HOW TO BEND A PIECE OF TUBING INTO THE SHAPE THAT YOU WANT

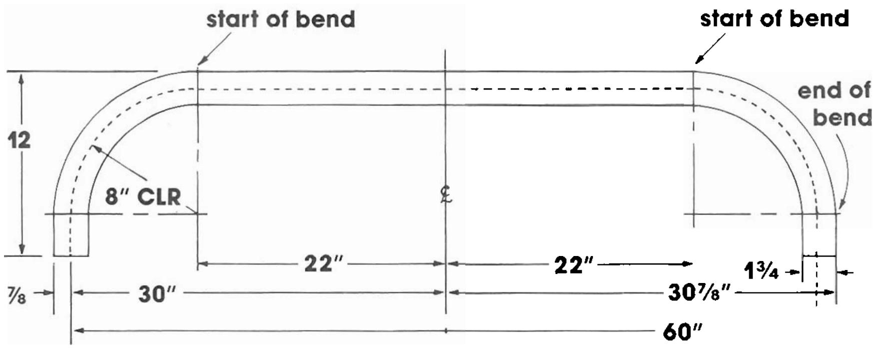
Did you ever wonder how professional shops bend tubing so that it fits perfectly? Here's how they do it and you can do it too.

by Doug Gore
photography by Robin Hartford

SUPPOSE you want to bend a piece of 1¾" tubing into a "U" shape like you might use for a rear bumper or for a nerf bar. Lets say that you have two sockets on your car that are separated by 60", center to center, and that you want the tube to stick out 12" overall. How do you go about bending this piece of metal?

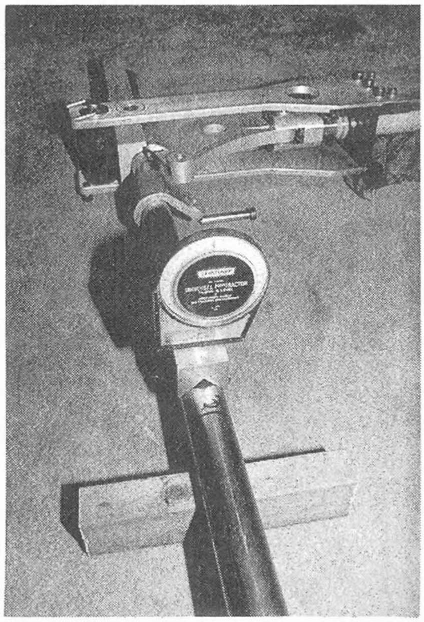
The first step is to draw a sketch of the finished piece on a sheet of paper and appropriately dimension the drawing. I know the centerline radius of the bending die that I am going to use is 8" and I have shown that in the drawing. You can chose whatever angle of bend you want by chosing the appropriate die set.

The next step is to figure out how long a piece of tubing will be required. There are many ways to do this but I have found that one easy way is to first figure out how long the tube would need to be if the corners were perfectly square and you measured along the centerline. In our case that measurement = 11⅛" + 60" + 11⅛", or 82¼". Since the corners on our finished tube will not be square, but round, we will actually need slightly less tubing than 82¼". If you don't mind wasting a little tubing you could start with an 82¼" piece and cut the ends off later (this is often the easiest thing to do) or you could figure out the correct length to start with. To figure out how much shorter the unbent tubing should be, realize that the circumference of a circle inscribed within a square is $\frac{3.14}{4}$ times the circumference of the square. We can round this figure off to ¾. The curved part of our tube will have an 8" centerline radius, and if the corner was square that radius would have required 8 + 8 = 16 inches of tubing. But since it is curved only ¾ of the 16", or 12", will be required for the actual bend. We will save 4" of tubing with each of these two bends, so the unbent piece of tube only needs to be 82 ¼ − 8 = 74¼ inches long. It is usually good to start with a little extra length until you get used to bending tubing, so I cut the tube to be one inch longer at 75¼".

