

WHY INSTALL CONDUIT?

Conduit provides mechanical protection to protect conductors, permits easy wiring modifications.

WHY BEND CONDUIT? Conduit fittings such as sweeping el's, factory elbows, boxes, or conduit fittings such as LB's, LL's, and LR's can be used to make almost any bend.

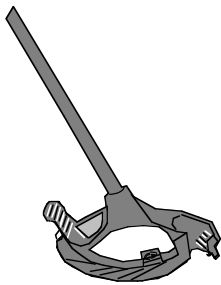
Conduit bending saves money as it is faster, more economical, and saves cutting and reaming time.

The fewer number of conduit fittings used in the raceway system the more effective the grounding path will be if you're using the metal conduit as the grounding conductor.

Conduit fittings such as LL's, LR's, and LB's are used mostly to turn corners.

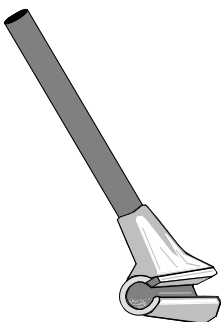
TYPES OF HAND BENDERS

Hickey and roll-type hand bender. There are also mechanical benders and hydraulic benders for the larger size conduits.



The roll-type hand bender is most commonly used on EMT with sizes 1/2" (13mm), 3/4" (19mm), 1" (25mm) and 1 1/4" (32mm). It is the most common hand bender. They have high supporting sidewalls to prevent flattening or kinking of the tubing and a long arc that permits the making of 90° bends in a single sweep without having to move the bender to a new position along the tubing as you would with a hickey type hand bender.

Don't confuse the hickey with the roll-type hand bender. Both are used to bend conduit by hand, but in totally different ways. The roll-type bender supports the walls of the conduit and provides a bending radius that conforms to the Code requirements.

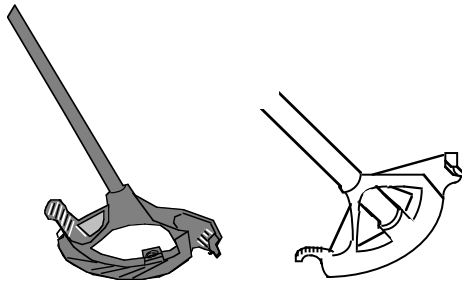


The hickey is used for rigid conduit only and the person holding the handle must form the bend as well as the radius as the bender is applied. This must be done in such a manner so as not to flatten or kink the conduit. The hickey is used somewhat like the hydraulic bender as you make segment bends. Several segment 10° bends are made to complete the bend at the proper radius. Hickeys should not be used to bend EMT because very little support is given to the walls of the conduit.

Less skill is required in using a roll-type bender compared to a hickey-type.

Bending rigid conduit is a laborious and time consuming process. Thinwall conduit has replaced rigid conduit in many installations because it's easier to bend and can be installed quicker.

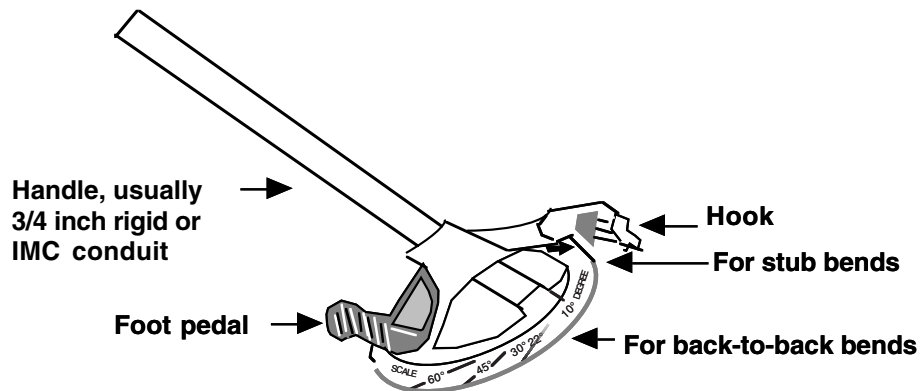
Rigid is used generally for mechanical protection or in hazardous locations. Where the conduit is exposed to mechanical damage rigid is the choice. In the walls and ceilings where the conduit is concealed, generally thinwall is used.



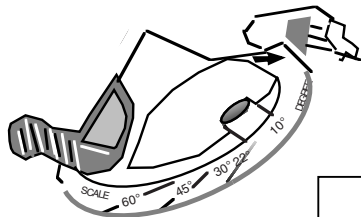
Several manufacturer's make conduit benders. Read the instructions that came with the bender.

Roll-type hand benders are available in sizes 1/2" (13mm) to 1 1/4" (32mm). Electrical metallic conduit, also referred to as "EMT" or thinwall is bent with hand benders up to 1" (25mm) in size, and 1 1/4" for small offsets. Larger sizes are bent with hydraulic benders. Small sizes of rigid steel, intermediate metal conduit (IMC), and aluminum conduit use this same bender. A 3/4" EMT roll-type bender will also bend 1/2" rigid.

