The Art of Bending

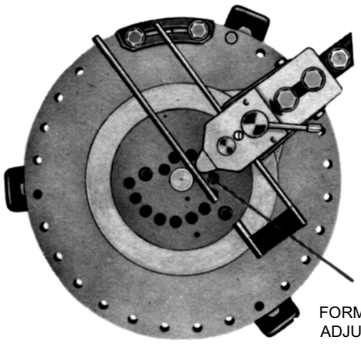
Di-Acro®

330-455-1942

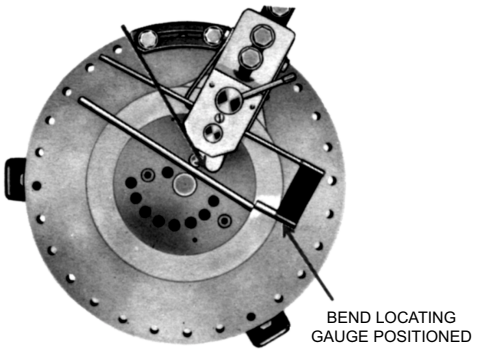
CENTERED EYE BENDING

Detailed illustrations below show procedure for cold forming a standard bend in solid material with the Di-Acro Bender. Bending a completely centered eye, containing two bends, in one forming cycle is one of the many valuable operations possible with all Di-Acro Benders. The diameter of the eye can be easily varied by merely using a different size Radius Pin or Collar. In Figure 1 below, the automatic Forming Nose is shown set for the exact material thickness and this adjustment is necessary when bending centered eyes as the Forming Nose must be in close contact with the material when the eye centering bend, shown in Figure 6, is made. To eliminate work making, Forming Nose must be grooved to fit material. See Figure 6 on page 12. Lubricating the forming Nose also reduces marking. When the material to be formed is sufficiently rigid and the required bend is somewhat less than 360°, it is often desirable to leave considerable clearance between the material and the Forming Nose, as this reduces the bending effort. Under these conditions it is also possible to use a Forming Roller as illustrated in Figures 1 to 3 on page 3 and its use is especially recommended when it is desirably to reduce work marking. Flattening on the inside of a bend, which occurs when round materials are formed to a small radius, can be eliminated by grooving the Radius Pin or Collar to exactly fit the Bar. If the bend is in excess of 180°, the Grooved Pin or Collar must be split horizontally so the formed material can be removed.

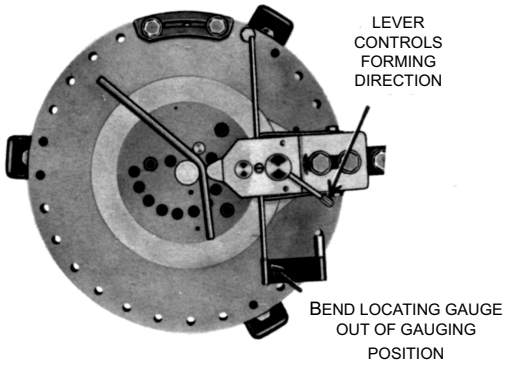
STANDARD DI-ACRO BENDING PROCEDURE



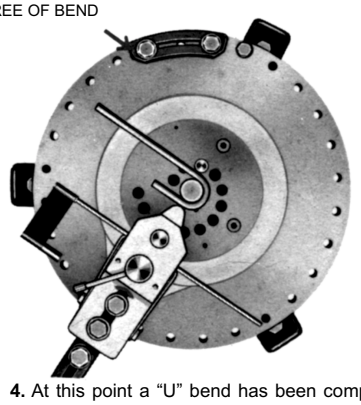
1. Mount Radius Pin or Radius Collar, of size required for desired bend, in center of Mounting Plate. Adjust automatic Forming Nose by moving Nose Holder so material will fit snugly between Nose and Radius Pin as illustrated, set Nose Holder Support against Nose Holder and tighten all bolts. Locate Locking Pin in the Mounting Plate hole nearest Radius Pin that will enable it to securely lock material.



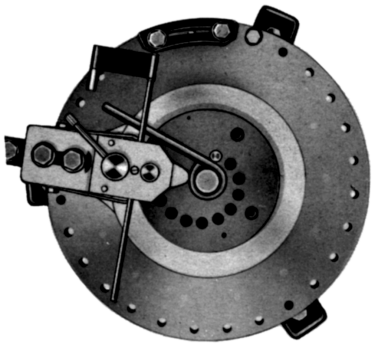
2. Adjust Angle Gauge for degree of bend and set Return Stop to limit opening of Forming Nose. Set Bend Locating Gauge to position Bend. See Figure 7, on page 12. Move Operating Arm in counter clockwise direction until Forming Nose opens, as illustrated. Then insert material between Locking Pin and Radius Pin and against Bend Locating Gauge. Lock material securely.



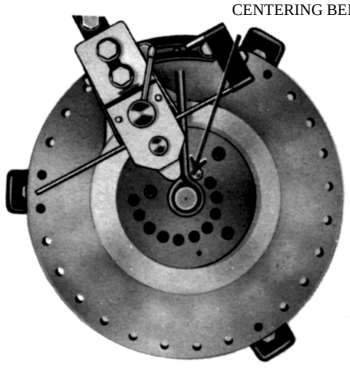
3. Move Bend Locating Gauge upward and begin bending operation by advancing Operating Arm in clockwise direction. When desirable to form in counter clockwise direction with No. 2, No. 3, or No. 4 Di-Acro Bender, move Control Lever, shown above, to opposite side of Nose Holder. Figure 8 on page 12 illustrates how bending direction of the No. 1 and No. 1A models can be reversed.



4. At this point a "U" bend has been completed. Any degree of bend can be accurately obtained and duplicated by adjustment of the Angle Gauge mounted in the outer rim of holes in the base casting.



5. A 360° bend has now been produced. In order to obtain a centered eye of greater diameter or a bend of a larger radius, it is only necessary to use a Radius Pin or Collar of the proper diameter.



6. An accurately centered eye is illustrated, completed in one operation. The centering or reverse bend is obtained simultaneously as the eye is being closed by forcing the rod against the Locking Pin.

OFF CENTER EYE BENDING

Di-Acro Bender should be used whenever possible as it provides a positive means of clamping the material against the Radius Pin or Collar so it will not slip when bending pressure is applied. When multiple bends are required in one part, the most logical sequence of bends should first be determined by completely forming one experimental piece to eliminate the possibility of interference. Confliction between bends can often be removed by reversing the forming direction of the Bender. After the bending sequence has been determined, highest production is usually obtained by setting the Di-Acro Bender for one particular bend and forming that bend in the entire production run of parts. Bender should be reset for each successive series of bends. As all metals are somewhat elastic they will springback, more or less, after they are formed and the bending pressure is released. To compensate for this, it is often necessary to overbend a few degrees beyond the desired angle. After springback has been determined, the Angle Gauge can be set so that all bends will be exactly duplicated. In addition to overbending to obtain the required shape, it is often necessary to form the material around a Radius Pin or Collar that has a smaller radius than that of the desired bend. This is equally true whether the material is tubing, angle, channel or a solid bar. The actual size of the Radius Pin or Collar can be best determined by experiment as the amount of sprinback is dependent upon the kind of material, its hardness and thickness as well as the radius of the bend.

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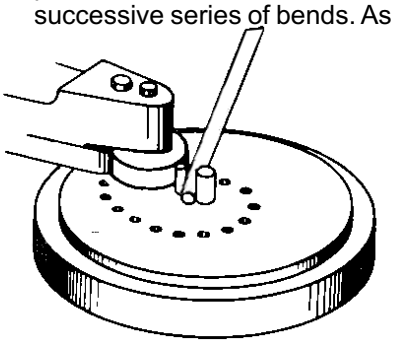
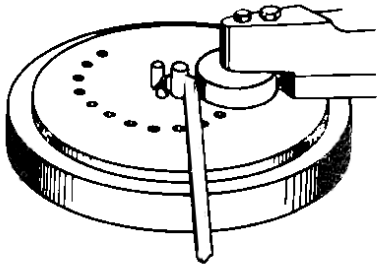
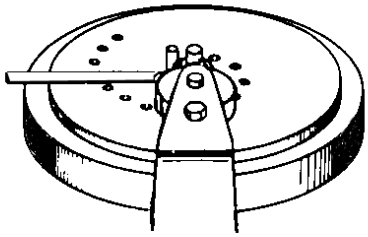


1. To reduce work marking and ease bending effort install a Forming Roller. Standard Forming Nose can also be used for this operation. Follow instructions in Figure 1 on page 2.

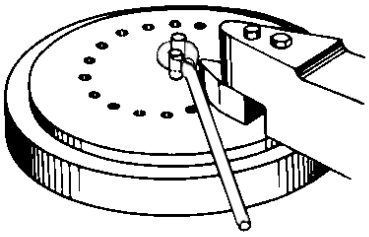


2. Insert material between Locking Pin and Radius Pin and set Forming Roller against material. Lock material against Radius Pin as illustrated in Figure 1. Advance Operating Arm until it strikes Angle Gauge.

