

OPERATION AND SERVICE MANUAL

Models:

1000-BL 1302-BL ("Blue Bullet")
1000-BAS 1302-BAS
1000-BA 1302-BA
1502-BL
1502-BAS
1502-BA

"America's Most Popular
Tubing Bender"



Model 1502-BA
shown with typical
tooling package.

SHIPPING DAMAGE CLAIMS

When this equipment is shipped, title passes to the purchaser upon receipt from the carrier. Consequently, claims for material damaged in shipment must be made by the purchaser against the transportation company at the time shipment is received.

BE SAFE

Bend-Pak, Inc. benders are designed and built with safety in mind. However, your overall safety can be increased by proper training and thoughtful operation on the part of the operator. DO NOT operate or repair this equipment without reading this manual and the important safety instructions shown inside.

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YOUR NEW BENDER

This instruction manual has been prepared especially for you. Your new bender is the product of over 25 years of continuous research, testing and development and is the most technically advanced bender on the market today.

READ THIS ENTIRE MANUAL BEFORE OPERATION BEGINS.

The manner in which you care for and maintain your bender will have a direct effect on it's overall performance and longevity.

RECORD HERE THE FOLLOWING INFORMATION WHICH IS LOCATED AT THE FRONT END OF YOUR MACHINE.

Serial No. _____

Model No. _____

Manufacturing date _____

WARRANTY

Your new bender is warranted for two years on equipment structure; one year on all operating components and tooling to the original purchaser, to be free of defects in material and workmanship. The manufacturer shall repair or replace at their option for this period those parts returned to the factory freight prepaid which prove upon inspection to be defective. The manufacturer will pay labor costs for the first 12 months only on parts returned as previously described.

This warranty does not extend to defects caused by ordinary wear, abuse, misuse, shipping damage, or lack of required maintenance.

This warranty is exclusive and in lieu of all other warranties expressed or implied. In no event shall the manufacturer be liable for special, consequential or incidental damages for the breach or delay in performance of the warranty. The manufacturer reserves the right to make design changes or add improvements to its product line without incurring any obligation to make such changes on product sold previously.

Warranty adjustments within the above stated policies are based on the **model** and **serial number** of the equipment. **This data must be furnished with all warranty claims.**

**WARRANTY IS NOT VALID UNLESS
WARRANTY CARD IS RETURNED**

SPECIFICATIONS

DESIGN FEATURES MODELS 1302-BAS / 1502 BAS	
Bending Capacity	Tubing from 1/2" OD - 3" OD
Maximum Capacity/Tube Thickness.....	See Chart Below
Maximum Bending Radius	5"
Minimum Bending Radius	3-1/2"
Swaging Capability*.....	Expansion / Reduction / Forming
Swaging Capacity.....	1" O.D. Tubing - 3" O.D. Tubing
Motor.....	5 H.P / Single or Three Phase / 220-380-440 VAC
Pump Output	3 GPM / 4200 psi (max. output)
Operation Modes	Full Automatic or Manual Foot Switch
Hydraulic Filter.....	Canister type
Bending Force	55,000 Pounds Maximum
Bend-Depth Control.....	Degree Plate With Adjustable Pointer / Automatic Stop and Return
Overall Length	62" I302-BAS / 64" 1502-BAS
Overall Width.....	30" I302-BAS / 26" 1502-BAS
Overall Height.....	41"
* Special radius dies are available.	
** Reduction tools do not come standard	

DESIGN FEATURES MODELS 1302-BA / 1502 BA	
Bending Capacity	Tubing from 1/2" OD - 3" OD
Maximum Capacity/Tube Thickness.....	See Chart Below
Maximum Bending Radius	5"
Minimum Bending Radius	3-1/2"
Swaging Capability*.....	Expansion / Reduction / Forming
Swaging Capacity.....	1" O.D. Tubing - 3" O.D. Tubing
Motor.....	5 H.P / Single or Three Phase / 220-380-440 VAC
Pump Output	3 GPM / 4200 psi (max. output)
Operation Modes	Full Automatic or Manual Foot Switch
Hydraulic Filter.....	Canister type
Bending Force	55,000 Pounds Maximum
Bend-Depth Control.....	Digital Readout Automatic Stop and Return
Overall Length	62" I302-BA / 64" 1502-BA
Overall Width.....	30" I302-BA / 26" 1502-BA
Overall Height.....	41"
* Special radius dies are available.	
** Reduction tools do not come standard	

DESIGN FEATURES MODELS 1302BL (BLUE BULLET) / 1502 BL	
Bending Capacity	Tubing from 1/2" OD - 3" OD
Maximum Capacity/Tube Thickness.....	See Chart Below
Maximum Bending Radius	5"
Minimum Bending Radius	3-1/2"
Swaging Capability*.....	Expansion / Reduction / Forming
Swaging Capacity.....	1" O.D. Tubing - 3" O.D. Tubing
Motor.....	5 H.P / Single or Three Phase / 220-380-440 VAC
Pump Output	3 GPM / 4200 psi (max. output)
Operation Modes	Manual Control Valve
Hydraulic Filter.....	Canister type
Bending Force	55,000 Pounds Maximum
Bend-Depth Control.....	Manual / No Automatic Stop
Overall Length	68" I302-BL / 65" 1502-BL
Overall Width.....	30" I302-BL / 26" 1502-BL
Overall Height.....	41"
* Special radius dies are available.	
** Reduction tools do not come standard	

DESIGN FEATURES MODELS 1000BL / 1000 BAS	
Bending Capacity	Tubing from 1/2" OD - 3" OD
Maximum Capacity/Tube Thickness.....	See Chart Below
Maximum Bending Radius	5"
Minimum Bending Radius	3-1/2"
Motor.....	5 H.P / Single or Three Phase / 220-380-440 VAC
Pump Output	3 GPM / 4200 psi (max. output)
Operation Modes	Automatic / BA or BAS Manual / BL
Hydraulic Filter.....	Canister type
Bending Force	55,000 Pounds Maximum
Bend-Depth Control.....	BA / Digital Readout / Automatic BAS / Depth-of-Bend Plate / Automatic BL / Manual
Overall Length	52" 1000-BA/1000 BAS 55" 1000-BL
Overall Width.....	39"
Overall Height.....	41"
* Special radius dies are available.	

GAUGE / WALL THICKNESS	DECIMAL EQUIVALENT	BENDER CAPACITY
4	.238	1"- 1-3/4 O.D. Tubing / Pipe
5	.220	1" - 7/8" O.D. Tubing / Pipe
6	.203	1" - 2" O.D. Tubing / Pipe
7	.180	1"- 2-1/8" O.D. Tubing / Pipe
8	.165	1"- 2-1/4" O.D. Tubing / Pipe
9	.148	1"- 2-1/4" O.D. Tubing / Pipe
10	.134	1"- 2-1/2" O.D. Tubing / Pipe
11	.120	1"- 2-1/2" O.D. Tubing / Pipe
12	.109	1"- 2-1/2" O.D. Tubing / Pipe
13	.095	1"- 3" O.D. Tubing / Pipe
14	.083	1"- 2-1/2" O.D. Tubing / Pipe
15	.072	1"- 2-1/2" O.D. Tubing / Pipe
16	.065	1"- 2-1/2" O.D. Tubing / Pipe
17	.058	1"- 2" O.D. Tubing / Pipe
18	.049	1"- 1-3/4" O.D. Tubing / Pipe

RADIUS SIZE	MAXIMUM BEND DEPTH
3-1/2"	135°
4"	145°
5"	172°
4"	150°
180° Style*	
5"	180°
180° Style*	

NOTE
180° STYLE DIES ARE NOT INCLUDED IN STANDARD TOOLING PACKAGES.

Special size dies not listed in this manual may be manufactured to your specifications.
Call factory for details. Special manufactured items require a 60-day minimum lead time.

UPON DELIVERY

1. Carefully remove the crating and packing materials.
2. Inspect the bender for any signs of concealed shipment damage or shortages. Remember to report any shipping damage to the carrier and make a notation on the delivery receipt.
3. Check the voltage, phase and proper amperage requirements for the motor shown on the motor plate. **Wiring should be performed by a certified electrician only.**

IMPORTANT SAFETY INSTRUCTIONS

Read these safety instructions entirely!

1. **Read and understand** all safety warning procedures before operating machine.
2. **Keep hands clear.** Remove hands prior to bending, forming, swaging or expanding tubing. Avoid pinch points.
3. **Keep work area clean.** Cluttered work areas invite injuries.
4. **Consider work area environment.** Do not expose equipment to rain. Do not use in damp or wet locations. Keep area well lighted.
5. **Only trained operators should operate this machine.** All non-trained personnel should be kept away from work area. Never let non-trained personnel come in contact with, or operate machine.
6. **Use tooling correctly.** Use all tooling in the proper manner. Never try to use a tool for something that it was not designed for. See manual for proper use.
7. **Dress properly.** Never wear loose gloves, clothing or jewelry. They can be caught in moving parts. Non-skid steel - toe footwear is recommended when operating machine. Wear protective hair covering to contain long hair.
8. **Always wear safety goggles** when operating this machine.
9. **Do not overreach.** Keep proper footing and balance at all times.
10. **Guard against electric shock.** This machine must be grounded while in use to protect the operator from electric shock. Never connect the green power cord wire to a live terminal. This is for ground only.
11. **Always unplug machine before servicing.** Never yank cord to disconnect it from the receptacle. Make sure electrical connections are good. Never use an extension cord longer than *15 feet*. If the power cord becomes frayed, replace it. Never alter electrical components on this machine. Never operate machine in or around water or damp environments.
12. **Warning!** Risk of explosion. This equipment has internal arcing or sparking parts which should not be exposed to flammable vapors. This machine should not be located in a recessed area or below floor level.
13. **Maintain with care.** Keep machine clean for better and safe performance. Follow manual for proper lubrication and maintenance instructions. Keep control handles and/or buttons dry, clean and free from grease and oil.
14. **Stay alert.** Watch what you are doing. Use common sense. **Be aware.**
15. **Check for damaged parts.** Check for alignment of moving parts, breakage of parts or any condition that may affect its operation. Do not use machine if any component is broken or damaged.
16. **Never remove electric foot switches** from their protective safety housing. Always remove foot from pedal enclosure between bends.
17. **Always allow for the "Safety Circle Of Swing"** around the bender. There should be at least 10 feet of space on both sides of the bender so that the tubing will not come in contact with persons and/or objects.

THESE SAFETY INSTRUCTIONS MUST BE GIVEN TO ALL OPERATORS TO READ.
IF THE INDIVIDUAL CANNOT READ, **INSTRUCTIONS MUST BE READ TO THEM.**

INTRODUCTION

Your new bender is a “press-style” bender that is capable of bending, flaring and swaging tubing up to 3 inches in diameter. The thickness of the tubing plays an important part. (See previous chart for recommended tubing allowances.) The front of the bender is where all the bending is performed. The top cylinder activates the bending or radius die which moves forward through the back shoes. The bottom cylinder keeps pressure applied to the back shoes by a chain assembly and integrated hydraulic sequence valve. In addition to the contoured shape of the radius dies, resistance pressure is applied to help the tubing maintain it's shape.

DEFINITION OF TERMS

The following definitions explain the major components and operating features of your machine. The **RIGHT**, **LEFT**, and **REAR** sides of the bender are relative to the **FRONT** of the machine where all bending is performed.

BENDER- The whole machine including all end finishing components.

BODY- The main 6” x 6” tubular structure that sits horizontal to the floor and is located just below the top cylinder.

SWAGER OR SWAGER BOX- The expanding/flaring unit located to the rear of the bender which utilizes pipe collars in conjunction with bullet shaped expander/forming dies to perform a variety of tube end finishing.

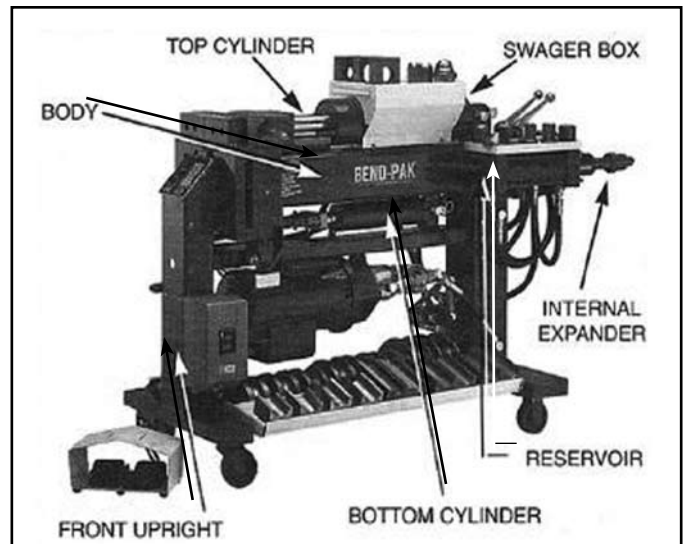
INTERNAL EXPANDER- The expanding/flaring unit located to the rear of the machine that utilizes segmented expander dies. These “segment sets” are expanded by the means of a tapered arbor pulled through their center. This style of end finishing is usually required with shorter pieces of tubing such as muffler nipples which do not allow the use of a collar.

TOP CYLINDER- The main hydraulic bending cylinder located at the top of the bender. It's primary function is to activate movement of the radius dies.

BOTTOM CYLINDER- The hydraulic cylinder located just below the body of the bender. It's primary function is to apply resistance pressure to the back shoes as the radius die pushes through.

RESERVOIR-The rear vertical leg that contains the hydraulic oil.

FRONT UPRIGHT- The front vertical leg.



Side view of Bender showing major components.

BENDER MODELS

There are nine different bender models available.

1000-BL 1000-BAS 1000-BA
1302-BL (Blue-Bullet) 1302-BAS 1302-BA
1502-BL 1502-BAS 1502-BA

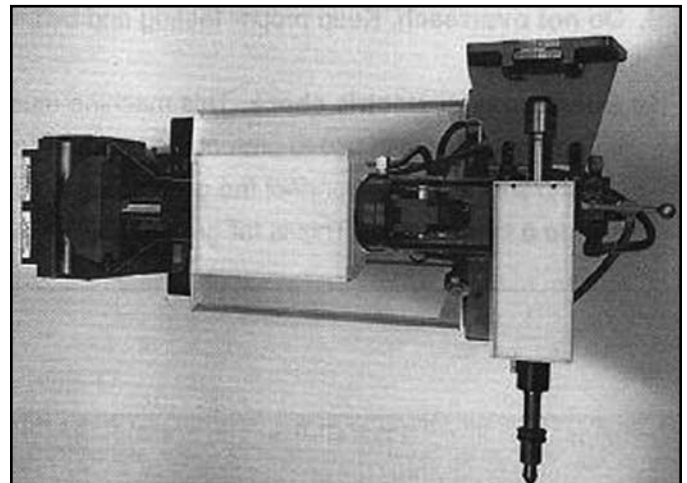
The following is a brief description of their controls and operating features. The model nomenclature consists of a number (1302) followed by letters BA. The numbers designate what style frame assembly is used while the letters signify the control features.

FRAME CONFIGURATION

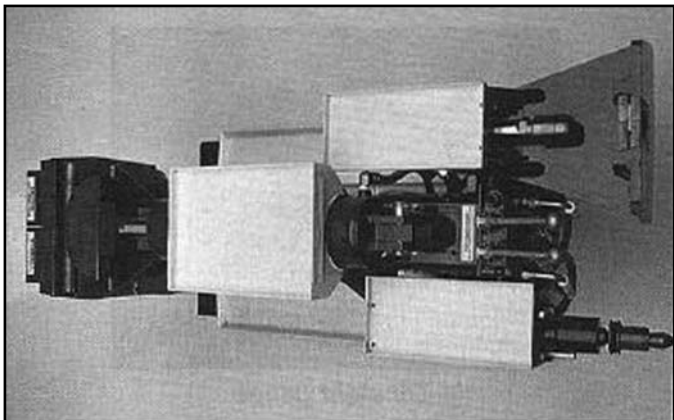
1000 Series- A machine capable of bending only. Does not come with any end finishing capabilities.

1302 Series- A machine capable of bending and end finishing. Equipped with both swager and internal expander. A double-ended hydraulic cylinder is used for both end finishing functions. The end finishing assembly, (the swager and internal expander) is positioned “cross-wised” on the rear of the machine.

Overhead view of Model 1302



1502 Series- A machine capable of bending and end finishing. Equipped with both swager and internal expander. Individual hydraulic cylinders are utilized for both end finishing functions. The swager and internal expander are positioned at the rear of the machine, one on each side and are positioned parallel with the main body.

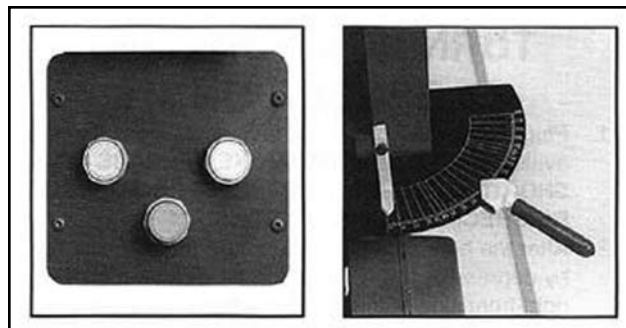


Overhead view of Model 1502

CONTROL FEATURES

BL or BLUE-BULLET Models- A hydraulic control valve is located at the front of the machine at knee height that allows the operators to manually control the machine with their leg. A degree plate is mounted up front that shows proper bend depths. This model does not incorporate any automatic bending features.

BAS Models- These models have two different control modes. An electric foot switch assembly for manual bending operations and a three-button control board for automatic functions. The degrees of bends are shown on a degree plate mounted near the front of the machine which also incorporates an adjustable slide pointer that can be set to any desired bend depth. The control board consists of three colored buttons; **GREEN, BLUE** and **RED**; each with its own operating functions. If you choose to use the machine in the automatic mode, you would simply set the pointer to 90 degrees for example, then press the **GREEN** button. At this time the bending head would activate and the radius die would begin to move forward. After the desired bend depth has been reached, the machine would automatically initiate the retract sequence that returns the die to the original starting position. The **BLUE** button is for automatically returning the die to the original starting position while the **RED** button is an emergency stop control. The electric foot switches will override the three button controls.



Three button control

D.O.B. Plate

BA Models - These models have two different control modes; an electric foot switch assembly for manual bending operations and a digital control board for automatic functions. The digital control board eliminates the depth of bend scale and replaces it with a digital readout labeled "DIE ANGLE". It also offers the user the capability to "program" certain bend depths in a desired sequence. When the power is turned off, all memory is erased. Once a bend depth is programmed into memory the number appears in a L.E.D. window labeled "SET ANGLE." The bend sequence is initiated by pressing the "AUTO" button. At this time the die moves forward and upon reaching the desired bend depth immediately retracts to the original starting position. An emergency "STOP" button pauses the machine at any time, and an additional auto "REVERSE" button activates the return sequence. The electric foot switches will override the digital controls.

INSTALLING THE



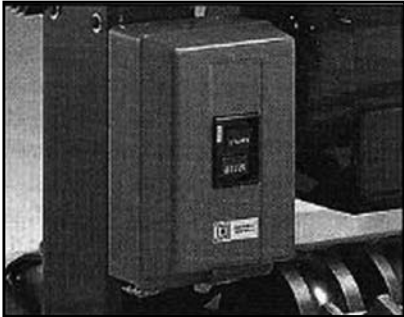
Digital control board

ELECTRICAL PLUG

Before installing a plug on the end of the power cord it is important to check for proper voltage, phase, and amp requirements. The tag attached to the end of the power cord, or the motor identification plate will show this necessary information. Due to the high amps and voltage required to operate this machine at long durations, it is recommended that you **DO NOT USE AN EXTENSION CORD LONGER THAN 15 FEET**. This motor must be grounded. The GREEN wire is for ground only. **All wiring should be done by a certified electrician only.** Damage to the motor caused by improper wiring is not covered under warranty.

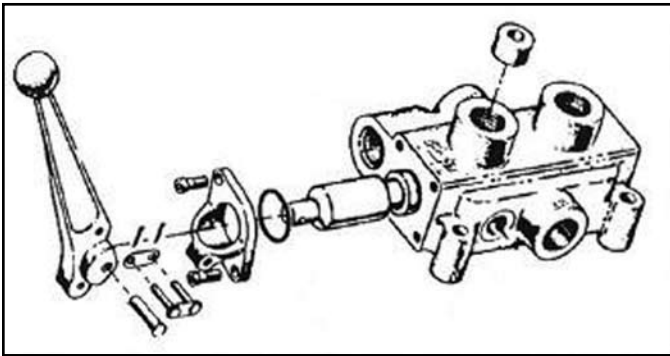
TURNING YOUR NEW BENDER ON

1. Plug the power cord into a receptacle closest to the available circuit panel. **IF SMOKE APPEARS OR SHORTING OCCURS, DISCONNECT IMMEDIATELY! RE-CHECK ALL CONNECTIONS.**
2. After the bender is plugged in, turn the machine on by depressing the "ON" button located on the lower right-front side of the machine. **IF SMOKE APPEARS OR SHORTING OCCURS, DISCONNECT IMMEDIATELY! RECHECK ALL CONNECTIONS.**



Electrical On / Off switch box

3. Let the bender run for approximately five minutes without operating the controls.
4. At this time, it is necessary to install all control handles by properly connecting the linkages as shown.

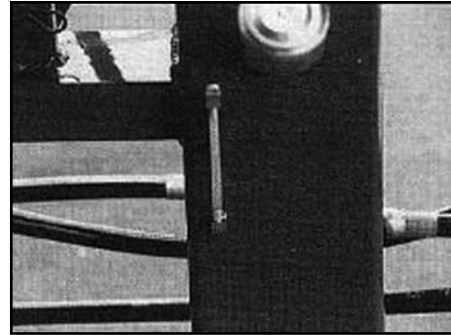


Control handle linkage assembly

5. After the bender is warmed up, retract the radius die that contains the sample tube. On automatic models do this by depressing the left foot switch. On Blue-Bullet or manual models activate the knee control valve by moving the handle to the right.
6. **IF THE RADIUS DIE DOES NOT MOVE, CONSULT THE FACTORY.**
7. After the radius die has completely retracted, remove the sample tubing that is in place.
8. Bring the radius die forward by depressing the right foot switch or by moving the manual control valve handle to the left.
9. Advance the radius die to 100 degrees then retract fully. Repeat this sequence for at least five times. The bending die may move erratically for the first

few cycles due to air trapped in the lines. This is normal. The air will dissipate after use. Do not try to "crack" a line to help the air escape.

10. At this time check for any possible leaks that could have developed during shipment. Tighten any hoses that may have loosened.
11. Check the oil level by observing the sight gauge located near the right-rear side of the machine. If the oil level appears low, add oil now. (See page 32 for recommended hydraulic oils.)



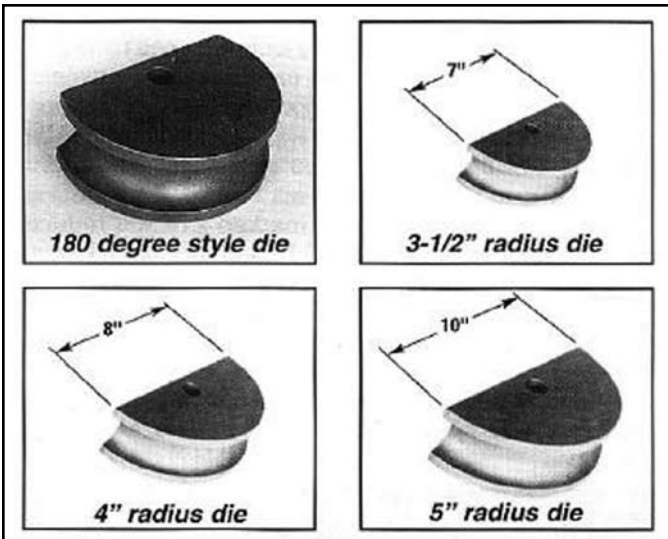
Oil sight gauge

12. Activate the swaging and internal expander cylinders by depressing the control handles located at the rear of the machine. Cycle the cylinders to their full extent at least five times. Again, these cylinders may act erratically until the air dissipates.

TOOLING

Find the packing list that accompanied your bender, itemizing each tool that was to be included in your tooling package. Double check the pieces you received with those that were checked off. **ALL THE TOOLS THAT ARE CHECKED OFF IN THE "SHIPPED" COLUMN DID SHIP WITH YOUR BENDER.** If you cannot find a certain piece that you feel should be with the shipment, check with the freight carrier or observe the packing list and check the back ordered column. If a certain item is back ordered it will be automatically forwarded to you. A description of tooling is listed below.