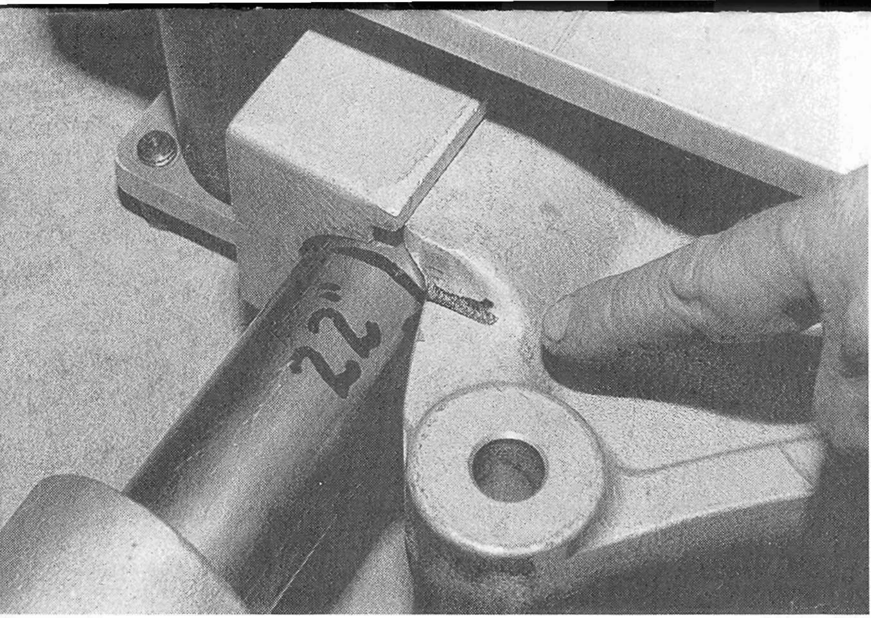


TUBE TO BE BENT
(not to scale)

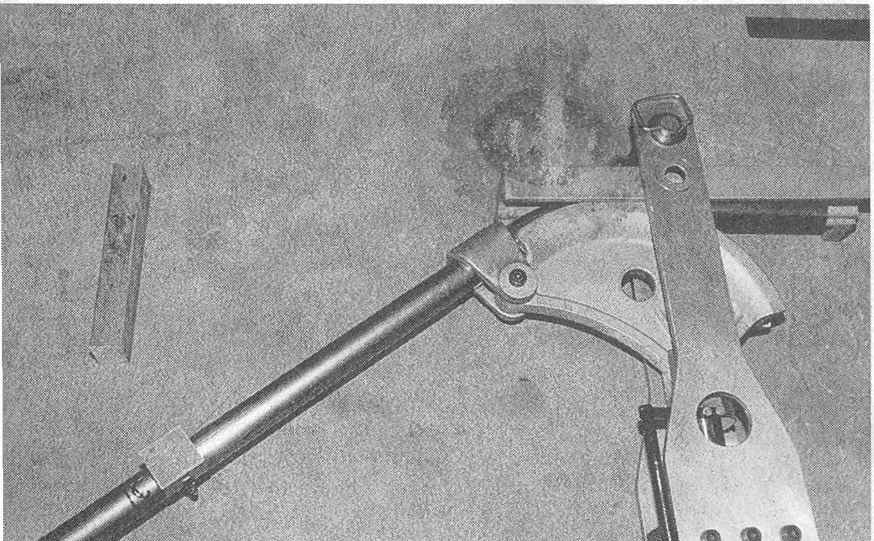
After cutting the tube to rough length, mark its center and mark the beginning of each bend out from there. In our case, each bend starts 22 inches from the center of the tube.



We are now ready to prepare for our first bend. I used one of the popular ram type tubing benders and placed the tube in the bender such that the mark indicating the start of the bend aligns with where the bending die begins to curve. The 2x3 helps to hold the ends of the tube up and a small "V" block has been clamped to the tube at an angle of zero degrees on a universal protractor.