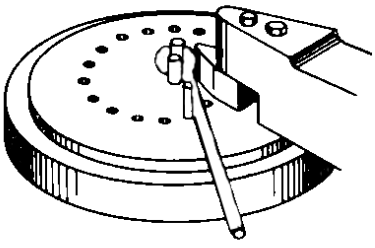


3. An off-center eye has now been completed in one operation and additional parts can be rapidly and exactly duplicated by following the same procedure. This same shape can be readily formed in all types of solid materials.

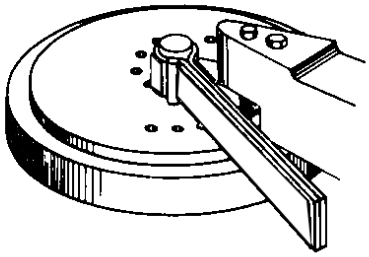
ALTERNATE METHODS OF CENTERED EYE BENDING



4. CENTERING EYE IN SECOND OPERATION
When the material is too heavy to be formed into a centered eye in one operation, an off-center eye should first be produced as shown above in Figures 1 to 3. The eye should then be placed over the Locking Pin and the centering bend made around a Radius Pin of the desired size as illustrated.



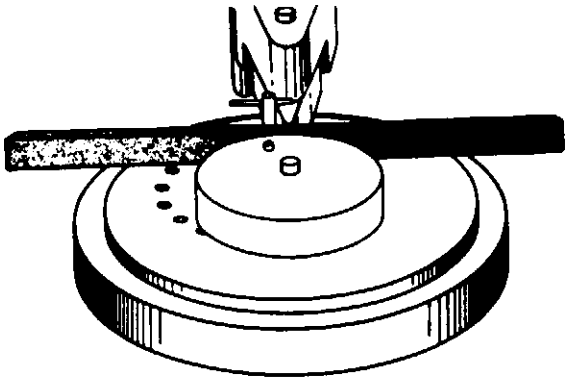
5. CENTERING THE EYE USING TWO LOCKING PINS
It is sometimes possible to form a centered eye in heavy materials in one operation by following the procedure in Figures 1 to 3. The centering bend is obtained by forcing the material against a pin remotely located in a Mounting Plate hole as shown. If necessary, this pin can be mounted from the Bender Base.



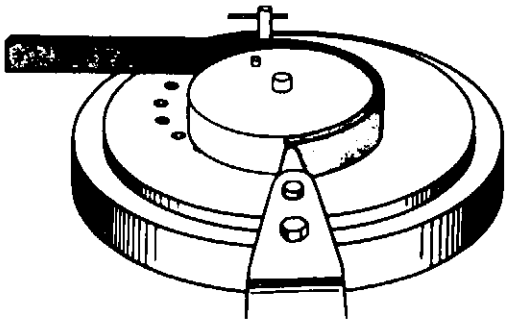
6. FORMING PIPE STRAP IN ONE OPERATION
A pipe strap containing three individual bends can be formed in one operating cycle by following the procedure outlined on page 2. The only difference is that the material must be gauged so that both ends will extend beyond the Locking Pin and thereby be formed during the centering operation.

CIRCLE BENDING

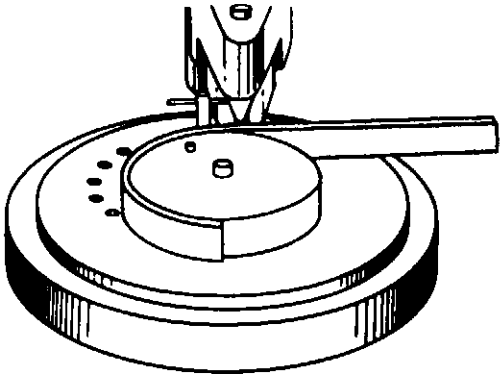
Although a circle can be readily formed with Di-Acro Benders, this operation is somewhat involved by the fact that most materials "springback" after they have been formed. To compensate for this, it is often necessary to use a Radius Collar having a smaller diameter than that of the circle required. Actual size can best be determined by experiment, as the "springback" varies in different materials. Material should be precut to exact length before forming.



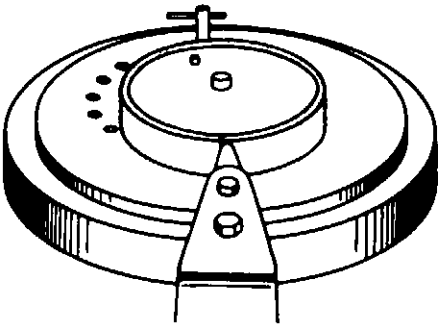
1. Set Forming Nose against material and clamp material against Radius Collar with Locking Pin.



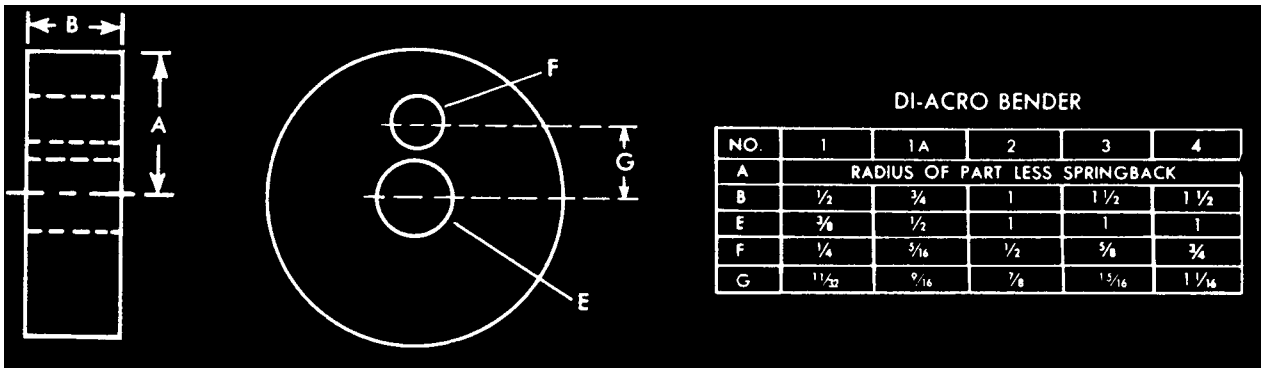
2. Advance Operating Arm until Forming Nose reaches extreme end of material.



3. Relocate material and clamp with Locking Pin at a point where radius is already formed.



4. Advance Operating Arm until Forming Nose again reaches extreme end of material.



DI-ACRO BENDER

NO.	1	1A	2	3	4
A	RADIUS OF PART LESS SPRINGBACK				
B	½	¾	1	1 ½	1 ½
E	⅜	½	1	1	1
F	¼	5/16	½	⅝	¾
G	11/32	9/16	⅞	15/16	1 1/16

ZERO RADIUS BENDING

A sharp zero radius bend can be easily formed with Di-Acro Benders by using a Zero Radius Block similar to the one illustrated. Although the sketches below show the forming of strip stock, this operation can be performed equally as well in round, square and other solid, ductile materials. When forming heavy materials to a zero radius, their ductile limits must be taken into consideration and it is often desirable to provide a small radius on the bending edge of the block to avoid fracture or marking on inside of the bend. By using a Built-up Forming Nose and mounting two or more Zero Radius Blocks on each other, the forming width capacity of all Di-Acro Benders can be increased considerably on this type of operation.

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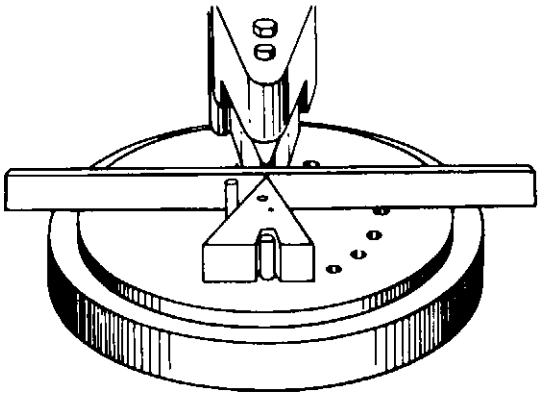
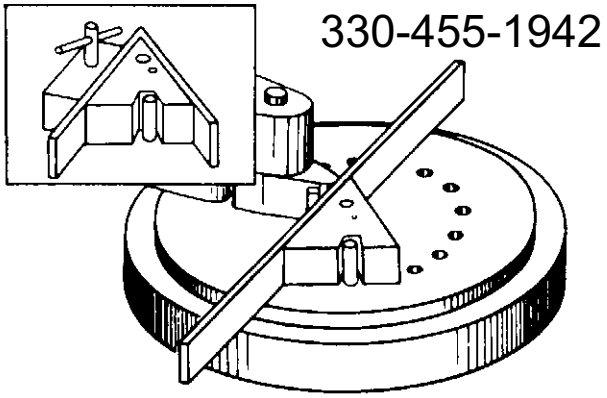
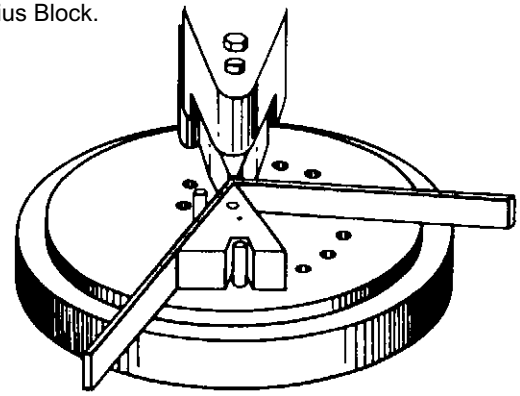