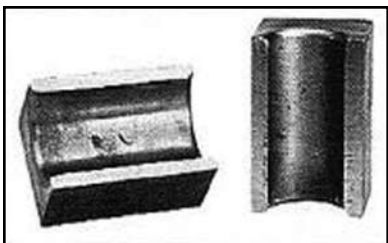
RADIUS DIES- These dies which are commonly referred to as the "bending dies" come in different radii and tubing sizes. Each die is machined and sized according to tubing diameters. The proper tube size is stamped on the top of each die. 112 represents 1-1/2" tubing, 134 represents 1-3/4" tubing etc. The radius dies are available in three standard radii, 5", 4" and 3-1/2". Each standard radius die represents half of a circle or diameter. 180 degree dies are also available which represent three quarters of a circle and allow the tubing to "wrap" around farther although the radii are the same.



BACK SHOES- Back shoes, which are commonly referred to as wiper dies come in pairs and are used together with the radius dies during the bending process. These dies play an important part as their primary purpose is to form the outside radius of the bend. These dies are used to clamp or retain the pipe as it is wrapped around the radius die. Each back shoe is machined and sized according to tubing diameter. The proper tubing size is stamped on the top of each back shoe.

NOTE:

Back shoes should be kept clean and lightly oiled. Never use the bender without back shoes in place. Never use the bender as a vice or a press.

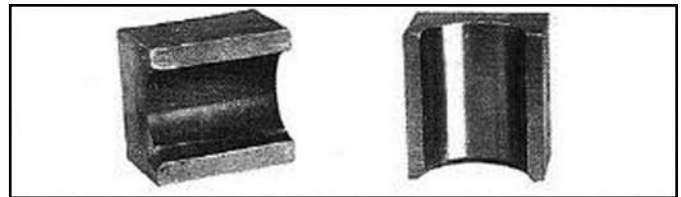


Back shoe dies

HALF SHOES AND THREE QUARTER SHOES Half shoes and three quarter shoes do not come in pairs. Only one is required. Half shoes are exactly half the length of a standard back shoe and three quarter shoes are three quarters the length. These smaller shoes are required when an upcoming bend is less than ten inches from an existing bend. The half/three quarter shoe will be used in conjunction with the back shoe and placed only on the side where the full back shoe may interfere with the upcoming bend. *(Details for the proper use of these tools are explained in the BENDING section.)*

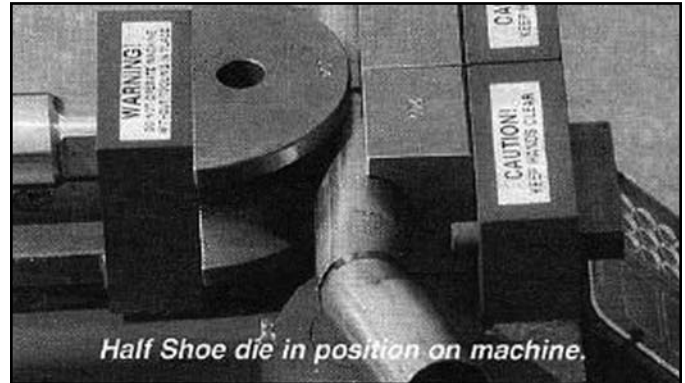
NOTE:

Half shoes and three quarter shoes must be used with radius dies and back shoes of the same corresponding size.



Half Shoe

Three Quarter Shoe



CAUTION!

All tooling described in this manual is heavy! HANDLE WITH CARE. Always wear steel toe boots when operating bender.

HAC's & STED's- HAC's are Commonly referred to as "adapter collars" while the STED's are referred to as "solid expander dies". HAC's are used to hold or clamp the tubing in place when performing end-finishing Operations or when using the STED's. These "adapter collars" are heat treated which causes the inside threads or "teeth" to become brittle. Because of this, these "teeth" have the tendency to chip during normal use. This is normal and will have no effect on their performance. The STED's or "solid expander dies" are used to expand the tubing to exact inside diameters and are also used to create male ball expansions. Both tools are stamped and marked with their appropriate tubing sizes. *(Details on the proper use of both tools is explained in the END FINISHING section.)*

NOTE:

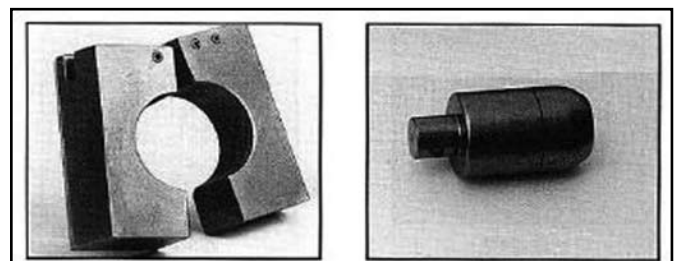
Keep collars free of debris and build up. Use a wire brush periodically to clean the inside threaded area. Keep all tooling lightly oiled.

CAUTION!

KEEP HANDS CLEAR when using all the tools described in this manual. Improper use of these tools may result in serious bodily harm

Adapter Collars

STED Expander dies

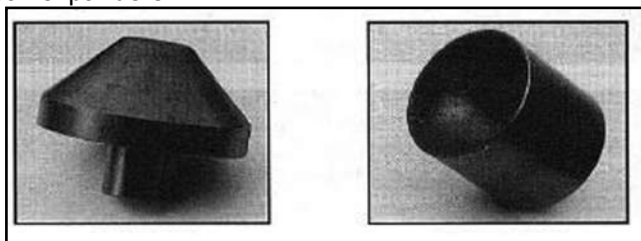


END-FINISHING TOOLS - A variety of end finishing tools are available that perform different functions. Not every tool is included with your tooling package. If you are unsure as to what was included, please consult your distributor or review the delivery receipt and invoice. Each tool is marked with the appropriate size.

CAUTION!
DO NOT attempt to use these tools unless you have read and fully understand the "Swaging and End Forming" section.

HPF-300 - A tool for making 45 and 90 degree flanges on pipe ends. Usually for manifold connections.

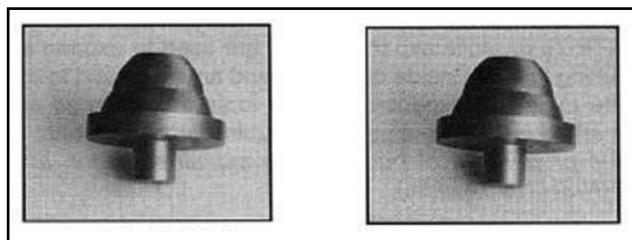
DD-134/212 - A tool for doming pipe ends or making male ball expansions when used in conjunction with the male ball expanders.



HPF-300

DD-134/212

DD-134/212 & BFED-200/214 - Tools for flaring pipe ends to make female ball expansions. Each tool is "stepped" and has the ability to flare two different sizes. The BFED-134/214 is used for tubing sizes 1-3/4" and 2-1/4" while the BFED-200/212 is used for tubing sizes 2" and 2-1/2".

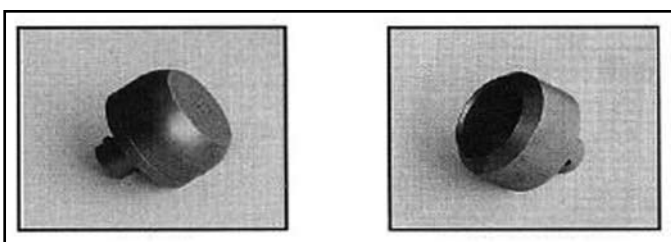


BFED-134/214

BFED-200/212

B-212 - A tool used for making male ball expansions on 2-1/2" pipe ends.

CFT-200 & CFT-214 - Tools for making manifold flanges on 2" and 2-1/4" pipe ends. Not included in standard tooling packages.



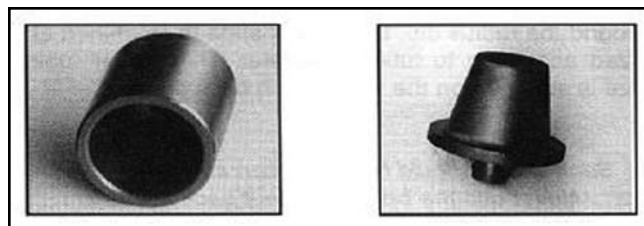
B-212

CFT-200

REDUCING TOOLS - Reducing tools are used for reducing or "shrinking" pipe ends to exact outside diameters. Each tool is marked with the appropriate size. It is important to understand that the size marked on the tool will be the size that the tubing will be reduced *down to*. For example, a tool marked 200 will reduce 2-1/4" tubing down to 2" O.D. and a tool marked 214 will reduce 2-1/2" tubing down to 2-1/4" O.D. *Not included in standard tooling packages.*

HCT-214/212 - This tool is for making header flanges or "collectors" on 2-1/4" and 2-1/2" pipe ends. This eliminates the need to purchase a collector when installing header type manifolds. *Not included in standard tooling packages.*

IMPORTANT NOTICE
Installing headers on any motor vehicle is illegal in most states and may violate the 1990 Clean Air Act. Consult the EPA at (202) 260-7645 for questions regarding the installation of any aftermarket performance product that may alter vehicle emissions.



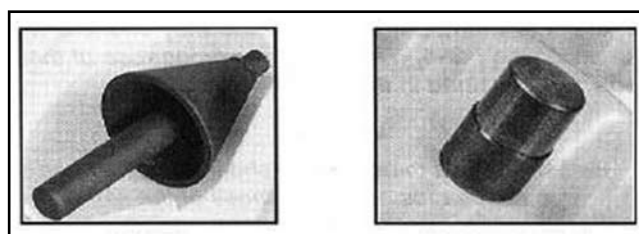
Reducing Tool

HCT-214/212

HSRO - A hand held pipe reshaping tool that is used for reshaping pipe ends while the tubing remains on the vehicle. By tapping the tool with a hammer or mallet the tool can be used to reshape pipe ends. Can be used internally or externally by simply reversing the tool. Not available in standard tooling packages.

CAUTION!
ALWAYS wear protective safety glasses or goggles when using this machine

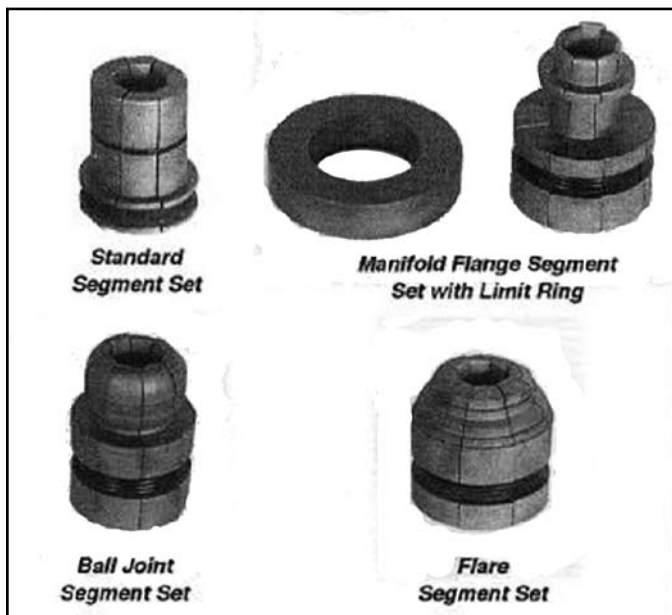
BENDING PLUGS - Bending plugs are used to contain the shape of pipe ends during the bending process when the radius die comes in close proximity to the pipe end. Once the bend is completed, the bending plug is removed. *Not included in standard tooling packages.*



HSRO

Bending Plug

SEGMENT EXPANDERS - Segment expanders or “segment sets” come in a variety of sizes and shapes, each performing its own distinct function. Segment sets are used for short pieces of tubing or when the tubing end is minimized due to an existing bend. They can also be used to expand tubing that is deformed in such a manner that will not permit use of the swager expander. Segment sets are used in conjunction with an arbor or mandrel. All segment sets are identified by grooved rings located at the bottom as described on the following chart. There are four different types of segment sets available; STANDARD SEGMENT SETS, MANIFOLD FLANGE SEGMENT SETS, BALL-JOINT SEGMENT SETS, and FLARE SEGMENT SETS.



STANDARD SEGMENT SETS - These segment sets are used to make straight expansions on tubing ends and are found in all standard tooling packages.

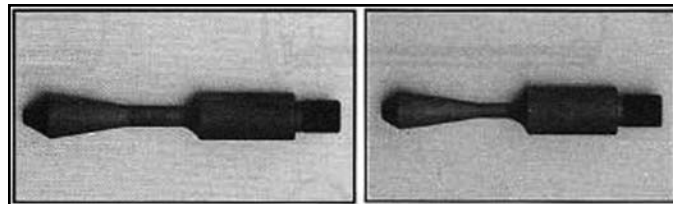
MANIFOLD FLANGE SEGMENT SETS - These segment sets are used to make donut-type manifold flanges on tubing ends. They are available in five sizes; 1-1/4”, 1-1/2”, 2”, 2-1/4”, and 2-1/2”. All manifold segment sets are used in conjunction with limit rings. *Not included in standard tooling packages.*

BALL-JOINT SEGMENT SETS - These segment sets are used to make ball-joint expansions on tubing ends. They are available in three sizes; 2”, 2-1/4” and 2-1/2”. *Not included in standard tooling packages.*

FLARE SEGMENT SETS - These segment sets are used to make 45 degree flares on tubing ends. Three different sets are available that work on tubing sizes 1-1/2” - 2-1/2”. *Not included in standard tooling packages.*

NOTE:

Keep segment sets and arbor well greased.
The ARBOR which is pulled through the center of the segment sets is available in two sizes. The HSA-114 is an arbor used exclusively for 1-1/4” and 1-3/8” tubing while the HSA-112 is used for tubing sizes 1-1/2” through 3”.

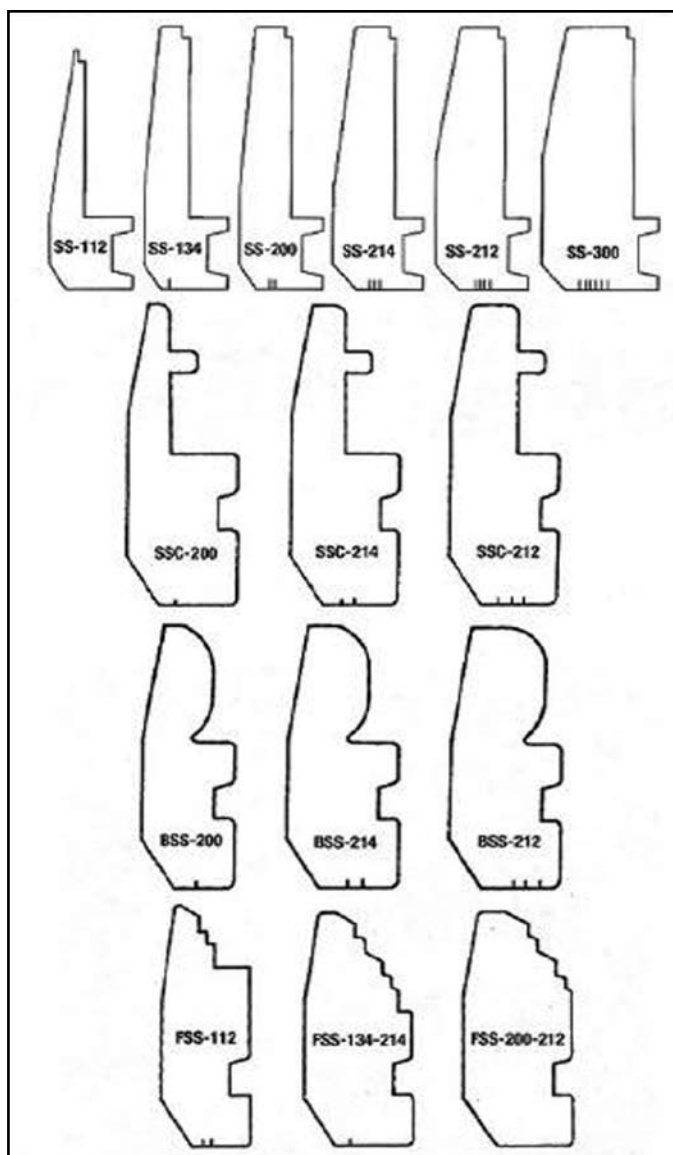


HSA-112 Arbor

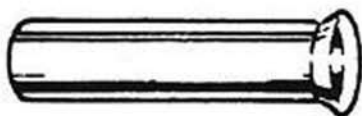
HSA-114 Arbor

WARNING!

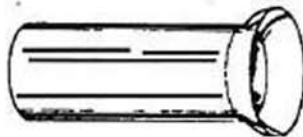
1. Always remove excess tooling from swager area before using internal expander.
2. To avoid breaking tooling ALWAYS use proper segment sets with appropriate tubing size.
3. NEVER stand in front of arbor when operating internal expander.



TYPICAL END FINISHING



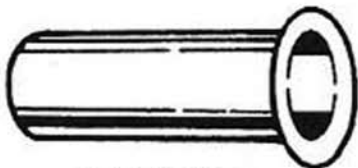
45° Flare



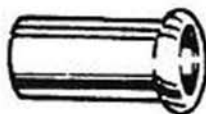
Female Ball Flare



Straight Expansion



90° Flat Flare



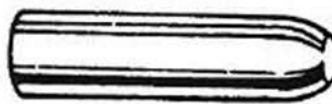
Male Ball Flare



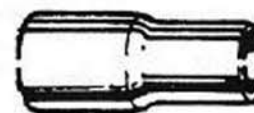
Manifold Flange



Manifold Flange
with Insert



Domed End



Reduction

DIGITAL CONTROL OPERATIONS. “BA” MODELS.

STOP!

Before any attempt is made to operate this machine it is important that you have read and fully understand all operating instructions described in this manual.

Read each of the following sections carefully before attempting any operation of this unit. All “BA” models are equipped with a computer microprocessor that allows minor storage and recall of certain bend data. It also gives the user the ability to bend automatically or manually.



DESCRIPTION OF CONTROLS:

SELCT - Selects KEYPAD or MEMORY functions.

CLEAR - Clears the SET ANGLE.

ENTER - Enters the numbers displayed in SET ANGLE into memory. (Only when KEYPAD is lighted.)

STEP - Advances station number display.

RESET - Resets station number back to one.

AUTO - Starts automatic cycle.

JOG/FWD - Press and hold to advance radius die manually. Release button and all forward motion will stop. Overrides AUTO button.

STOP/REVERSE (Also, EMERGENCY STOP) -

Press to stop forward movement of radius die. Press again to reverse, then again to stop.

SET ANGLE WINDOW - Displays depth-of-bend degrees programmed for the next bend.

DIE ANGLE WINDOW - Continuously displays the degrees of bend as the radius die moves forward.

STATION WINDOW - Shows the position or station number that a particular bend depth has been programmed into.

REMOTE FOOT SWITCHES - Used for manual operation. The right foot switch advances the radius die while the left foot switch retracts it. Either foot switch will also serve as an emergency stop.

WARNING!

1. Either foot switch will act as an **EMERGENCY stop**.
2. **NEVER** operate the remote electric foot switches in or around water or damp areas.
3. If the foot switch cords become frayed or damaged in any way, discontinue use until they are properly repaired.
4. **ALWAYS** disconnect power cord before making any electrical repairs.

NOTE:

Practice the following bending steps without tubing and initiate a few "dry runs" until you understand the operating features.

USING THE REMOTE FOOT SWITCHES OR AUTO BUTTON

- When using a card system or bending a pipe, you are not required to use the "Memory" function. Some operators will use the memory function only when multiple pipes are to be bent. The most popular method will be manual or semi-automatic. When KEYPAD is lighted, the machine will operate manually using the remote foot switches or JOG/FWD button or semi-automatically, performing one bend at a time using the AUTO button. The actual depth-of-bend degrees will continuously appear in the DIE ANGLE window any time the machine is running. To manually operate the bender, depress the right foot switch to advance the radius die and the left one to retract it. The foot switches will always override the automatic controls. When using the foot switches, the radius die will NOT stop at the SET ANGLE.

CAUTION!

KEEP HANDS CLEAR while dies are in motion. Familiarize yourself with the **EMERGENCY STOP** button and its operation. **NEVER** place hands near bending area or any pinch points when motor is running. **ONLY TRAINED PERSONNEL** should be near machine when it is in operation.

To bend one bend at a time using the AUTO button, follow these step-by-step instructions.

1. Turn the bender on and depress the SELCT button to illuminate the KEYPAD light.
2. Find out what degree of bend is required and enter it by depressing the appropriate number keys. This number will then appear in the SET ANGLE window. If you make a mistake and improperly enter the wrong number, simply clear the SET ANGLE by depressing the CLEAR button then re-enter the proper information.
3. With the KEYPAD light illuminated, disregard any numbers that may appear in the STATION window.

4. After installing a matched die set, position the tubing so that you can begin bending.
5. Check your "circle-of-swing" for allowable clearance.
6. Depress the AUTO button to initiate the semi-automatic cycle.
7. At this time the radius die will begin to move forward until it reaches the designated depth-of-bend displayed in the SET ANGLE window. The retract sequence will then automatically initiate, reversing the radius die until it is fully retracted.
8. For the remaining bends, move the pipe over until the next bend position or "center mark" is centered between the back shoes. Repeat steps 5-7.
9. After all bends are completed, cut off the tubing end to match the existing pipe or master.

CAUTION!

If operating controls are malfunctioning, discontinue use immediately. DO NOT attempt to operate machinery until controls have been repaired.

PROGRAMMING THE DIGITAL BOARD- Follow these step-by-step instructions to properly utilize the MEMORY feature. The PROGRAM DATA CONTROL board stores bend depths only. All data will be cleared once power is turned off. The memory feature can be used when bending multiple or individual pipes. The following instructions illustrate how to properly enter the data which is shown on the program cards.

1. Press the SELCT button to illuminate the KEYPAD light.
2. Press the RESET button to return the STATION window to number one.
3. Using your program card, enter the first degree of bend shown in the BEND-DEPTH column. Press the appropriate number keys to display the recommended bend depth in the SET ANGLE window. Now press the ENTER key. You have just entered the first bend depth in station number one.
4. Press the STEP button to change the station to display the number "2".
5. Using your program card, enter the second depth of bend by pressing the appropriate number keys. The number should appear in the SET ANGLE window. If the information is correct press the ENTER key. You have now entered the second bend depth in station number two.

6. Repeat these steps until all depth-of-bends have been entered. Always remember to press the ENTER key prior to advancing to the next station.
7. Now press the SELCT key to illuminate the MEMORY light.
8. Press the RESET button. This will change the STATION window to number "1".
9. To double check the data that has been entered, press the STEP key to advance the stations through their appropriate sequence. Review the data that has been entered. If you reach a particular station that is incorrect, press the SELCT key to illuminate the KEYPAD light, the SET ANGLE will show zero at this time then press the appropriate number keys and retain the data by depressing the ENTER key. After correcting the improper data, press the SELCT button to illuminate the MEMORY light and the RESET key to reset the STATION window. Review the information once again.

NOTE:

In order to store data into program memory the KEYPAD light must be illuminated. Entered data will not be shown in the SET ANGLE window until the MEMORY light is illuminated.

THREE-BUTTON CONTROL OPERATIONS "BAS" MODELS

Read each of the following sections carefully before attempting any operation of this unit. All "BAS" models are equipped with a three-button control board that controls the semi-automatic bending function. In addition to the three-button control board, all "BAS" models are equipped with a remote foot switch for manual operation.



DESCRIPTION OF CONTROLS:

NEVER HOLD IN COLORED CONTROL BUTTONS! -

To properly operate the colored control buttons, quickly press and release. By holding the colored control buttons in, damage to the machine and/or components may result.

GREEN BUTTON - Activates the automatic bending cycle. After pressing the GREEN button, the radius die will move forward until the desired depth-of-bend is reached then automatically retract until the die is returned to the original starting position.

BLUE BUTTON - Automatically returns or retracts the bending die to the original starting position. NEVER hold the BLUE button in when retracting the bending ram.

RED BUTTON - Serves as an "Emergency Stop" button. Automatically stops all movement of the bending die during the automatic cycle.

REMOTE FOOT SWITCHES - Used for manual operation. The right foot switch advances the radius die to start the bending process. The left foot switch retracts the radius die. Either foot switch will also serve as an emergency stop.

WARNING!

