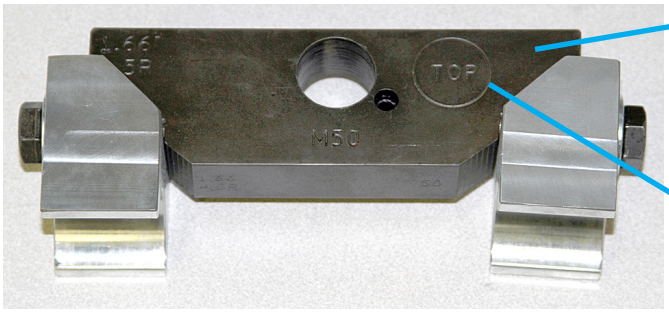
Description of the pressure die assembly

The pressure die is shown in the 2 pictures below. It is sometimes referred to as a 'followbar'. It constrains the outside of the tube while bending. It is made up of 2 inserts and the backing block. The inserts are cast and machined from a special, scratch and wear resistant, metal alloy. The inserts are relatively self lubricating but are considered as consumable. They are NOT aluminum. Their typical life span is 1,000s of bends when using clean tubing.

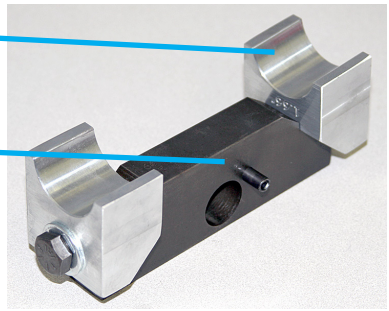
In the left side picture you can see the left insert is in line with the backing block and the right insert is angled. The angled insert is the trailing insert and will always be closest to the u-strap during bending. It rides where the tube has already been bent, thus helping to minimize the amount of flattening on the outside of the bend. It is computed to within 1/1000th of a degree at the time of manufacture to produce the best bend conditions for the size of tubing and the bend radius. Therefore, the pressure die must be installed into the bender correctly in order to take advantage of this design feature or you will experience poor bend quality.

In the right side picture you can see the bottom of the pressure die. The roll pin will hold the pressure die up when the pressure screw is retracted. It must be adjusted so that the insert's grooves are 1/16" or so below the forming die's groove when the tube is not loaded. This will allow the pressure die to rise slightly and level itself when the toggle is advanced into the bending position.

The standard tool plate has 2 pin hole locations. This allows the amount of rear insert force to be tailored to the tube being bent, thus producing a better quality of bend.



Pressure die top view

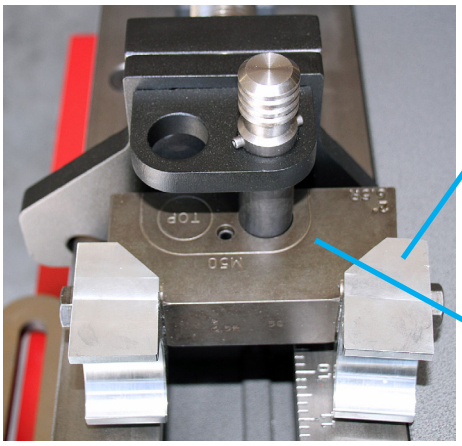


Pressure die bottom view

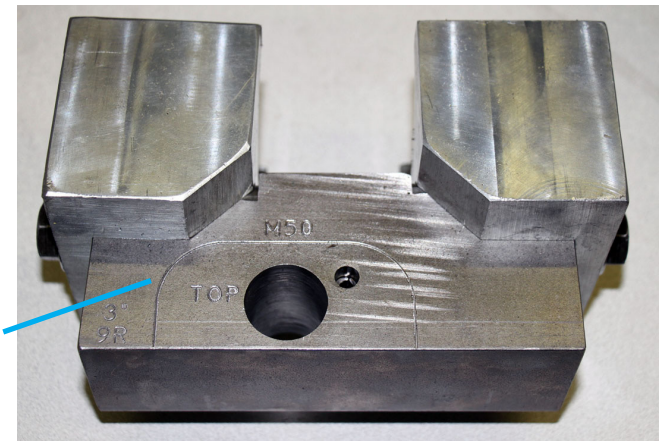
Installing the pressure die into the bender

If you examine the pressure die's top surface you will notice the engraved word TOP and usually a circle and tool plate outline. This engraving illustrates which tool plate is needed and what hole to place the 1" pin into. Place the pressure die into the tool plate and align it with the engraved markings aligned with the tool plate's outline. The lower left picture shows a pressure die designed for the standard 2 hole tool plate. The 1" pin obviously goes into the hole on the right side of the photo. Always be very careful to ensure the 1" pin as been completely seated all the way down to the roll pin.

The 3" tube pressure die shown below right is designed for a 1 hole tool plate as can be seen by the engraving.



A pressure die installed into a two hole tool plate.



A 3" tube pressure die. It is designed for a one hole tool plate as can be seen by the engraving.

Loading a Square/Rectangle Tube Die Set

Installing the forming die onto the spindle

Install the square groove forming die onto the spindle exactly as described in the previous section about installing a round groove die.