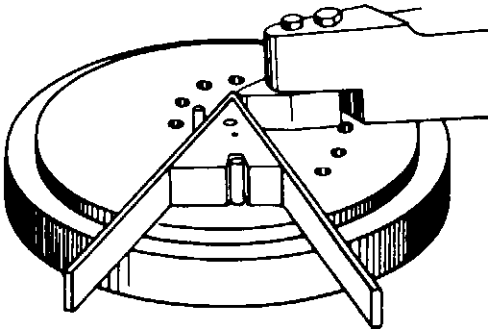
1. Adjust Forming Nose so material will fit snugly between Nose and apex of Zero Radius Block.



2. Clamp material closed to bending edge using Locking Pin or Holding Block illustrated.



3. Advance Operating Arm until it strikes Angle Gauge, thereby establishing exact degree of bend.

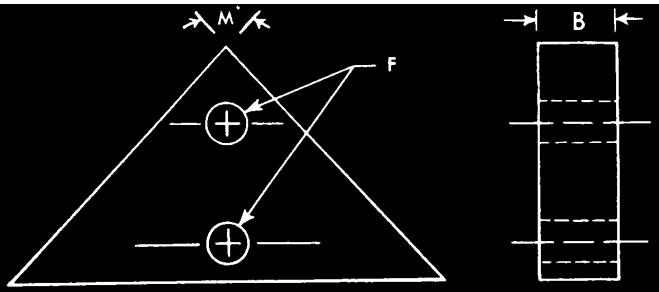


4. Bend is now completed and additional parts can be exactly duplicated by repeating cycle.

DI-ACRO BENDER

NO.	1	1A	2	3	4
B	½	¾	1	1 ½	1 ½
F	¼	5/16	⅓	⅜	¾
M*	60°	78°	78°	82°	82°

*DEGREE OF ANGLE IS ONLY LIMITED BY THE AMOUNT OF MATERIAL THAT MUST BE LEFT AROUND MOUNTING HOLES F FOR STRENGTH.



SCROLL BENDING

Scrolls and other shapes of irregular radii can be readily formed with Di-Acro benders in rigid materials even though the Forming Nose of the Bender revolves in a perfect circle. This type of forming is accomplished by using a collar having the same contour as the shape to be formed, as illustrated below, and adjusting the Forming Nose so it is located only the material thickness away from the “high point” of the contour collar. As the material will only bend where this contour collar offers resistance, the Forming Nose can lead the material around until it contacts the “high point” and exerts sufficient pressure to force it into the shape of the collar.

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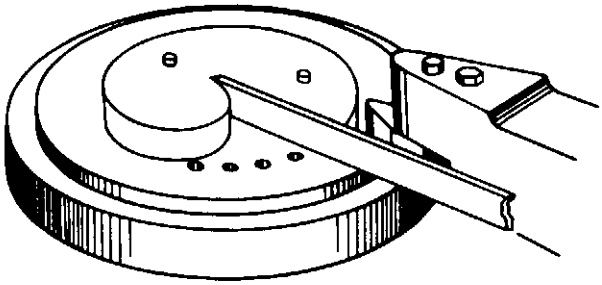
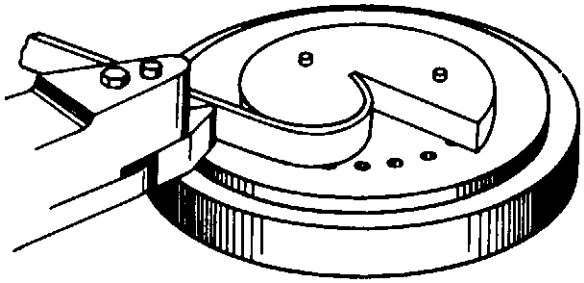
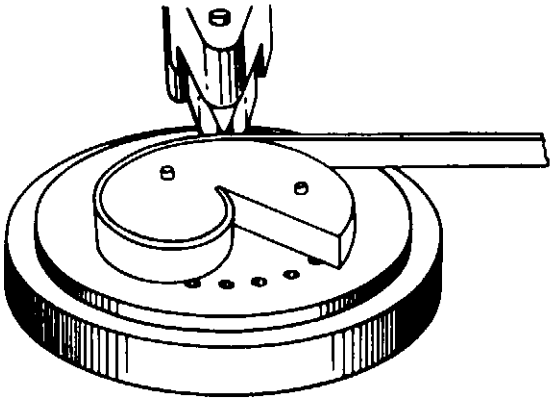


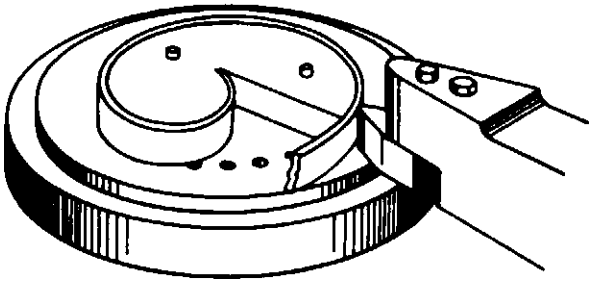
1. Adjust Forming Nose so material will fit snugly between Nose and “high point” of contour collar and insert material as shown.



2. Advance Operating Arm with a steady even pressure. Note how material bends only where resistance is offered by contour collar.

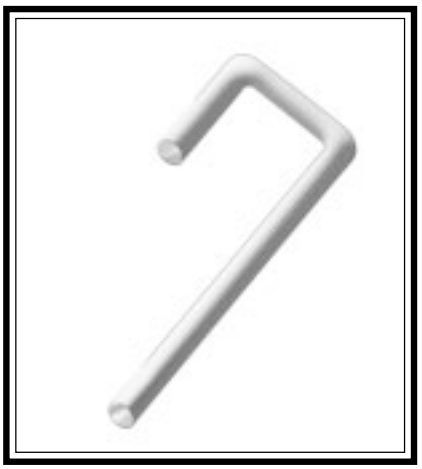


3. Material continues to bend and take shape of contour collar as Operating Arm is advanced.



4. As Forming Nose reaches “high point” of contour collar, material is “set” in new shape.

SQUARE BENDING



Forming zero radius bends around square, rectangular, or other multi-sided blocks employs the same principle used in scroll bending. Forming Nose "leads" material between corners of the block. Any number of zero radius bends can be obtained in one operation by this method in all types of solid materials. Both centered and off-center square eye can also be formed by following the same procedure outlined on pages 2 and 3. This method of bending is limited by the size of the square block and the ductility of the material. In general, when squares larger than 1" are needed, they should be formed in progressive operations using the zero radius block shown on page 5.

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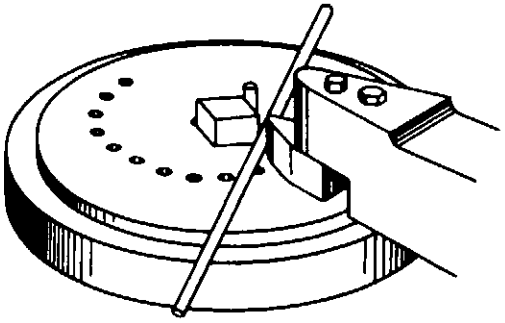
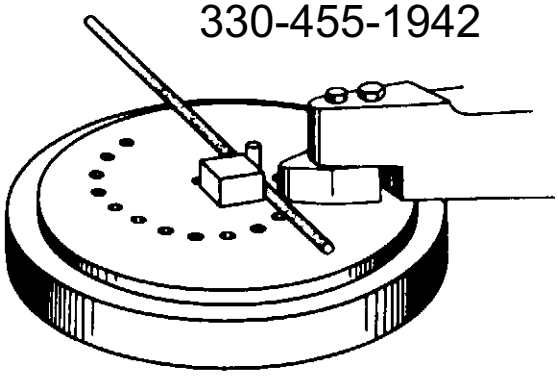
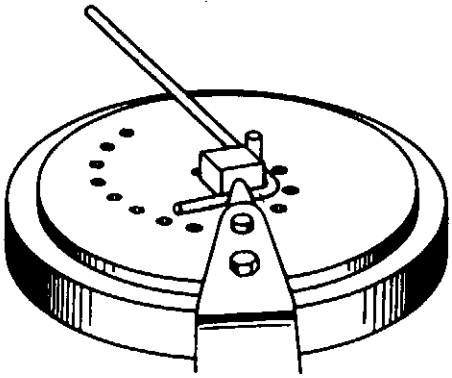


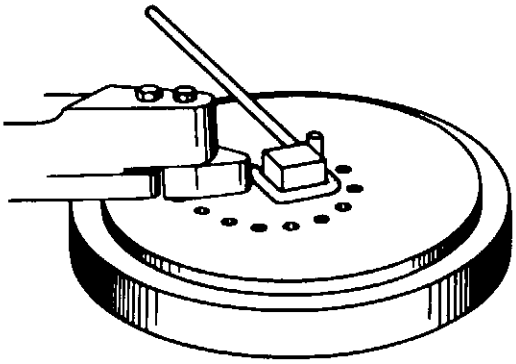
1. Adjust Forming Nose so material will fit snugly between Nose and any edge of Square Block.