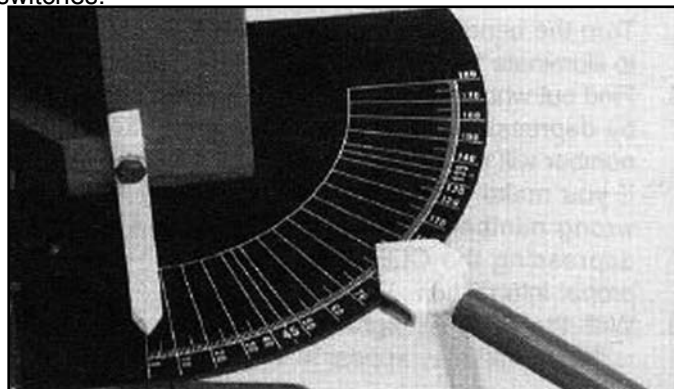
1. Either foot switch will act as an EMERGENCY stop.
2. NEVER operate the remote electric foot switches in or around water or damp areas.
3. If the foot switch cords become frayed or damaged in any way, discontinue use until they are properly repaired.
4. ALWAYS disconnect power cord before making any electrical repairs.
5. If any operating controls are malfunctioning, discontinue immediately.

NOTE:

Practice the following bending steps without tubing and initiate a few "dry runs" until you understand the operating features.

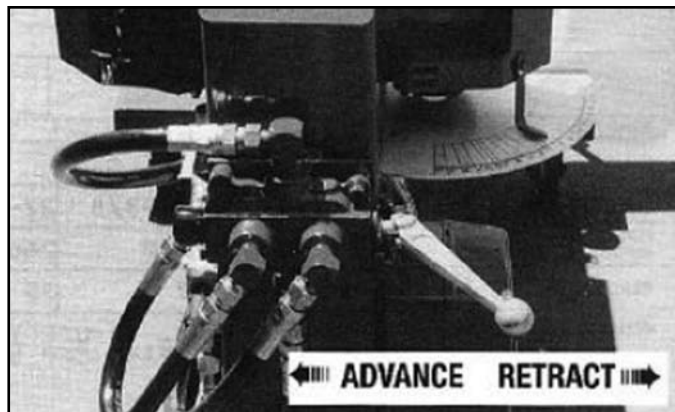
USING THE "AUTO-STOP" DEPTH-OF-BEND FEATURE -

The "Auto-Stop" slide pointer is attached to the depth-of-bend degree plate and stops the radius die at pre-set bend depths. The "Auto-Stop" feature works with either the GREEN automatic control button or the remote foot switches.



To use the three-button automatic controls, follow these simple instructions.

1. Position the "Auto-Stop" pointer at the desired depth of bend.
2. Position the tubing at the appropriate bend mark.
3. Check your "circle-of-swing" and prepare to begin bending.
4. Press the GREEN control button.
5. At this time the radius die will advance until the desired depth-of-bend is reached, then, retract to the original starting position.
6. Be prepared to support the tubing as it is released from the dies.



To retract the radius die, move the handle to the right (or plunger up) to return to the original starting position. Always be prepared to support the pipe as it is released from the dies.

CAUTION!

Be alert at all times. NEVER place hands near bending area or other pinch points when motor is running.

USING THE REMOTE FOOT SWITCHES - The remote foot switches are used for manual bending functions. When using the foot switches for manual operation it is best that you position the "Auto-Stop" pointer out of the way or at 180 degrees so that it does not interfere. If you want to use the foot pedals in conjunction with the "Auto-Stop" pointer, position the pointer at the desired bend depth and proceed by pressing the RIGHT foot switch until the radius die stops at the pre-set bend angle. Press the LEFT foot switch to retract the radius die. Always be prepared to support the pipe as it is released from the dies.

OPERATING THE MANUAL KNEE CONTROL. "BL" / BULLET MODELS

Read the following section completely before attempting any operation of this unit. All "BL" models are equipped with a hydraulic control valve mounted at knee height that allows the user to operate the machine manually with their leg. A degree plate with pointer is mounted near the front of the machine that gives the user accurate bend depths. "BL" models are not equipped with any automatic features.

To operate the manual control valve, move the handle to the left or the plunger down to advance the radius die. The handle must be fully engaged to properly control radius die movement.

OPERATION NOTE / BL MODELS:

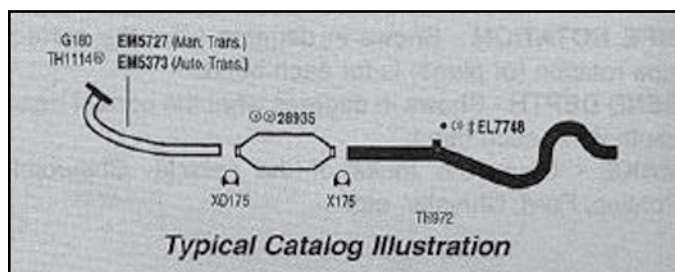
If the operating control handle is pressed half way or partially down during the bending operation, the radius die may slow down or even retract slightly. To keep the bending die at a controlled speed you must fully depress the valve handle. If you wish to advance the radius die a few degrees only, instead of easing the handle down, try "tapping" the handle.

BENDING OPERATIONS

There are basically two styles of bending that can be performed on your new bender. The first is PROGRAM CARD BENDING which requires the use of PROGRAM CARDS that contain instructional data for specific applications. The second is PATTERN BENDING which is the most popular method and duplicates pipes by using an existing pipe or wire pattern as a master.

USING THE PROGRAM CARDS - The Program Card System contains bending data for specific applications. The following instructions define each section of the card. It is important that you read the entire card carefully before attempting to bend. Due to the many cards and applications covered, there may be some inaccuracies. No responsibility is assumed by the manufacturer for any consequences arising from inaccuracies found on the program cards.

Look up the card number in the appropriate reference catalog. Exhaust pipes numbers start with the letter "E" and tail pipes numbers start with the letter "T".



1397 UPDATED 01-90										
	EM5727				YEAR	DIAMETER	O/A LENGTH	SIDE		
BEND NO.	1	2	3	4	5	6	7	8	9	
SYMBOLS	F	A	C	C					R	
CENTER MARKS	5-1/4	11-1/8	17-5/8	22-7/8	41-1/8	51-5/8				
PIPE ROTATION	0	147	250	260	223	277				
BEND DEPTH	17	116	7	35	18	9				
BENDING INSTRUCTIONS: USE 3-1/2" RAD. A=USE 1/2" SHOE. C=REV. USE 1/2" SHOE. EXPAND "F" WITH FEMALE BUICK BALL.										
MAKE: CHEVROLET PONTIAC BUICK CADILLAC OLDSMOBILE					MODEL: CAVALIER-CIMMARON-FIRENZA J2000-SKYHAWK 2.0L ENGINE					

Sample card layout to be used in conjunction with bending instructions.

Take down the number of the pipe to be bent, find and remove it from the deck. Remember to place a marker of some type in its place. The cards are filed in numerical sequence by the number shown on the top left section of the card. Only the last four digits shown are in sequential order. Some cards start with a prefix such as T3 or T5 then are followed by a four digit number. ALWAYS disregard the prefix and follow the last four digits only.

DEFINITION OF CARD SECTIONS:

YEAR - Gives the year of the vehicle that the card pertains to.

DIAMETER - The original equipment factory recommended tubing diameter for that particular vehicle,

O/A LENGTH - Overall length of tubing required for that particular pipe. Also referred to as the cut-off point.

SIDE - When more than one section of tubing is required for a particular card number, this section shows if it is the front, rear, left or right side.

SYMBOLS - Shows certain symbols that pertain to individual bending instructions that are explained in greater detail in the BENDING INSTRUCTIONS section. The symbol section also includes the descriptive "F" and "R" symbols that indicate how the pipe fits on the vehicle. "F" means front and "R" means rear.

CENTER MARKS - Refers to the actual locations or measurements that the bends will be located.

PIPE ROTATION - Shows in degrees what the correct pipe rotation (or plane) is for each bend.

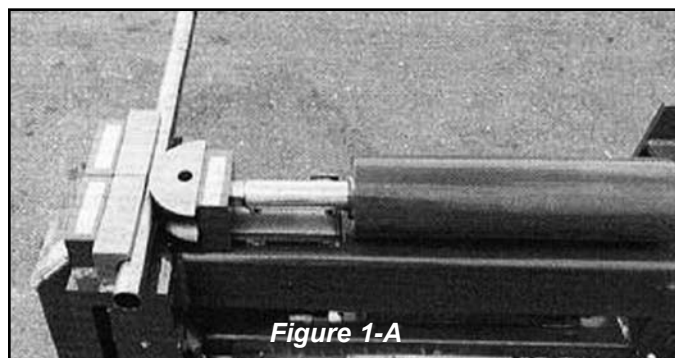
BEND DEPTH - Shows in degrees what the correct bend depth is for each bend.

MAKE - Gives the make of the vehicle. Chevrolet, Pontiac, Ford, Chrysler, etc. **MODEL** - Gives descriptive factors such as the model, engine and frame size.

BENDING INSTRUCTIONS - Shows what radius die will be used in addition to other tooling such as half shoes and three quarter shoes. Also gives instructions on reversing and certain end-finishing requirements. Not all applications will be shown on the card.

Follow these step-by-step instructions to bend the pipe for the card shown above.

1. Select the proper tubing size for the application as called for in the DIAMETER SECTION of the card. (See *Recommended Tubing Chart on page 48*) Wipe tubing to remove excess oil.
2. Install the correct radius die as called for in the BENDING INSTRUCTION section. Two back shoes are required unless otherwise specified. Place tubing in the bender between the back shoes and radius die with the greater portion of the tubing extending out the LEFT side of the bender. This is necessary so that you can mark the tubing with the appropriate CENTER MARKS shown on the card.
3. Engage the bending dies until the pusher block springs are compressed and the tubing is held firmly. Carefully control the advancement of the radius die so as not to dent or bend the tubing at this time. (See figure 1-A)



- Using the program card, refer to the section marked CENTER MARKS for the list of measurements in inches where the different bends will be made. Each CENTER MARK is measured from the left end of the tubing. Mark and number the CENTER MARKS on the tubing using a crayon or felt tip pen. The last mark you make should be the cut off point shown in the O/A LENGTH section. DO NOT CUT THE TUBING at the last center mark until the final bend is made. (See figure 1-B.)

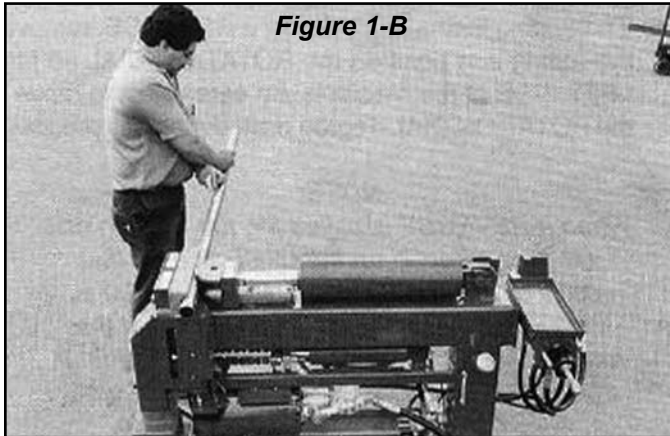


Figure 1-B

- Disengage the dies and reposition the tubing so that the greater portion is now extending out the RIGHT side of the bender and the first CENTER MARK is lined up with the center of the two back shoes.
- Engage the bending dies until the pusher block springs are compressed and the tubing is held firmly. (See figure 1-C)

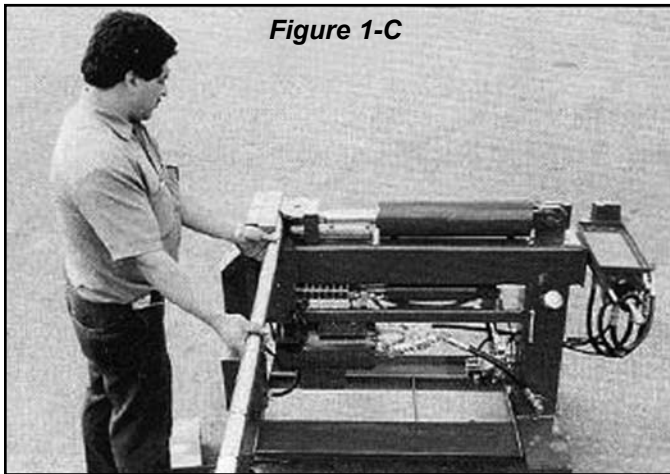


Figure 1-C

- Rotate the tubing so that the weld seam on the tubing is facing up or at the 12 o'clock position. The pusher block springs are designed to hold the tubing secure but still allow rotation of the pipe. Install the rotation dial on the RIGHT end of the tubing. Loosen the butterfly nut if necessary and insert the segmented expander inside the tubing end. Tighten the butterfly nut until the rotation dial is secure.
- With the rotation dial properly installed, rotate the degree plate not the tubing so that the pendulum pointer is showing ZERO. Make sure the butterfly nut remains tight.

NOTE:

The weld seam on the tubing should be directly in line with the ZERO mark at this time. (See figure 2-A)

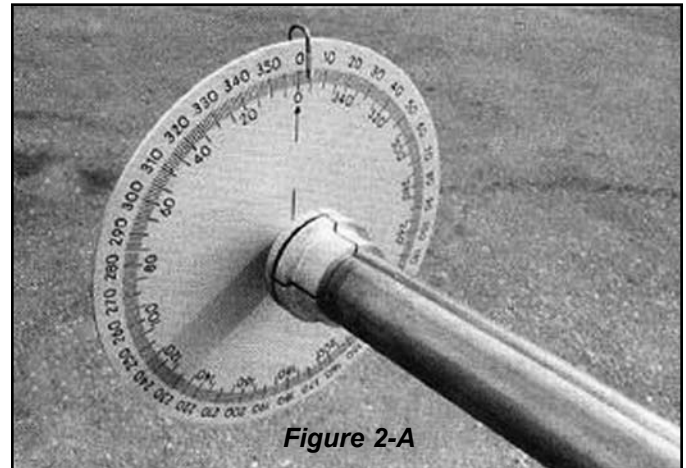


Figure 2-A

- You are now ready to make your first bend. At this time you may program your depth-of bends on the digital board as described in the DIGITAL CONTROL OPERATION section; position the depth-of bend pointer on BAS models; or elect to use the electric foot switches or manual knee control valve. For beginning operators we suggest that manual controls are used until you become more familiar with the operating features of your machine

CAUTION!
Before advancing the radius die check your circle-of-swing for allowable bending clearances.

- As described in the BEND DEPTH section of the card, advance the radius die to 17 DEGREES then retract the die to the original starting position. The rotation dial should still show ZERO at this time.
- Review the SYMBOLS section of the card and check for any special instructions. On bend number two you will notice that a HALF SHOE is called for. Install the HALF SHOE now. Unless a special instruction is given to change the radius size, you will continue to use the 3-1/2" radius through the remaining bends.

NOTE:

Always position the HALF SHOE or THREE QUARTER SHOE on the same side as the previous bend.

- For the second bend, slide the tubing to the LEFT so that the second CENTER MARK is lined up with the center of the shoes. (See figure 2-B.)

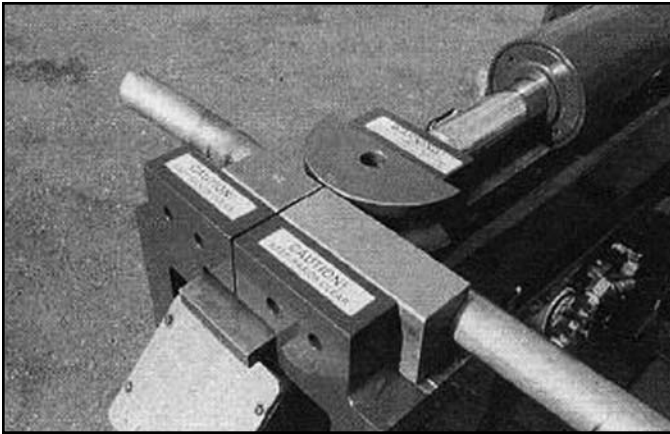


Figure 2-B

14. With the HALF SHOE in place and the second CENTER MARK lined up at the center of the shoes, advance the radius die forward until the pusher block springs are compressed and the tubing is held securely. Carefully control the advancement of the radius die to prevent denting or bending of the pipe at this time.
15. Now, rotate the tubing not the dial so that the pendulum pointer or dial indicator points to the proper setting as shown in the PIPE ROTATION section of the card. In this case the PIPE ROTATION will be 147 degrees. ALWAYS use the inside set of numbers. (See figure 2-C)

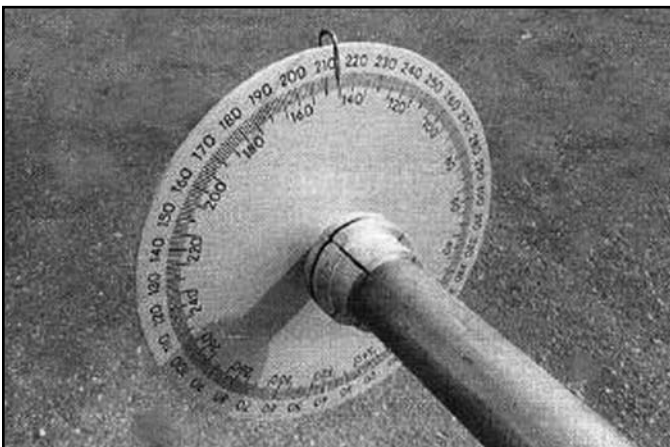


Figure 2-C

NOTE:

The rotation dial is equipped with two scales. The standard scale which is used for all regular bending operations is positioned to the INSIDE of the dial. The OUTSIDE scale is used for bending "mirror images" or opposite side pipes.

16. With the rotation dial properly set at 147 degrees and the center mark lined up, advance the radius die to 11 degrees as shown on the card. Retract the die to the original starting position.
17. Review the SYMBOLS section of the card and check for any special instructions. On bend number three you will notice that a REVERSE / USE HALF SHOE is called for.

The ROTATION DIAL degree plate **MUST NEVER** be moved after bending has begun. ALWAYS be prepared to support the tubing as it is released from the dies to prevent it from hitting the ground. If the dial is accidentally moved during the bending process, re-position the dial so that the ZERO mark is located at the weld seam of the tubing, or return to the previous bend and position the pendulum pointer to the degrees required for that particular bend.

18. If a bending instruction calls for a REVERSE, remove the tubing and position the ROTATION DIAL on the LEFT SIDE of the machine. Be careful not to move the ROTATION DIAL degree plate during this process.

NOTE:

When a REVERSE is called for, the rotation dial will be positioned on the LEFT side for that bend only. If the SYMBOL section shows a REVERSE again for the following bend, the rotation dial MUST remain on the LEFT side. If no REVERSE is called for, the rotation dial MUST be returned to the RIGHT side.

19. For bend number three, REVERSE the tubing and install the HALF SHOE now. (See figure 3-A)

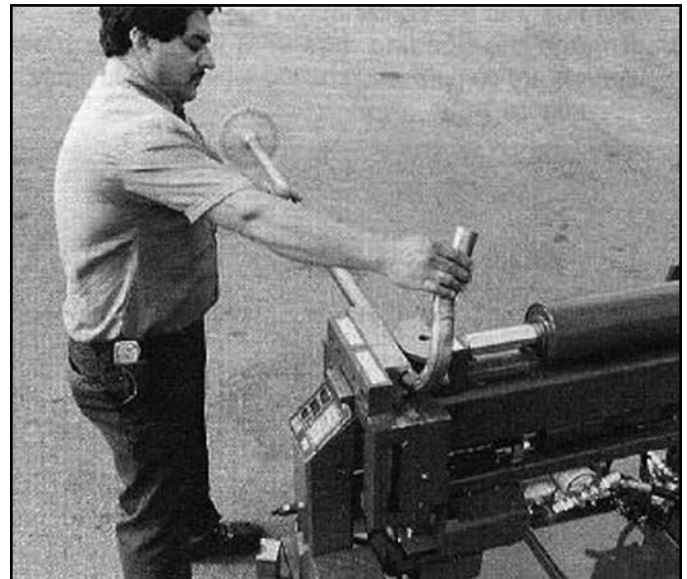


Figure 3-A

20. With the HALF SHOE in place and the third CENTER MARK lined up at the center of the shoes, advance the radius die forward until the pusher block springs are compressed and the tubing is held securely.
21. Rotate the tubing not the dial so that the pendulum pointer or dial indicator points to the proper setting as shown in the PIPE ROTATION section of the card. In this case the PIPE ROTATION will be 250 degrees. USE THE INSIDE set of numbers. Advance the radius die to 7 degrees.

22. Review the SYMBOLS section of the card and check for any special instructions.
23. On bend number four you will notice that a REVERSE USE HALF SHOE is again called for. Keep the ROTATION DIAL on the LEFT side for this bend.
24. Advance the radius die forward until the pusher block springs are compressed and the tubing is held securely.
25. Rotate the tubing so that the pendulum pointer or dial indicator points to 260 degrees.
26. Advance the radius die to 35 degrees then retract the die to the original starting position.
27. Review the SYMBOLS section of the card and check for any special instructions for bend number five.
28. On bend number five no special instructions are shown. In this case, return the ROTATION DIAL to the right side and install the full BACK SHOE. A HALF SHOE is not required for this bend. (See figure 3-B.)

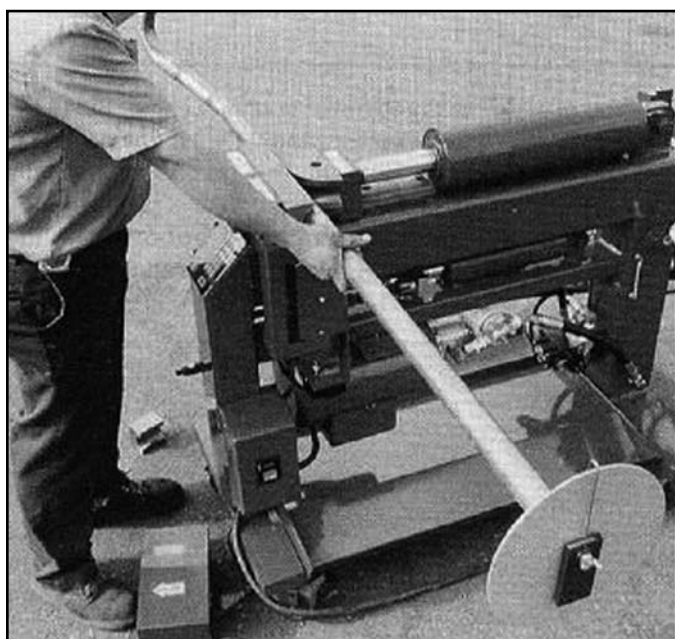


Figure 3-B

29. Advance the radius die forward until the pusher block springs are compressed and the tubing is held securely.
30. Rotate the tubing so that the pendulum pointer or dial indicator points to 223 degrees.
31. Advance the radius die to 18 degrees then retract the die to the original starting position.
32. Review the SYMBOLS section of the card and check for any special instructions for bend number six.
33. On bend number six no special instructions are shown.
34. Advance the radius die forward until the pusher block springs are compressed and the tubing is held securely.
35. Rotate the tubing so that the pendulum pointer or dial indicator points to 277 degrees.
36. Advance the radius die to 9 degrees then retract the die to the original starting position.
37. You are now finished bending the pipe. Remove the ROTATION DIAL and cut the tubing end off at the last O/A mark. (See figure 3-C.)

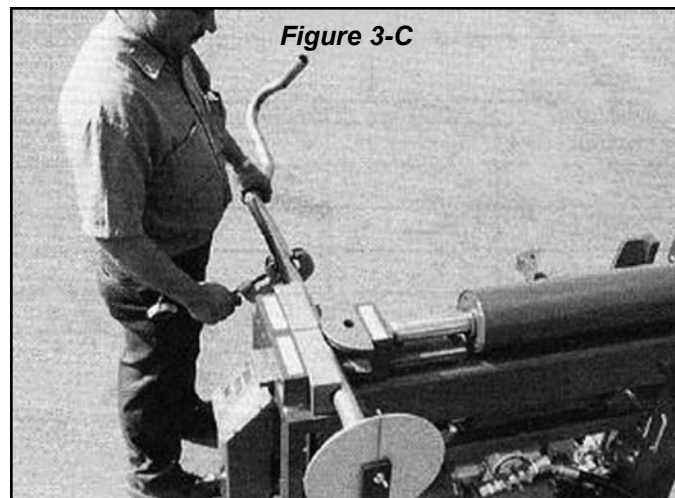


Figure 3-C

38. Now check the BENDING INSTRUCTIONS section and check for any END FINISHING requirements. On this particular card, it calls for a FEMALE BUICK BALL on the FRONT or "F" side of the pipe. See page 12 for TYPICAL END FINISHING illustrations.)

