Woodinville Wonderland

Precision EMT Bending

Overview - Background:

At some point doing a Christmas display, there becomes a need to have some rigid arcs or circles. These have various uses, from Light Fans, to Mega/RGB Tree Bases, Leaping Light Arches, Mounting Bars for Floods, etc… The potential is unlimited. EMT has specific advantages over PVC based conduit, because it is more rigid, can be welded (very carefully), tapped, screwed, clamped down, it holds up to wind & weather. Plus, like PVC conduit, when prepped properly, it can be painted. Over the years, I have used the method of drawing my radius in chalk on the ground, grabbing my Bender and ad-hoc going to town. Now, this method worked OK, but for me it was frustrating and time consuming. I had no "plan" nor understanding of technique. So I ended up with ovals, helix effects etc… that required a lot of fudging. The results were OK, but IMHO, could have been better. Walter Monkhouse planted the seed for creating this document in talking to him about his ColorMotion Tree, the base he made, and how he made it. I got to thinking that there had to be a better way to approach this. With the help of a good buddy, fellow light crazy, certified electrician and teacher, Pete Peters, he got me bending in the proper way. I felt it was something others would need, and appreciate. My suggestion is to read this entire How-To a few times, review the pictures, then orient yourself to the tools and materials, then start your first project. It takes a project or 2 to really get the feel for how this all works.

Before Starting:

You first need to figure out the size of bend, arc or circle you require. Then you need to calculate the circumference of that element to determine the "straight length". This is where the Circumference Calculator on the first page comes in handy. Plug in the diameter of your element, and it provides the other information. For this How-To: we will be using a 5ft. diameter circle as our example. The calculator gives us a circumference of approximately 15.7 feet. Which means that we will need 2 10ft sticks of EMT to create our circle. We will build this in 2 180 degree halves and join them with our EMT Couplers. Note:1

Calculating the Area of Circles - Online Calculator

Measuring Circles

Area:	19.6349540	Solve Others
Diameter:	5	Solve Others
Circumference:	15.707963	Solve Others

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Items Needed:
- EMT—Electrical Metallic Tubing (thin wall)
    - 1/2" - 3/4" - 1" (Approx $2 - $7 per stick)
    - Determine size for your purpose
- Matching EMT Couplers (Approx $.55 apeice)
- Conduit Bender
    - 2 sizes available
        - 1/2" - 3/4" (Approx $40)
        - 3/4" - 1" (Approx $80)
- Magnetic Protractor (Approx $10)
- Hack Saw
- Screw Driver
- Tape Measure / Steel Ruler
- Metal File
- Upright Bender Holder (Optional-see Picture 5)

Picture 1 - Required Tools

Circumference Calculator:
- http://math.about.com/library/blcirclecalculator.htm

Calculating for the 90 degree arc:

Electricians figure bends in term of 90 degrees. They have a specific formula to calculate the concentric bending of the conduit.

That formula is:

- **Radius x 1.57***, divide by 18 (to get the spacing between bends for one quarter of a circle)**
- **The 18 represents the number of 5 degree bends for every quarter of a circle (90 degrees)**

Let's take a look at our example, it is best to break this down into inches:

1. **5ft Dia = 60 inches - divide by 2 to get the radius = 30"**
2. **30" times 1.57*** = 47.10" (Developed Length*** of our 90 arc)**
3. **47.10" divided by 18 (5 degree bends) = 2.62**
4. **Putting back into fractions for our tape measure, or ruler, (.125 = 1/8" & .0625 = 1/16") we attempt to convert back to the nearest 1/16th inch, for this example, we have approximately 2 5/8" between each 5 degree bend.** I've included a fractions/decimal conversion chart for reference on Page 14 .

NOTE: You can calculate for 10 degree bends, which makes things somewhat easier as you have less bends. But, at 5 degrees, you get a smoother EMT arc, and it gives you more opportunities to "fix" your angles when you get to the bending stage. 10 degrees would give you 9 bends in 90 degrees and a more segmented look. You would need to substitute "9" for the "18" in line 3 above. OR: you can calculate all this the same and only bend every other mark.

***- Math lesson– 1.57 is half of 3.14 (Pi) and is known as the "Developed Length" of the Ninety. We use 3.14 times the Diameter to get the circumference. We use the radius which is half the Diameter. Therefore, we use half of 3.14 (Pi), 1.57 times the radius to get the Developed Length. The Developed Length is what we divide by 18 (5 degrees) or 9 (10 degrees) to get the spacing between bends. Probably more info than you wanted to know!

We will then take the above information and apply it to an EMT stick and create an arc that will be a full 180 degrees or one half of our circle. Note:1

Set up:

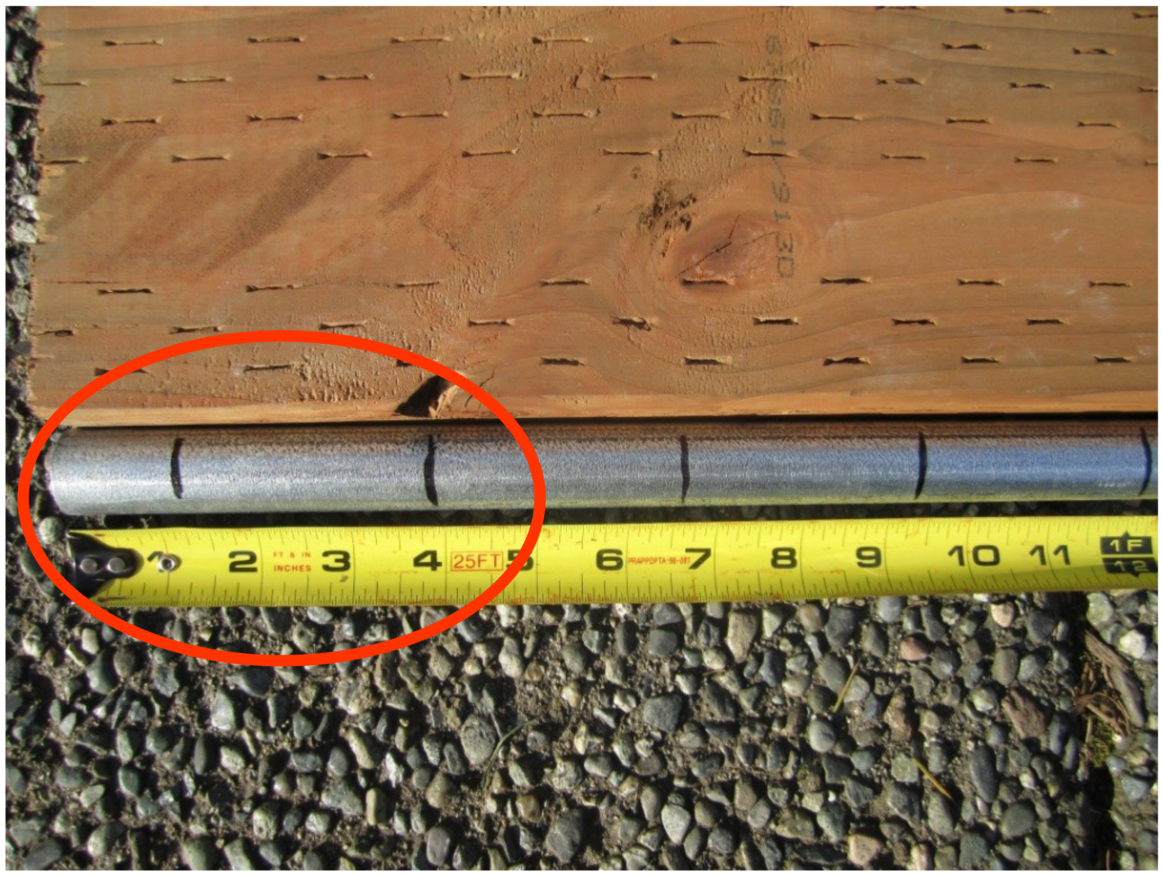
1. First you will need to put a mark on your bender head for our 5 degree bends. This will only need to be done once. The benders come pre-marked with set degrees (10,22,30,45,60). You always bend your EMT so that the bottom of the EMT aligns with the desired degree mark (See Picture 11). We need to make a 5 degree reference on our bender head. This requires a bit of fudging. To do this, grab a spare stick of EMT, use a pencil to mark the bender head, bend a sample and check the bend with your protractor. Once you have identified where 5 degrees is, mark it with a permanent marker. **NOTE: MAKE SURE YOU ARE MARKING AND WORKING WITH THE CORRECT SIDE OF THE BENDER.** The bender will have numbers on both sides of the head. One for each size EMT the bender was made for. See **Picture 3**.