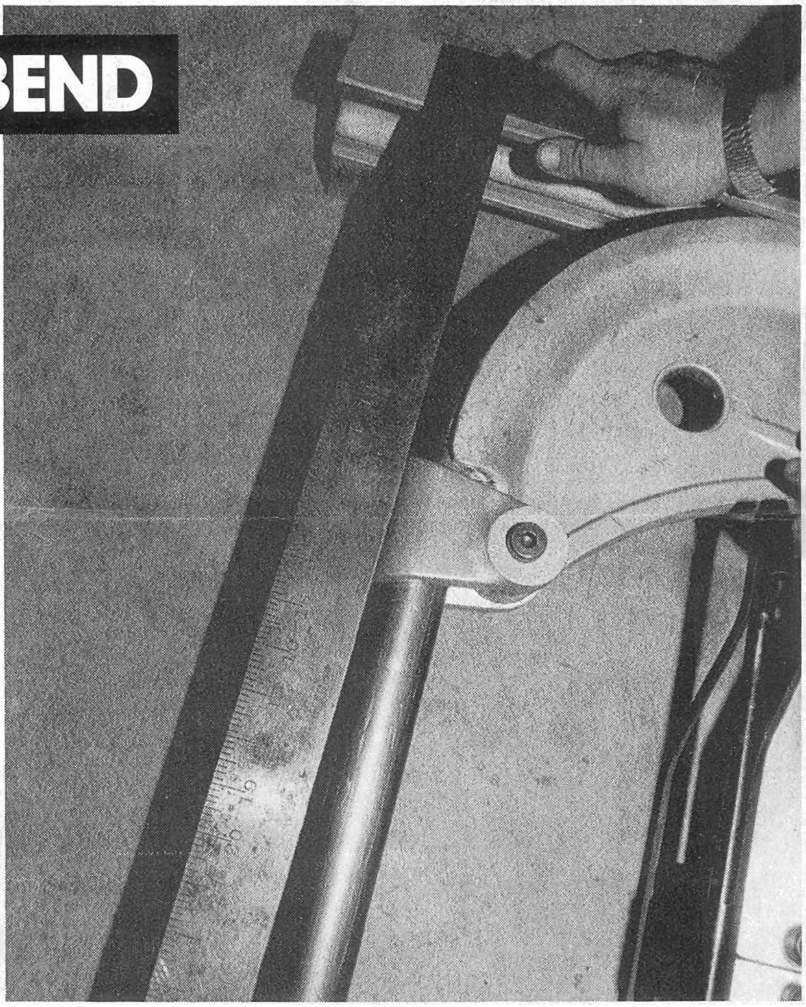


This photo shows the alignment of the 22″ mark on the tube with the beginning of the bend point on the die. This beginning of the bend point was determined by me by bending a piece of scrap tubing earlier and will change from bender to bender.

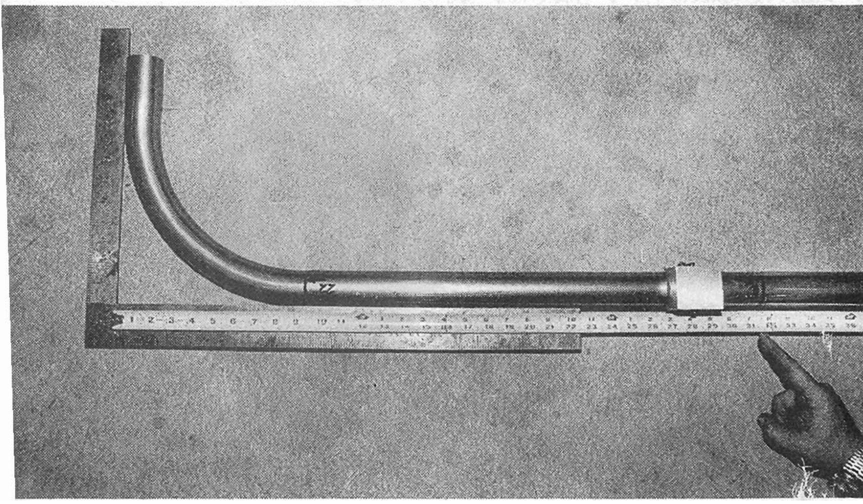


Here we are actually bending the tube.