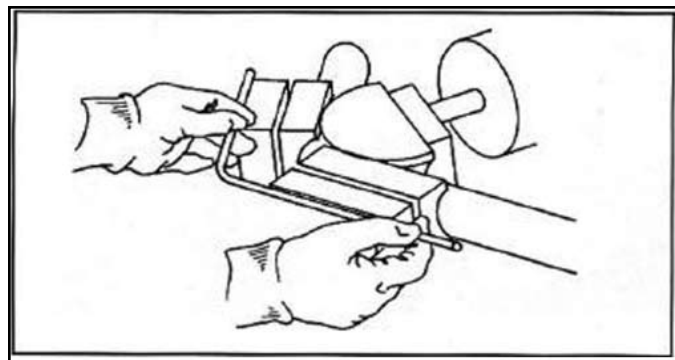
PATTERN BENDING

To pattern bend, proceed as follows. In order to retain the information for later use, save the information as described below.

NOTE:

Use the blank program card found on the next page as a master to make additional copies for later use.

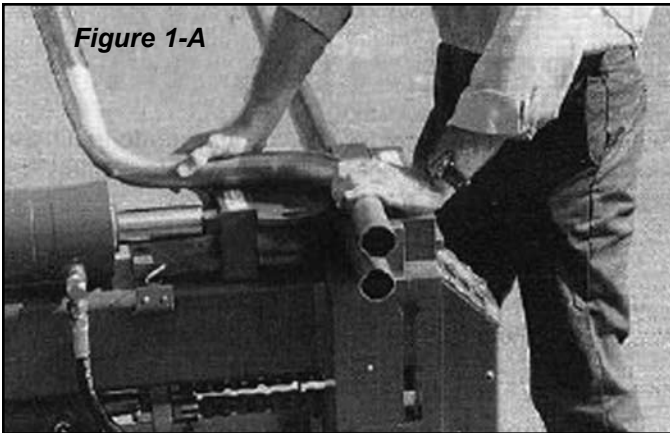
1. Select the proper tubing size and die set to do the job. Try to match the radius size with that of the existing pipe.
2. Place the tubing in the bender with the greater portion of the tubing protruding out the right side of the bender.
3. Place the master pattern (existing pipe or bent wire) on the top of the back shoes so that the first bend is centered between the back shoes.



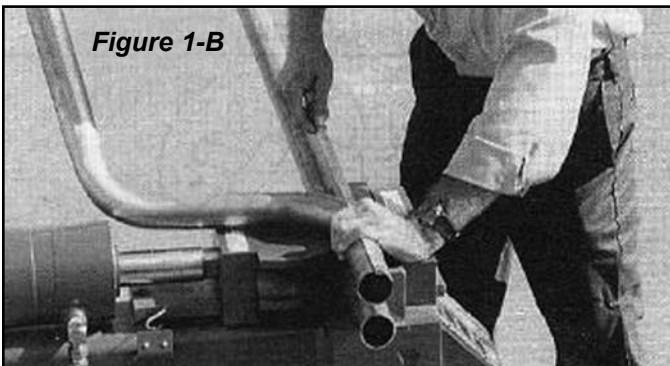
Wire pattern being used as a master.

4. Adjust the tubing out the left side of the bender so that the tubing end matches the length with that of the master. (See figure 1-A) Secure the straight pipe by advancing the radius die until the pusher block springs compress.

						YEAR	DIAMETER	O/A LENGTH	SIDE	
BEND NO.	1	2	3	4	5	6	7	8	9	
SYMBOLS										
CENTER MARKS										
PIPE ROTATION										
BEND DEPTH										
BENDING INSTRUCTIONS:										
MAKE:										
MODEL:										

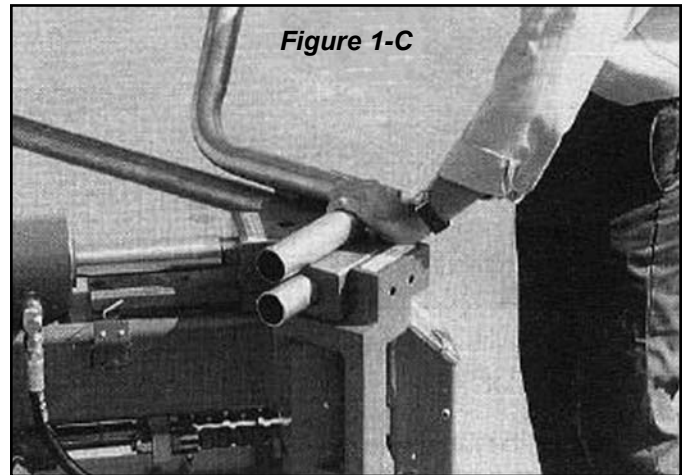


5. Using a measuring tape, measure the distance from the end of the tubing to the center of the back shoes. This is the measurement to the first bend and should be recorded in the CENTER MARKS section of a blank card. (See figure 1B)



6. Place the ROTATION DIAL on the far right end of the straight tubing and secure by tightening the wing nut. Center the ROTATION DIAL degree plate so that the indicator points to zero. ALWAYS USE THE NUMBERS CLOSEST TO THE CENTER OF THE ROTATION DIAL. THE OUTSIDE NUMBERS ARE FOR SPECIAL APPLICATIONS ONLY. Record the rotation degree as zero for your first PIPE ROTATION.

7. You are now ready to make your first bend. Place the first bend of the master pipe or wire flat on top of the back shoes. Hold in this position. Gradually extend the radius die forward until the gates start to open and the tubing begins to bend. Continue bending until the bend depth is equal to that of the master. (See figure 1-C)



8. Look at the Depth-of-Bend plate or observe the DIE ANGLE window. This is the depth or degrees of the first bend. Record this information in the BEND DEPTH section.
9. Retract the bending dies and slide the straight tubing to the left. Place the tubing or master on top of the back shoes so that the centerline of the second bend lines up with the centerline of the back gates. Be sure that the master lies perfectly flat.
10. Line up the second bend of the new pipe with the second bend of the master. Be sure that the master remains flat on top of the back shoes. Advance the radius die until the pusher block springs are compressed and the tubing is held securely. Make any adjustments at this time. Your second bend is now correctly located. (See figure 2-A)

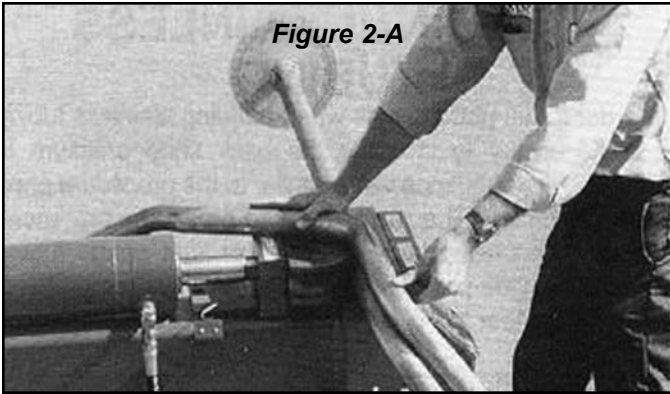


Figure 2-A

11. The measurement for the second bend should now be taken. Since bent tubing is difficult to measure, It is best to measure from the centerline of the first bend, to the centerline of the second bend. This measurement should then be added to the measurement taken for the first bend. Record this information in the CENTER MARKS section. (See figure 2-B)

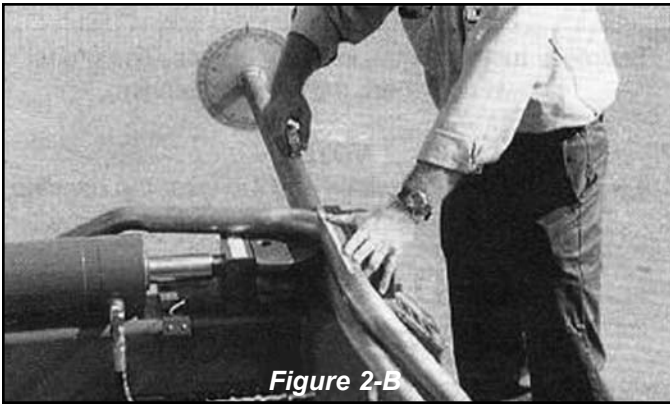


Figure 2-B

12. Look at the rotation dial and take the reading for the pipe rotation. Record this information in the second PIPE ROTATION section.
13. You are now ready to make your second bend. With the tubing or master laying flat on top of the back shoes gradually extend the radius die forward until the gates start to open and the tubing begins to bend. Continue bending until the bend depth is equal to that of the master. (See figure 2-C)

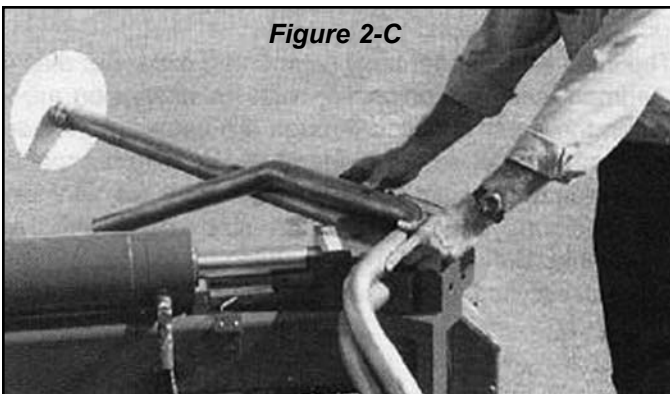


Figure 2-C

14. Take a reading for the bend depth and mark this in the second BEND DEPTH section on the card.

NOTE:

Repeat these steps for the remaining bends. After all bends are completed, make the necessary end finishing and take a measurement for the overall cut off length. Be sure to make all notations on the blank program card for later reference.

USING A BLOCK OF WOOD

Some bending cards or certain bending applications require the use of a BLOCK OF WOOD. This is used to “cushion” the tubing when a half shoe is being used. The BLOCK OF WOOD should be approximately 2” x 4” x 4” and will be used together with the half shoe. When half shoes are used on larger size tubing they have the tendency to depress or indent the tubing somewhat due to the reduced surface area on the half shoe itself. The block of wood will crush as the bend is being made and will help support the tubing and minimize distortion. (See figure 3-A)

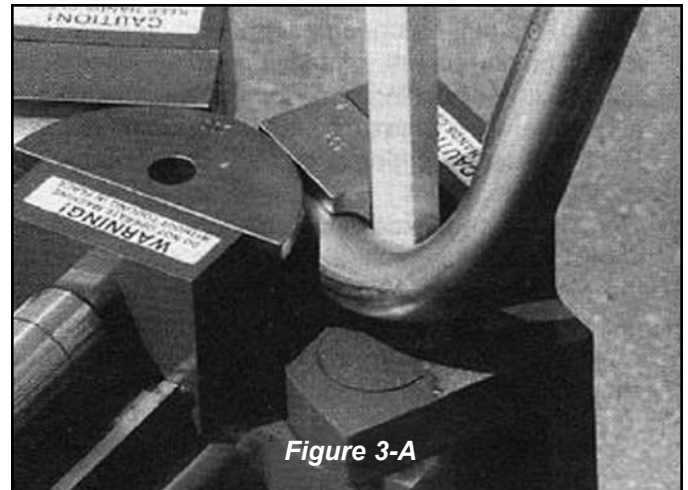


Figure 3-A

THREE INCH TUBE BENDING PROCEDURE

High initial back gate pressure is required when bending three inch tubing in order to get good, uniform bends. Good bends will result when 13 gauge (.095 wall thickness) is used. 14 gauge (.083 wall thickness) may be used, but some tube deformation or inconsistency may result.

These instructions **MUST** be followed closely for best results. During this procedure use only the manual operating controls. **DO NOT USE AUTOMATIC CONTROLS.**

1. Upon installation of the three inch bending dies, it is essential to readjust the sequence valve pressure. This adjustment will require the use of a 1/4” Allen wrench and a 3/4” open-end wrench.
2. Loosen the securing nut on the SEQUENCE VALVE and insert the Allen wrench in the end of the adjusting screw. The Allen wrench will remain in this position during this bending process. (See figure 3-B)

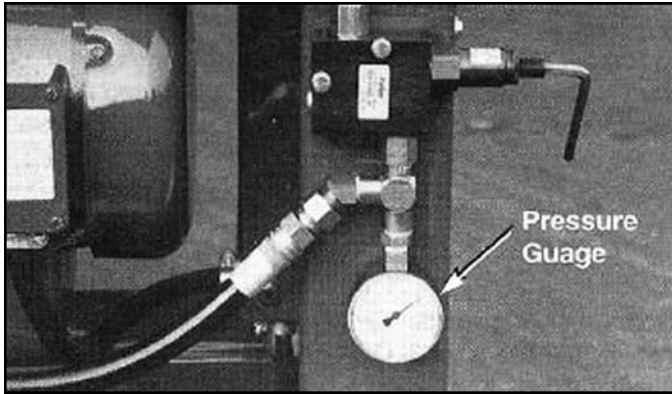


Figure 3-B

1. Tubing is not required for steps 1-3. Advance the radius die and check the sequence valve pressure. Sequence valve pressure is shown on the pressure gauge attached to the valve itself. The correct pressure will be shown only as the radius die travels forward through the bending gates while the radius die is in motion. Normal operating pressure should be 1600 P.S.I. The correct return pressure will be set at 300-350 P.S.I. For bending three inch tubing, the initial sequence valve pressure should be raised to 2000 P.S.I. for each bender (See page 33 for pressure adjusting procedure.)
2. To raise the sequence valve pressure, turn the Allen wrench clockwise until 2000 P.S.I. is maintained as the radius die moves forward through the bending gates. The return pressure will remain unchanged.
3. After proper pressures have been set, the dies should be heavily greased.

NOTE:

Bending dies MUST be cleaned and polished smooth for best results.

4. Position the tubing in the bender and advance the radius die forward to begin the bending process. Remember to USE MANUAL CONTROLS ONLY.
5. At a bend depth between 30 degrees and 40 degrees the bender may start to “bog” down. At this time start turning the Allen wrench counter-clockwise to reduce the sequence valve pressure. Do not adjust below 400 P.S.I. This will allow the radius die to advance further. Continue bending until the desired bend depth is reached. Return the pressure to 2000 P.S.I. for the next bend.

CAUTION!

DO NOT turn the adjustment screw beyond the end threads of the screw,

6. If further bends are required, repeat this procedure for each bend. ALWAYS return the sequence valve pressure back to 1600 P.S.I. when finished. (See page 33 for pressure adjusting procedure.)

BENDING STAINLESS TUBING

In order to get good results when bending stainless tubing, it is necessary to increase the back shoe pressure by adjusting the sequence valve similar to the procedure previously described. The recommended pressures are shown below. When using large diameter or light gauge tubing, more back shoe pressure is required. Always remember to reset the bender to 1600 P.S.I. when you are finished.

Tubing Size	Recommended Tubing Grade	Tubing Thickness	Proper Backshoe Pressure
1"-2" O.D. Tubing	304 or 409 Stainless Gauge	16 Gauge only for 304	2200-2500 PSI
		For 409	
2"-2-1/2" O.D.	409 Stainless Tubing	14 Gauge	2400-2700 PSI

Stainless tubing comes in many grades. The grades shown above are the best for bending.

NOTE:

It is very important to clean and lubricate the bending dies during all bending procedures.

END FINISHING OPERATIONS

CAUTION!

Before any attempt is made to use the end finishing components on this machine, it is important that you have read and fully understand all operating instructions. KEEP HANDS CLEAR of all pinch points. ONLY TRAINED PERSONNEL should be near machine when it is in operation. NEVER stand in front of arbor when operating internal expander. ALWAYS wear safety glasses when operating this machine.

USING THE INTERNAL EXPANDER

The internal expander uses segmented expander dies or “segment sets” in conjunction with an expansion arbor. When the arbor is pulled through the center of the segment set it spreads the “fingers” which in turn expands the tubing to an exact inside diameter. The segment sets are designed to work on one size arbor only. An adjustable Buttress Canister attached to the internal expander cylinder is used to control the expansion range.

NOTE:

The arbor must be snug to cylinder shaft before operation begins to avoid damaging threads.

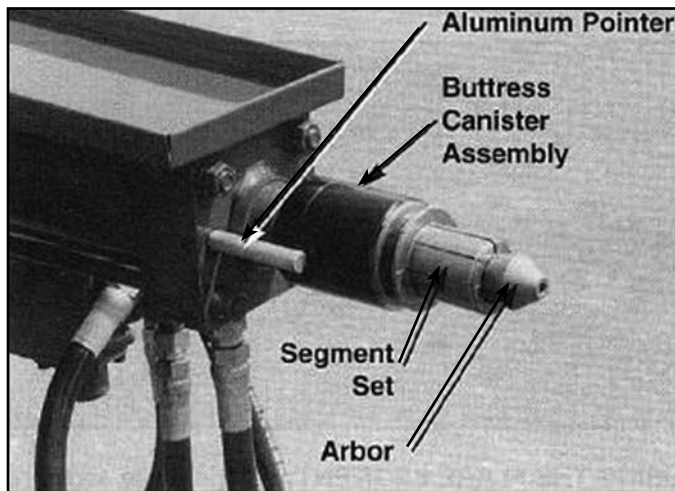
USING THE STANDARD SEGMENT

EXPANDERS - There are five standard segment sets included with your bender. Each segment set is designed to be used with a particular size tubing only. The appropriate sizes are shown below. Standard segment sets are used for making straight expansions. (See chart on page 12 for typical end finishing illustrations.)

Part Number	Maximum Expansion
SS-112	1-1/2" O.D. tubing to 1-5/8" I.D.
SS-134/178	1-3/4" or 1-7/8" O.D. tubing to 1-7/8 I.D.
SS-200	2" O.D. tubing to 2-1/8" I.D.
SS-214	2-1/4" O.D. tubing to 2-3/8" I.D.
SS-212	2-1/2" O.D. tubing to 2-5/8" I.D.

IMPORTANT!

ALWAYS use the correct segment sets with the corresponding tubing size. Incorrect usage of segment sets will result in premature wear and breakage. ALWAYS keep arbor well greased.



The following procedure is provided as a step-by-step instruction to begin proper use of the internal expander.

1. Turn the machine on.
2. Lift the control handle to extend the cylinder shaft. Install the arbor making sure that it is threaded all the way on to the shaft.
3. Grease the arbor thoroughly.
4. Install the appropriate segment set by simply forcing the set over the head of the arbor. Grasp the segment set firmly to keep fingers together.
5. Adjust the buttress canister until the grooved line on the canister is lined up with the grooved line on the aluminum pointer. Then center the "X" symbol on top. With the buttress canister properly lined up, the arbor will automatically stop so that the tubing is expanded to the exact inside diameter for the corresponding size segment set. (See figure 1-A)

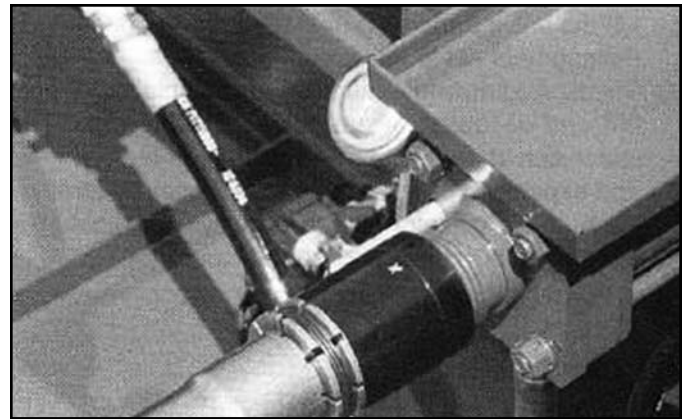


Figure 1-A

6. Place the tubing over the segment set. Be sure to slide the tubing all the way down to the shoulder.

NOTE:

If there is a burr or dent on the end of the tubing, place the tubing on the notched end of the segment set and tap the valve handle until the burr is removed.

(See figure 2-A)

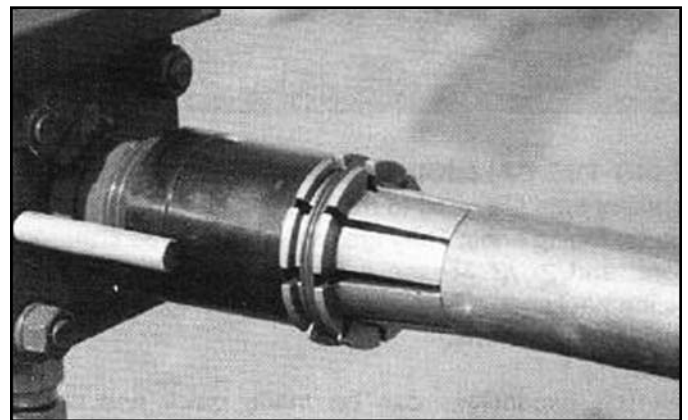


Figure 2-A

7. With the tubing in position and the buttress canister lined up you are ready to expand.
8. Tap the control handle down until the tubing begins to expand. Release and rotate the tubing clockwise. Repeat until a smooth uniform expansion is produced. Continue depressing the valve handle and rotating the tubing until the arbor stops expanding. (See figure 3-A)

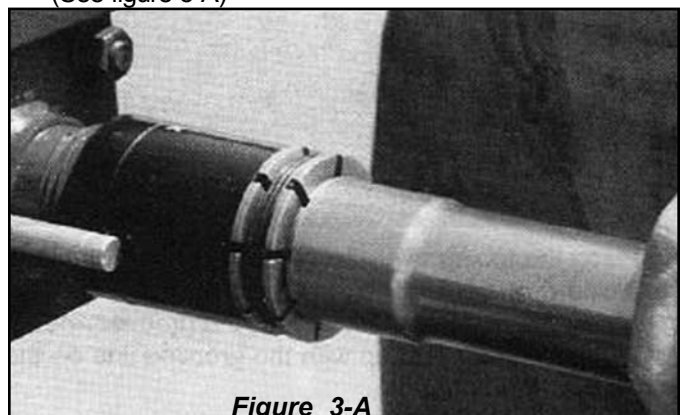
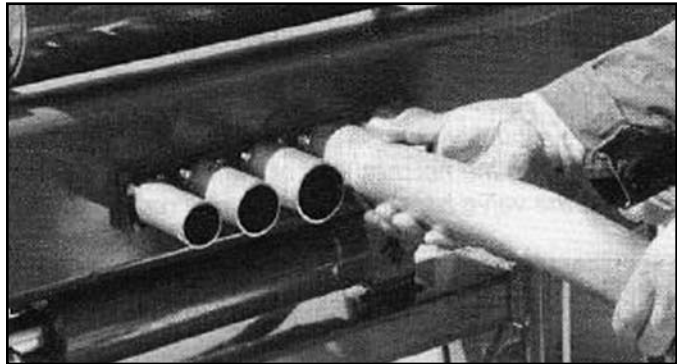


Figure 3-A

9. Lift the valve handle up until the arbor extends and the segment set is released.
10. Check the finished expansion end by placing it over the end of tubing of the corresponding size. The expansion should allow the tubing to fit snugly.
11. The expansion can be made to fit looser by turning the buttress canister counter-clockwise or tighter by turning the buttress canister clockwise.

HELPFUL TIP...
 Cut off sections of tubing in all sizes approximately 3" in length and weld them to a bracket similar to the one shown below. Attach to your bender and use it to check your expansions.



USING THE BALLJOINT SEGMENT SETS - Ball-joint segment sets are used to make ball-joint expansions on shorter tubing ends. They are available in three sizes; 2", 2-1/4" and 2-1/2". These are not included in standard tooling packages. (See chart on page 12 for typical end finishing illustrations.)

Ball-type expansions can be made quick and easily using ball segment sets on the internal expander as explained below.

1. Slide the proper size ball-joint segment set over the arbor. (See figure 1-A)

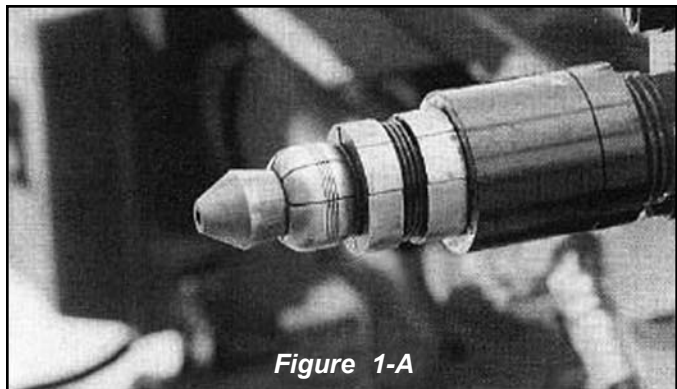


Figure 1-A

2. Place the tubing over the ball segment set until the tubing end is flush with the shoulder.
3. Adjust the buttress canister until the grooved line on the canister is lined up with the grooved line on the pointer.