Installing the square groove tube clamp

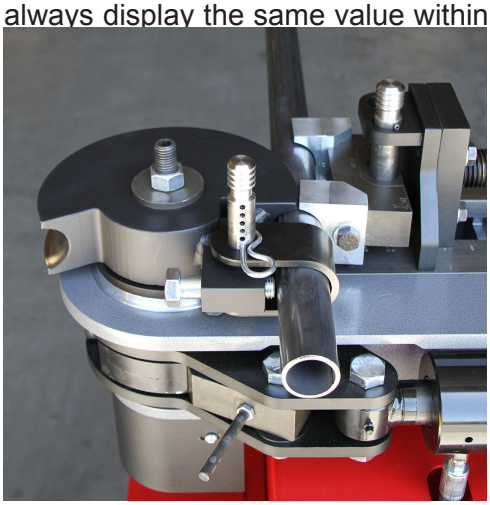
Adjusting the Toggle Mechanism

The Model 54 has been designed to make it easy to obtain repeatable bend angle. You do not need to worry about springback calculations, mechanical tolerances and so on. The bender doesn't even need the computer to home the spindle upon powering on.

The main operating principle is simple. Where does the spindle need to rotate to in order to achieve the desired degree of bend? It seems obvious, but how is this accomplished?

A key feature of the Model 54 is that it uses an absolute position encoder on the spindle. It has been factory set to read zero when the spindle is rotated to the start position. When the spindle is rotated to any arbitrary position, even if the bender was previously turned off and back on, it will always display the same value within the encoder's .1^{o} error range.

The other key principle is that the toggle mechanism must ALWAYS be set to the EXACT same position every time a particular die set is used. Before we explain further, it will be much easier to understand if you learn to adjust the toggle mechanism as described next. After that we will continue.

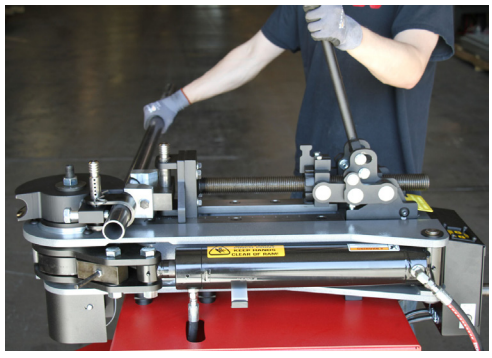


Pressure die pushed onto the tube.

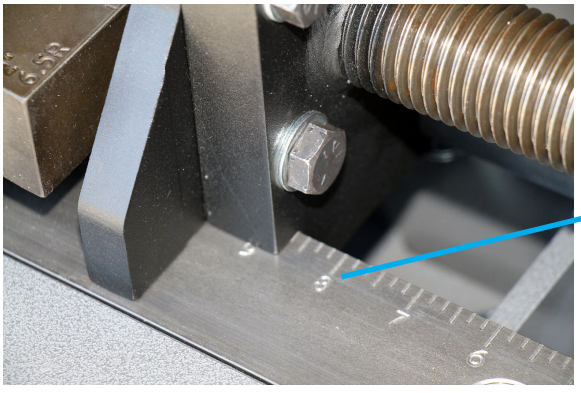
Adjusting the toggle mechanism for bending

When the toggle mechanism has been properly adjusted, the tube will protrude straight out the back of the bender at 90^{o} to the frame during bending. Follow these steps to accomplish this.

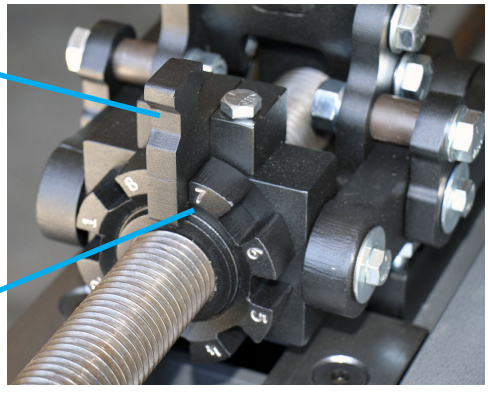
1) Load the die set, tube and u-strap components as described earlier.
2) Install the pressure die as also described earlier.
3) Lift the index wheel lever to disengage it from the slot.
4) Push the pressure die forward until it wraps over the tube completely as shown in the picture in the upper right.
5) Push the toggle lever to the full forward locked position. The safety bar will engage. Note, you may need to unscrew the index wheel to achieve this.
6) Adjust the index wheel to the rear of the screw as far as it will go.
7) Pull rearward on the right side of the tube as shown to the right. If the tube does not stop at 90^{o} to the frame, push the pressure die forward again and readjust the index wheel a little further rearward. Disengaging the toggle to the rear position makes this much easier.
8) When you're satisfied, lower the index wheel lever into the nearest slot.
9) For this particular die set you should ALWAYS return the pressure die to this EXACT setting every time it is installed. We recommend recording the below setting as 8.3.7 and then stamp it into the top of the die. The 8 is the major number from the side scale as shown in the below left picture. The 3 is the number of WHOLE increments past the 8 and the 7 is the slot used in the index wheel as shown below and to the right. It may appear we're at 8.4 but in reality the reading is slightly less because the wheel has 8 slots and we're all the way to slot 7, just shy of the 4th increment.