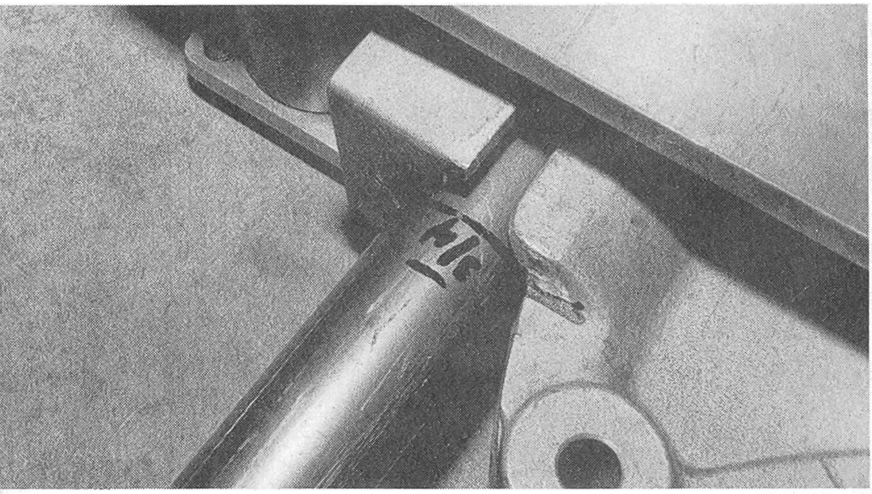
BEND



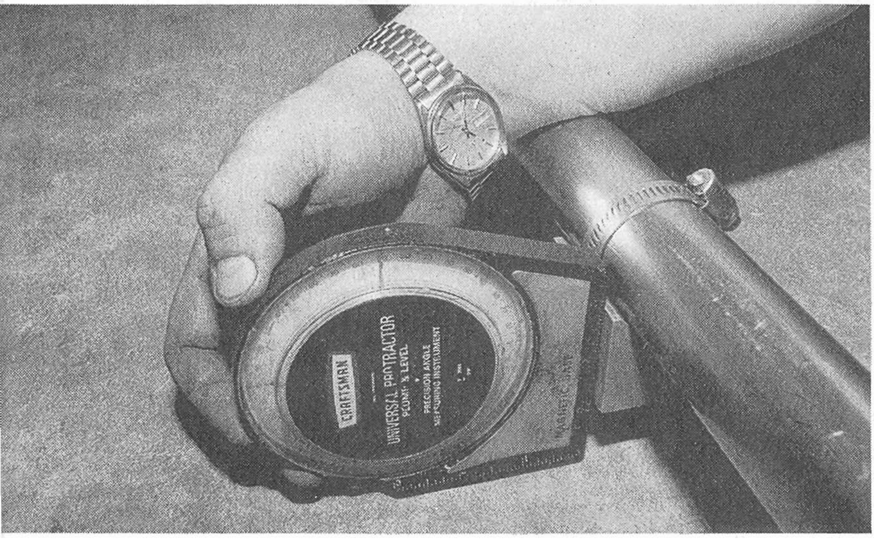
In this photo we are using a carpenters square to check the angle of the bend. Notice that we have over bent the tube slightly to allow for the springback. If you over bend the tube a little, it can easily be straightened in a vise since the steel has some memory. If on the other hand the tube is not bent enough, it will be necessary to put it back in the bender.



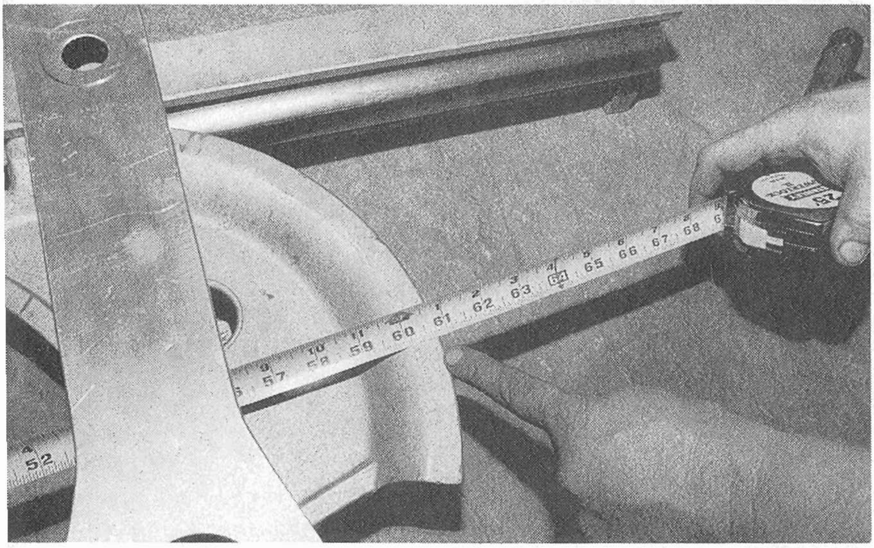
After we removed the first bend from the bender, we measured what we actually had done. Our drawing indicated that there should be 30⅞″ from the centerline to the outside edge of the bend, but the actual measurement was 31¼″. We had gained ⅜″ due to radius growth and springback. If we bent the other end of this tube at the existing mark, it to would be ⅜″ too long, and the finished piece would be ¾″ too long.