4. Depress the valve handle to form the ball on the end of the tubing. Be careful not to distort the end of the tubing. (See figure 2-A)

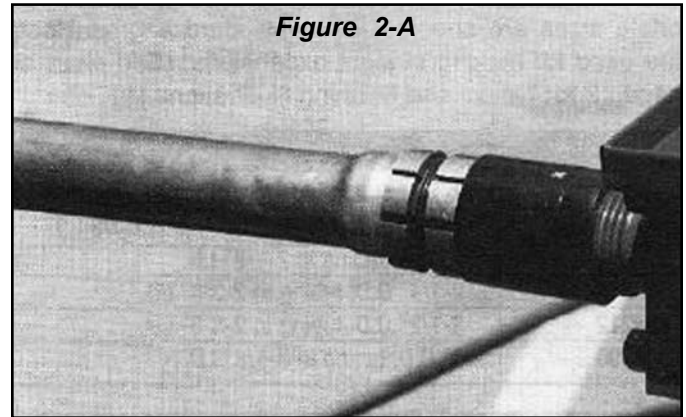


Figure 2-A

5. To make a female ball expansion, place the tubing over the arbor and segment set until the tubing is positioned midway at the grooved area. Depress the valve handle to flare the end of the tubing to match with the mating male ball joint. (See figure 3-A)

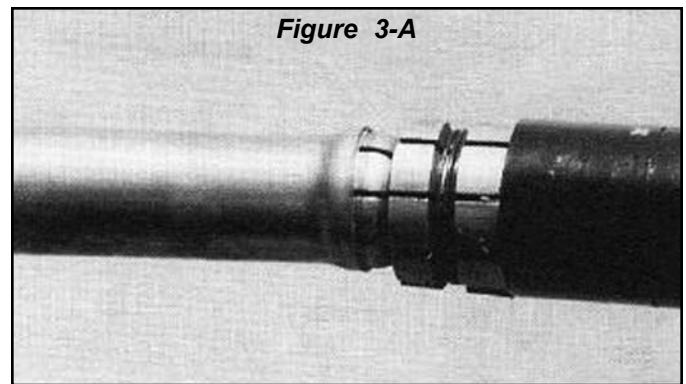


Figure 3-A

USING THE FLARE SEGMENT SETS - These segment sets are used to make 45 degree flares on tubing ends. Three different sets are available that work on tubing sizes 1-1/2" - 2-1/2". These are not included in standard tooling packages. (See chart on page 12 for typical end finishing illustrations.)

To produce a flare, proceed as follows.

1. Slide the proper size flare segment set over the arbor. (See figure 1-B)

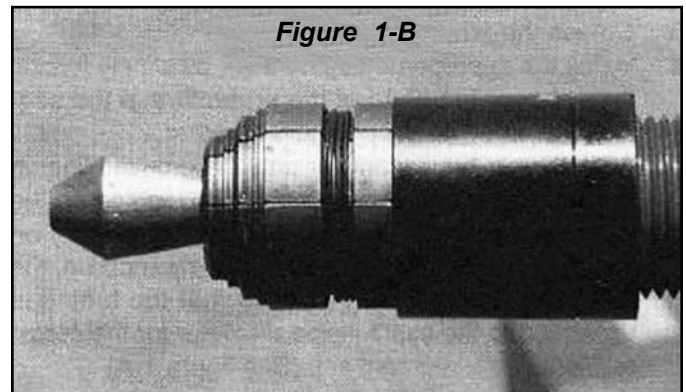
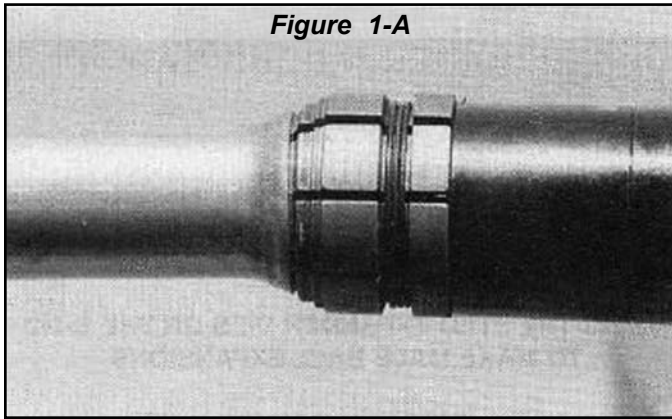


Figure 1-B

- Place the tubing over the arbor and segment set, but DO NOT place the end of the tubing past the last step on the segment set. (See figure 1-A)



- Depress the valve handle and rotate the tubing clockwise until the desired flare is produced.

NOTE:

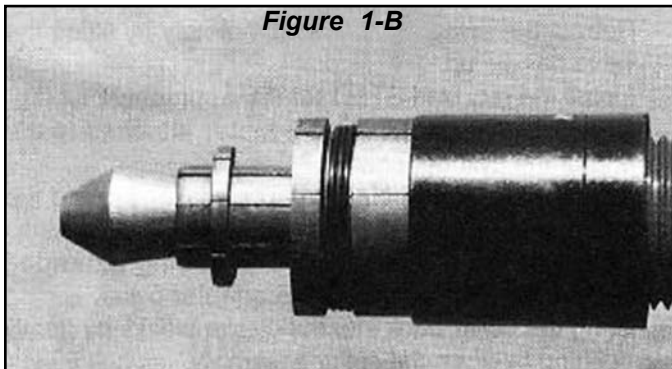
Smaller size tubing should be gradually worked up onto the flare segment set until the desired flare has been produced.

USING THE MANIFOLD FLANGE SEGMENT SETS -

These segment sets are used to make donut-type manifold flanges on tubing ends. They are available in five sizes; 1-1/4", 1-1/2", 2", 2- 1/4", and 2-1/2". All manifold segment sets are used in conjunction with limit rings. These are not included in standard tooling packages. (See chart on page 12 for typical end finishing illustrations.)

To produce a manifold flange proceed as follows.

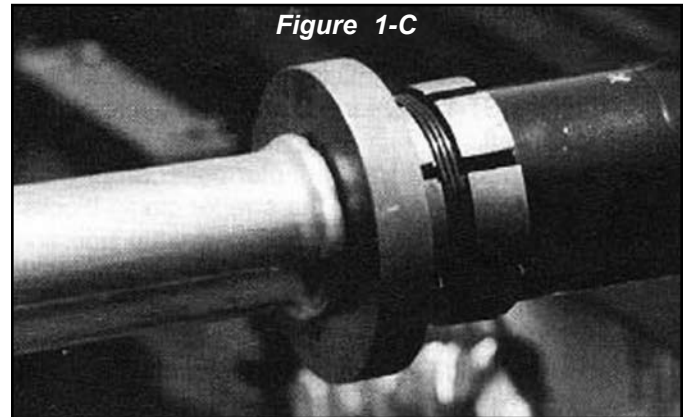
- Place the proper size segment set over the arbor. (See figure 1-B)



- Place the proper size limit ring over the end of the tubing.

CAUTION!
 NEVER use a limit ring that is defective or cracked. DO NOT maintain constant pressure on the limit ring by continuing to hold the valve handle down once the expansion has been made. ALWAYS wear protective safety goggles when operating the internal expander.

- Position the tubing over the arbor and segment set until the tubing meets the shoulder.
- Push the limit ring forward until it also meets the shoulder and is flush with the end of the tubing. (See figure 1-C)



- Depress the valve handle to form the flange. The flange will be formed as the raised areas expand and the tubing end is contained by the limit ring.

USING THE SWAGER BOX

The swager box is an expanding/flaring unit located to the rear of the bender which utilizes pipe collars in conjunction with bullet shaped expander/forming dies to perform a variety of tube end finishing.

CAUTION!
 Read the following section carefully before attempting to operate the swager unit. BE CAREFUL when using the swager assembly due to the extreme pressure created by the hydraulic cylinder. NEVER allow untrained personnel to operate machinery. KEEP HANDS CLEAR of all pinch points. ALWAYS wear protective safety goggles.

USING THE "STED" EXPANDER DIES - STED's are referred to as "solid expander dies". Each tool is marked for the proper size tubing. Some of these dies perform two different functions. The STED expander dies will swage/expand the tubing to exact inside diameters but some can also be used for making male ball expansions. The tooling applications are explained below.

Part Number	Application
STED-112	Expands 1-1/2" tubing to 1-1/2" I.D.
STED-134	Expands 1-3/4" tubing to 1-3/4" I.D.
STED-178	Expands 1-7/8" tubing to 1-7/8" I.D.
STED-200 B-134	Expands 2" tubing to 2" I.D. Also used to make 1-3/4" Male Ball
Expansion STED-214 B-200	Expands 2-1/4" tubing to 2-1/4" I.D. Also used to make 2" Male Ball
Expansion	

Special sizes are available upon request

MAKING STRAIGHT EXPANSIONS - Follow these steps to produce straight expansions using the STEP expander dies. (See chart on page 12 for typical end finishing illustrations.)

1. Retract the swager cylinder completely by lifting the valve handle up.
2. Install the required STED for the appropriate tubing size on the ST-1 adapter attached to the end of the cylinder shaft.
3. Install the required HAC adapter collar around the tubing and position within the swager clamp blocks. The hinge should be positioned on the top side and the smaller tapered edge of the collar should be towards the cylinder shaft.
4. Leave at least three inches of tubing extended beyond the inside edge of the adapter collar. (See figure 1-A)

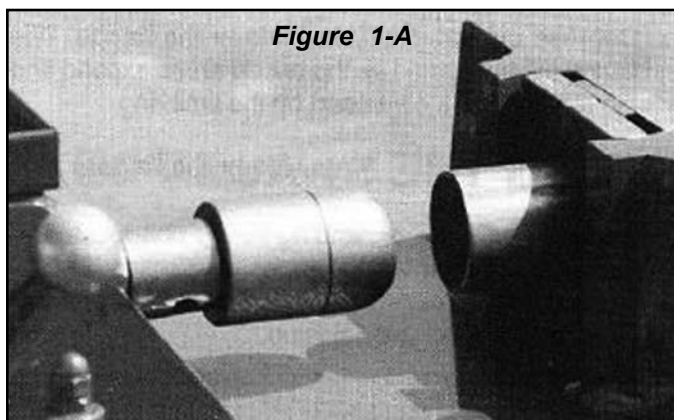


Figure 1-A

5. To secure the tubing firmly, snug the collar back into the clamp blocks by gently pushing back on the collar assembly.
6. Slowly, while depressing the valve handle down, move the shaft forward until the expander die enters the tubing. Be sure that the tool is centered with the tubing. Continue moving the cylinder forward until the expansion is formed. (See figure 2-A)

NOTE:

NEVER run the expander die into the tubing more than 1/4" from the end of the die. NEVER completely bury the die into the tubing.

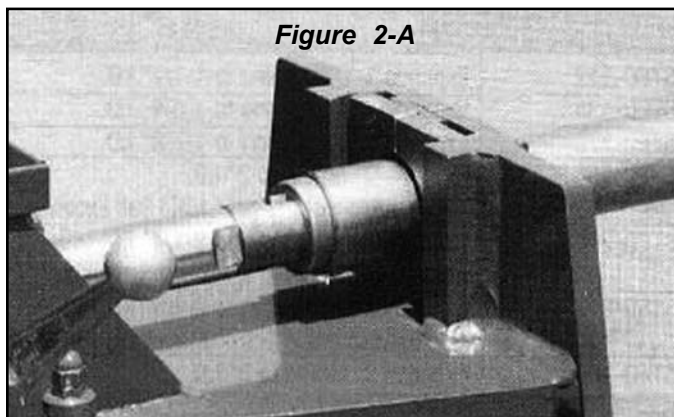


Figure 2-A

7. After the tubing has been expanded, retract the die by lifting up on the control handle.
8. Separate the collar from the tubing. Remove tooling and return to the storage area.

CAUTION!

BE SAFE. DO NOT rush any procedure. **ALWAYS** operate the swager unit **SLOWLY** and **CAUTIOUSLY**. **KEEP HANDS CLEAR** from all pinch points. **ALWAYS** wear protective safety goggles

USING THE STED EXPANDER DIES OR THE B-212 TO MAKE MALE BALL EXPANSIONS

IMPORTANT NOTE:

When making male ball expansions it is necessary to first install the pipe flange or clamp around the tube prior to finishing the ends.

To make a male ball expansion using the STED expander dies or B-212, proceed as follows. (See chart on page 12 for typical end finishing illustrations.)

NOTE:

The "B" symbol stamped on the STED expander dies identifies the tool required for making male ball expansions. The "E" symbol identifies the tool required for making straight expansions. Some STED expander dies do not show a "E" or "B" symbol. These are used for making straight expansions only. The B-212 tool is used for making male ball expansions on 2-1/2" tubing only.

1. Retract the swager cylinder completely by lifting the valve handle up.
2. Install the required STED for the appropriate tubing size or B-212 on the ST-1 adapter attached to the end of the cylinder shaft.
3. Install the required HAC adapter collar around the tubing and position within the swager clamp blocks.
4. Leave at least three inches of tubing extended beyond the inside edge of the adapter collar.
5. Snug the collar back into the clamp blocks by gently pushing back on the collar assembly.
6. Slowly, while depressing the valve handle down, move the shaft forward until the tool enters the tubing. Be sure that the tool is centered with the tubing.
7. Slowly, bring the tool forward until it meets the marking ring etched around the circumference of the tool. Do not go beyond the grooved marking ring.
8. After the tubing has been expanded, retract the die by lifting up on the control handle.
9. DO NOT remove tubing from the collar.
10. Install the DOMING DIE on the ST-1 adapter attached to the end of the cylinder shaft. (See figure 3-A)

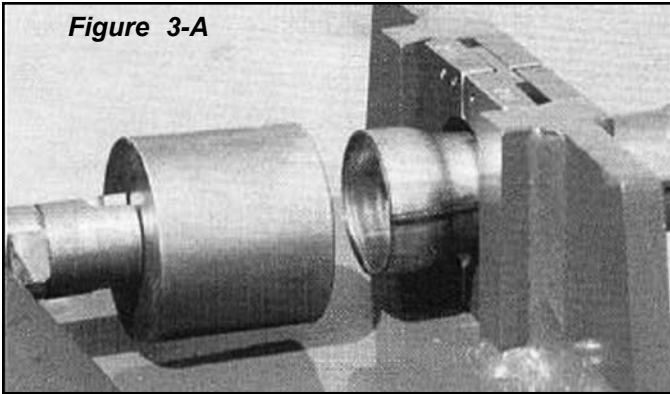


Figure 3-A

11. Slowly move the tool forward until the desired ball is achieved. This procedure requires careful control. (See figure 1-B)

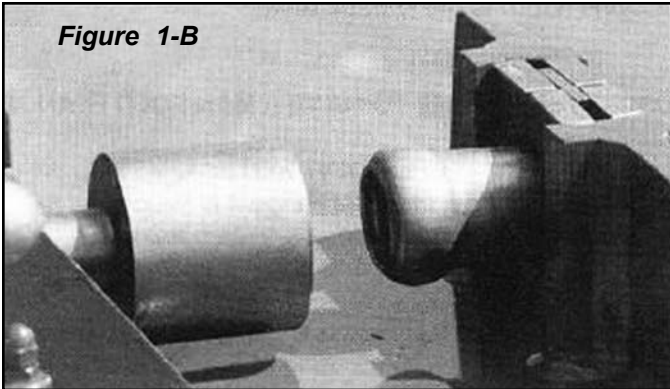


Figure 1-B

12. Retract the die by lifting up on the control handle.
13. Separate the collar from the tubing. Remove tooling and return to the storage area.

USING THE BFED TOOLS TO MAKE FEMALE BALL EXPANSIONS

IMPORTANT NOTE:

When making male ball expansions it is necessary to first install the pipe flange or clamp around the tube prior to finishing the ends.

The BFED-134/214 & BFED-200/212 are forming tools for flaring pipe ends to make female ball expansions. Each tool is “stepped” and has the ability to flare two different sizes. The BFED-134/212 is used for tubing sizes 1-3/4” and 2-1/2” while the BFED-134/214 is used for tubing sizes 1-3/4” and 2-1/4”.

Follow these steps to produce female ball expansions using the BFED dies. See chart on page 12 for typical end finishing illustrations.

1. Retract the swager cylinder completely by lifting the valve handle up.
2. Install the required BFED for the appropriate tubing size on the ST-1 adapter attached to the end of the cylinder shaft.
3. Install the required HAC adapter collar around the tubing and position within the swager clamp blocks.

4. Leave at least three inches of tubing extended beyond the inside edge of the adapter collar. (See figure 2-B)

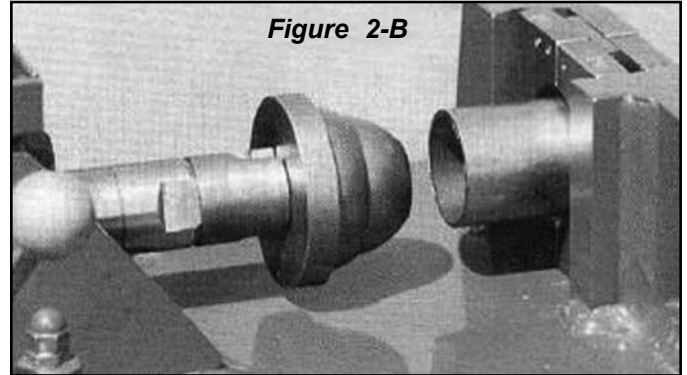


Figure 2-B

5. Snug the collar back into the clamp blocks by gently pushing back on the collar assembly.
6. Slowly, while depressing the valve handle down, move the shaft forward until the tool enters the tubing. Be sure that the tool is centered with the tubing. Continue moving the cylinder forward until the expansion is formed. (See figure 3-B)

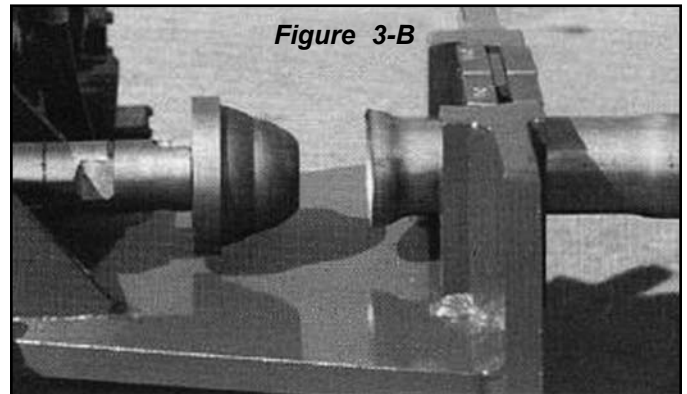


Figure 3-B

7. After the tubing has been expanded, retract the die by lifting up on the control handle. Separate the collar from the tubing. Remove tooling and return to the storage area.

USING THE HPF-300 TOOL TO MAKE 45 DEGREE FLARES AND FLAT FLARES

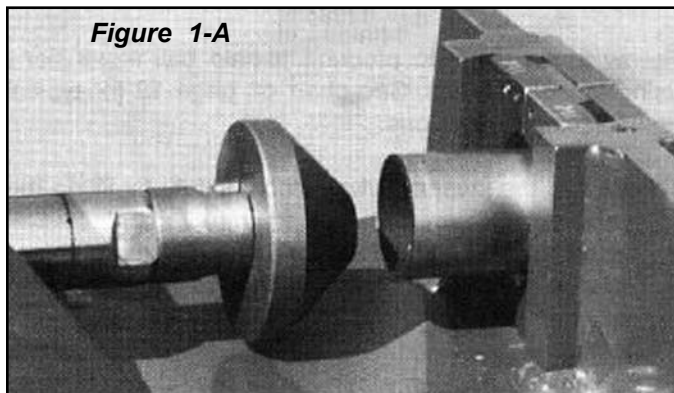
IMPORTANT NOTE:

When making 45 degree flares and flat flares it is necessary to first install the pipe flange or clamp around the tube prior to finishing the ends.

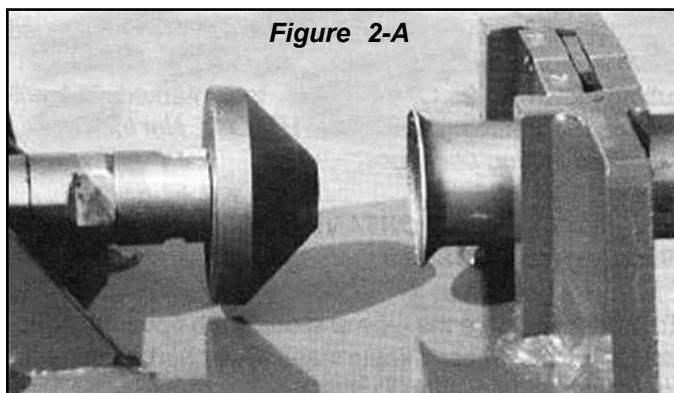
Follow these steps to produce flares using the HPF-300 tool. See chart on page 12 for typical end finishing illustrations.

1. Retract the swager cylinder completely by lifting the valve handle up.
2. Install the HPF-300 tool on the ST-1 adapter attached to the end of the cylinder shaft.
3. Install the required HAC adapter collar around the tubing and position within the swager clamp blocks.

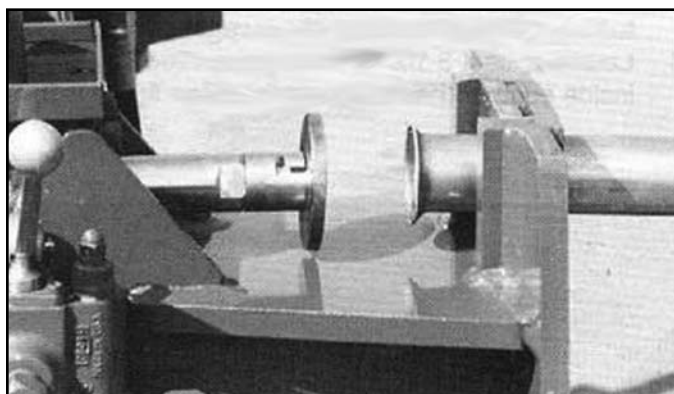
4. Leave at least three inches of tubing extended beyond the inside edge of the adapter collar.
(See figure 1-A)



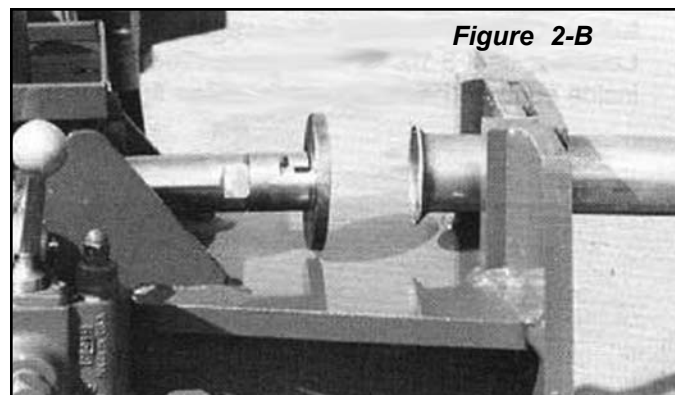
5. Snug the collar back into the clamp blocks by gently pushing back on the collar assembly.
6. Slowly, while depressing the valve handle down, move the shaft forward until the tool enters the tubing. Be sure that the tool is centered with the tubing.
7. Slowly, move the tool forward until the desired flare is achieved. (See figure 2-A)



8. Retract the die by lifting up on the control handle. You have now completed the 45 degree flare.
9. To complete the FLAT FLARE proceed as follows.
10. After retracting the cylinder, install the flattening tool as shown below.



11. Slowly, move the tool forward until the flare forms a flat surface. (See figure 2-B)



12. Retract the die by lifting up on the control handle.
13. Separate the collar from the tubing. Remove tooling and return to the storage area.

USING THE HPF-300 TO MAKE A MANIFOLD FLANGE

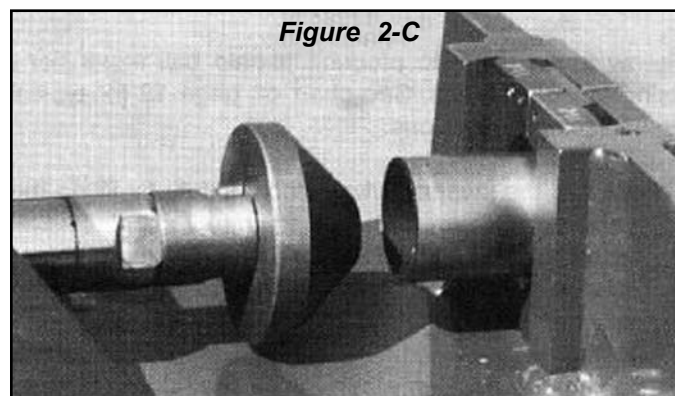
IMPORTANT NOTE:

When making a manifold flange it is necessary to first install the pipe flange or clamp around the tube prior to finishing the ends.