THINWALL	RIGID
3/4"	1/2"
1"	3/4"
1 1/4"	1"







Manufacturers cast bold symbols, arrows, stars, etc., on the bending shoe to mark the center of the bend and degree scales (slash marks) on the sides of the bender to mark the degrees of bend for accuracy. These cast markings are usually recessed and filled with paint for easy identification. The radius of the bending shoe of the bender is based on the minimum radius for each size of conduit in the National Electrical Code. The hook area at the front of the bender has a ribbed interior to grip the conduit and prevent the conduit from slipping. This ribbed interior is designed so as to not nick or score the conduit. The back end of the bender has a non-skid foot pedal for constant foot pressure during the bend and increases leverage by 75 percent. The top of the bender has recessed threads for the handle to be installed.



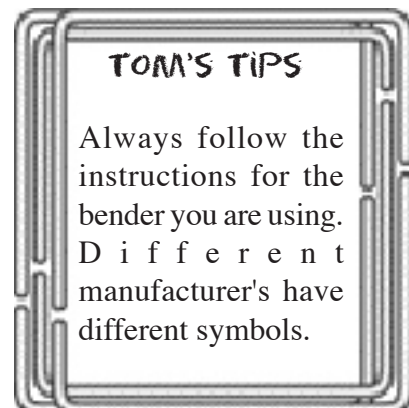
SLASH MARKS TO INDICATE DEGREE OF BEND

•It's very important to understand the symbol markings on the bender you are using.

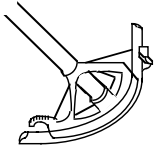
BENDER SYMBOLS ON DIFFERENT BENDER HEADS		
90° STUB-UP	3-POINT SADDLE CENTER BEND	BACK TO BACK BEND MARK
 ARROW	 TEAR DROP	 STAR
	 RIM NOTCHES ON BOTTOM OF SHOE	"B" MARK
	"A" MARK	

Hand benders are shipped without handles. A handle is often made in the field by cutting and threading a piece of *rigid* steel conduit or IMC. It's best to buy a bender handle manufactured by the bender company. These bender handles will not bend, they stay straight, and the threads are tapered so that the handle tightens firmly into the bender. A bender with a crooked handle is awkward to work with. The length of the handle is important. It gives proper leverage for bending and the proper length also provides better body balance when working with the bender.

SUGGESTED HANDLE LENGTHS		
1/2" bender	38 inches	965mm
3/4" bender	38 inches	965mm
1" bender	44 inches	1.12m
1 1/4" bender	54 inches	1.37m



90° STUB-UP



90° Stub Bend The 90° stub bend is probably the most basic and the most bent. All other bends are less than 90°. Let's practice bending a stub-up.

Take a 10' (3.05m) length of 1/2" EMT and cut it in half and lay one piece on the floor. For a 12 inch (305mm) 90° stub up, take a rule and measure 7 inches (178mm) from the end of the conduit and with a pencil make a mark completely around the conduit. The 7" (178mm) mark is the 12" (305mm) minus the take up 5" (127mm).



Take your 1/2" EMT bender in your hand and with your other hand, lift the conduit off the floor just enough to place the conduit into the hook of the bender and place the pencil mark on the conduit on the arrow mark on the bender.

With the conduit firmly on the floor put your right foot on the conduit and your left foot on the foot pedal at the back of the bender. Bend the conduit straight up just past the 90° mark on your bender (this allows for a small amount of kick back) keeping constant pressure on the foot pedal.

In general bender take-ups (the length that must be subtracted from the desired stub length) are:

BENDER TAKE-UP TABLE		
1/2" E.M.T.	5"	(127mm)
3/4" E.M.T. - 1/2" Rigid	6"	(152mm)
1" E.M.T. - 3/4" Rigid	8"	(203mm)
1 1/4" E.M.T. - 1" Rigid	11"	(279mm)

The take-up is the distance measured from the arrow or reference point on the bender to the back side of the conduit after the 90° bend is made.