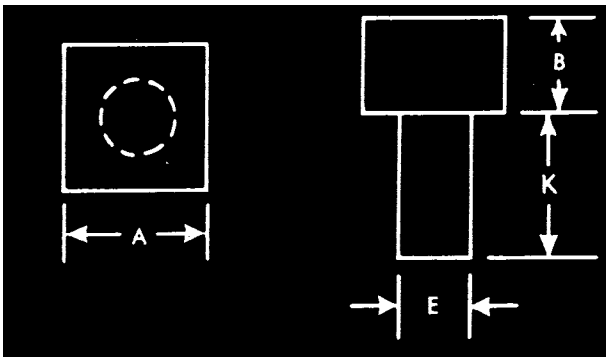
2. Clamp material between Locking Pin and Square Block and then advance Operating Arm.



3. Note how material remains straight between corners of block as Forming Nose moves into position for second bend.



4. Two bends have now been completed. A third bend can be obtained by merely advancing the Operating Arm.



DI-ACRO BENDER

NO.	1	1A	2	3	4
A	DESIRED DIMENSION BETWEEN BENDS				
B	½	¾	1	1½	1½
E	⅜	½	1	1	1
K	1⅛	1⅛	1⅛	1¼	1¼

SPRING OR COIL BENDING

A spring or coil can be easily made in all materials with Di-Acro Benders by following the method illustrated below. The number of turns in the coil is only limited by the height of the Forming Nose and Radius Pin and these can be easily made in any reasonable dimensions dependent on the size and ductility of the material. The Forming Nose must be set so it will clear the end of the material held by the Locking Pin. The maximum length of this end is determined by the ductile limits of the material as it must be sufficiently rigid so it will not bow between the Forming Nose and the Radius Pin.

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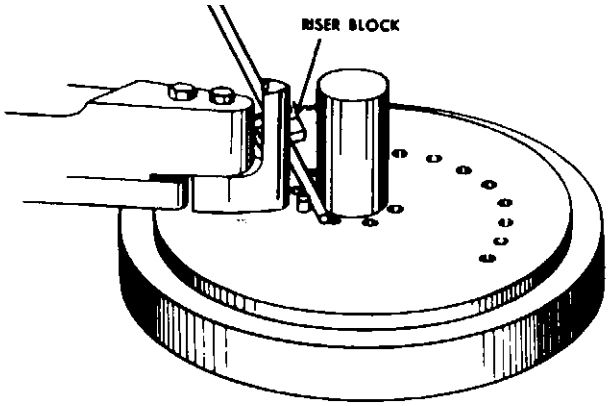
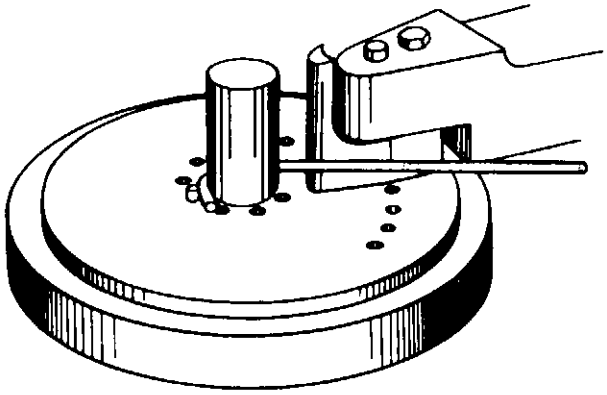
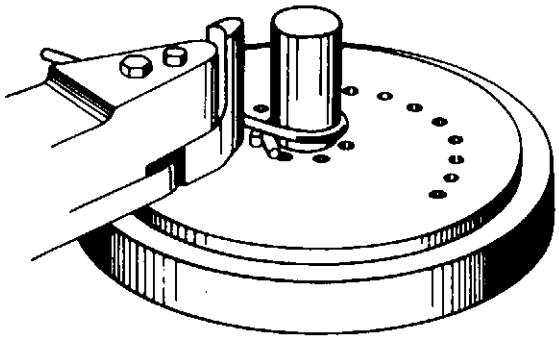


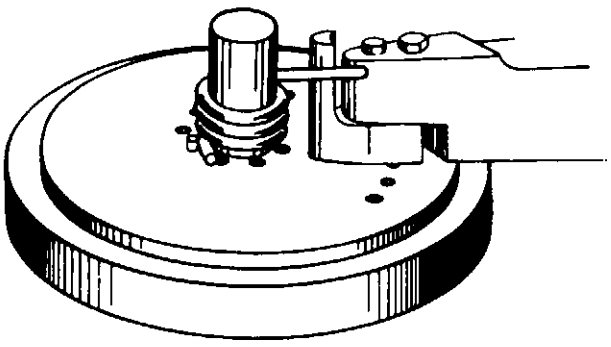
1. Use Locking Pin short enough to allow material to pass over it as first coil is made and set built-up Forming Nose to clear end of material.



2. Tilt material to obtain the desired pitch of coil using riser block on Mounting Plate as illustrated to duplicate the pitch.



3. Note how Forming Nose clears end of the material and how material spirals as first revolution of operating arm is made.



4. The desired number of turns in the coil are readily and easily obtained by merely revolving the Operating Arm.

LOOP AND SPIRAL BENDING

Either a single loop or a spiral bend can be readily formed at any point in a length of material with Di-Acro Benders as shown below. First a 180° bend is made, and the material is then advanced and set at the required angle. As the Operating Arm is revolved, the previously formed bend will spiral over the Radius Pin completing the loop. Numerous loops can be made by duplicating this procedure. This forming method should only be employed when the position of the loop is so far from the end of the material that its ductile limits will not allow following the procedure shown on page 8.

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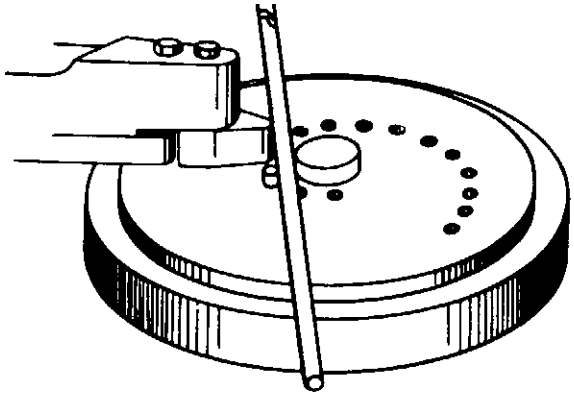
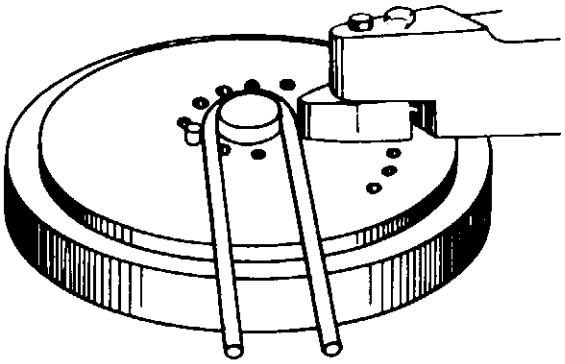
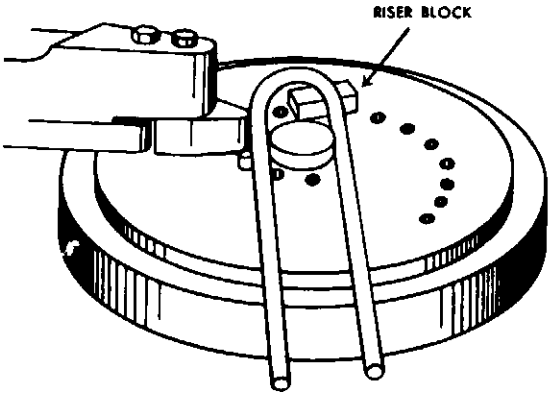


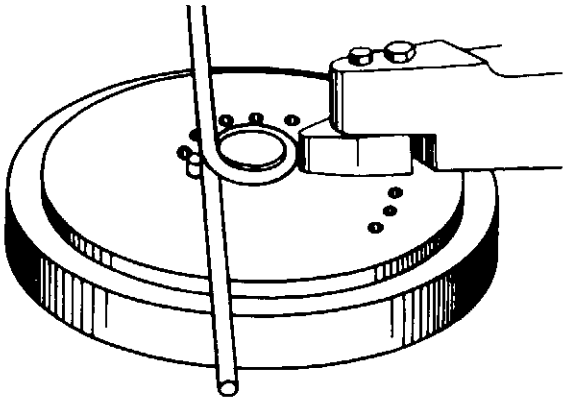
1. Use both a Holding Pin and Radius Pin short enough to allow material to pass over them as first loop is made. Set Forming Nose so material will fit snugly between nose and Radius Pin.