Picture 3 - Bender Holder w/ 5 Degree Bender Head Mark

Set up:

2. Looking at our 15.70' circumference, we will be making 2 half circles that will be just under 8' each (7.85'). Next we go to our EMT and place our bending marks every 2-5/8". NOTE: Each stick of EMT will have several alignment lines marked horizontally down the stick. These are used for alignment later. Make your bend marks perpendicular to one of those lines. See **Picture 4** for EMT marking & Picture 7 & 8 EMT alignment lines.

Something to consider : You may want to make the very first bend mark on your EMT stick, half your initial bend angle increment. The reason is to create a smoother arc where the couplers join the sticks. **Picture 4** below reflects this technique.



Picture 4 - Marking EMT at 2 5/8" Increments

Set up:

3. Bending can be done on the ground, however Walter Monkhouse stated he was doing this "above his head". So I devised my Upright Bender Holder using 1-1/4" black pipe. I use a lot of this stuff in my display, so I have all kinds of pieces of various lengths lying around. I found that having the bender stationary and upside down, allows more stability, control & makes it easy to align everything to eliminate the "helix" effect. I found it was way easier to work by pulling downward on the EMT with 2 hands. You will need to have the riser, taller than the diameter of your circle. See **Picture 5**. The example here is approx. 6' tall.

NOTE 1: 1-1/4" pipe will accommodate the handles for both sizes of EMT benders. PVC may not be rigid enough, should you try to use it as a riser. The weak point would be the PVC threads in the floor flange with the downward pressure applied during the bending process.

NOTE 2: This works well for smaller circles, and as you get beyond 6' in diameter, going to the ground may be the best approach, rather than going up/down a ladder constantly.

Alternate Base: I use a 5 way cross shown here, but you could mount a 1-1/4" floor flange on a piece of plywood as a base as well.

Picture 5 - Upright Bender Holder

Set up:

4. Lastly, before you insert the EMT into the Bender, starting with your second 5 degree measurement mark, I label these 1—18 to represent the 10 degree designations (10-20...90 etc...). You will be pulling the EMT out several times to check the angle with your protractor, this helps you keep track of where you are at on your EMT bends, and the angle it corresponds to. In **Picture 6** you see the 80-90-100 degree marks on this EMT.

5. Insert the bender into the Upright Holder, then insert your EMT into the bender. See Pictures 7 & 8.

Picture 6 - 10 Degree Marks on EMT

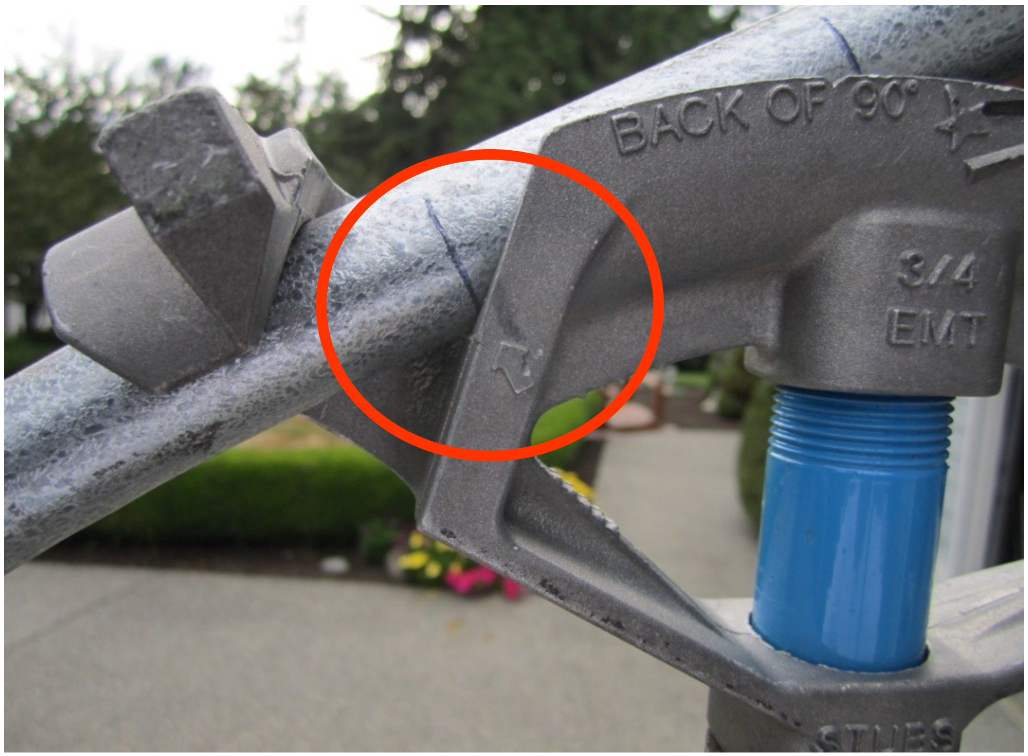
Precision EMT Bending

Picture 7 - Bender Holder w/ Bender

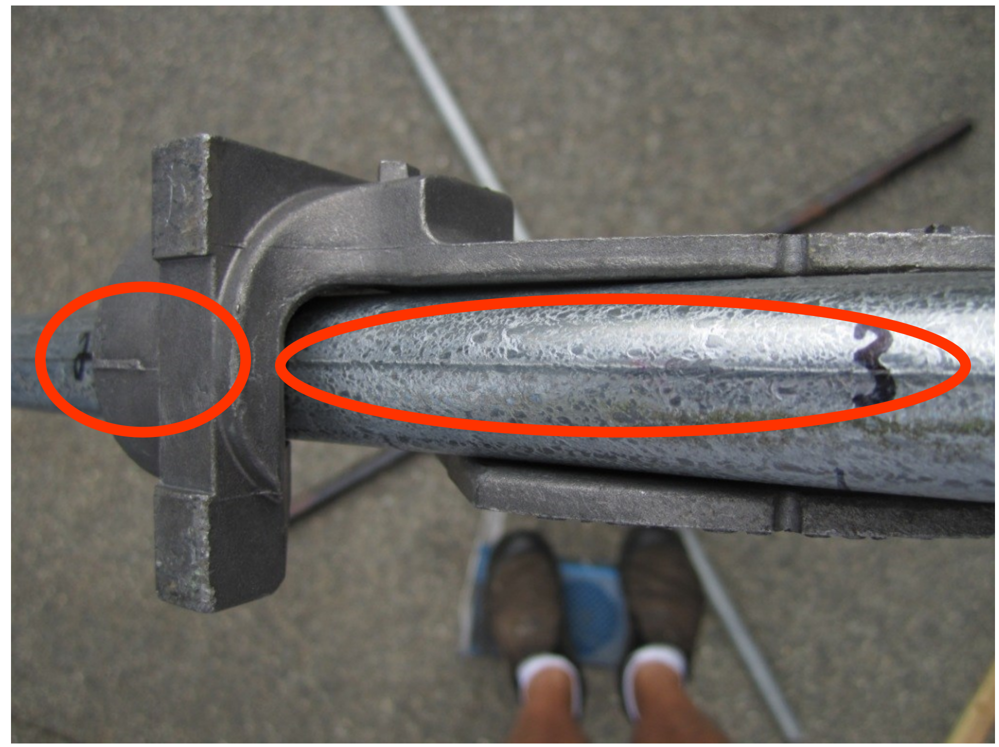
Picture 8 - EMT Inserted Into Bender

EMT Bending:

1. With the EMT in the bender, there are 2 alignments required before you can start your bend. First is your 5 degree mark. This is aligned with an arrow on the side of the bender head. You can really align these marks with anything, but you just have to be consistent in this alignment through the entire bending process. Then you need to align the horizontal mark on the EMT with the bender head alignment mark. See **Picture 9 & 10** for the alignment set up.