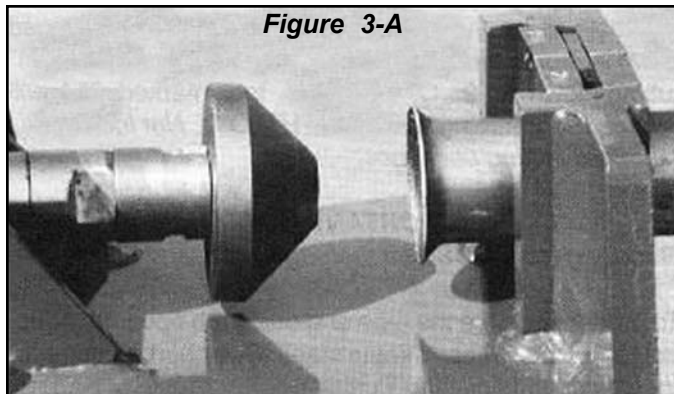
On this application it is necessary to use a scrap piece of tubing approximately 1-1/2" long of the same O.D. size. This tubing section will be inserted into the tubing end to form a gasket retainer.

Follow these steps to produce a manifold flange using the HPF-300 tool. See chart on page 12 for typical end finishing illustrations.

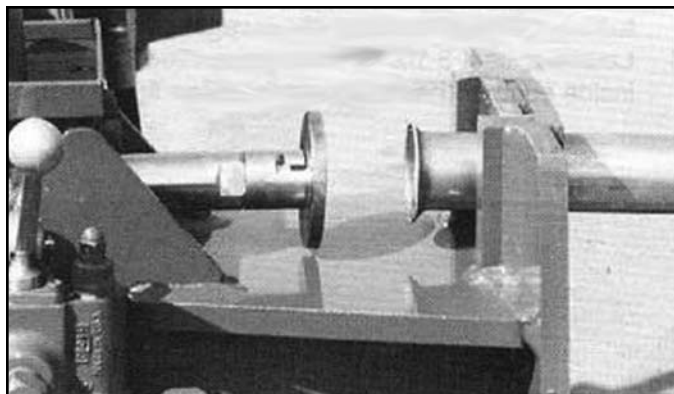
1. Retract the swager cylinder completely by lifting the valve handle up.
2. Install the HPF-300 tool on the ST-1 adapter attached to the end of the cylinder shaft.
3. Install the required HAC adapter collar around the tubing and position within the swager clamp blocks.
4. Leave at least three inches of tubing extended beyond the inside edge of the adapter collar.
(See figure 2-C)



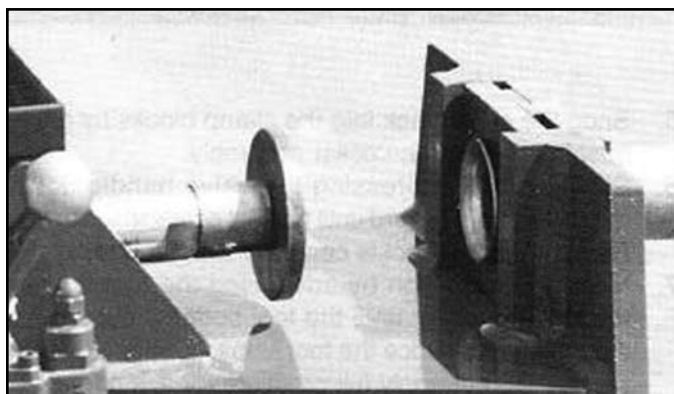
5. Snug the collar back into the clamp blocks by gently pushing back on the collar assembly.
6. Slowly, while depressing the valve handle down, move the shaft forward until the tool enters the tubing.
7. Slowly, move the tool forward until a 45 degree flare is achieved. (See figure 3-A)



8. Retract the die by lifting up on the control handle. You have now completed the 45 degree flare.
9. After retracting the cylinder shaft, install the flattening tool as shown below.

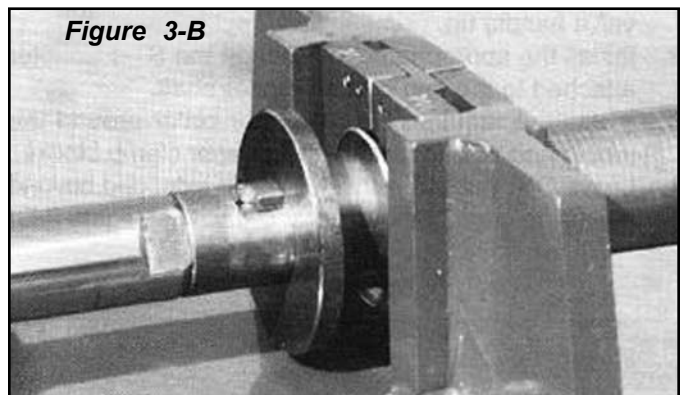


10. Now, pull the flared tubing end up against the chamfered edge of the adapter collar as shown below. **THIS STEP IS VERY IMPORTANT** so that the tubing end is retained within the clamped area. This will prevent the flared end from swelling when the insert is pressed in.

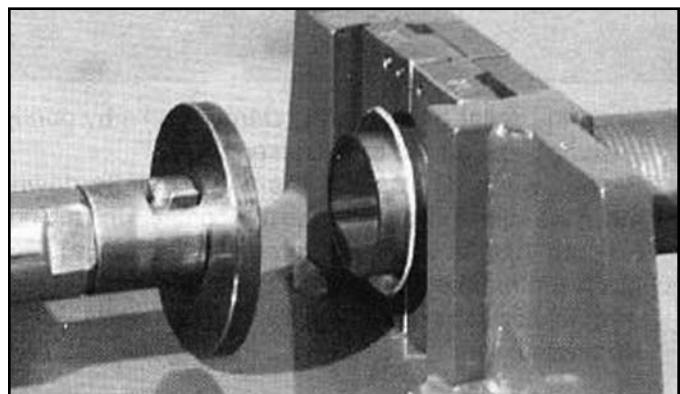


CAUTION!
 Pay careful attention when performing the following steps. **KEEP HANDS CLEAR** from all pinch points. **ALWAYS** remove hands from the expanding area when cylinder is in motion. **ALWAYS** wear protective safety goggles.

11. Insert the scrap pipe nipple into the flared end of the tubing. The nipple should hold itself in position.
12. Remove hands from the swaging area and slowly move the tool forward until the scrap nipple is forced into the tube opening. Stop when the scrap nipple protrudes 1/2" from the tube end. (See figure 3-B)



13. Retract the die by lifting up on the control handle.
14. This will form a seat for the round donut gasket as shown below.



15. Separate the collar from the tubing. Remove tooling and return to the storage area.

CAUTION!
 Remember, on 1302 models the swager side of the cylinder moves simultaneously when operating the internal expander. **ALWAYS REMOVE TOOLING FROM THE SWAGER AREA** when finished to avoid damage to the tooling and cylinder when the internal expander is being used.

USING THE CFT TO MAKE A MANIFOLD FLANGE.

IMPORTANT NOTE:

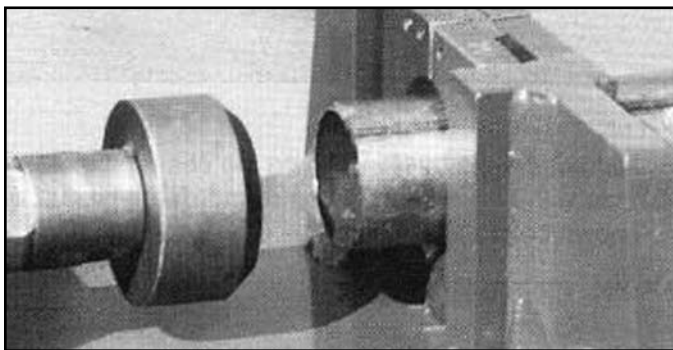
When making a manifold flange it is necessary to first install the pipe flange or clamp around the tube prior to finishing the ends.

CFT tools are used for making manifold flanges quick and easy. *Not included in standard tooling packages.*

Follow these steps to produce a manifold flange using the optional CFT tool. See chart on page 12 for typical end finishing illustrations.

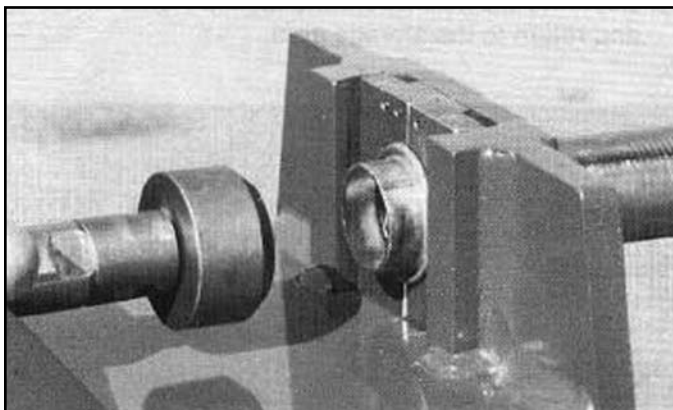
1. Retract the swager cylinder completely by lifting the valve handle up.
2. Install the appropriate CFT tool on the ST-1 adapter attached to the end of the cylinder shaft.
3. Install the required HAC adapter collar around the tubing and position within the swager clamp blocks.
4. Leave ONLY 1-1/2" inches of tubing extended beyond the inside edge of the adapter collar. (See figure 3-C)

Figure 3-C



5. Snug the collar back into the clamp blocks by gently pushing back on the collar assembly.
6. Slowly, while depressing the valve handle down, move the shaft forward until the tool contacts the tubing. Be sure that the tool is centered with the tubing.
7. Make the manifold flange by advancing the tool forward towards the collar until the cylinder stops. Apply full pressure for this operation. (See figure 1-A)

Figure 1A



8. Retract the die by lifting up on the control handle.
9. Separate the collar from the tubing. Remove tooling and return to the storage area.

USING THE REDUCING TOOLS - Reducing tools are used for reducing or "shrinking" pipe ends to exact outside diameters. Each tool is marked with the appropriate size. It is important to understand that the size marked on the tool will be the size that the tubing will be reduced down to. For example, a tool marked 200 will reduce 2-1/4" tubing down to 2" O. D. and a tool marked 214 will reduce 2-1/2" tubing down to 2-1/4" O.D. *Not included in standard tooling packages.*

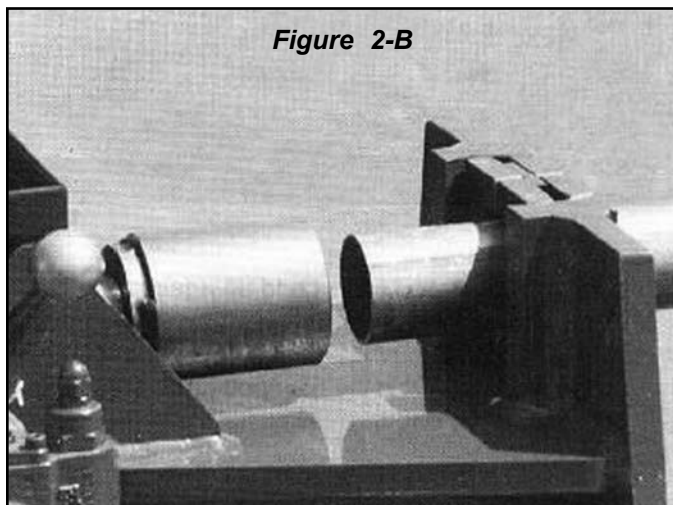
IMPORTANT NOTE:

Reducing tools MUST be thoroughly greased before use.

To properly reduce the tube end using the optional reducing tools follow these simple steps. See chart on page 12 for typical end finishing illustrations.

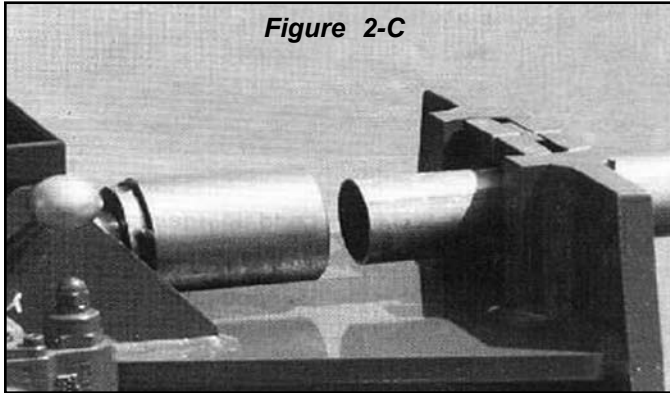
1. Retract the swager cylinder completely by lifting the valve handle up.
2. Install the appropriate REDUCING TOOL on the ST-1 adapter attached to the end of the cylinder shaft.
3. Install the required HAC adapter collar around the tubing and position within the swager clamp blocks.
4. Leave at least 3-1/2" of tubing extended beyond the inside edge of the adapter collar. (See figure 2-B)

Figure 2-B



5. Snug the collar back into the clamp blocks by gently pushing back on the collar assembly.
6. Slowly, while depressing the valve handle down, move the shaft forward until the tool contacts the tubing. Be sure that the tool is centered with the tubing.
7. Make the reduction by advancing the tool forward towards the collar until the tool bottoms out against the tubing end. Once the tool stops, release the valve handle. Do not apply full pressure for this operation.

- Retract the die by lifting up on the control handle. (See figure 2-C)

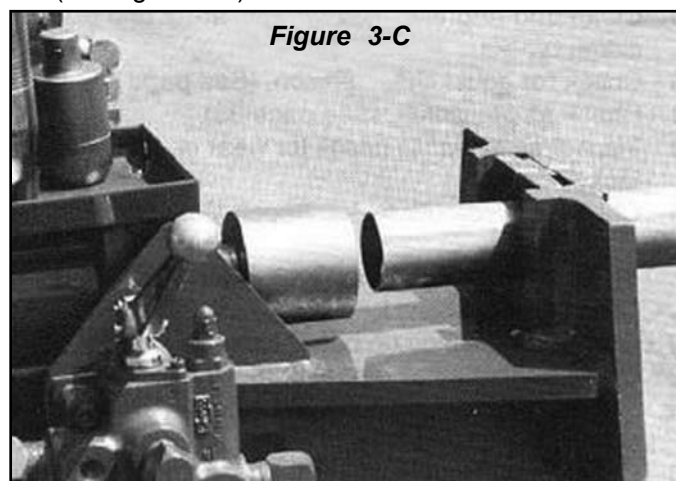


- Separate the collar from the tubing. Remove tooling and return to the storage area.

USING THE DOMING DIE TO FINISH TAILPIPE ENDS -

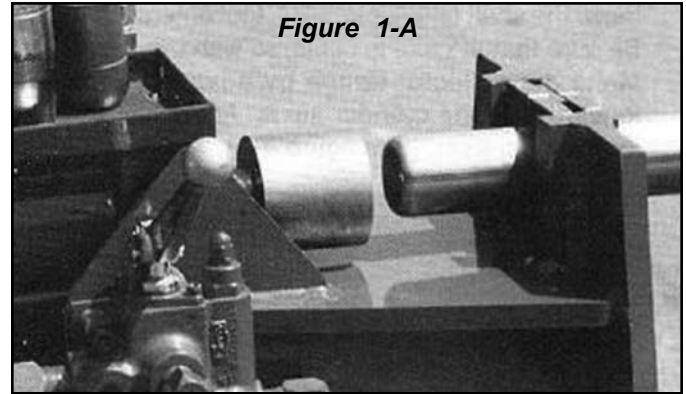
For a more finished look on tailpipe ends, you may use the DOMING DIE to slightly dome the ends. To properly do this, follow these simple steps. (See chart on page 12 for typical end finishing illustrations.)

- Retract the swager cylinder completely by lifting the valve handle up.
- Install the DD-134/212 tool on the ST-1 adapter attached to the end of the cylinder shaft.
- Install the required HAC adapter collar around the tubing and position within the swager clamp blocks.
- Leave the maximum amount of tubing extended beyond the inside edge of the adapter collar as possible. This will keep any slight clamp marks that may occur away from the end of the tailpipe which is usually exposed as it is installed on the vehicle. (See figure 3-C)



- Snug the collar back into the clamp blocks by gently pushing back on the collar assembly.
- Slowly, while depressing the valve handle down, move the shaft forward until the tool contacts the tubing. Be sure that the tool is centered with the tubing.

- Slowly, move the tool forward until the desired finish is achieved. (See figure 1-A)



- Retract the die by lifting up on the control handle. Separate the collar from the tubing. Remove tooling and return to the storage area.

USING THE HCT-214/212 - This tool is for making header flanges or "collectors" on 2-1/4" and 2-1/2" pipe ends. This eliminates the need to purchase a collector when installing header type manifolds. *Not included in standard tooling packages.*

IMPORTANT NOTE:

When making a manifold flange, it is necessary to first install the pipe flange or clamp around the tube prior to finishing the ends.

To properly produce a header collector using the optional HCT-214/212 tool follow these simple steps. (See chart on page 12 for typical end finishing illustrations.)

- Retract the swager cylinder completely by lifting the valve handle up.
- Install the HCT-214/212 on the ST-1 adapter attached to the end of the cylinder shaft.
- Install the required HAC adapter collar around the tubing and position within the swager clamp blocks.
- Leave at least 4" of tubing extended beyond the inside edge of the adapter collar. (See figure 2-A)

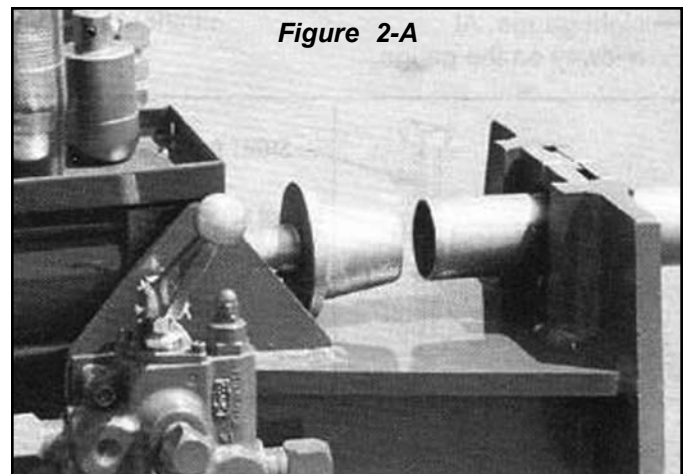


Figure 2-A

5. Snug the collar back into the clamp blocks by gently pushing back on the collar assembly.
6. Slowly, while depressing the valve handle down, move the shaft forward until the tool enters the tubing. Be sure that the tool is centered with the tubing.
7. Make the collector flange by advancing the tool forward until the cylinder stops. Apply full pressure for this operation. (See figure 3-A)

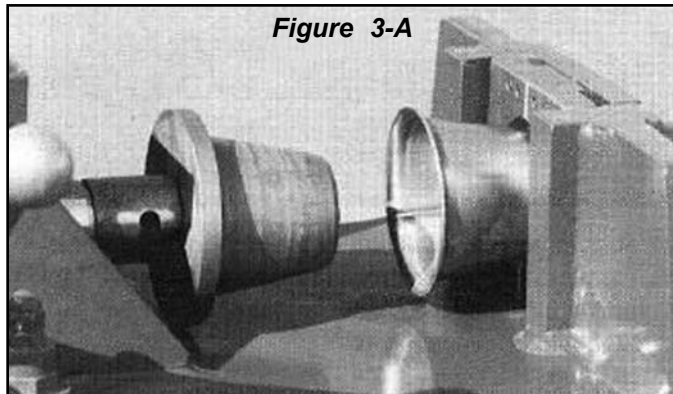


Figure 3-A

8. Retract the die by lifting up on the control handle.
9. Separate the collar from the tubing. Remove tooling and return to the storage area.

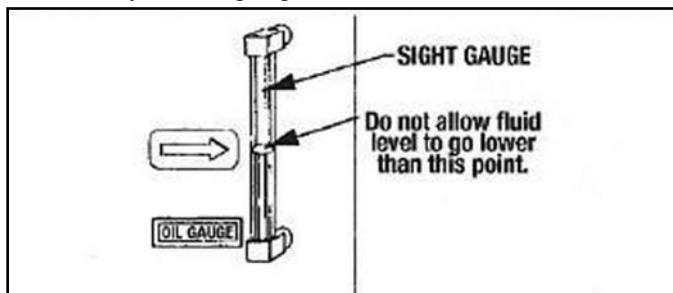
MAINTENANCE

Your new bender was designed and built for years of dependable service. The following maintenance schedule has been formulated to produce satisfactory performance and longevity of your machine. Reasonable care and daily observation of wear items will supplement this schedule and result in a prolonged service life.

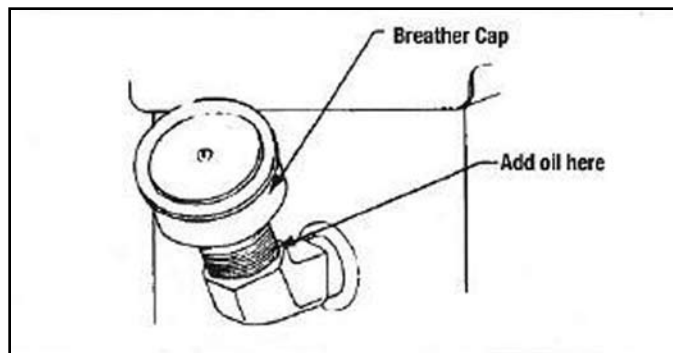
HYDRAULIC OIL

Your new bender was shipped with approximately seven gallons of hydraulic oil. The correct oil level will be shown on the sight gauge located to the rear right of the machine. To properly check the oil level, proceed as follows.

1. Advance the radius die until it just comes in contact with the back shoes.
2. At this time visually check the oil by observing the oil sight gauge. At the proper level, oil should appear midway on the gauge.



3. If oil cannot be seen, it will necessary to add oil via the filler cap located on the reservoir.



If the oil level continues to drop and oil needs to be added frequently, the machine should be checked thoroughly for possible leaks.

Any of the following hydraulic oils may be used.

Make	Brand
Chevron	OC Turbine 46
Mobile	DTE Medium
Texaco	Rando HD 46
Conoco	Turbine 46
Shell	Shell Turbo 46
Citgo	AW46
Pennzoil	Zoil Medium or No.10
Union 76	UNAX AW46

If the above brands are not available, use any 10 medium weight mineral based hydraulic fluid with a non-foaming additive.

NOTE:

The hydraulic oil should be changed after 1,500 hours of operation or yearly, whichever comes first. The oil filter should also be changed at this time.

RECOMMENDED WEEKLY MAINTENANCE

Clean and re-grease guide plate, arbor and swager clamp blocks.

Check for equal chain tension. (See page 34)

- ◆ Check all pressures. (See page 33)
- ◆ Inspect all hydraulic hoses for wear or cuts. Replace faulty hoses.
- ◆ Check for hydraulic leaks. Repair leaks immediately.

RECOMMENDED MONTHLY MAINTENANCE

- ◆ Check depth-of-bend for accuracy. (See pages 39 & 40)
 - ◆ Grease zirk fittings on barrel assembly.
 - ◆ Clean and spray all dies with rust inhibitor.
 - ◆ Tighten all hydraulic hoses as required. Do not over-tighten.
 - ◆ Check squareness of back gates and level guide plate. Shim / adjust as required. (See page 35)
 - ◆ Re-torque mounting bolts and nuts on all hydraulic components.
 - ◆ Lubricate caster assemblies.
 - ◆ Remove any nicks or burrs from tooling with a small file.
- Snug arbor and ST-1 to cylinder shaft.

NOTE:

Loose hoses and hydraulic components will not always show a visual sign of leakage, however they can cause aeration of the system by "sucking" air. It is very important to tighten all hoses and mounting bolts on hydraulic components monthly.

PRESSURE SETTINGS

There are three critical pressure settings on your bender that affect its performance. These pressures should be checked weekly. The following is a brief description of the pressures and the roles they play.

CAUTION!

Improper back pressure settings will cause tubing to wrinkle and/or collapse and may also damage machine and/or dies.