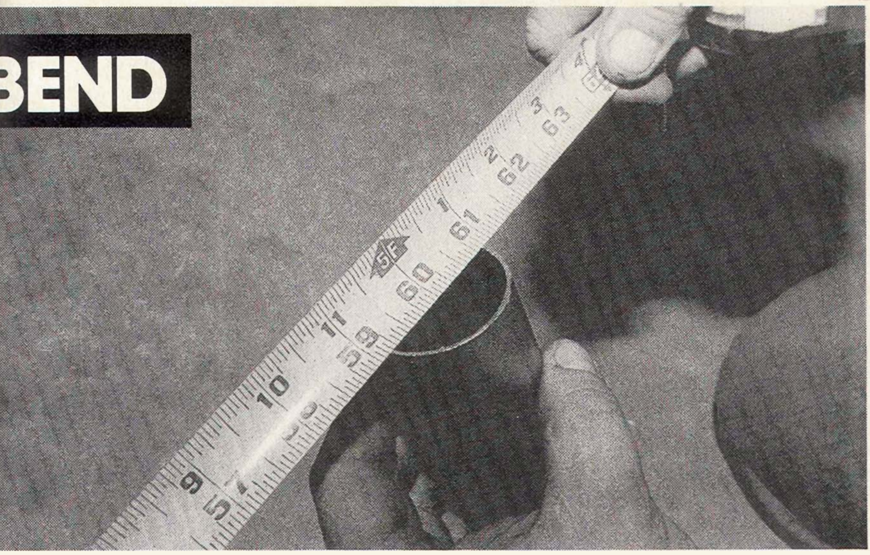
To compensate for this growth, we subtracted ¾″ from the remaining mark for the start of the second bend, and then put the tube back in the bender for the second bend.



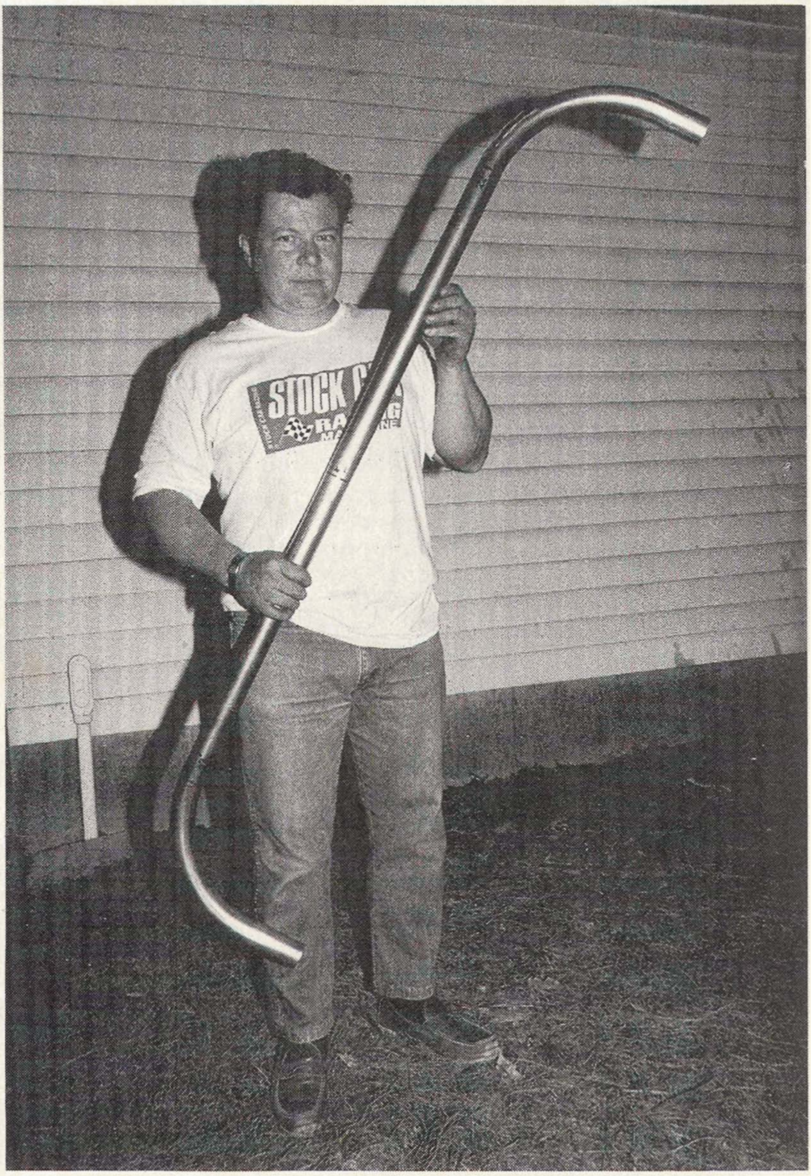
In order to insure that both of the bends will lie in the same plane when we are finished, we check the twist of the tube with the universal protractor and our clamped on "V" block.