Picture 9 - 5 Degree to Bender Arrowhead Alignment.

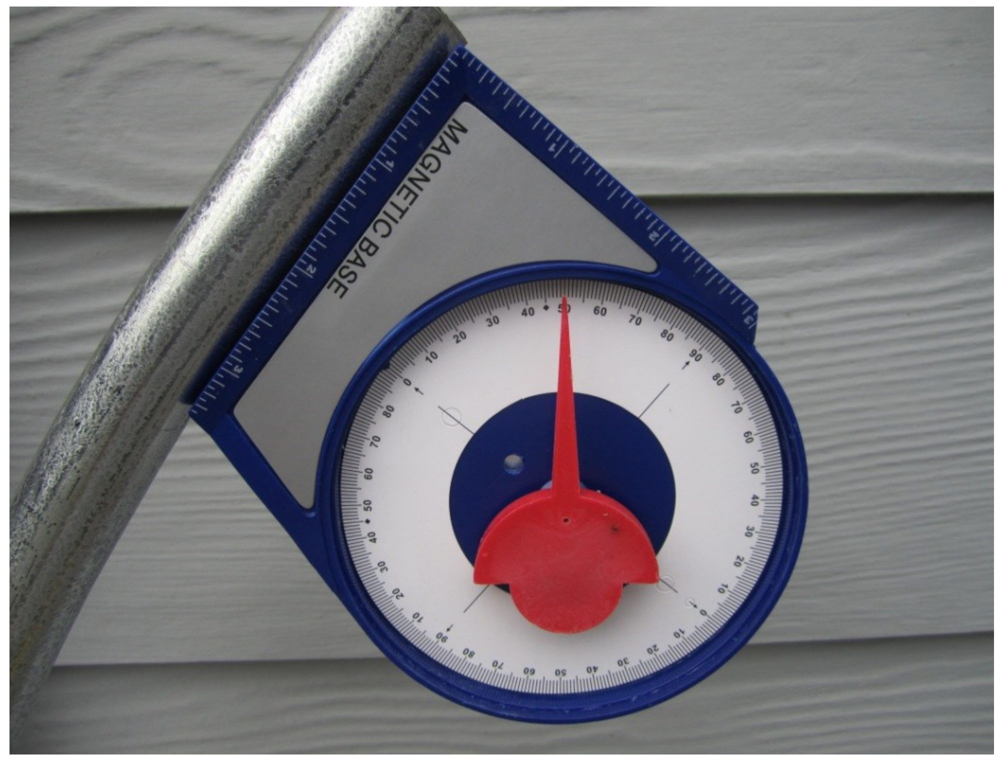


Picture 10 - Alignment Marks EMT & Bender

EMT Bending:

2. Slowly and smoothly pull the EMT down, a very small amount. You want to pull till the bottom of the EMT is aligned with your 5 degree mark, see **Picture 11**. After each bend, and as you move to the next mark, be sure to re-align both the horizontal and vertical degree marks, as you get further into arc formation, the horizontal alignment becomes important to alleviate creating a helix.
3. Every other bend, where we marked the degree numbers in Set Up, Step - 4, pull the EMT out of the bender and check it with your protractor. Put the EMT on level ground, set the protractor on the very end of the EMT and ensure you have the correct corresponding angle. If it is not enough, put the EMT back in the bender and slightly adjust the last 2 bends, then re-check. If it is too much, make your NEXT 2 bends a bit shallower with less angle. You can see how you did after the next check. **Picture 12** below shows the results of our arc at the 130 degree bend.

Picture 11 - 5 degree & EMT Relationship After Pull



Picture 12 - Protractor Angle Check

EMT Bending:

4. Once you get beyond the first 6-8 bends, you can also use your Upright Holder to ensure your horizontal alignment, preventing the helix effect, this could save you a trip up a step ladder. Stand behind the set up and make sure the EMT is fully aligned with the vertical upright. See **Picture 13**.
5. Once you get close to 120 degrees, you will need to move the EMT past the vertical pole on the Upright Holder. Make sure with each bend after this point, the EMT is in contact with the post as shown in **Picture 14**.

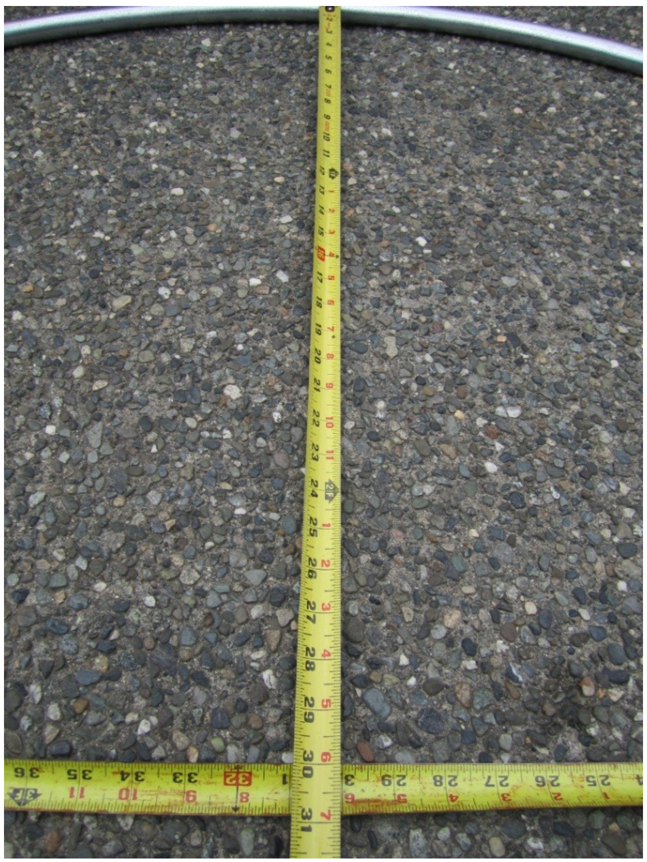
Picture 13 - Horizontal Alignment Check

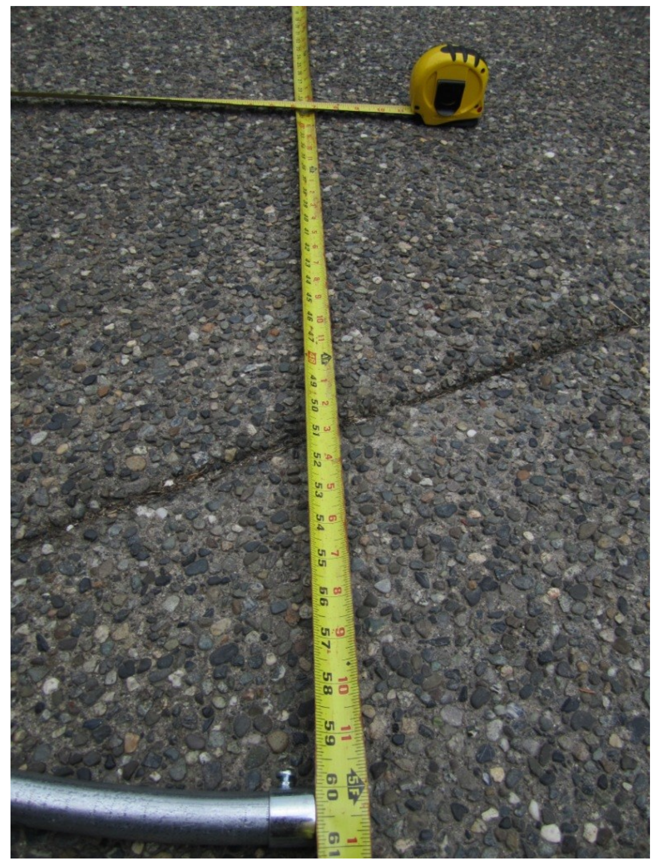
Picture 14 - EMT Past Vertical Upright

EMT Bending:

6. Note: On the larger diameter elements, where you will be using most of, if not all of the EMT stick, the last few bends will be very tough. I suggest inserting a secondary pipe into the end of the EMT as a "cheater bar" to assist you with these last few bends. See Note 2 on Page 14

7. Once you complete your 180 degree arc, pull it out of the bender, lay it on the ground and check the dimension using a tape measure. Some very slight adjustments may be needed, but at this point you should be very close to your radius size. Once satisfied, cut the excess EMT off the arc using your hacksaw. Attach the EMT couplers to the arc ends, you may need to use your metal file to remove burrs caused from the hacksaw, then tighten them down with a screwdriver. **See Pictures 15 & 16**.