Pulling tube rearward



Side scale shown at 8.3

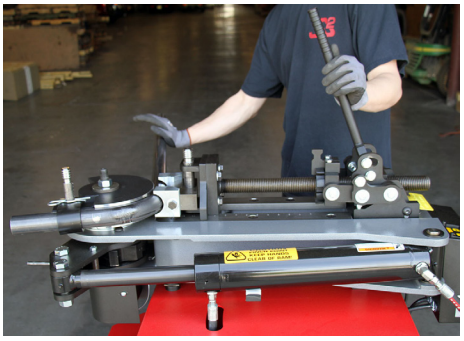


Index wheel shown at slot 7

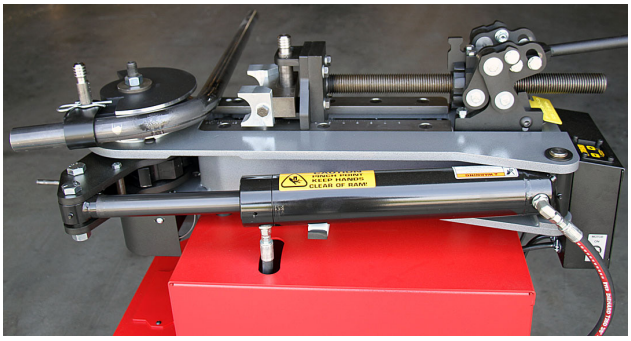
How to make a bend and remove the work piece when finished

1) Load the tube to be bent and adjust the toggle as described earlier.
2) Lubricate ONLY the outside of the tube where the pressure die slides. Do NOT oil the groove. Cooking spray works surprisingly well here.
3) Verify the pressure die's 1" pin is all the way down and extends below the lower plate. Verify the u-strap pin extends below the u-strap by a 1/4" or more and will not hit the button head bolts or frame during bending.
4) Stand well clear of the toggle lever's ENTIRE range of travel. Injury may result in the extremely unlikely event the lever snaps back under load.
5) Press the ram advance button on the pendant to start bending.
6) Upon completion, retract the ram a few seconds to relieve the bending pressure. Most of the time the tube will come loose by itself. However, you may hit the rear of the tube as shown below to help dislodge it.
7) Press the safety bar down and retract the toggle lever. You can now remove the tube.

Pressing the advance button



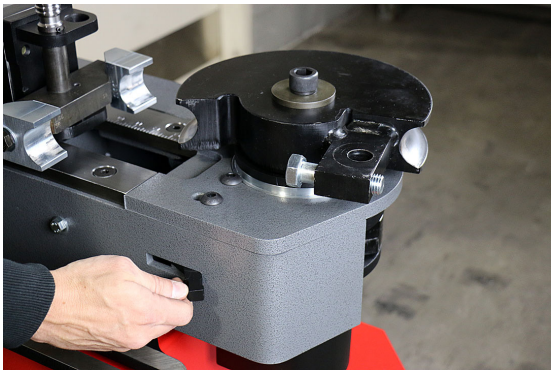
Striking the tube's end



Toggle in the disengaged posyion

Spindle lock operation

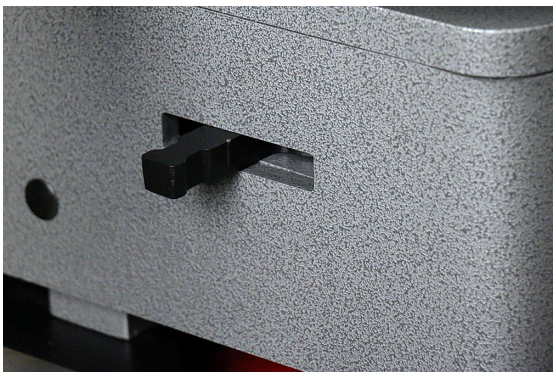
When activated, the spindle lock will engage at 22.5^{o} intervals to prevent the forming die from rotating counter-clockwise. This is necessary if for any reason the bend process must be stopped and the cylinder is retracted such as making a 180^{o} bend. If the spindle is allowed to rotate backwards the pressure on the tube relaxes allowing the tube to lift slightly in the die groove. This can cause problems when the bend is continued. It is the main cause of wrinkling thin wall tubing (.065" or less). The tube may also slide backwards in the die making it very difficult to obtain accurate bends.



The spindle lock in the disengaged position.

The spindle lock is not needed for bends up to 90^{o} because a single stroke of the ram advances the spindle approximately 115^{o}. To disengage it, push the lever forwards as shown to the right. For bends greater than 90^{o} use the procedure below.

1) Engage the spindle lock by moving the lever to the rear position as shown to the right.
2) Press the pendant button and start bending. Every 22.5^{o} you will hear the spindle lock click into the locked position. You can also see the lever moving back and forth as the bend progresses. At approximately 90^{o} of bend you will hear the spindle lock engage again. Immediately stop bending. Try to stop the bender as close as possible after the lock has engaged.
3) Retract the ram until the drive pawl engages another tooth. If you retract it all the way to its start position, a full 180^{o} bend can be made with only two shots of the ram.



The spindle lock in the engaged position.

4) When the bend is complete, move the latch to the forward position to disengage the spindle lock.
5) You can now remove the tube is described in an earlier section.

Computer Operation

Computer modes

The computer has only 2 modes, the program selection mode and the operation mode. In the program selection mode the display flashes between the selected program number and its degree setting. The operating mode shows the current degree of spindle rotation and the display does not flash. To change from one mode to the other, press both buttons together.

Changing computer modes

Program selection mode

This mode allows you to select 1 of the 100 programs available in the computer. At start up, the computer is in this mode and displays the program in use when the bender was turned off. Select a different program by pressing the + or - key until the one you want is displayed. This mode also is where the P.I.D. settings for the ram control are programmed. Do not change these values without consulting the factory first.