As an additional check, we measure the distance between the far end of the bent tube and the edge of the die. Remember to allow for the ⅞″ radius of the tube itself, and a little extra for springback.



After completing the second bend we measured the width of the finished bent tube, centerline to centerline, and found it to be nearly perfect.



[redacted] part ready for installation on the car. If your drivers are like mine have been, best make several of these at once. You'll need 'em!

EXAMPLE BEND:

Suppose you have a piece of tubing and you want to make the main hoop for the rollcage in your racecar. You measured between the door posts and have determined you need a rollbar with a total width of 48" and a height of 40". You've chosen 1 3/4" tubing. Here's the procedure:

A) Measure the radius of the bending shoe you are using. If already installed in the bender, using a ruler, measure the distance from the 1" center pin to the outside edge of the shoe and ad a 1/2". Remember the radius of a shoe is from the center of the pin sleeve welded to the shoe to the outside edge of the shoe, hence the additional 1/2" added when the center 1" pin is installed.

B) Using formula 1 below determine how much tubing will be required for the degree of bend needed.

R x D x .0175 = Length of tubing in bend. (Formula 1)

Where R = Radius of bending shoe in inches.
D = Number of degrees in bend.

Example: Your 1 3/4" shoe radius is 7 1/2" and you are bending 90 degrees. Therefore R = 7.5 and D = 90. So 7.5 * 90 * .0175 = 11.8 inches. This is how much tubing will be used in the bend itself. No problem so far.

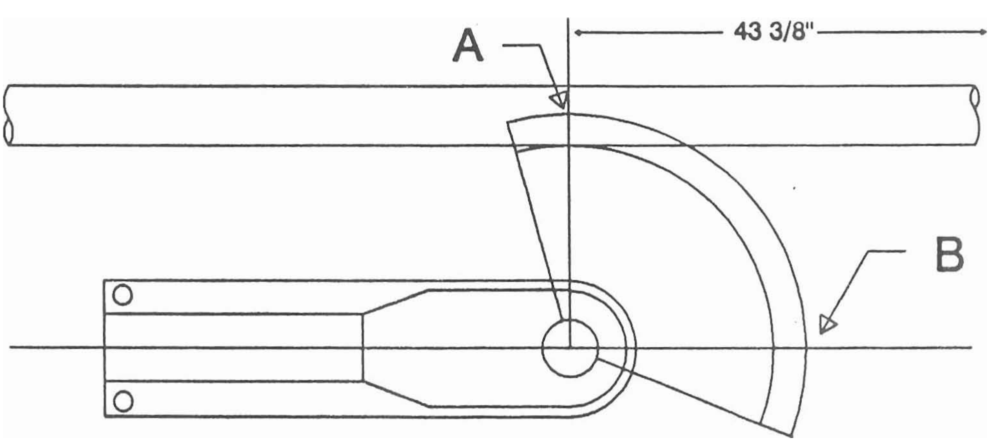
C) You figured earlier that the height of the rollbar was going to be 40". Using formula 2 determine how much total tubing is required from the start of the bend. The start of the bend is labeled point "A" in figure 8.

L - R - TR + HGT = Total tubing needed. (Formula 2)

Where: L = Length of tubing in bed from formula 1 above.
R = Radius of shoe in inches.
TR = Radius of tubing (half of diameter).
HGT = Total height of rollbar in inches.