Picture 15 & 16 - Arc Sizing Check

EMT Bending:

7. Once you have completed the first arc, go through the outlined steps to complete the 2nd half of your circle. Slip the EMT Couplers in place. You may need to use your metal file to take off any burrs if you cut the EMT at all. Re-measure. There may be some slight tweaking to be done to reduce the “egg effect” and VIOA-LA!, you have precision bent display element.

Picture 17 - Completed Element

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Precision EMT Bending

	DECIMAL	M M
1/64	.0156	0.396
1/32	.0312	0.793
3/64	.0468	1.190
1/16	.0625	1.587
5/64	.0781	1.984
3/32	.0937	2.381
7/64	.1093	2.778
1/8	.125	3.175
9/64	.1406	3.571
5/32	.1562	3.968
11/64	.1718	4.365
3/16	.1875	4.762
13/64	.2031	5.159
7/32	.2187	5.556
15/64	.2343	5.953
1/4	.250	6.350
17/64	.2656	6.746
9/32	.2812	7.143
19/64	.2968	7.540
5/16	.3125	7.937
21/64	.3281	8.334
11/32	.3437	8.731
23/64	.3593	9.128
3/8	.375	9.525
25/64	.3906	9.921
13/32	.4062	10.318
27/64	.4218	10.715
7/16	.4375	11.112
29/64	.4531	11.509
15/32	.4687	11.906
31/64	.4843	12.303
1/2	.500	12.700

	DECIMAL	M M
33/64	.5156	13.096
17/32	.5312	13.493
35/64	.5468	13.890
9/16	.5625	14.287
37/64	.5781	14.684
19/32	.5937	15.081
39/64	.6093	15.478
5/8	.625	15.875
41/64	.6406	16.271
21/32	.6562	16.668
43/64	.6718	17.065
11/16	.6875	17.462
45/64	.7031	17.859
23/32	.7187	18.256
47/64	.7343	18.653
3/4	.750	19.050
49/64	.7656	19.446
25/32	.7812	19.843
51/64	.7968	20.240
13/16	.8125	20.637
53/64	.8281	21.034
27/32	.8437	21.431
55/64	.8593	21.828
7/8	.875	22.225
57/64	.8906	22.621
29/32	.9062	23.018
59/64	.9218	23.415
15/16	.9375	23.812
61/64	.9531	24.209
31/32	.9687	24.606
63/64	.9843	25.003
1	1.000	25.400

Notes:

1. It will be obvious quickly that any circle over 6.5′ will need to be broken up into 3 EMT sticks. You would bend each EMT segment at 120 degrees. Anything 10′ or over, will be looking at 4 EMT sticks to complete a full circle creating 90 segments.

2. Cheater Bar. Depending on your diameter EMT, I suggest you use a 2′ length of pipe, (galvanized or black is best) that is the next standard size down from your conduit. In this case I used 3/4″ EMT. If you get a 2′ section of 1/2″ pipe, grind a very slight amount off one end that you will use to insert into the EMT. After grinding down slightly, sand it to smooth it out. Then use WD-40 to aid in inserting the lever into the EMT. You want something that will give you leverage to pull down, *without stretching the EMT opening.* **This is especially critical if you are using the full length of your EMT for your element.**

Again, many thanks and credit go to Walter Monkhouse and Pete Peters for their contribution to this How-To.

If you have any questions, below is all my contact information:

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"Zman" on all the Christmas Forums

The document on the following pages was initially found by me many years ago. Links to it have since been removed from the internet as best I can tell. I am including it here just as a supplemental reference on the subject of conduit bending. It is not my material I just include it to augment this subject matter.

Conduit Bender Guide

Conduit Bending Basics:

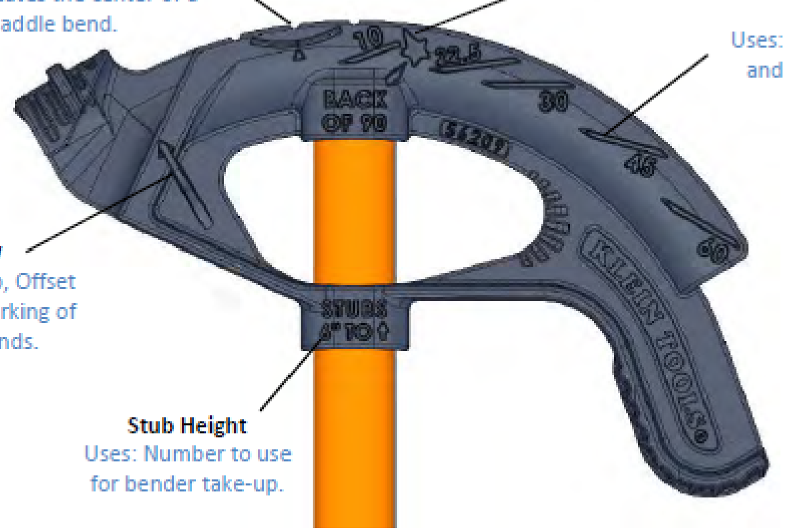
The line of Klein Tools conduit benders have been designed for performance and durability exceeding the expectations of today's professional. It is recommended to familiarize yourself with bending concepts, techniques and learn the bender's functionality to provide you a positive experience while greatly improving the overall outcome of your project.

Conduit come in two types, EMT and Rigid conduits and can be found in various sizes. Klein Tools provides conduit benders for EMT in ½", ¾", 1" and 1-¼" conduit and ½", ¾", and 1" Rigid conduit.

To aid bending when performing a ground or air bend, the benders are marked with different alignment symbols to help the operator create the bends necessary to accomplish any project. The symbols found on the Klein Tools benders are the arrow, the teardrop, the star point and angle markings. These markings are found on various sides of the bender head.

Klein Tools
Ductile Iron Series:
½" EMT: #56203
¾" EMT: #56204
1" EMT: #56205
1-¼" EMT: #56211

Klein Tools
Aluminum Series:
½" EMT: #56206
¾" EMT: #56207



The 4 most common bends to know how to make are the 90° Stub-Up, Back to Back, Offset and the 3 Point Saddle bends. It is common to use a combination of the bender markings when making certain tube profiles. Knowing the proper technique and method of making the bends will allow you to accomplish most projects efficiently.