Operation mode

This mode displays the current angle of the spindle. It is also where you can change the angle where the bender will automatically stop at. To change the angle setting press the + or - key until the angle you want is displayed. Two seconds after releasing the button the computer will store this value permanently into memory. *NOTE: A video of the computer's operation is available online at www.jd2.com.*

How to Calculate the Correct Bend Angle

How do you achieve an accurate degree of bend? Normally there are 3 values that need to be added together in order to determine what angle the computer's readout must display to be at the desired bend angle. They are:

1) The finished degree of bend we want to make. In this case it's 90^{o}.
2) The amount to bend past 90^{o} to account for the spring back of the material. This is usually just a few degrees for common steel tube. However, a different material such as chrome-moly, aluminum, copper, titanium, etc. will greatly influence the amount of springback. Other factors are wall thickness, hardness, etc.
3) The number of degrees the spindle must rotate before the tube actually starts bending. The is because there must be play in the u-strap and pressure die to allow the tube to be loaded.

That's a lot to add up every time we want to make a bend. So, let's just not do it. The Model 54's has a much simpler solution. This will be easier if we go through an example. I have a piece of 1" tube and wish to bend it to 90^{o}. I also have a 1" die set that I have never used. All I really need to know is how far past 90^{o} do I need to go to get my bend. Follow these steps to determine this value.

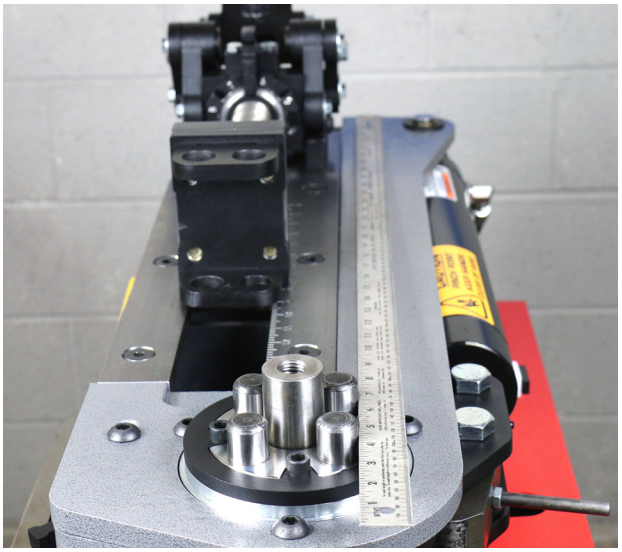
1) First the computer needs to be in operating mode. If the display is not blinking you are already in operating mode. If the display is blinking it is in program selection mode. To switch to operating mode, press both the + and - keys together and the display will stop blinking.
2) Tap the up button on the pendant to advance the cylinder until the excess play in the tube has been removed.
3) Look at the display and for this example let's say it reads 6.9^{o}. Adding 6.9^{o} to the 90^{o} we are testing for to gives us 96.9^{o}.
4) Pressing the pendant, advance the cylinder until it is a few degrees shy of 96.9^{o}.
5) By quickly tapping the pendant button, advance the cylinder slowly until you see 96.9^{o}.
6) Retract the cylinder a for a couple of seconds. Disengage the toggle and remove the tube.
7) Now we measure the angle. It will be short of the desired 90^{o}.
8) Let's say it measures out at 85^{o}. We needed to go another 5^{o} to make the desired 90^{o} bend. We should have stopped at 96.9^{o} + 5^{o} which equals 101.9^{o}. I should of added 11.9^{o} to the 90^{o}.
9) So whenever I load this die set and this exact kind of tube I will need to add 11.9^{o} to the desired bend.

Unfortunately, this does not guarantee perfect bends every time but, it will be very close. Even using the same kind and size of material there are still variations do to the manufacturing realities of making tube and pipe. To make your life easier, keep a journal of this value for each different size and kind of material being bent.

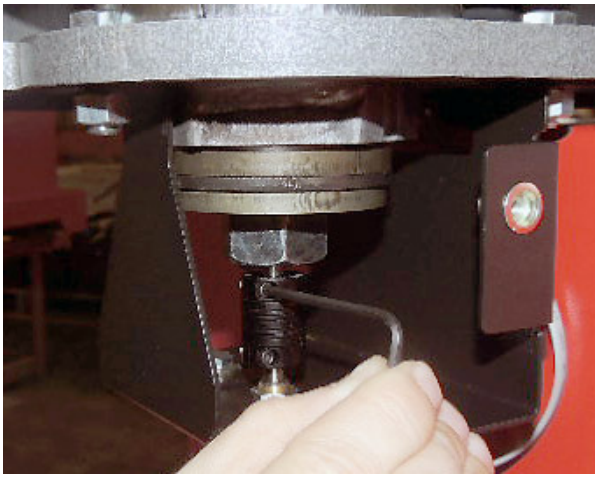
Maintenance

Setting the spindle to zero

1) Fully retract the cylinder. This will bind the spindle and lock the spindle in place. To free up the spindle, advance the cylinder slightly until the spindle can rotate freely. Rotate the spindle to its normal starting position. This is where the drive pawl will engage the largest tooth on the drive hub.
2) Rotate the spindle clockwise 45º so that the 2 left side dowel pins are lined up with the benders frame. The drive paw will now be in position to drive the 2nd tooth. As shown below, using a ruler, place it on the 2 dowel pins closest to the cylinder. Rotate the spindle until the ruler is as straight as possible with the bender's frame. It does NOT have to be perfect. You may need to disengage the drive pawl if you can't rotate the spindle back far enough to line up the ruler.
3) Turn the computer off and then back on.
4) As shown below, loosen the encoder coupling's UPPER set screw.
5) Being sure not to let the spindle move, rotate the encoder until the display reads '45.0'. Tighten the set screw.
6) The spindle has now been zeroed. You can verify this by disengaging the drive paw lever and rotating the spindle counter-clockwise 45º so that the display reads '0'. The drive largest tooth can now be engaged with the drive pawl.