2. Set angle stop for a 180° bend. Revolve Operating Arm until it strikes angle stop thereby completing a U bend. This is the first step in loop and spiral bending.



3. Advance material a distance equal to one half the circumference of Radius Pin and tilt material using Riser Block as shown on Mounting Plate to duplicate pitch.



4. Previously formed section will now spiral over center pin completing loop. By continuously advancing material as shown in Figure 3 and repeating cycle, any number of coils can be formed.

TUBE BENDING

Di-Acro®

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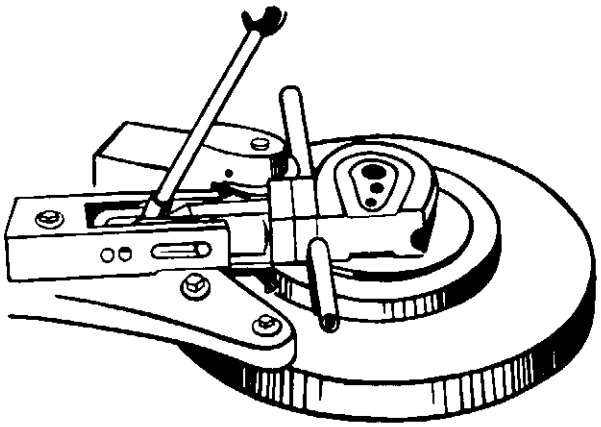
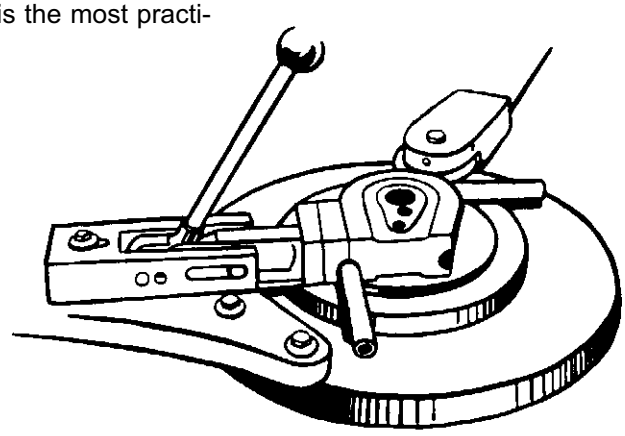
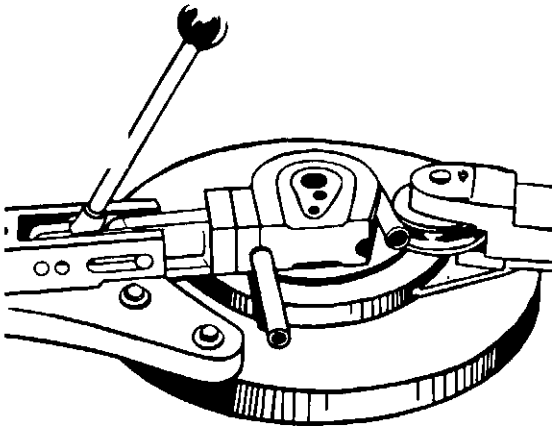
The Forming Roller method of tube bending is recommended for all large bends where the centerline radius is at least 4 times the outside diameter of the tube. It can also be successfully employed for bending pipe or heavy wall tubing to smaller radii and is the most practical method of bending very small diameter tubing. The Forming Roller and Radius Collar must be grooved to exactly fit the tube and the tube must not be allowed to slip during the bending operation as even a slight amount of slippage will cause distortion.



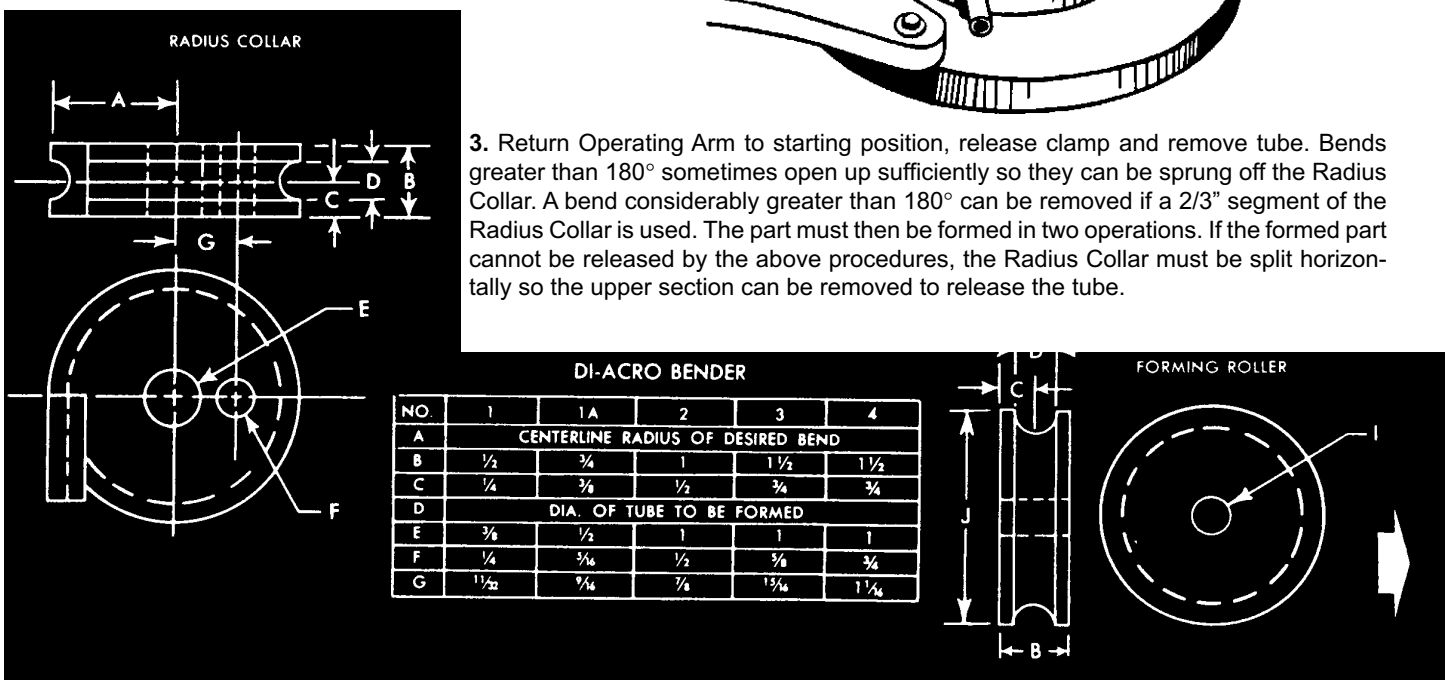
1. Set Forming Roller approximately 1/8" away from Radius Collar as this will eliminate distortion on the inside contour of the tube.



2. Clamp tube tightly so it cannot slip and advance. Operating Arm with a steady even pressure until it strikes Angle Stop.



3. Return Operating Arm to starting position, release clamp and remove tube. Bends greater than 180° sometimes open up sufficiently so they can be sprung off the Radius Collar. A bend considerably greater than 180° can be removed if a 2/3" segment of the Radius Collar is used. The part must then be formed in two operations. If the formed part cannot be released by the above procedures, the Radius Collar must be split horizontally so the upper section can be removed to release the tube.



NO.	1	1A	2	3	4
A	CENTERLINE RADIUS OF DESIRED BEND				
B	½	¾	1	1 ½	1 ½
C	¼	⅜	½	¾	¾
D	DIA. OF TUBE TO BE FORMED				
E	⅜	½	1	1	1
F	¼	5/16	½	⅝	¾
G	11/32	9/16	⅞	15/16	1 1/16

FOLLOW BLOCK METHOD

By supporting the tube over a wide area through the use of a Follow Block, as illustrated, thin wall tubing can often be satisfactorily formed to a centerline radius as small as 2-1/2 times outside diameter without the use of inside mandrels or fillers. As there are many variable factors in the bending quality of tubing, the smallest practical radius to which it can be formed can be best determined by experiment. Our Engineering Department will gladly give you recommendations if you will send us samples of your material together with prints showing the required bends. The Follow Block eliminates marring of material as it rolls around with the tube without friction or sliding action.