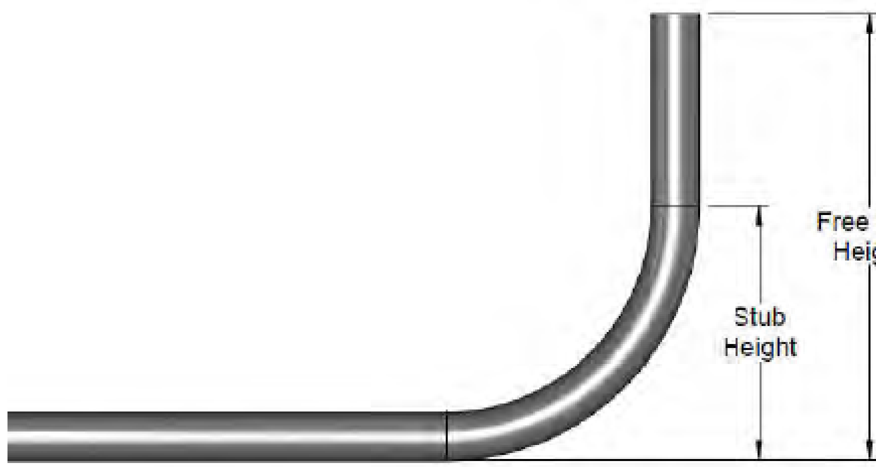
Things to remember while bending:

1. A proper bend is made by rolling the conduit about the bender in the conduit's cradle using all foot pressure.
2. Use the correct size bender for the conduit size being bent.
3. Some over bending may be required to allow for spring back of the conduit. The resting condition of the conduit is to be at the final angle desired.
4. Measure and properly mark your conduit using the tables and information provided.
5. Floor bending: Make sure conduit is secure so it does not slide prior to bending. Apply ample foot pressure to the benders heel while minimizing the use of the handle as a lever but more of a guide.
6. Air Bending: Make sure handle's hilt is secure on ground and is reinforced by your foot so it does not slide out. Make sure you are balanced and apply force close to the tool and your body controlling the tubing as you bend it around the bender's cradle making sure the conduit does not slide in the bender head.
7. To prevent injury, always wear protective gear and do not over exert.

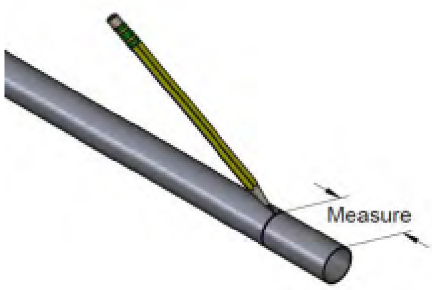
90° Stub-Up Bend: 

The stub bend is made by bending a piece of conduit into an L shape or 90° bend by placing the free end (short end) of the tube to a predetermined length as indicated in the diagram below. This is the most common bend and is a building block for other bends. Common uses for this bend are: Running conduit into electrical boxes, running conduit up or down walls, running conduit into walls through floors and ceilings and making inner and outer corner turns.

Bender Take Up Table 90° Stub-Up Bend	
Conduit Size	**Stub Height** Amount to subtract from Measurement
½″ EMT	5″
¾″ EMT and ½″ Rigid	6″
1″ EMT and ¾″ Rigid	8″
1-¼″ EMT and 1″ Rigid	11″

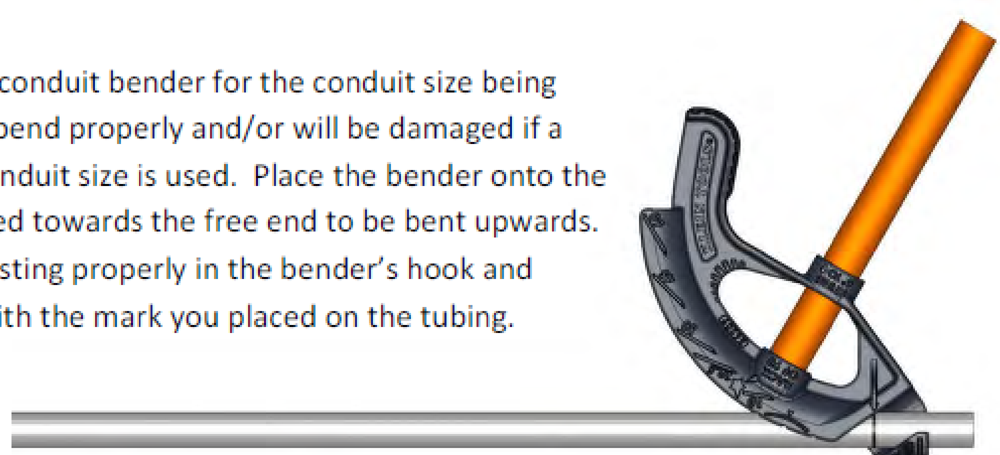


1. Determine the overall free end height of the conduit you want after the bend.
2. From the overall free height, subtract the stub height listed in the Bender Take-Up Table for the conduit size you are bending. *Klein Tools has provided the correct stub height on each bender head.*
3. On the conduit, measure from the free end to be bent up the calculated number and mark the conduit.



As an example, to bend 3/4″ EMT conduit have a free end height of 8.5″, the table indicates to subtract 6″ from the 8.5″ which leave 2.5″ from the end to bend up to make the mark. *Tip: Advanced benders can lay a tape measure next to the conduit and perform the bending operations if the bend does not call for high degree of accuracy.*

4. Always use the proper size conduit bender for the conduit size being bent. The conduit will not bend properly and/or will be damaged if a mismatch of bender and conduit size is used. Place the bender onto the tubing with the hook pointed towards the free end to be bent upwards. Make sure the conduit is resting properly in the bender's hook and lineup the **arrow symbol** with the mark you placed on the tubing.



5. Keeping the conduit flat, apply ample foot pressure to the bender's heel minimizing the use of the handle as a lever, rolling up the free end into the 90° position checking the degree with a level. When done properly the free end will be at the desired height and the arrow will be at the stub height as indicated.

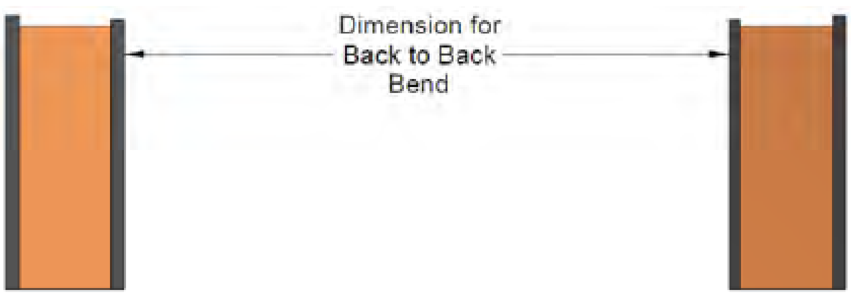
In some installations there will be a need to cut down the unbent side of the conduit to another desired length to fit the installation. Use a tube cutter for smooth precise cutting and burr removal to ensure the safety of the electrical wiring when pulled through. A hacksaw can be substituted as long as the tubing's cut edge is prepared properly.

Klein Tools Tube Cutter: **#88975 & 88977**
Klein Tools Hacksaw: **#701-10, 701 -12 &701 -S**
Klein Tools Level: **#931-6RE & 931-7RE**

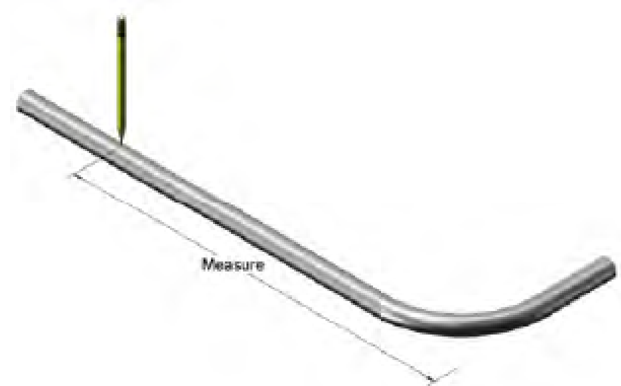
Back to Back Bends: 

The back to back bend is the next style of bend that is needed while running electrical conduit. In reality the concept is formulated by the need to know the distance from the **back** edge of a 90° bend to a fixed point down the conduit to mark for other bend operations to meet the installation requirement. As you will see it builds on the 90° stub bend and when done the most common use of this bend will look like an elongated U.