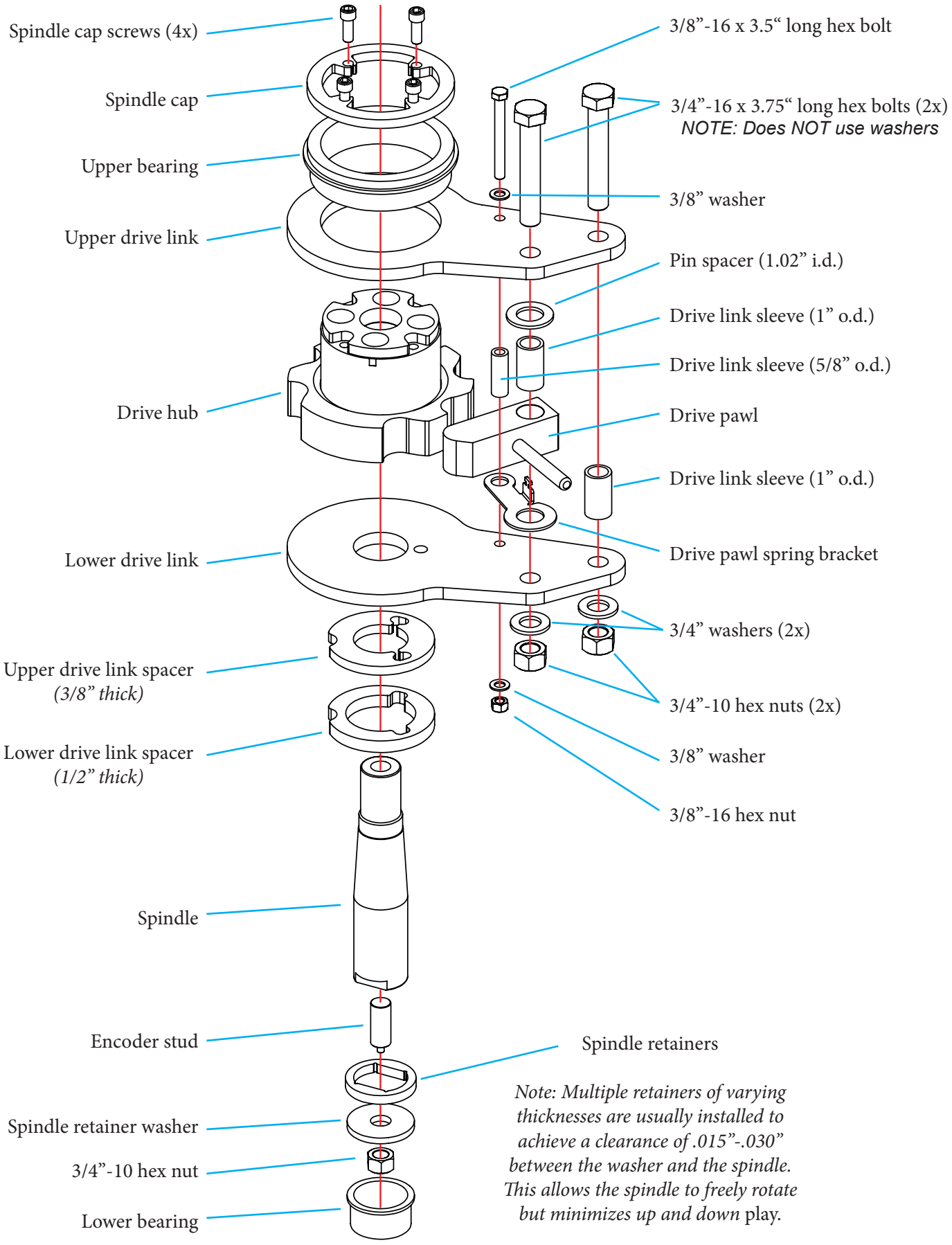


Using a ruler to set the spindle readout to 45º



Adjusting the encoder's coupling.