Tube Bending

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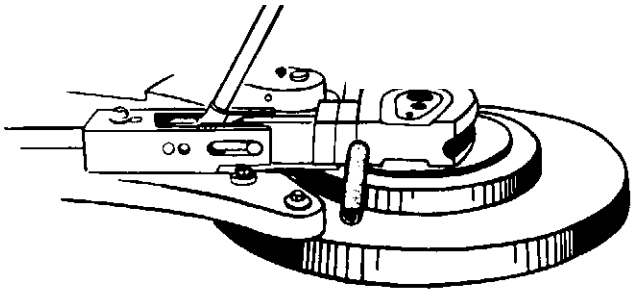
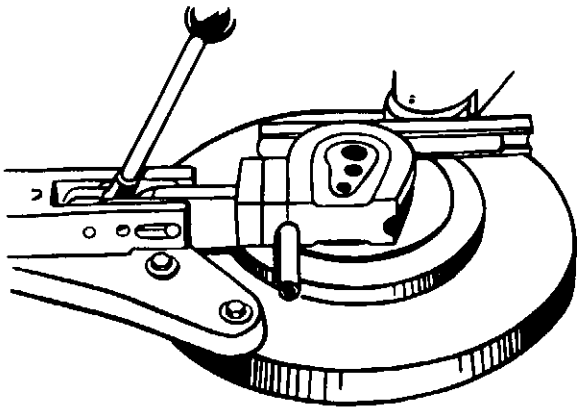
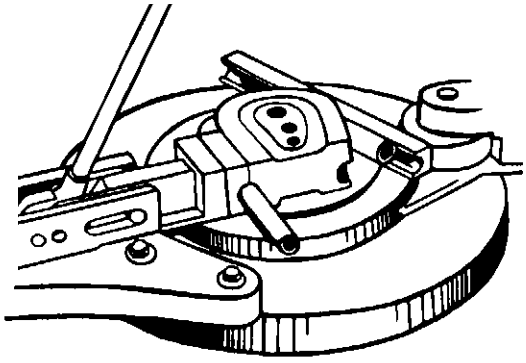


1. Adjust standard Forming Roller so Follow Block will fit snugly against tube at start of bend. Clamp tube tightly so it cannot slip.



2. Advance Operating Arm with a steady even pressure until it strikes Angle Stop. Note how Follow Block rolls around the tube without friction.



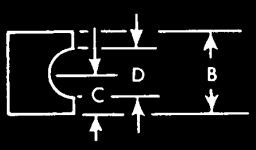
3. Remove Follow Block, return Operating Arm to starting position, release clamp and remove tube. Bends greater than 180° sometimes open up sufficiently so they can be sprung off the Radius Collar. A bend considerably greater than 180° can be removed if a 2/3" segment of the Radius Collar is used. The part must then be formed in two operations. If formed part cannot be released by above procedures, Radius Collar must be split horizontally so upper section can be removed to release the tube.

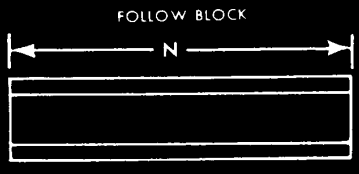
DI-ACRO BENDER

NO.	1	1A	2	3	4
B	½	¾	1	1½	1½
C	¼	⅜	½	¾	¾
D	DIA. OF TUBE TO BE FORMED				
N	3½ X RADIUS FOR 180° BEND				

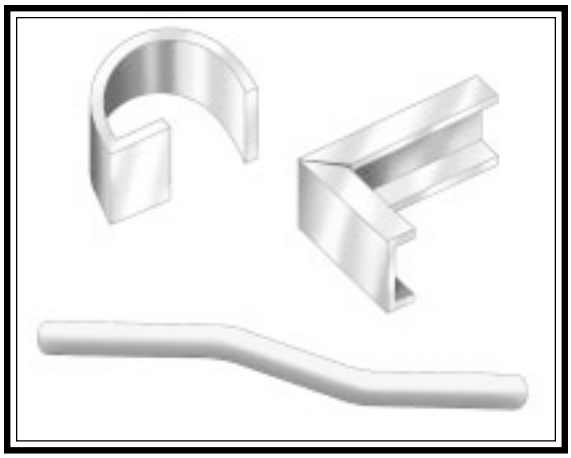
DI-ACRO BENDER

NO.	1	1A	2	3	4
B	½	¾	1	1½	1½
C	¼	⅜	½	¾	¾
D	DIA. OF TUBE TO BE FORMED				
I	5/16	½	¾	1	1
J	1¼	1⅜	3	3	3

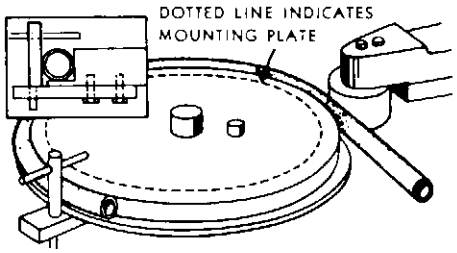




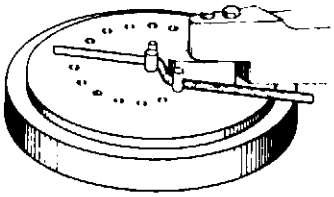
SPECIAL SETUPS



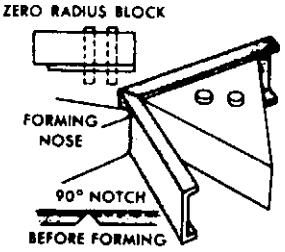
The forming range of Di-Acro Benders is considerably greater than the many operating illustrations shown throughout this booklet may indicate, as the information contained herein is necessary quite general in its scope. By studying the bending rules and principles outlined, the operator will soon become well acquainted with the various factors involved in arranging the Di-Acro Bender for a particular application and the below illustrations may provoke additional ideas that will provide the solution for many difficult bending problems. Fullest value from Di-Acro Benders will only be realized when they are tooled in your own plant as bending jobs arise, since knowing the desired production, delivery requirements and tolerances that must be held, you are in the best position to determine the type of tooling that should be prepared to facilitate manufacture of the part.



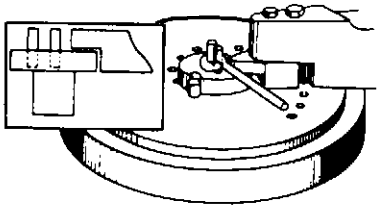
1. LARGE RADIUS FORMING
Radius collar can be of any size within capacity of bender. If larger than Mounting Plate, it must have built-in Locking Pin as shown.



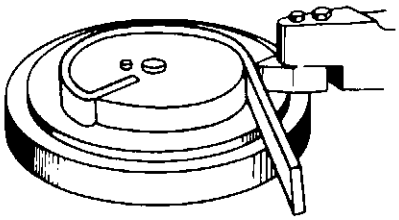
2. OFFSET BEND EASILY FORMED
By locating a second Locking Pin in a Mounting Plate hole as illustrated, it is often possible to form two closely adjacent bends in one operation.



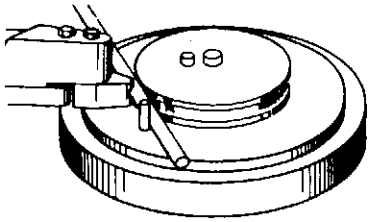
3. ZERO RADIUS BEND CHANNEL
A right angle zero radius bend can be made in channel with flanges either in or out by notching the flanges and forming around a Zero Radius Block as shown.



4. SMALL DIAMETER EYE BEND
To form a very small eye, a Radius Pin should be prepared in which the Locking Pin can be mounted as shown in the cross section view above. The Forming Nose should also be cut away so that it can reach over the edge of Center Pin.

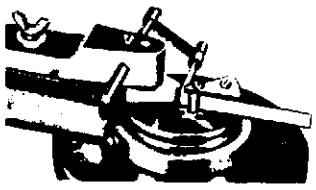


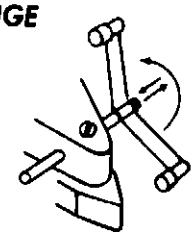
5. TWO BENDS IN ONE OPERATION
Obtained by inserting one end of the material in a slot at any angle in the Radius Collar. Any number of coils can be made by setting Forming Nose to allow space for material and rotating the operating Arm.



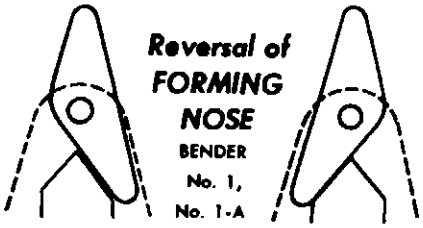
6. GROOVED NOSE AND COLLAR
Round materials can be formed without work marking on outside of bend by grooving the Forming Nose or Forming Roller to exactly fit the contour of the rod. Flattening on inside of bend can be eliminated by grooving the Radius Collar.