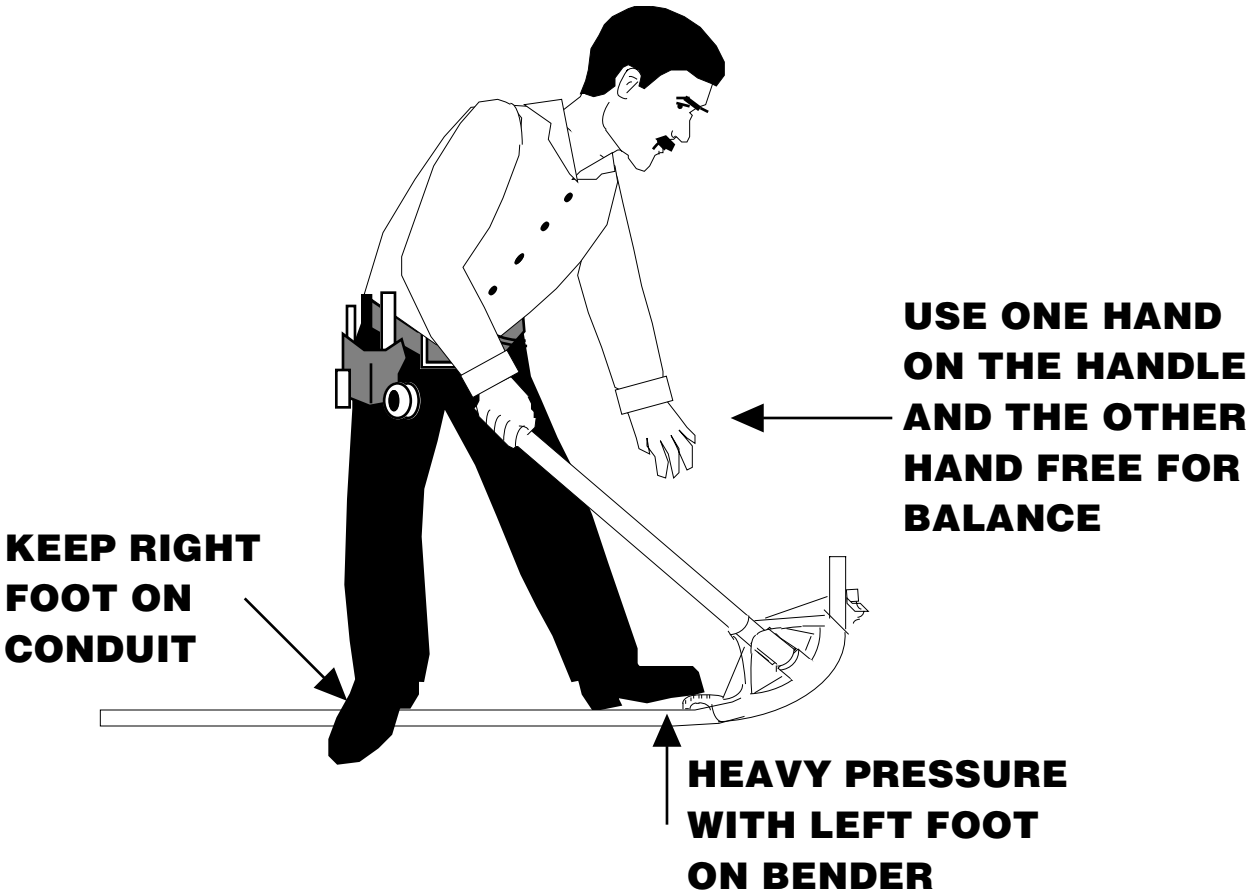
Use a wide stance, feet 30" (762mm) apart. If right handed put heavy pressure on left foot on the bender. Keep right foot on the conduit.

TOM'S TIPS

The stronger the foot pressure the more accurate the bend.

90° STUB-UP

All 90° bends should be made on a *hard surface* floor (not carpet). Bending conduit on carpet may cause flattening of the bend.



Remember to keep constant *foot pressure* throughout the full bend for the most accurate bend.

38" (965mm) is the best length for a handle on a 1/2" or 3/4" bender. A longer handle encourages too much pull on the it. Remember, *foot pressure* is accuracy, not handle pull. Conduit is curved into a gradual sweep to avoid flattening.

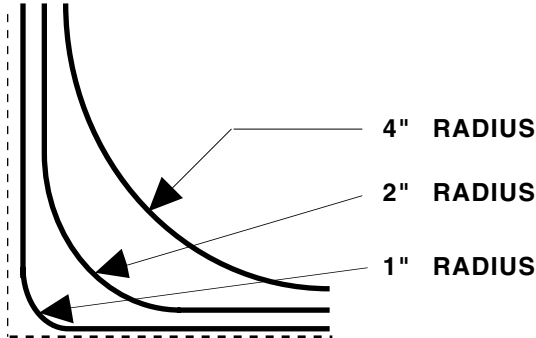
TOM'S TIPS

Conduit must be installed so conductors can be pulled and withdrawn easily.

RADIUS OF THE BEND

It is the radius of the angle formed by the shoe of the bender that has to be considered. Different shoe units for different size conduit benders are purposely constructed with different diameters and radii.

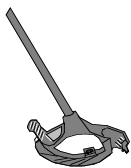
If the radius is too small you would have trouble pulling the wire around the 90° bend than you would a 90° bend with a larger radius.



The larger 4" (102mm) radius will allow the wires to be pulled easier through the conduit. Also, the larger the radius, the greater the length of conduit gain will be.

With a shoe unit on a bender you can make the bend in one continuous curve or motion of the bender.

With a shoe unit, the required bend is easy to make, but with a *hickey bender* you have to be careful to obey the radius requirements. Several small segment bends are required to make a 90° bend with a hickey.



The roll-type bender provides a bending radius that conforms to the Code requirements.

STANDARD CONDUIT BENDS	
TRADE SIZE	MINIMUM RADIUS TO CENTER OF CONDUIT
1/2" (13mm)	4" (102mm)
3/4" (19mm)	4 1/2" (114mm)
1" (25mm)	5 3/4" (146mm)

TOM'S TIPS

Code Table 2, Chapter 9 lists the minimum radius for field bends using a roll-type one shot bender.