Exploded view of spindle components

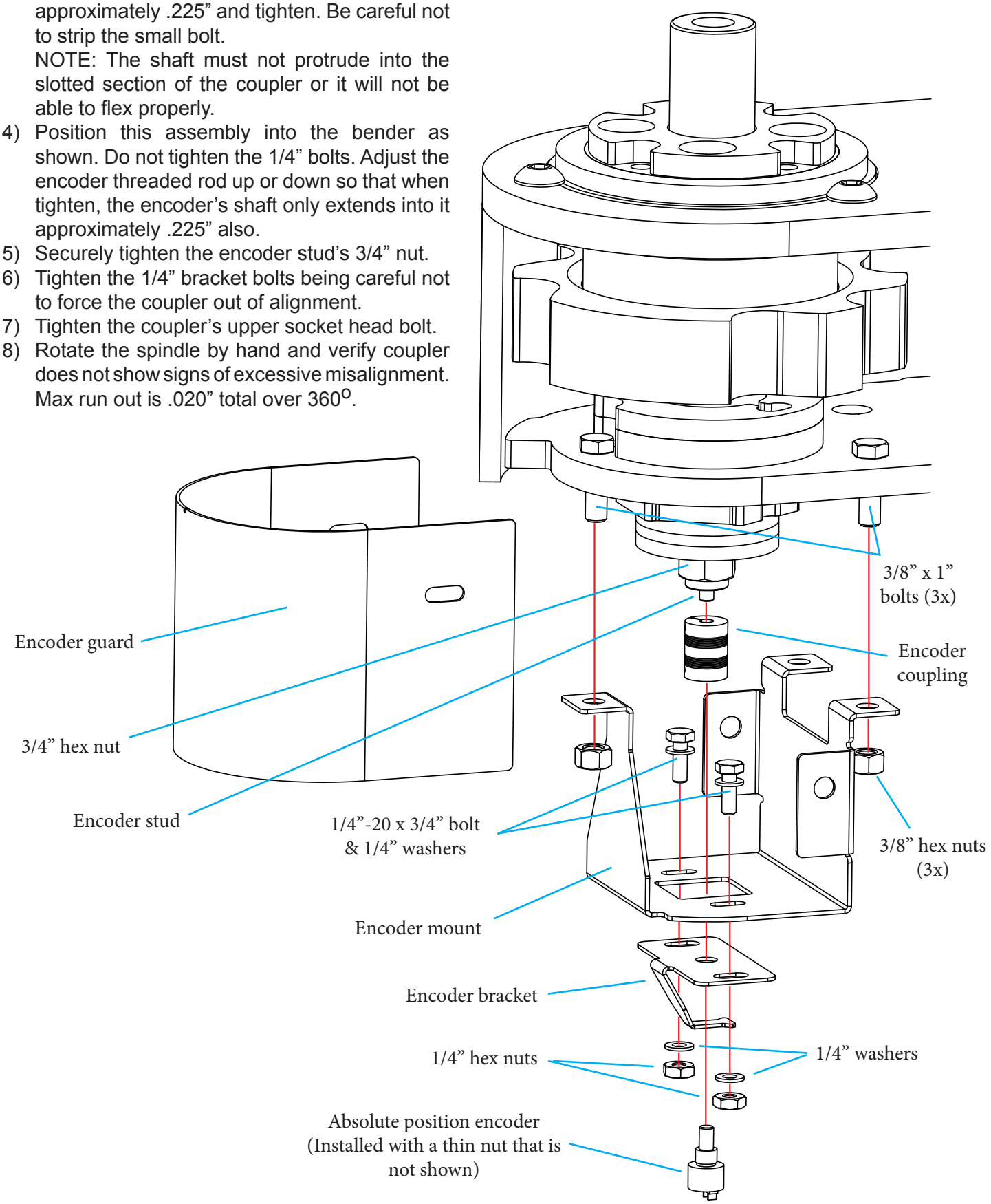


Note: Multiple retainers of varying thicknesses are usually installed to achieve a clearance of .015"-.030" between the washer and the spindle. This allows the spindle to freely rotate but minimizes up and down play.

Installing the Encoder

1) Install the encoder mount.
2) Install the encoder onto the encoder bracket and tighten. Do not place it into the machine.
3) Slide the encoder into the coupling approximately .225" and tighten. Be careful not to strip the small bolt.
   NOTE: The shaft must not protrude into the slotted section of the coupler or it will not be able to flex properly.
4) Position this assembly into the bender as shown. Do not tighten the 1/4" bolts. Adjust the encoder threaded rod up or down so that when tighten, the encoder's shaft only extends into it approximately .225" also.
5) Securely tighten the encoder stud's 3/4" nut.
6) Tighten the 1/4" bracket bolts being careful not to force the coupler out of alignment.
7) Tighten the coupler's upper socket head bolt.
8) Rotate the spindle by hand and verify coupler does not show signs of excessive misalignment. Max run out is .020" total over 360°.

Encoder components



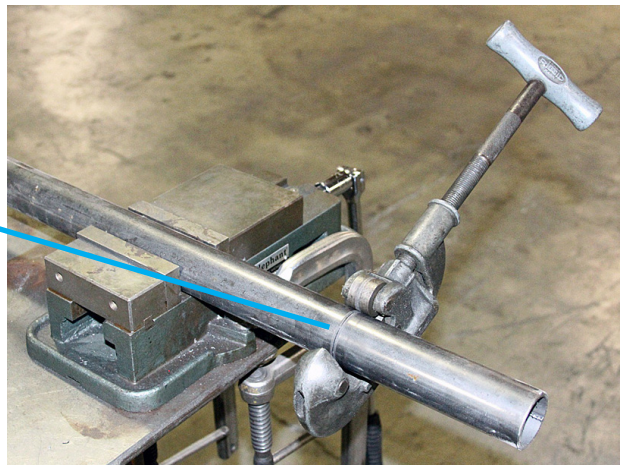
Bending Tutorial Using Template Bends

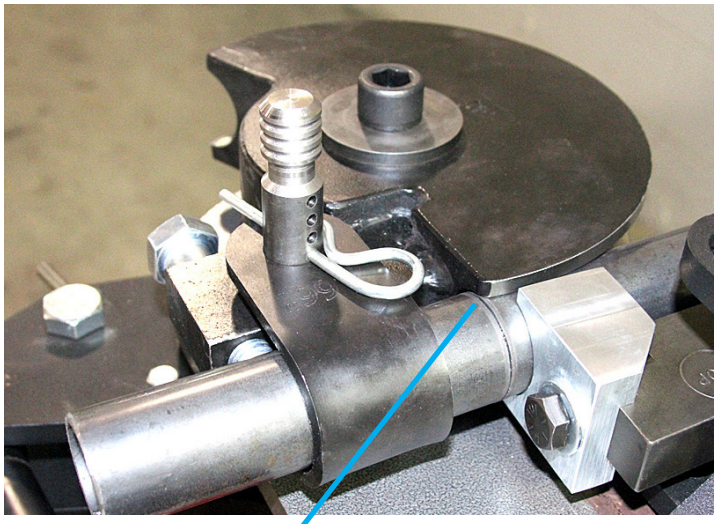
The Easy Way To Position Bends

Learning to operate the bender is fairly easy. The real challenge is accurately placing the tube into the bender so that the bend comes out in the right position. This tutorial will teach you a technique called 'Template Bending' to make a rollbar. This is a good example because it's a common request and there are no simple 90^{o} bends.