In our example L = 11.8, as obtained from formula 1 above. R = 7.5", TR = .875" (7/8", half of our 1 3/4" tubing diameter) and HGT = 40", as measured in the car. Plugging these numbers into our calculator we arrived at 43.425". Round this off to 43 3/8" (43.375") and we're in business. If we now set the distance from point "A" in diagram 1 to the end of the tubing to our calculated 43 3/8", after completing our 90 degree bend our rollbar should be 40" tall. (Actually it will be .050" taller due to our rounding off of numbers). It is generally a good idea to leave a little tubing on the end in case of an error. It's alot easier to remove tubing then it is to add it.

Figure 8



D) After making our first 90 degree bend but before removing the tubing from the bender it is necessary to measure the amount of spring back that occurs when you pull the followbar free from the tubing. You can see the tubing spring away from the shoe. Measure this spring back at point "B" (See figure 9). If you look closely at the top of the tubing and the edge of the shoe you will see a mark left by the spring back on the tubing itself. The width of this mark is the amount of spring back. This mark is easily removed from the tubing with a swipe of medium sand paper. Once painted the mark is invisible.

E) Now remove the tubing from the bender and reposition it in the bender as shown in figure 9. Make sure once locked into place that the bend already in the tubing is lined up in the same plane as the bending shoe or else the two bends will be crooked. If your bender is mounted on a flat table a simple method exists to insure that both bends are on the same plane. Measure from the bottom of the groove in the bending shoe to the top of the table and cut wood blocks to this size. Now when you place your tubing in the bender simply position the wood blocks as tubing supports and your bends will always be inline with each other.

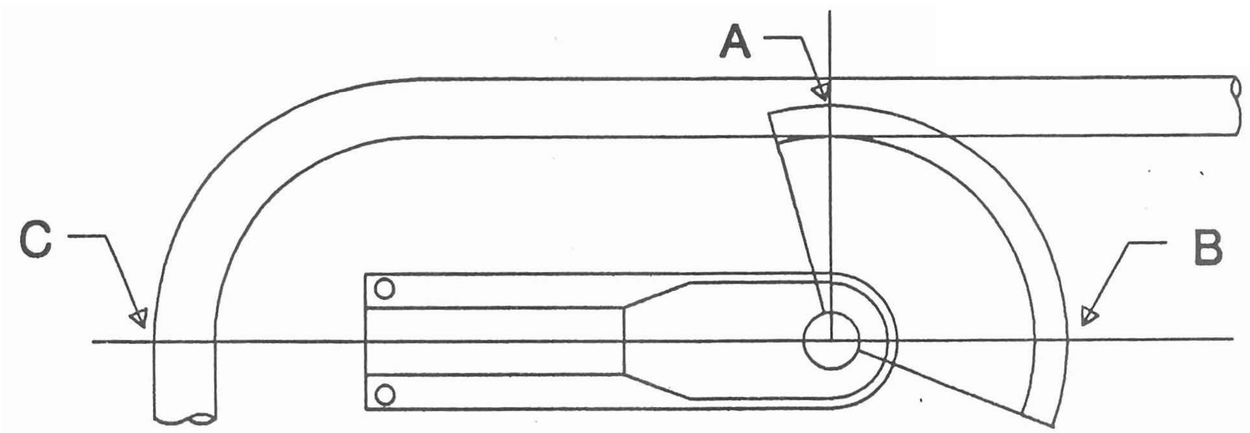


Figure 9

F) Now using formula 3 determine the distance needed from point "B" to point "C" as illustrated in figure 9.

W - SB - TR = Distance needed "B" to "C". (Formula 3)

Where: W = Total width of rollbar.
SB = Measured spring back.
TR = Radius of tubing.

Once again in our example, the width desired is 48". Therefore W=48", and say we measured 1/8" spring back, so SB=1/8" and finally TR=7/8" (half the radius of the tubing which in this case is 1 3/4"). Plugging these numbers into formula 3 and we have, 48 - 1/8 - 7/8 = 47". This is the distance needed between "B" and "C". Measure off 47" and lock tubing into place and make the final 90 degree bend. If done correctly you should have at the most a 1/8" TOTAL error. Now if you initially leave yourself an ample amount of tubing for the first bend you could have skipped everything except step "E". You would of course had to cut off the excess tubing on both sides instead of just one. If done this way (step E only) in time you will be fabricating rollbars in under 10 minutes with no more than 1/8" TOTAL error.

The above 3 formulas may be used to determine the bend setups for all common bending requirements. In the example, a rollbar fabrication for a racecar was used simply because it is a job requiring multiple bends and close tolerances.