How to use the BEND POSITIONING GAUGE





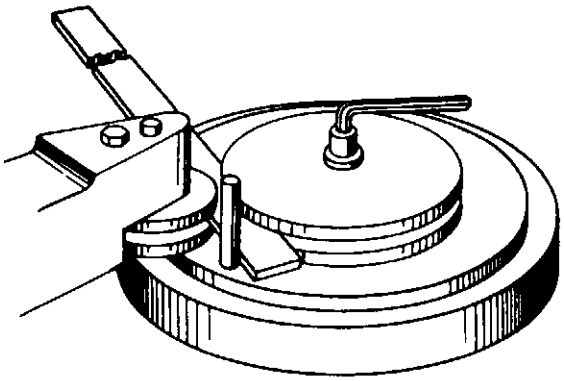
7. To adjust the Bend Positioning Gauge, loosen set screw on Nose Holder, move Gauge Rod to desired position and tighten set screw. If bend is more than 180°, move Gauge Arm upward after gauging as shown above so it will not strike material. Gauge Arm can be returned to original position without losing accuracy of adjustment.



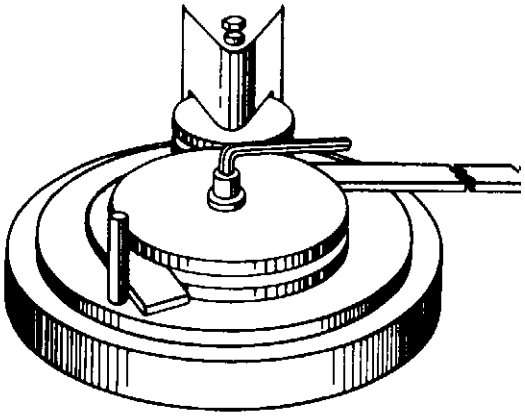
8. REVERSAL OF FORMING NOSE Bender NO. 1, NO. 1A The forming direction of the Di-Acro Bender No. 1 and No. 1A can be reversed by removing the Nose Holder, lifting the Nose from the Bearing Pin and turning it over as shown above. The Nose Spring should then be relocated on the opposite side of the Nose Holder.

EDGEWISE BENDING

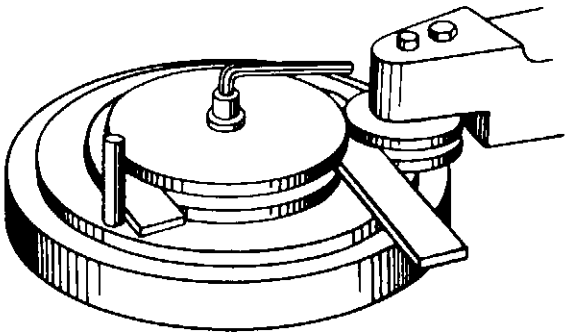
All flat materials can be readily formed edgewise with Di-Acro Benders to any degree of angularity by following the procedure illustrated. When performing this type of bend, the outside edge sketches while the inside edge is compressed and therefore the material must be closely confined to prevent distortion. Although a radius of three to four times the material width is desirable to allow for this expansion and contraction, it is often possible to reduce this ratio to less than twice the width if the material is sufficiently ductile. The prints below are offered as a guide to assist the user in preparing the accessories required for edgewise bending of parts. Material should be closely confined in Radius Collar as only .002" or .003" variation in clearance can make a great difference in quality of bend. Clearance is increasingly important in thinner materials.



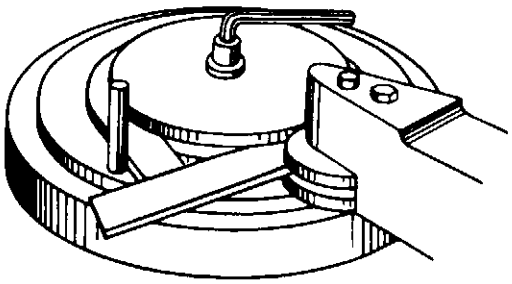
1. Insert material in slots in Forming Roller and Radius Collar and tighten center bolt.



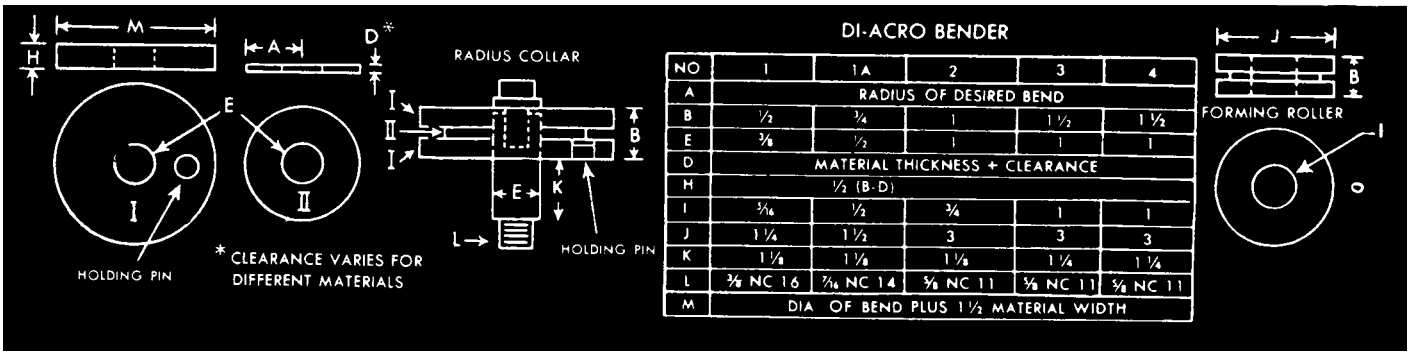
2. Advance Operating Arm with a steady, even pressure as thin or low ductile materials may otherwise fracture.



3. A 180° bend has now been formed and material can be easily slipped out of Radius Collar by merely loosening center bolt.



4. An off-center eye has now been completed. To release part, remove top of Radius Collar.



DI-ACRO BENDER

NO	1	1A	2	3	4
A	RADIUS OF DESIRED BEND				
B	½	¾	1	1½	1½
E	⅜	½	1	1	1
D	MATERIAL THICKNESS + CLEARANCE				
H	½ (B-D)				
I	5/16	½	¾	1	1
J	1¼	1½	3	3	3
K	1⅛	1⅛	1⅛	1¼	1¼
L	⅜ NC 16	7/16 NC 14	⅝ NC 11	⅝ NC 11	⅝ NC 11
M	DIA OF BEND PLUS 1½ MATERIAL WIDTH				

CHANNEL BENDING

Di-Acro Benders will successfully form channel provided the flanges are adequately confined during the bending operation so they will not buckle or distort. It is generally recommended that the radius of the bend be three to four times the width of the flange to allow for stretching of the metal, although this ratio is primarily determined by the thickness and ductility of the material and can often be reduced considerably. As the different dimensions of channel vary with almost every requirement, it is impractical to offer a standard group of accessories for this type of forming. It is suggested that the user prepare these parts and the cross-section view in Figure 4 below, as well as the prints on page 13 which cover all edgewise bending, are given as a guide. Flanges should be closely confined in Radius Collar as .002" or .003" variation in clearance makes a big difference in the quality of bend. Clearance is increasingly important in thinner materials.

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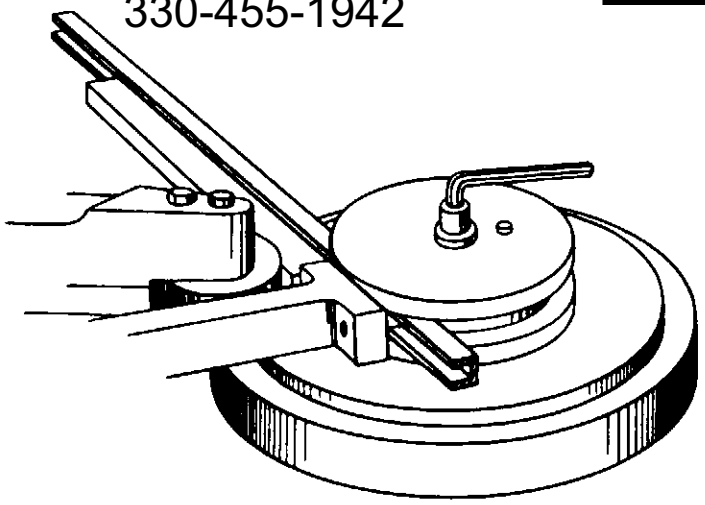
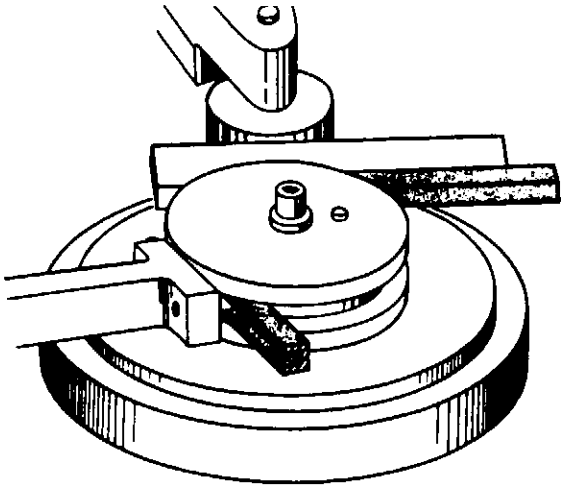
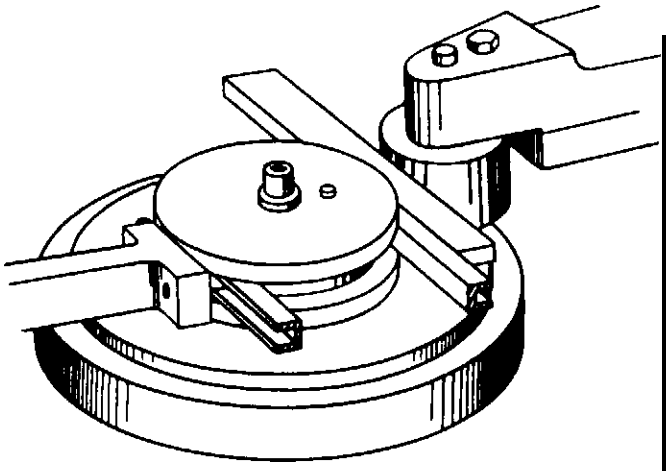
Flanges Out