First, you need to make a template. A template is a piece of tubing bent to 90^{o} with 6" or more of straight tubing left on each side of the bend. A reference line cut into the template that allows you to visualize where the bendmarks should be placed on the tube to be bent. After bending your tube will spring out to a larger radius than the forming die's size indicates. The larger the O.D. or the stronger the tube, 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 of 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.

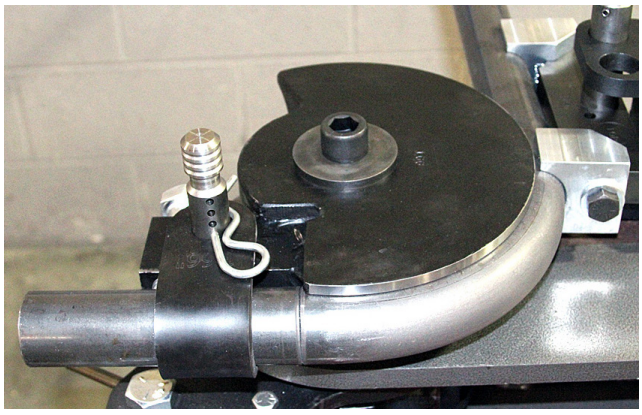
Cut a piece of tubing roughly 30" long. Next, cut an accurate line all the way around the tube 6" from the end. The best way to do this is to use a pipe cutter. Hand scribing this line is difficult and not recommended. To the right is shown the reference line being cut into the tube.

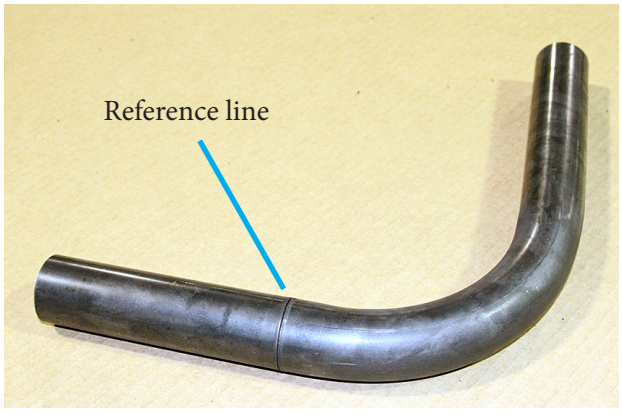




Reference line installed at the flat side of the forming die

Load the tube into the bender as shown to the lower left. The reference line must be positioned EXACTLY at the flat side of the forming die where the u-strap block has been welding onto the die. You must always use the forming die's flat side as a reference. Bend the tube to 90^{o}. 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 the template will not give you accurate results later.

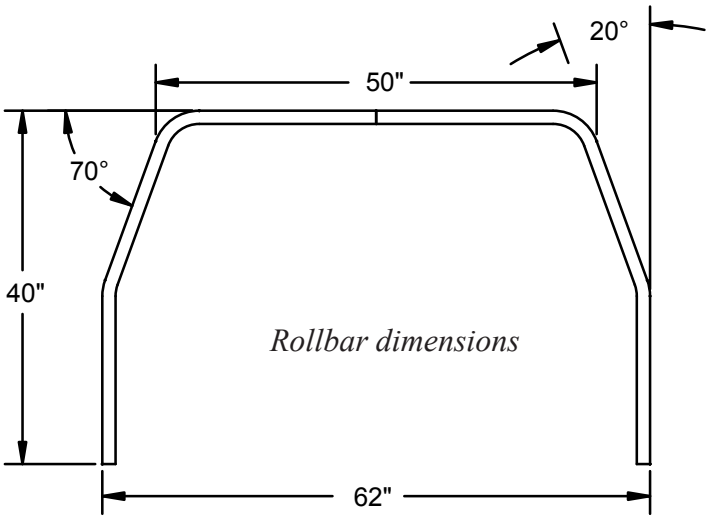




The completed template

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 70º and the two lower bends are 20º.

To determine the total length of tubing needed, you could sit down and calculate it. Time usually cost more than tubing, so let’s do it the easy way. Take the total width of the rollbar (62”) and add it to twice the height (40”). This gives us a length of 142” (62” + 40” + 40”). This is slightly longer than we actually need, 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.

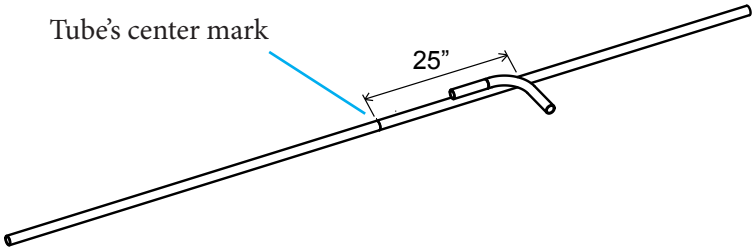


Rollbar dimensions

An important rule of bending is, 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 below.

BEND 1:

The first bend will be the upper right side bend. 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 tube to be bent on the floor and hold the template above and parallel to it as shown below. The scribed side of the template will always face towards the center of the tube being bent. Using a tape measure, slide the template left or right until it is 25” from its outside edge to the rollbar’s center mark as shown to the right. Using a marker, draw a line on the rollbar directly below the scribed line. Since the desired bend is only 70° and the template is 90º, you will have to use your best judgement of when the template is 25” out. This gets easier with experience. 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. 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. Once you know the correct over bend required, you may want to record it for future reference.