You will need to know this bend method when you want to fit conduit between two parallel surfaces such as two walls or joists while keeping the U's outer edges of the legs touching the two surfaces. This allows for proper anchoring and a nice clean appearance.



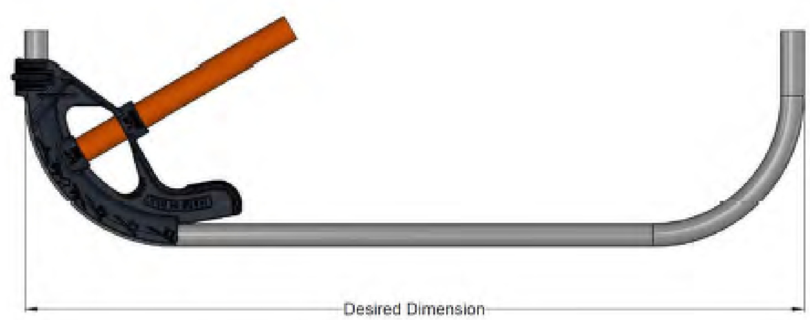
1. Determine the distance between the two parallel surfaces to get the dimension for back to back bend.



2. The first bend for the back to back bend is the 90° stub-up bend. Follow the steps from the 90° Stub-Up section to create the ideal bend for the connection on the first side.
3. From the **back** edge of the 90° stub-up bend, measure the distance found in step 1 and make your mark on the conduit.
4. Place the bender on the conduit with the bender's hook facing the free end of the tube to be bent **opposite** the original bend side. Make sure the conduit is resting properly in the bender's cradle and lineup the **Star Point Symbol** with the mark you placed on the tubing.

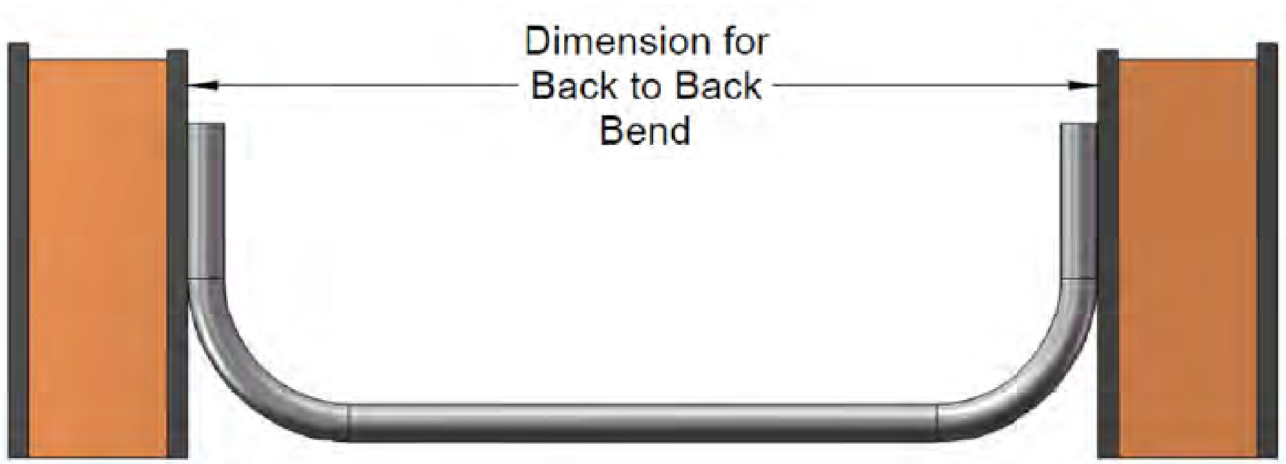
5. Keeping the conduit flat, apply ample foot pressure to the bender's heel, with minimal use of the handle as a lever, rolling up the free end into the 90° position checking the degree with a level. It is very important to keep the first 90° bend in the same plane as the new bend. If not the two legs of the U will be skewed and will not produce the desired shape. If this happens, some correcting can be done to properly align the legs depending on how out of shape they are. When the bend is done properly the conduit will lay flat and will fit inside the two surfaces measured.

In some installations there will be a need to cut down the unbent side of the conduit to another desired length to fit the installation. Use a tube cutter for smooth precise cutting and burr removal to ensure the safety of the electrical wiring when pulled through. A hacksaw can be substituted as long as the tubing's cut edge is prepared properly.



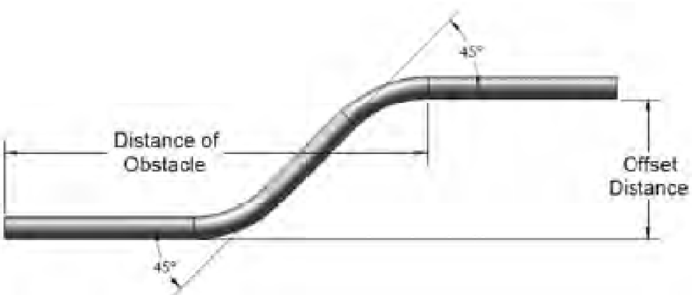
Klein Tools Tube Cutter: #88975 & 88977
Klein Tools Hacksaw: #701-10, 701 -12 &701 -S
Klein Tools Level: #931-6RE & 931-7RE

If the back to back distance is short (a tight U) so the bender has problems fitting to make the second bend, you may compensate by subtracting the stub height from the measured distance to fit the gap then follow step 3 to mark the calculated number on the conduit. But this time you would put the bender on the conduit with the hook facing the first bend and line up the **Arrow Symbol** as demonstrated in the Stub-Up section, step 5, with the conduit mark and proceed to make the bend as in step 5 rolling up the previously bent end up into the 90° position giving you the desired dimension. *Caution should be taken when creating the second bend. With this technique the first bend will be coming at the operator as the second bend is made.*



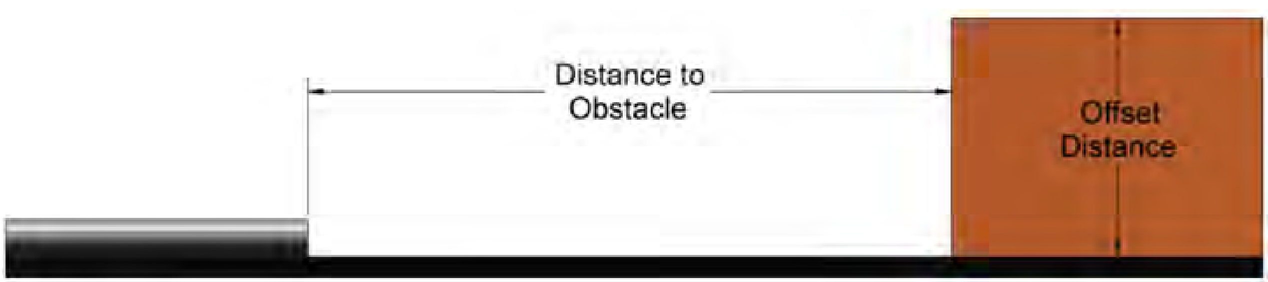
Offset Bends: 

An offset bend is a style of bend that is built independently of the 90° stub and the Back to Back bend and is an important bend to know when running conduit. It is common to shift the conduit a certain distance while continuing to run parallel in the same direction as the pre-shift portion of the conduit. There are many situations that call for an offset bend. The most common uses of this bend are: staggered joists, running tight on a wall and offset into an electrical box and changes in elevation.



Offset Formula Table		
Angle of Bend	Constant Multiplier	Shrink Per Inch of Offset
10° X 10°	6	1/16 = .063
22½° X 22½°	2.6	3/16 = .188
30° X 30°	2.0	1/4 = .250
45° X 45°	1.4	3/8 = .375
60° X 60°	1.2	1/2 = .500

1. Determine/measure the offset distance necessary to clear the obstacle and how far away the offset will need to be bent from the end of the conduit.



2. Decide what angle you wish to make the offset bend and determine the proper values from the Offset Formula Table. Calculate the proper values to mark on the conduit to clear the obstacle and fit in the gap measured.