BACK PRESSURE - Back pressure is actually resistance pressure applied to the back gates during the bending process. The pressure is transferred to the back gates via the bottom cylinder and chain assembly. The setting itself is controlled by the sequence valve. This "resistance" pressure is required in order to form the shape of the tubing as the radius die advances. This pressure is read on the gauge attached to the sequence valve located near the front left side of the machine. The pressure reading is taken as the dies advance through the gates during a bend. **The normal operating back pressure should be set at 1600 P.S.I.** In some cases it may be necessary to adjust this pressure. (See Three Inch and Stainless Bending Procedures found on pages 21 & 22.)

If the back pressure needs adjusting, proceed as follows.

1. Turn the machine on.
2. Place a radius die and set of back shoes in position. Tubing will not be required for this operation.
3. Advance the radius die until it begins to pass through the gates.
4. At this time read the pressure shown on the gauge attached to the sequence valve. (See figure 3-B)

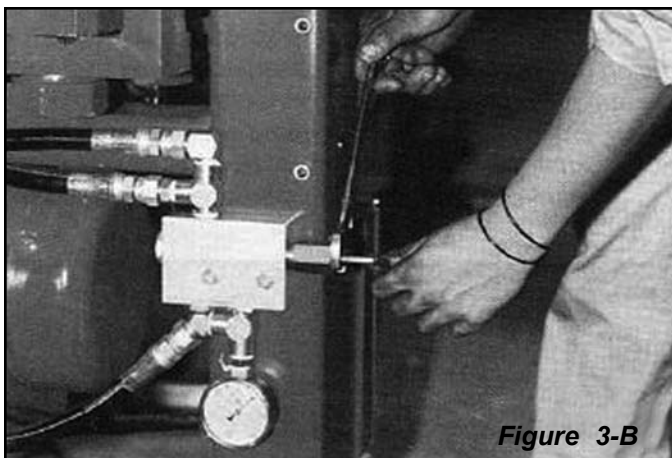


Figure 3-B

5. If an adjustment is required, loosen the locking nut that secures the adjusting screw.
6. To increase the pressure, turn the adjusting screw clockwise; to decrease, counterclockwise. Never exceed 2000 P.S.I.

CAUTION!

Never exceed 2000 P.S.I. for the back pressure unless specifically instructed to do so by the factory for special circumstances. If it is necessary to increase the back pressure, always remember to return the pressure back to 1600 P.S.I. before proceeding with the next bend.

RETURN PRESSURE - This pressure reading is also taken on the gauge located near the front left side of the machine. The purpose of this pressure is to maintain adequate tension on the chain assemblies during the retract sequence. This is important so that the gates close in unison with the radius die. Upon initiating the return sequence, hydraulic fluid is "split" and redirected, so that an equal portion is transferred to the top cylinder and bottom cylinder simultaneously. If the pressure is set too high, the machine will groan and strain when reversing as the top cylinder tries to overcome the bottom cylinder. If the pressure is too low, the gates may hesitate or remain open when the radius die retracts as the top cylinder receives more fluid than the bottom cylinder. It is seldom necessary to readjust this pressure setting. **The normal operating return pressure should be set at 350 P.S.I.** This pressure reading is taken as the radius die retracts just after it releases from the back shoes. This pressure setting is controlled by the flow control valve. (See figure 1-A and 2-A)

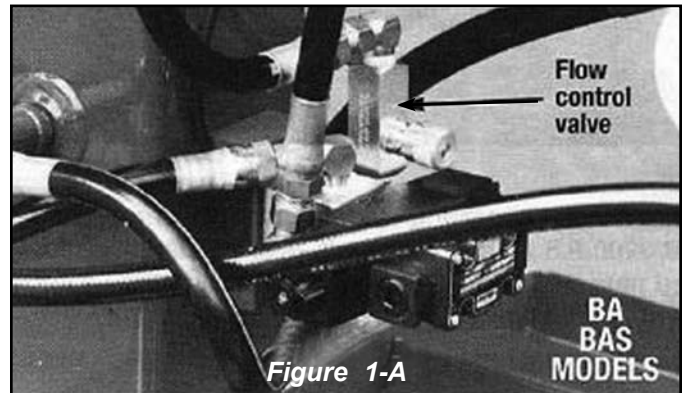


Figure 1-A

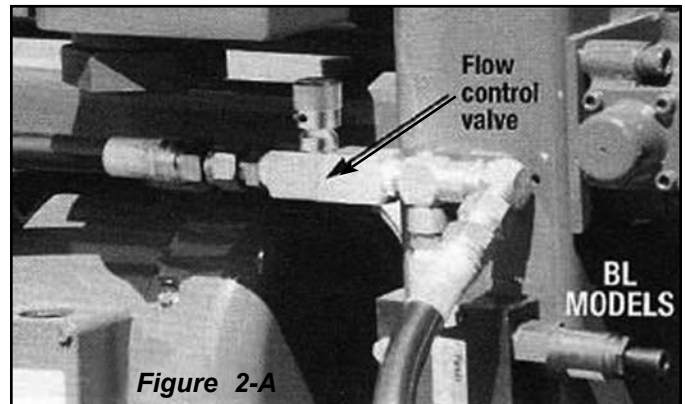


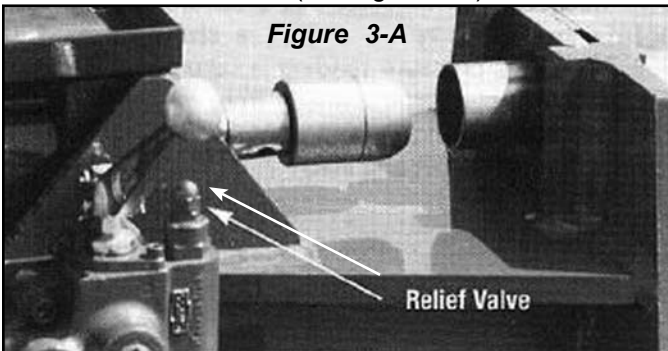
Figure 2-A

If the return pressure needs adjusting, proceed as follows.

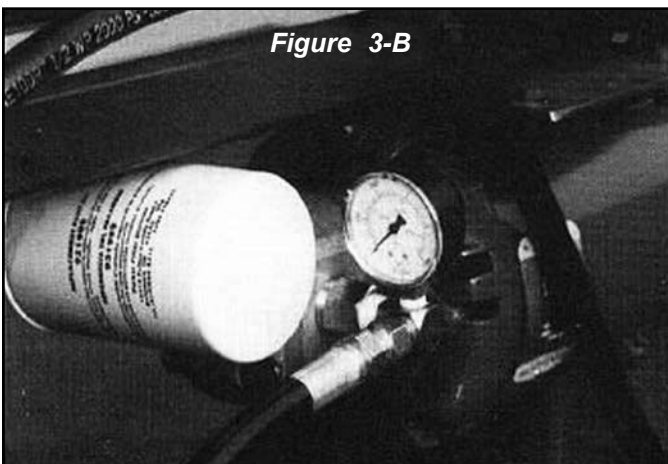
1. Turn the machine on.
2. Place a radius die and set of back shoes in position. Tubing will not be required for this operation.
3. Advance the radius die until it just comes in contact with the back shoes.
4. Using the manual controls, initiate the retract sequence and read the pressure shown on the gauge located to the front of the machine.
5. If an adjustment is required, loosen the locking nut that secures the adjusting screw.
6. To increase the pressure, turn the adjusting screw slightly clockwise; to decrease, counter-clockwise. Never exceed 350 P.S.I.

CAUTION!
 Never exceed 350 P.S.I. for the return pressure unless specifically instructed to do so by the factory for special circumstances.

SYSTEM PRESSURE - Your bender has a built in relief valve in order to control maximum pressure output for the entire machine. As the fluid exits the hydraulic pump, it first enters the swager control valve that contains an adjustable "ball-check" relief valve. (See figure 3-A)



The normal operating system pressure should be set at 3200 P.S.I. This pressure is read on the gauge located near the center of the machine next to the hydraulic pump. (See figure 3-B)

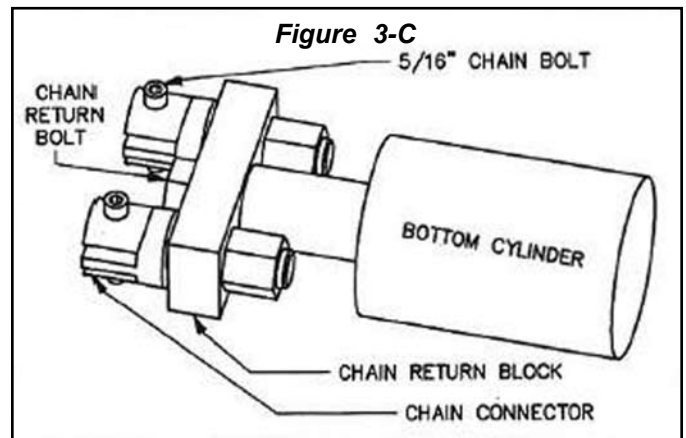


To check and adjust the system pressure, proceed as follows.

1. Turn the machine on.
2. Press the swager control valve down until the swager cylinder is bottomed out.
3. When the cylinder bottoms out or is extended to maximum travel the pressure will surge and the machine will "groan" as the relief valve opens up and fluid is redirected back to the reservoir. This is when the reading should be taken.
4. If an adjustment is required, loosen the locking nut that secures the adjusting screw on the relief valve.
5. To increase the pressure, turn the adjusting screw slightly clockwise; to decrease, counter-clockwise. Never exceed 3200 P.S.I.

CAUTION!
 Never exceed 3200 P.S.I. for the system pressure unless specifically instructed to do so by the factory for special circumstances.

ADJUSTING THE CHAINS - When the chains are properly adjusted, the threaded chain connector will protrude from the adjusting nut approximately one quarter of an inch. Both chains should have equal tension. If one chain has more slack than the other, tighten the chain connector adjusting nut using a 1-1/16" open end wrench. NEVER tighten the chain connector so that it is bottomed out against the chain return block. (See figure 3-C)



NOTE:
The chain return bolt has the tendency to loosen during normal use. If it is necessary to tighten this bolt, remove one of the chain connectors and tighten using a 1-3/8" open end wrench. After the bolt is secure, replace the chain connector and adjust as described above.

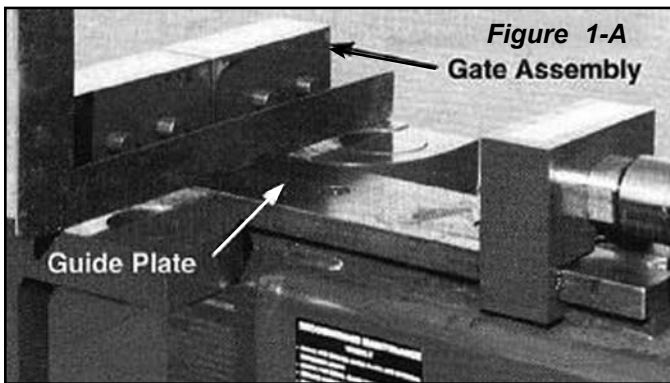
CAUTION!
 If any part of the chain or assembly bolts appear to be damaged in any way, discontinue use until they are replaced.

LEVELING THE GUIDE PLATE WITH THE BACK GATES

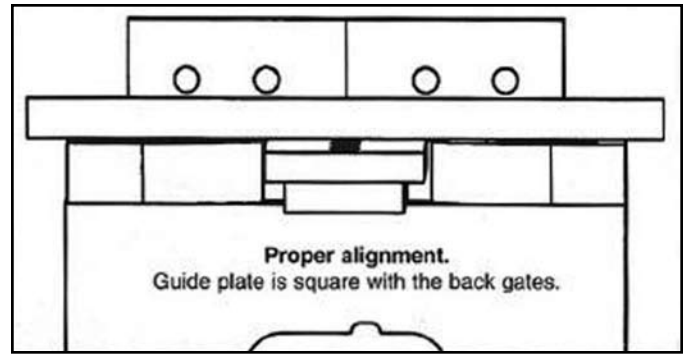
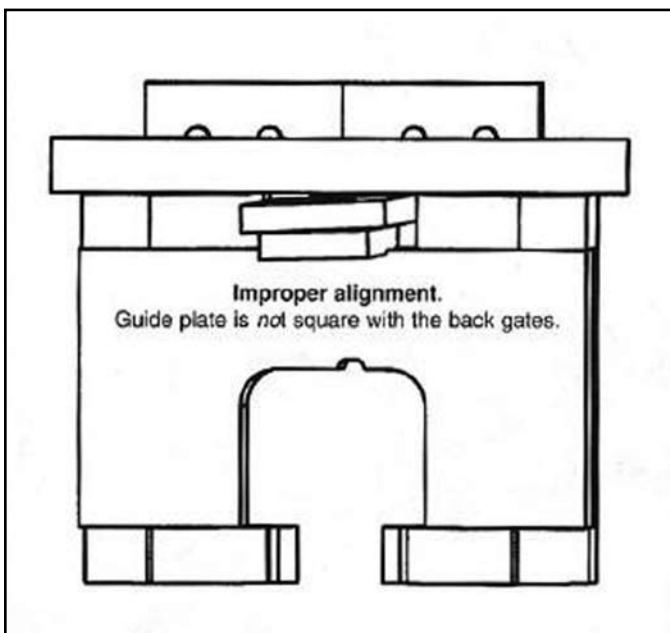
The back gates and guide plate have been precisely leveled at the factory and should seldom require adjustment. If however, the guide plate becomes unlevel with the back gates, the bending dies will become misaligned and cause the tubing to wrinkle.

To properly check the guide plate and back gates for proper levelness, follow these steps.

1. Remove bending dies from machine.
2. Retract pusher block completely.
3. Clean the guide plate and gate surface of all dirt, grease, and other debris.
4. Seat the barrel shaft with a lead hammer.
5. Tighten the barrel shaft nuts located directly underneath each back gate. Do not overtighten.
6. Place a straight edge across the surface of the back gates just above the guide plate. (See figure 1-A)



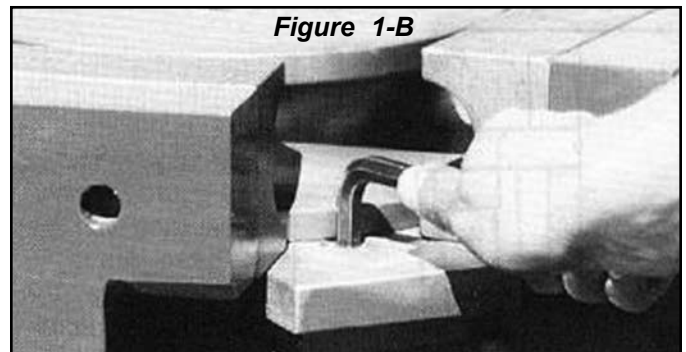
7. With the straight edge in position, check for proper clearance as illustrated below. The straight edge should contact the gate surface evenly on both sides and lay flat on the surface of the guide plate.



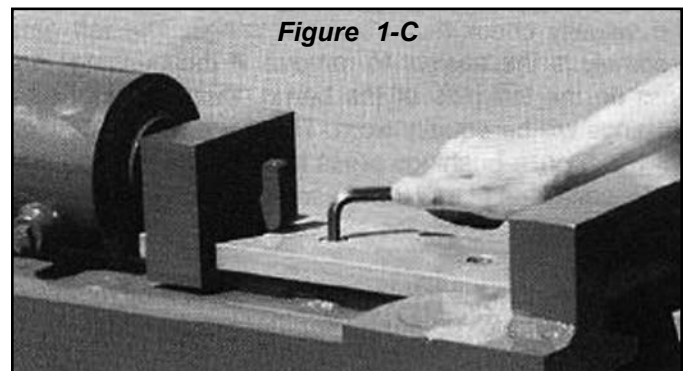
8. The guide plate will require adjustment/shimming if:
 - ◆ there is more than .01" gap between the plain of the back gates and the surface of the guide plate.
 - ◆ the plain of the gate assemblies is not square with the guide plate.
 - ◆ the plain of the back gates is actually lower than the surface of the guide plate.

If it is necessary to shim the guide plate so that it is square with the back gate assemblies, follow the steps as outlined below.

1. Turn the machine on.
2. Place a set of bending dies in position.
3. Advance the radius die forward until the front allen bolt on the guide plate is exposed.
4. Loosen the front allen bolt on the guide plate using a 3/8" hex wrench until the head of the bolt is flush with the surface of the guide plate. (See figure 1B)



5. Retract and remove the radius die so that the two middle bolts are exposed on the guide plate and loosen. Make sure that the head of the bolt DOES NOT protrude from the surface of the guide plate. (See figure 1-C)



6. It will not be necessary to loosen the rear most bolt on the guide plate for this service.
7. Using a pry bar, elevate the front of the guide plate. (See figure 2-A)



Figure 2-A

8. Using shim stock .002 - .005 thick, shim underneath the guide plate as required until proper levelness is achieved.
9. Tighten all allen bolts on the guide plate then grease well.

VISUALLY CHECKING THE BARREL BUSHINGS FOR WEAR

The barrel bushings should be checked every six months for excessive wear. If the barrel bushings become worn, the barrel shafts will have too much play and the gates will become misaligned causing the tubing to wrinkle. (See figure 2-B)

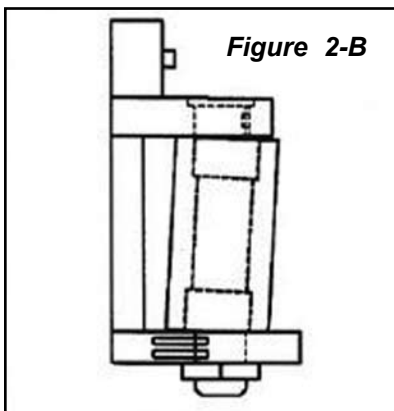


Figure 2-B

This diagram shows the gate assembly misaligned with the barrel due to excessive wear on the barrel bushings.

To check the barrel bushings for excessive wear it is necessary to completely remove one of the gate assemblies and visually check the bronze bushings. The left gate assembly is the easiest to remove. If the bushings are worn on the left side of the barrel, then the right side bushings will be equally worn. There are two 2-1/2" x 2" x 1-1/2" bronze bushings press fitted on the top and bottom of each side of the barrel assembly. To visually check these bushings, follow the steps outlined below.

1. Disassemble the left side chain assembly by removing the left side chain connector. (See figure 2-C)

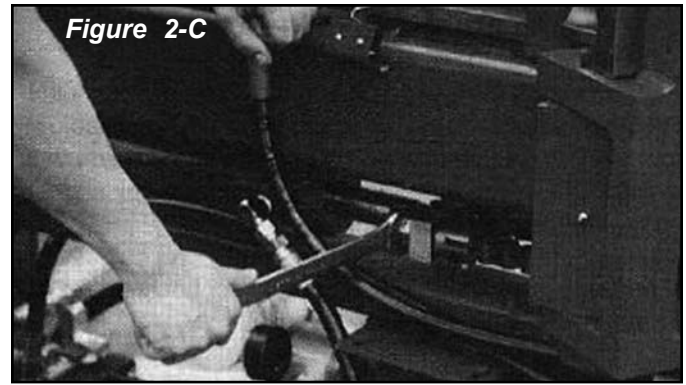


Figure 2-C

2. Remove the barrel shaft nut located below the left side gate assembly. (See figure 3-A)

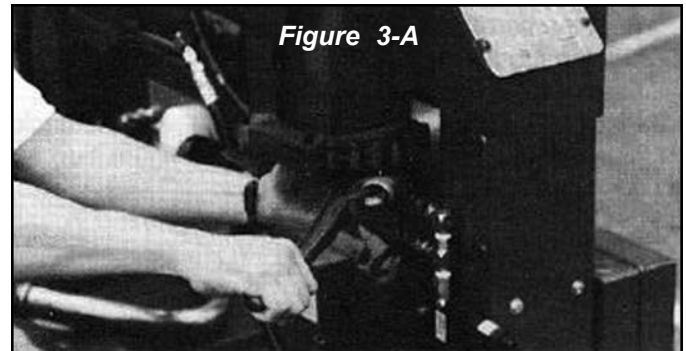


Figure 3-A

3. Using a rubber mallet, carefully tap the shaft up and out of the barrel. BE CAREFUL when removing shaft to prevent threads from being damaged. Be sure to keep shaft key as it is required for re-installation. (See figure 3-B)



Figure 3-B

4. Remove the left gate assembly.
5. Clean shaft and inside of barrel of all grease and debris.
6. Visually check shaft for excessive wear. Replace shaft if diameter is less than 1.997". (See figure 3-C)

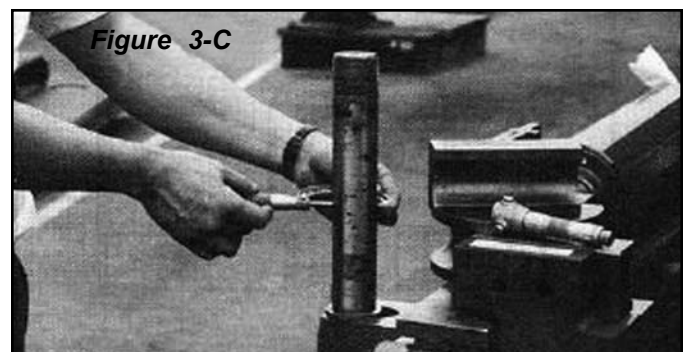


Figure 3-C

7. Visually check bronze bushings for excessive wear. *Replace bushings if inside diameter is greater than 2.005" or more.* (See figure 3-A)

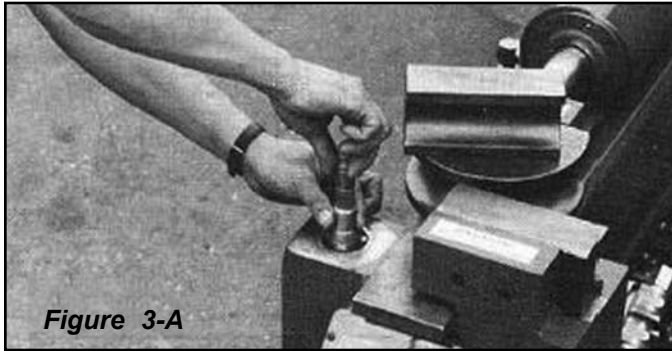


Figure 3-A

8. After check is completed, reverse steps and adjust chain assembly as described on page 34.

IMPORTANT NOTE:

Be sure to grease zirk fittings on each side of the barrel after re-installation of gate assemblies.

ALIGNING THE SWAGER BOX CYLINDER

The swager cylinder should be checked periodically for proper alignment. If the swager cylinder is not square or centered with the swager clamp blocks, the tubing will not expand correctly.

NOTE:

If the swager cylinder is damaged or bent due to improper use, there is no way to correct other than total replacement of the cylinder.

To properly check the swager cylinder for proper alignment, follow the steps outlined below.

1. Turn the machine on.
2. Install a HPF-300 or similar tool on the ST-1adapter. (See figure 3-B)

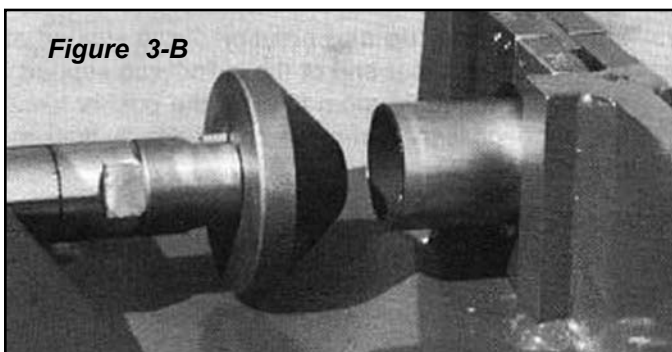
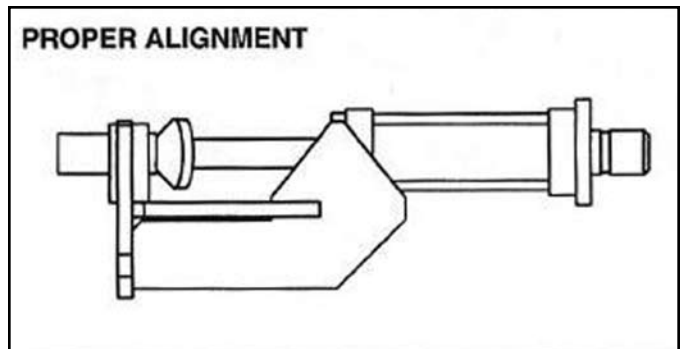
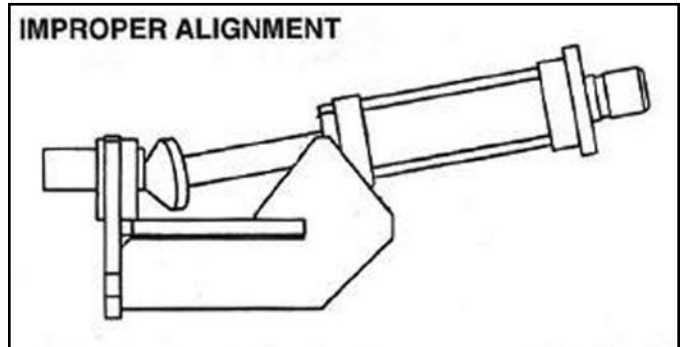


Figure 3-B

3. Position a section of squarely cut 2" tubing approximately 12" long into the clamp block area using the necessary HAC adapter collar.
4. Gently snug the collar back into the clamp blocks by gently pushing back on the collar assembly.