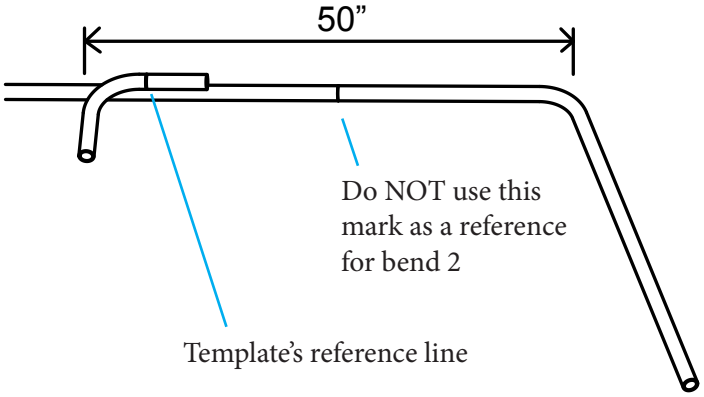


Template positioned for the 1st bend.

BEND 2:

Place the template above the rollbar tube with the reference line facing bend 1 as shown below. Slide it to 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 is that if the first bend was not made at the correct position to achieve 25” from rollbar’s center you can correct this error in the second bend’s position. Mark the rollbar tube exactly underneath the template line and make the second 70° bend.

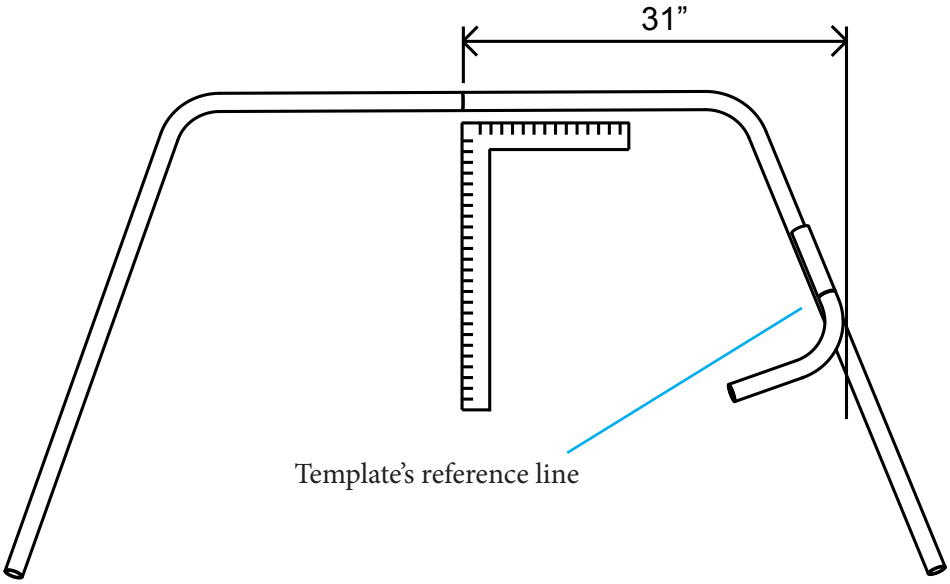
Erase the center mark on the rollbar tube and mark a new center exactly midway between the outside of the two bends. Why? Let’s say your measurement shows the two top bends are really 50 1/4” wide instead of the desired 50”. In that case, your old center mark could be off by as much as a 1/4”. The NEW center mark corrects this error. With template bending your errors can generally be fixed in the next bend. If you had started bend 2 from the rollbar’s center mark you would not have made the correction. Eventually, every bend adds a little more error and you end up with a rollbar that does not fit.



Template positioned for the 2nd bend.

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 to the right. 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.

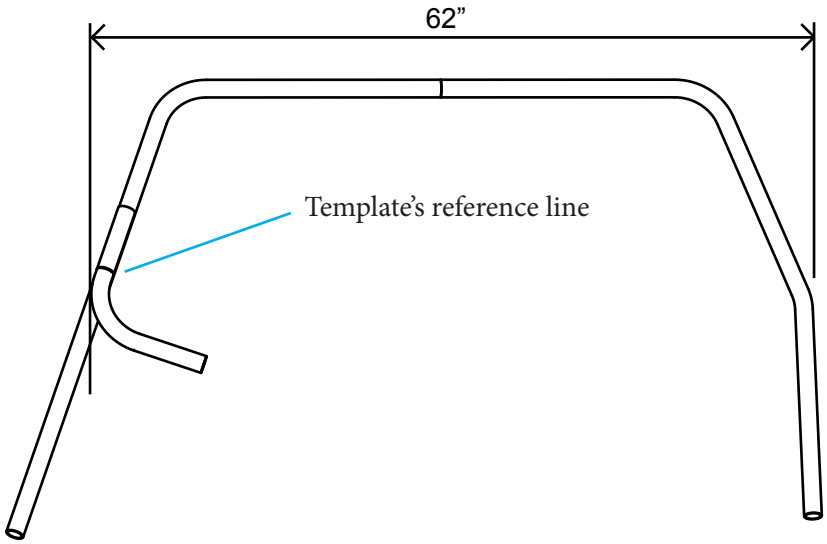


Template positioned for the 3rd bend.

BEND 4:

Position the template with the template line facing up towards the top of the rollbar as shown to the right. 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.



Template positioned for the 4th and last bend.