Offset Formula Table		
Angle of Bend	Constant Multiplier	Shrink Per Inch of Offset
45° X 45°	1.4	3/8 = .375

As an example, the offset distance of the obstacle is 6" and the distance to obstacle is 20". The installation allows for a 45° X 45° offset bend. *Note: The choice of degree is usually the installer's choice and most of the time the installation location will determine what degree will fit.*

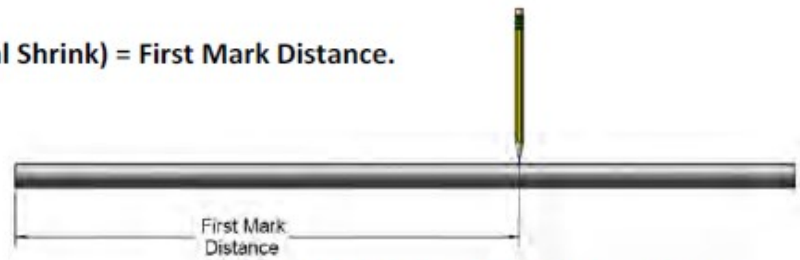
3. From the table use the 45° X 45° offset row for the values to calculate the series of markings necessary to make the proper bend. To find out where to place the first mark on the conduit, multiply the measured *Offset Distance* to clear the obstacle by the tables *Shrink/Inch* that will occur to the conduit after all the bends are made due to that offset distance or:

(Offset Distance) X (Shrink/Inch) = Total Shrink.

Example: 6" X .375 = 2.25" of total shrink.

This value is then *added* to the measured *Distance to Obstacle* number or:

(Distance to Obstacle) + (Total Shrink) = First Mark Distance.

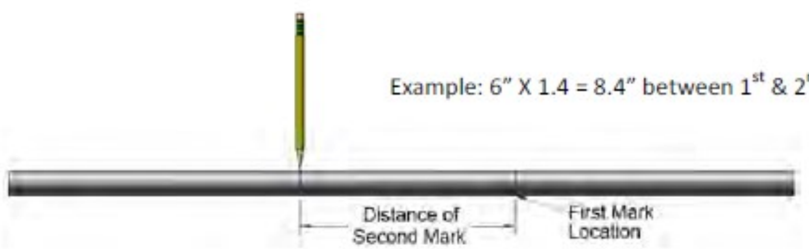


Example: 20" + 2.25" = 22.25" to make first mark.

To calculate the second mark needed on the conduit, *multiply* the measured *Offset Distance* by the *Constant Multiplier* of the table or:

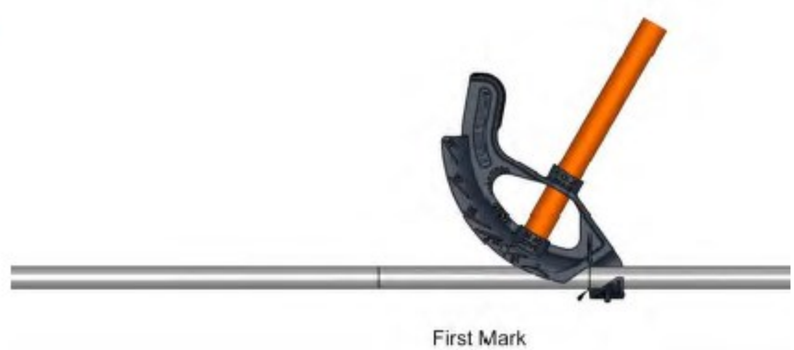
(Offset Distance) X (Constant Multiplier) = Second Mark Distance (Distance between Marks).

Example: 6" X 1.4 = 8.4" between 1st & 2nd mark.



This calculated value is how far apart to make your marks from each other on the conduit and where to make your 45° bends.

4. Using the technique to align the bender on the conduit as described under the Stub-Up Section 5, Place the bender on the conduit with the hook facing away from the second mark and line up the **Arrow Symbol** up with the first mark.



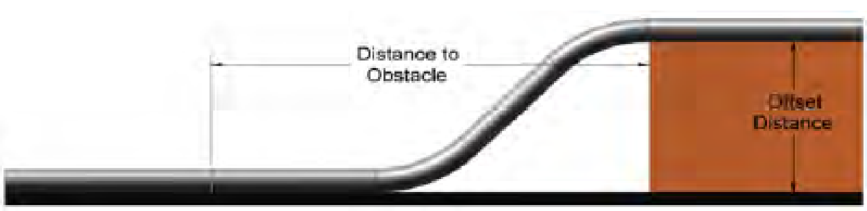
5. Keeping the conduit flat, apply ample foot pressure to the bender's heel minimizing the use of the handle as a lever, smoothly rolling up the free end until the **45° mark** is reached. When done properly the free end will be at a 45° angle from the original plane.

Note: Some over bending may be required to allow for spring back of the conduit. The resting condition of the conduit is to be at the final angle desired.

6. Keeping the bender and conduit together flip the two parts upside down and put the bender's handle hilt on the floor, balancing the conduit in the air, allow the conduit to rotate 180° in the cradle. Slide the conduit down so the first bend is moving away from the bender head, aligning the second mark as outlined before using the **Arrow Symbols** (See Stub-Up section, note 5).

7. The second bend of the offset is accomplished by performing an air-bend. Make sure the handle hilt is secure on ground and is reinforced by your foot so it does not slide out. Make sure you are balanced and apply force close to the tool and your body controlling the tubing as you bend it around the bender's cradle. Bend the free end until the **45° mark** is reached.

It is very important to keep the first 45° bend in the same plane as the new bend will be. If not, the two legs of the offset will be skewed and will not produce the desired shape. If this happens, some correcting can be done to properly align the legs depending on how out of shape they are. When the bend is done properly the conduit will lay flat and fit inside the measured distance to and clear the obstacle.

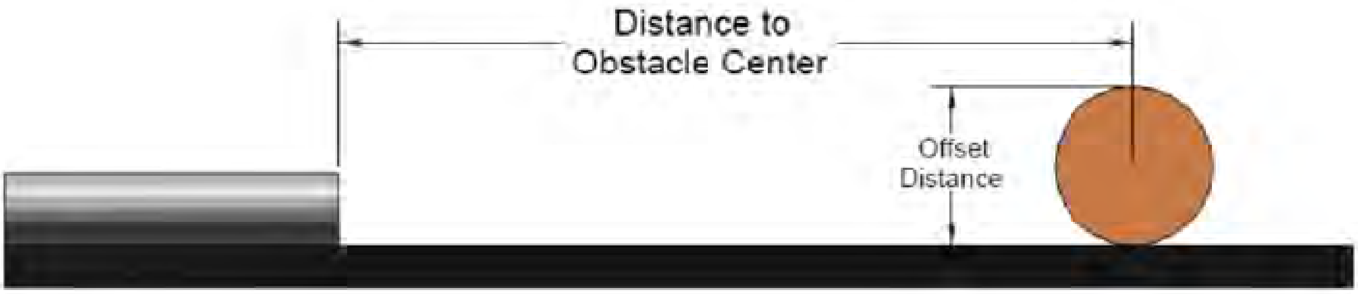


In some installations there will be a need to cut down the unbent side of the conduit to another desired length to fit the installation. Use a tube cutter for smooth precise cutting and burr removal to ensure the safety of the electrical wiring when pulled through. A hacksaw can be substituted as long as the tubing's cut edge is prepared properly.

Klein Tools Tube Cutter: #88975 & 88977
Klein Tools Hacksaw: #701-10, 701 -12 &701 -S

Three Point Saddle Bend: 

The three point saddle bend is a variant of the offset bend since it is an offset bend that returns to the original in-line run after clearing an obstacle. This bend is intended to bridge over obstacles such as existing conduit or plumbing running perpendicular to the intended conduit installation.



1. Determine/measure the offset distance necessary to clear the obstacle and how far away the saddle bend will need to be from the edge of the conduit. Unlike the offset bend you must measure to the center of the obstacle to bridge over.