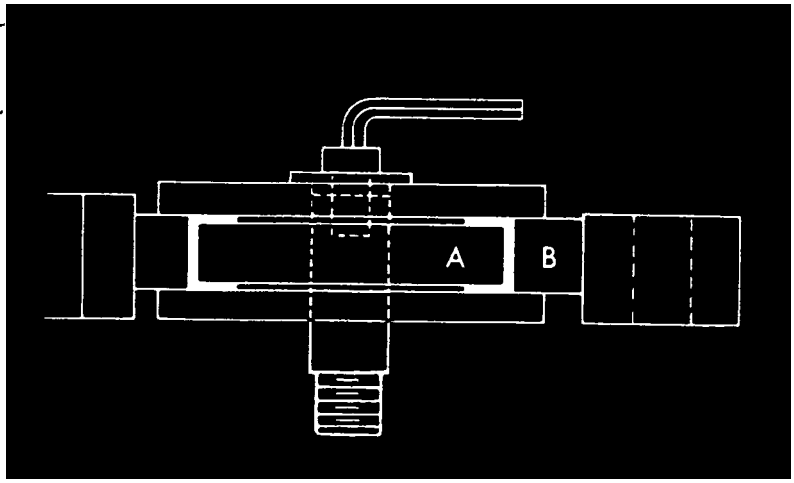
1. Position material in the Radius Collar. Insert Follow Block in the channel and tighten center bolt as illustrated in drawing.



2. Clamp channel tightly. Advance Operating Arm with a steady, even pressure until it strikes stop pre-set for angle of bend.



3. Loosen center bolt, release clamp, and slide material out of Radius Collar. Remove Follow Block.



4. Cross-section view shows how Radius Collar supports material. By changing size of spacer "A" in Radius Collar and Follow Block "B", different sizes of channel can be formed.

CHANNEL BENDING

The same general bending rules which cover the forming of channel with "flanges out" also apply when it is formed with "flanges in." Since it is necessary to compress the flanges as they are bent inward, the operation shown below requires considerably more bending pressure than when forming with the "flanges out", and it is recommended that the largest possible radius be used to allow for compression of the material. if a sharp 90° bend is desired, it can be obtained by cutting a notch out of the channel flanges before forming around a special Zero Radius Block as illustrated on page 12 Figure 3. It is sometimes possible to make a circle in channel by using a segment of a Radius Collar similar to sketch in Figure 4 below. By following the procedure outlined on page 4, the circle can be formed in three operations. To form channel with the flanges facing upward it is necessary to first fill it with Cerrobend or some other commercial filler as it is not possible to support the flanges in this position with a radius Collar.

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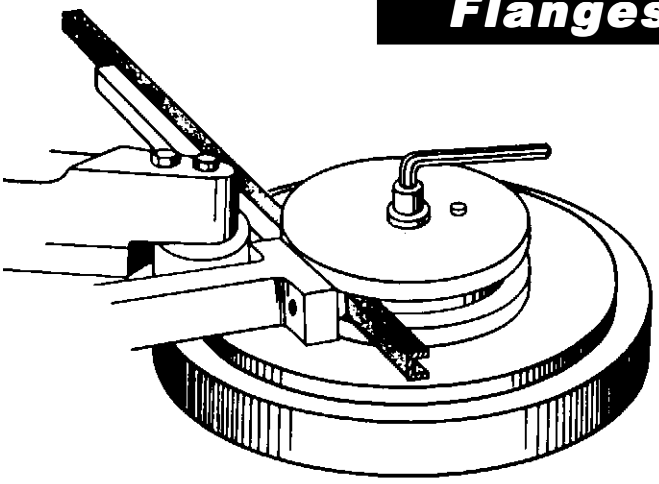
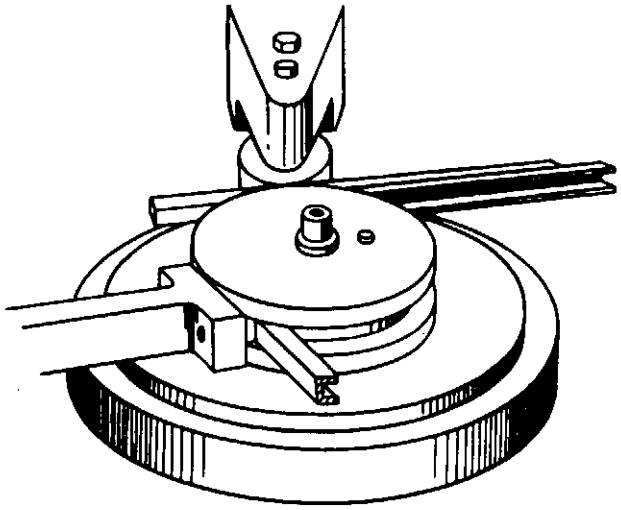
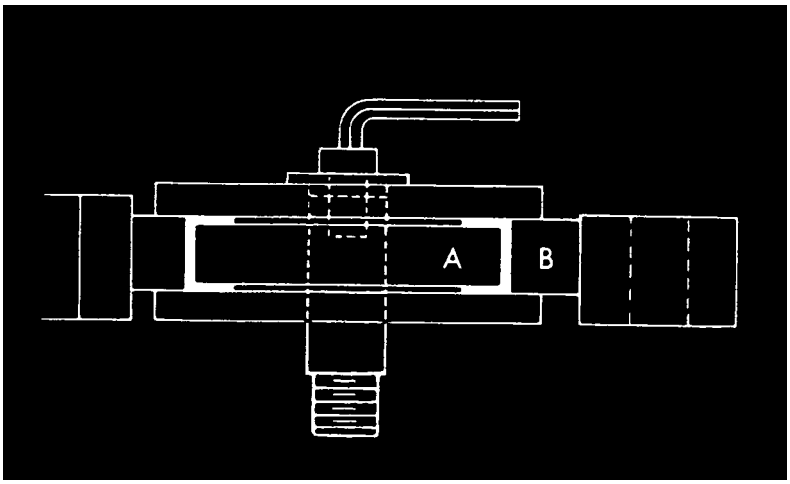
Flanges In



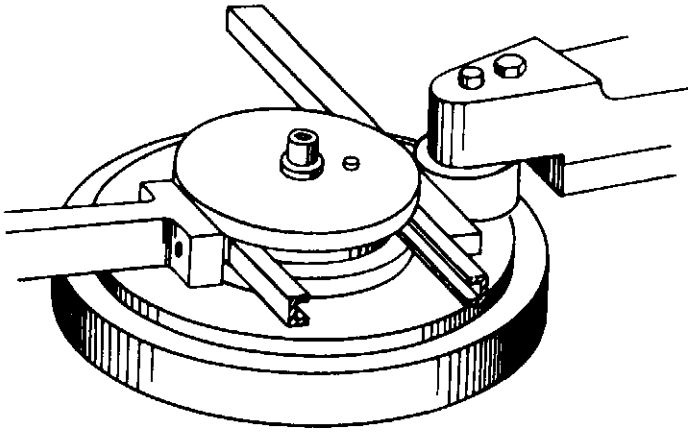
1. Insert material in slots in Radius Collar, position Follow Block between channel and Forming Roller and tighten center bolt.



2. Clamp channel tightly. Advance Operating Arm with a steady, even pressure until it strikes stop pre-set for angle of bend.



4. Cross-section view shows how Radius Collar supports material. By changing size of spacer "A" in Radius Collar and Follow Block "B", different sizes of channel can be formed.



3. Loosen center bolt, release clamp, remove Follow Block and slide material out of Radius Collar.