2. Choose the angle that will be used for the center bend. The other two return bends will be 1/2 the center angle chosen. If the center angle is 45°, the two return bends will be 22.5°. Use the table to calculate the distance between bends and how much shrink is to occur to the conduit due to the bends.

3 Point Saddle Bend Table				
Degree of Bend:	45° Center Bend 22.5° Return Bends		60° Center Bend 30° Return Bends	
Obstruction Height	Shrink Amount	Distance off Center Mark	Shrink Amount	Distance off Center Mark
Every inch Add:	3/16"	2-1/2"	1/4"	2"
1"	3/16"	2-1/2"	1/4"	2"
2"	3/8"	5"	1/2"	4"
3"	9/16"	7-1/2"	3/4"	6"
4"	3/4"	10"	1"	8"
5"	15/16"	12-1/2"	1-1/4"	10"
6"	1-1/8"	15"	1-1/2"	12"

Example: As an example, the offset distance of an obstacle is 2" and the distance to obstacle's center point is 20". The installation allows for a 45° saddle bend. *Note: The choice of degree is usually the installer's choice and most of the time the installation location will determine what degree will fit.*

3. Calculate the value needed to place your first mark on the conduit. This number is determined by the *Measured Distance to Center Point* of the obstacle *plus* the *Shrink* from the 3 Point Saddle Bend Table that will occur.

(Measured Distance to Center Point) + (Shrink) = Center Mark

Example: 20" + 3/8" = 20-3/8"

4. Using the *Distance off Center Mark* values found in the table to clear a 2” obstacle, simply mark that distance from the center line in both directions or subtract this number from the center mark value for the first return bend mark and add that number to the center mark value to obtain the second return bend mark distance.

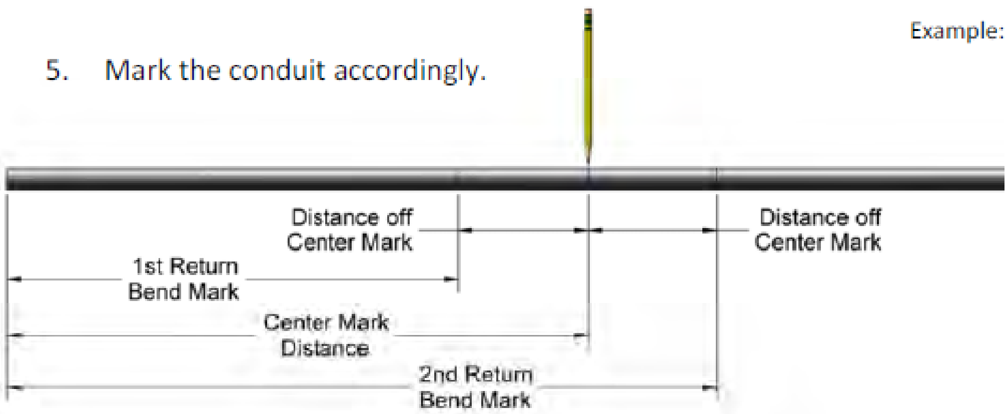
(Center Mark) – (Distance off Center Mark) = 1st Return Bend Mark

Example: (20-3/8”) – 5” = 15-3/8”

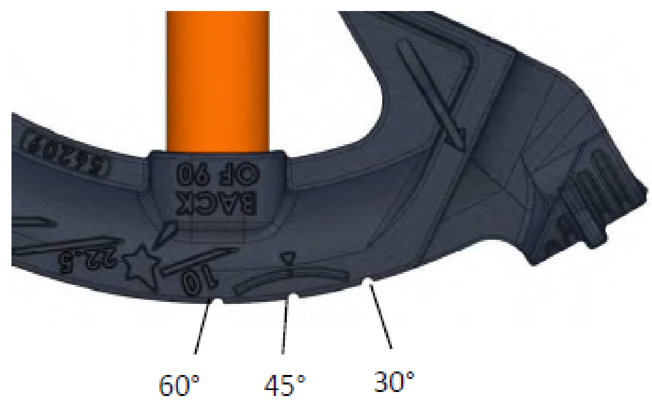
(Center Mark) + (Distance off Center Mark) = 2nd Return Bend Mark

Example: (20-3/8”) + 5” = 25-3/8”

5. Mark the conduit accordingly.



6. Place the bender on the conduit and position the appropriate **Center of Bend Rim Notch** on the center mark in the orientation shown.



7. Keeping the conduit flat, apply ample foot pressure to the bender's heel minimizing the use of the handle as a lever, smoothly rolling up the free end until the **45° mark** is reached.

   Note: Some over bending may be required to allow for spring back of the conduit. The resting condition of the conduit is to be at the final angle desired.

8. Keeping the bender and conduit together, flip the two parts upside down and put the bender's handle hilt on the floor, balancing the conduit in the air, allow the conduit to rotate 180° in the cradle. Slide the conduit down so the first bend is moving away from the bender head, aligning the 1st return bend mark with the **Arrow Symbol** (See Stub-Up section, note 5).

Note: Some over bending may be required to allow for spring back of the conduit. The resting condition of the conduit is to be at the final angle desired.

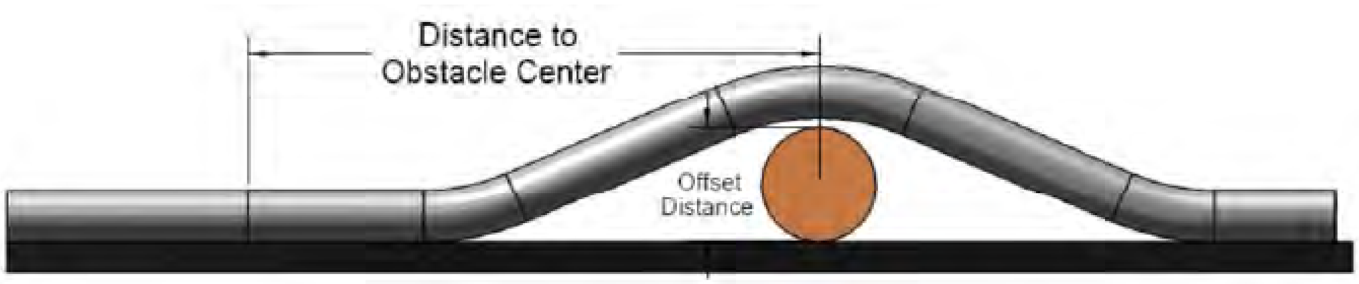
9. The second bend of the saddle bend is accomplished by performing an air-bend. Make sure handle hilt is secure on ground and is reinforced by your foot so it does not slide out. Make sure you are balanced and apply force close to the tool and your body controlling the tubing as you bend it around the bender's cradle. Bend the free end until the **22.5° mark** is reached.

10. Remove bender and place it back on the conduit on the other side of the center bend with the hook facing the center bend as before aligning **Arrow Symbol** (See Stub-Up section, note 5). On the 2nd return bend mark.

Note: Some over bending may be required to allow for spring back of the conduit. The resting condition of the conduit is to be at the final angle desired

11. The last bend of the saddle bend is made again by performing an air-bend. Make sure handle hilt is secure on ground and is reinforced by your foot so it does not slide out. Make sure you are balanced and apply force close to the tool and your body controlling the tubing as you bend it around the bender's cradle. Bend the free end until the **22.5° mark** is reached.

It is very important to keep all the bends in the same plane. If not, the offset will be skewed and will not produce the desired shape. If this happens some correcting can be done to properly align the legs depending on how out of shape they are. When the bend is done properly the conduit will lay flat and will fit the measured distance to obstacle, clear the object and return to the original line continuing the run as desired.



In some installations there will be a need to cut down the unbent side of the conduit to another desired length to fit the installation. Use a tube cutter for smooth precise cutting and burr removal to ensure the safety of the electrical wiring when pulled through. A hacksaw can be substituted as long as the tubing's cut edge is prepared properly.

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