5. Hold the tubing securely making sure that the HAC-300 is square within the clamp blocks.
6. Advance the tool forward until it just makes contact with the tubing.
7. At this time, the tool should contact the complete circumference of the tubing end simultaneously. If the swager cylinder is out of alignment or the cylinder shaft is bent, then the tool will only partially contact the tubing circumference. (See illustrations)



8. If the swager cylinder is out of alignment, proceed as follows to make proper adjustments.
9. Turn the machine off until all necessary adjustments are made.
10. Remove the two allen bolts securing the swager tool tray using a 1/8" hex wrench. (See figure 3-C)

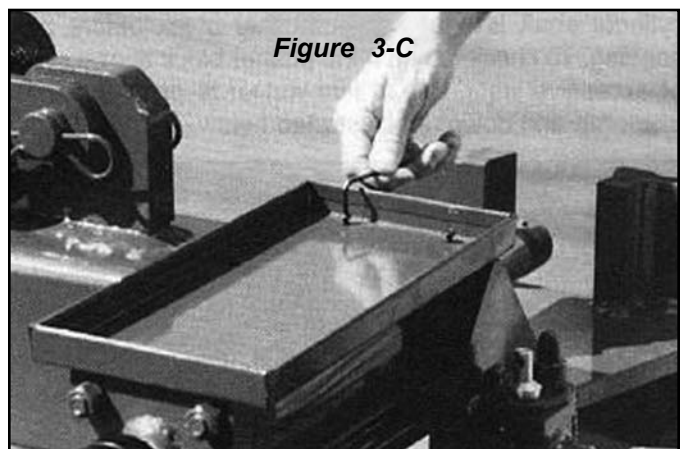


Figure 3-C

11. Loosen the four (4) 1/2" nuts (or bolts) attaching the cylinder to the swager box using a 3/4" socket or open end wrench. It is not necessary to completely remove the nuts or bolts. (See figure 1-A)

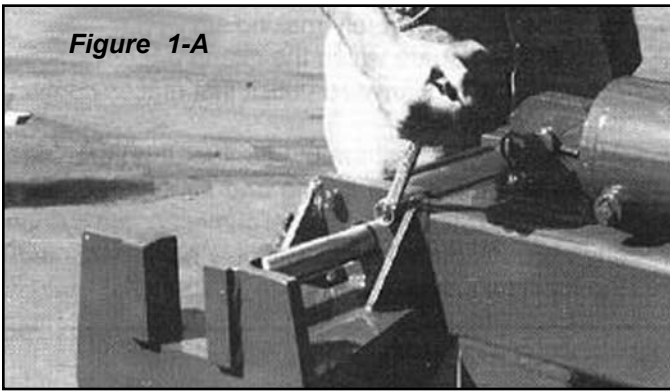


Figure 1-A

12. Shim the swager cylinder as necessary by inserting shim stock between the cylinder end block and the swager box until proper alignment is achieved. (See figure 1-B)

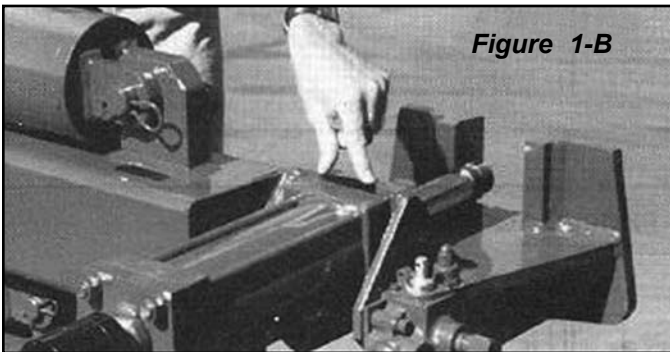
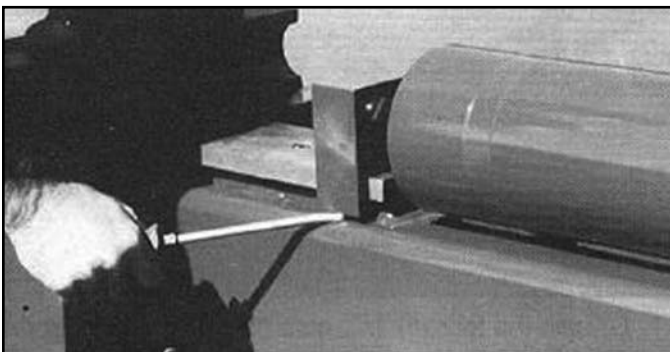


Figure 1-B

13. Tighten the four nuts or bolts securing the swager cylinder to the swager box frame.
14. Turn the machine on and repeat check.
15. Re-install the tool tray if no further adjustments are required.

CHECKING THE PUSHER BLOCK FOR WEAR

If the pusher block becomes badly worn or out of square, the radius dies could become misaligned with the back shoes causing the tubing to wrinkle. Make sure that the cylinder shaft is snug to the pusher block before proceeding. To check to see if the pusher block shows signs of excessive wear, use a screwdriver to pry the pusher block "up and down" as illustrated below.



If there is more than 1/32" of movement in either direction, the pusher block should be replaced.

Check to see if the pusher block is square to the guide

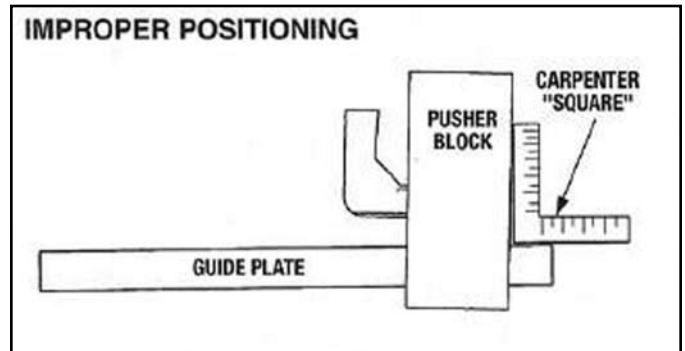
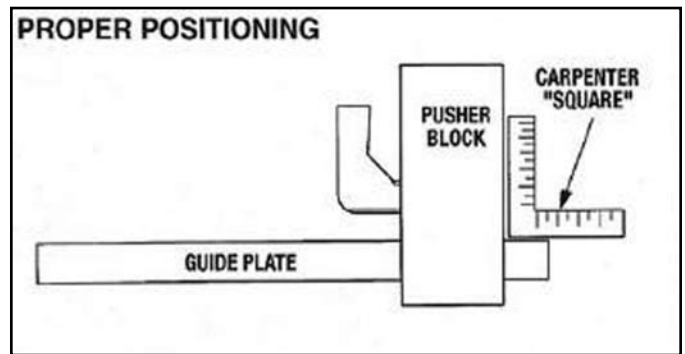


plate as illustrated below.

If the pusher block is excessively worn or out of square, then replace the pusher block as follows.

1. Using a large crescent wrench or equivalent, disconnect the cylinder shaft from the pusher block by turning

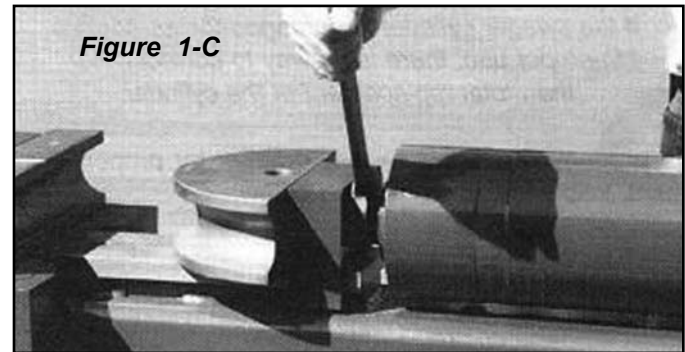


Figure 1-C

2. Lift the cylinder up and position a block of wood underneath the rear end of the cylinder to support it and allow adequate room to clear the pusher block. It is not necessary to remove any hydraulic hoses. (See figure 2-A)

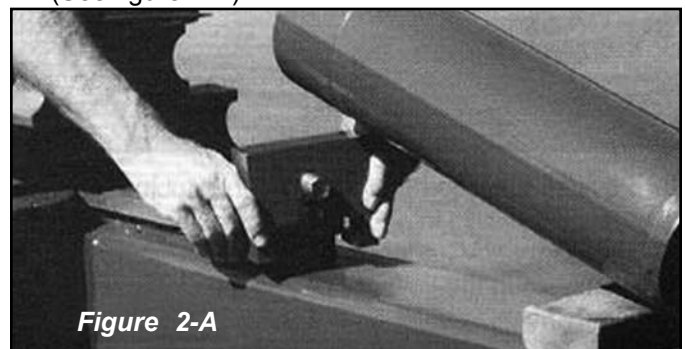


Figure 2-A

3. Remove the pusher block by sliding it to the rear end then off of the guide plate.
4. Carefully re-install the new pusher block (it should be tight) by reversing these steps.
5. Snug the cylinder to the pusher block and thoroughly grease the guide plate.

CALIBRATING THE DEPTH-OF-BEND PLATE / "BL" (BLUE-BULLET) AND "BAS" MODELS

To properly calibrate the depth-of-bend plate on all "BL" and "BAS" models, follow the steps outlined below.

1. Turn the machine on.
2. Place a set of bending dies in position.
3. Using a carpenter's square, advance the radius die until the back gates are at a true 90 degrees, contacting the inside of the square evenly across the front of the gates. (See figure 2-B)

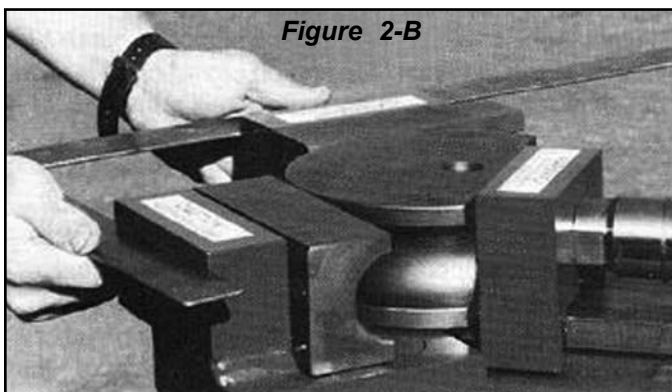


Figure 2-B

4. Check the depth-of-bend plate and adjust the pointer so that it reads 90 degrees at this time. (See figure 2-C)
5. Retract the radius die and check that the pointer returns to zero. If not, loosen the mounting bolts on the degree plate and adjust the plate until both 90 degree and zero degree readings are achieved.

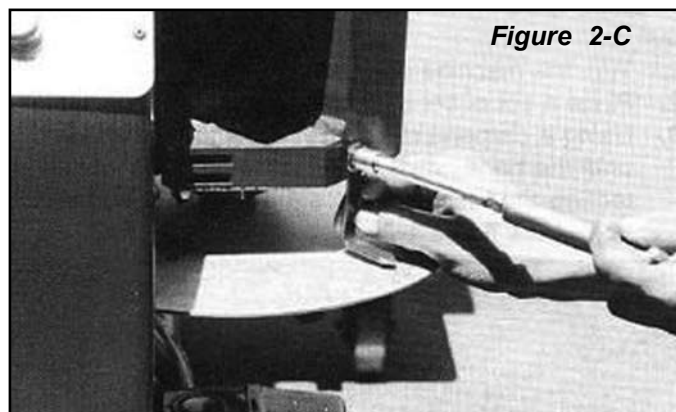


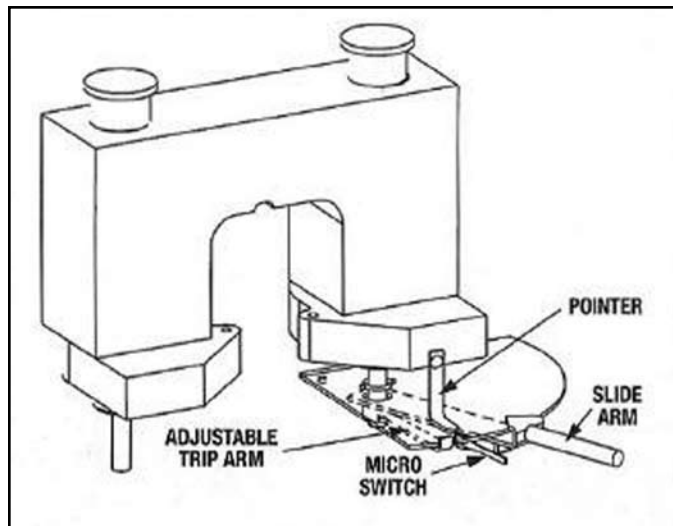
Figure 2-C

NOTE:

Some tubing may experience "spring back" after the bend is made. To compensate for this, set your depth-of-bend pointer 2 degrees less than the actual position of the gates.\

CALIBRATING THE AUTOMATIC DEPTH-OF-BEND SWITCH / "BAS" MODELS

Before attempting the following, first calibrate the depth-of-bend plate as previously described. To properly calibrate the automatic depth-of-bend switch on all "BAS" models, follow the steps outlined below.



1. Turn the machine on.
2. Place a set of bending dies in position.
3. Advance the radius die forward until the depth-of-bend / pointer reads 90 degrees. (See figure 3-A)

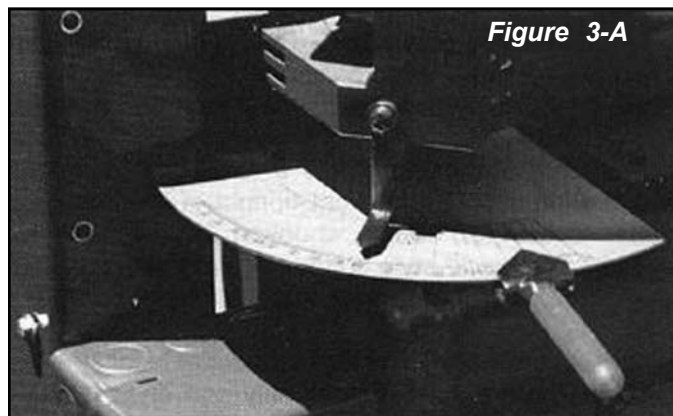


Figure 3-A

4. Gently slide the automatic depth-of-bend switch handle back until the two pointers are lined up with each other. (See figure 3-B)

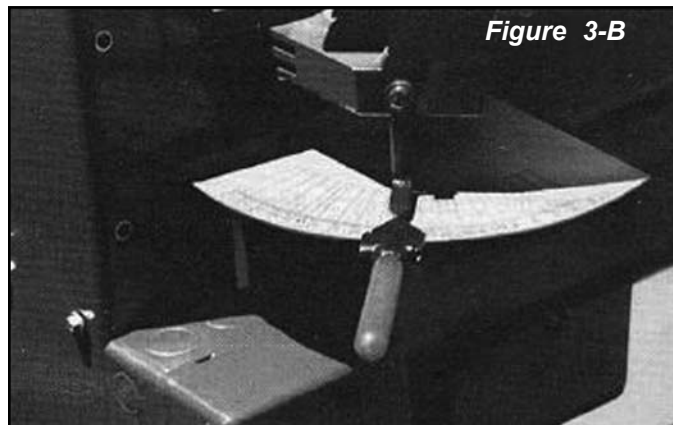


Figure 3-B

5. Loosen the set screw on the adjustable trip arm located directly underneath the depth-of bend plate and adjust so that it just activates the micro switch.
6. Re-tighten the set screw.
7. Retract the radius die and re-check.
8. If further adjustment is required, repeat steps.

CALIBRATING THE DIGITAL READOUT DISPLAY / "BA" MODELS

Automatic depth-of-bend and digital readout functions on all "BA" models are performed by an electronics package consisting of three main components. The circuit board assembly, digital encoder and the zero angle micro switch. (See figure 3-C)

DANGER!

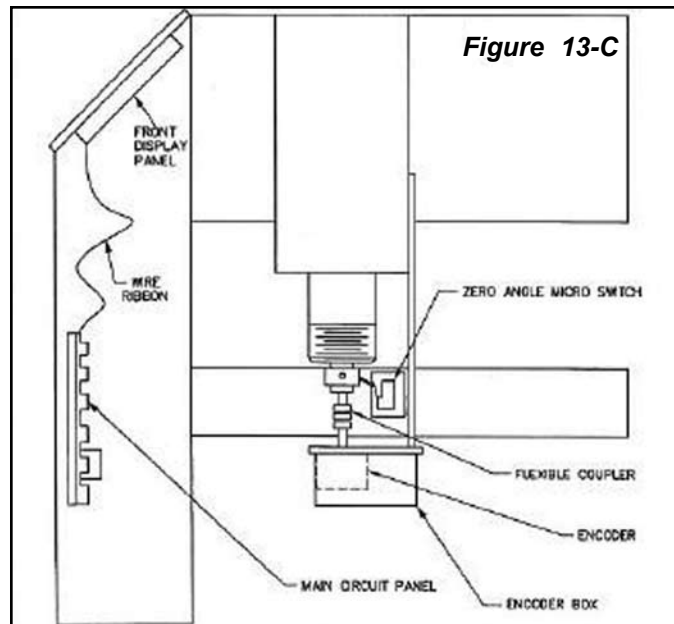
This machine contains high voltage. Disconnect power at the receptacle before performing any electrical repairs. Secure plug so that it cannot be accidentally plugged in during service.

◆ **Circuit board assembly** - The printed circuit board is made up of three basic components. The main circuit panel, front display panel and wire ribbon that connects the two. The main circuit panel is held in position by "card guides" and then plugged into a "pin-edge" connector mounted internally in the front upright of the bender. A bypass board for trouble shooting is also attached (stored) "piggyback" style on the back of the main circuit panel. (See page 41 for proper use of jumper board.)

◆ **Digital encoder** - The digital encoder is located just below the right side gate assembly and enclosed in a metal box. As the encoder rotates by the means of a flexible coupler attached to the barrel shaft, it registers degrees and shares this information with the main circuit panel.

◆ **Zero angle micro switch** - The zero angle micro switch is located up front just below the right side gate assembly and attached to the bender frame. The zero angle micro switch has three distinct functions.

1. Initiates the counting cycle and serves as an adjustment device for properly calibrating the die angle.
2. Resets the die angle to zero upon retraction of the radius die.
3. Advances the "steps" in the STATION window when using the MEMORY function.

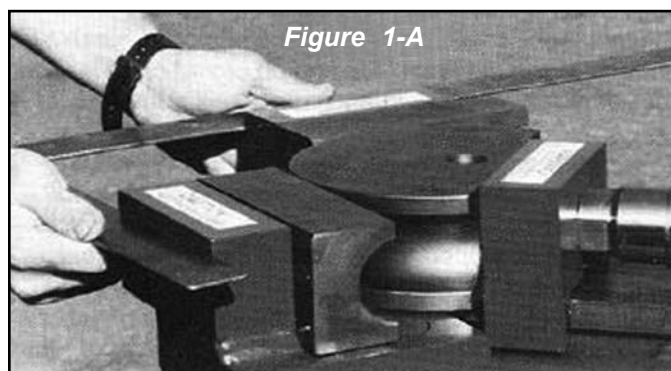


NOTE:

Only slight adjustments of 4 degrees or less can be made to the die angle reading on digital models. The digital readout is accurately maintained with the help of logic functions in the digital control board and optical sensors of the encoder. The system automatically re-calibrates itself upon full retraction of the radius die as the zero angle micro switch is tripped. By adjusting the trip arm that activates the zero angle micro switch you can effectively "stall" or advance the counting process which will in turn change the die angle reading. If the die angle appears to be more than 5 degrees out of calibration it is most likely a faulty encoder. Dirt, oil or moisture will contaminate the encoder and cause it to malfunction. If the encoder becomes contaminated, remove from the machine and clean with alcohol or T.V. tuner spray. DO NOT use harsh or oil based solvents.

To properly calibrate the digital readout, follow the steps outlined below.

1. Turn the machine on.
2. Place a set of bending dies in position.
3. Using a carpenters square, advance the radius die until the back gates are at a true 90 degrees, contacting the inside of the square evenly across the front. (See figure 1-A)



4. Read the degree of bend shown in the DIE ANGLE window on the control board and make the following adjustments.

NOTE:

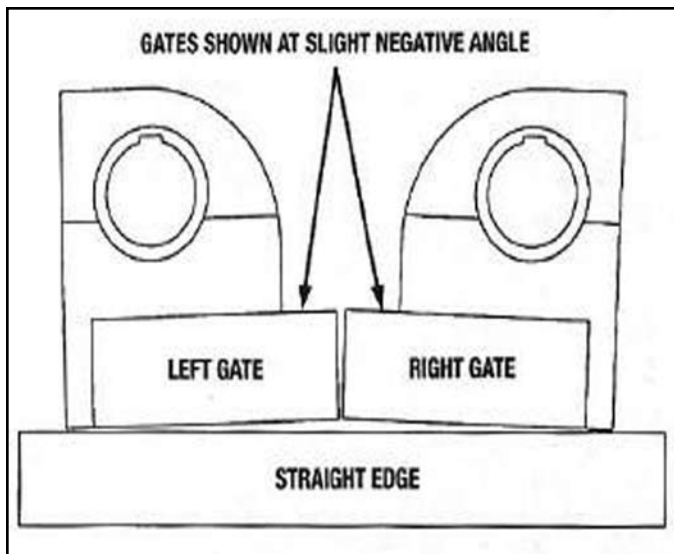
Before making any adjustments, check to make sure that the flexible coupler or "U-Joint" is functioning properly. Excessive free-play will cause irregular encoder readings. If there is excessive play between the steel roller plates and the nylon rider, loosen the set screws and snug up the coupler assembly. Be careful not to exert excessive pressure on the encoder shaft.

The DIE ANGLE display shows a few degrees LESS than 90° - This means the gates are moving slightly before the micro switch deactivates and starts the counting process. To make the proper adjustment, loosen the trip arm set screw and adjust it slightly AWAY from the micro switch lever so that upon initial movement of the gate assembly the switch immediately deactivates. ALWAYS BE SURE that when the gates return to zero, the trip arm still contacts the micro switch lever enough to activate it

The DIE ANGLE display shows a few degrees MORE than 90° - In most cases this signifies that the encoder is malfunctioning. Return the radius die back to zero then slowly advance the radius die and check the DIE ANGLE display for irregularities. If the counting appears to be in proper sequence, then loosen the set screw on the trip arm and adjust it slightly TOWARDS the zero angle micro switch lever. DO NOT adjust the trip arm far enough to allow it to "crash" into the micro switch upon full gate closure.

NOTE:

The back gates on digital models should close at a slight negative angle. This is to compensate for the initial 1/8" of forward travel (or movement) the gate needs to allow the trip arm to deactivate the zero angle micro switch and start the counting process. (See figure 1-B)



USING THE JUMPER BOARD

All "BA" models have a bypass device or "jumper board" included that can be used to effectively bypass the digital control board for trouble shooting or diagnostic purposes. ALWAYS consult the factory before attempting to use the jumper board. The jumper board is stored within the front upright of the bender and attached to the back side of the main circuit panel by retaining clips.

(See figure 1-B)

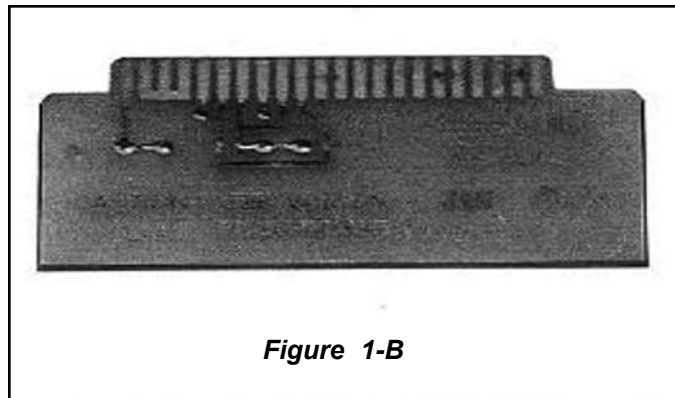


Figure 1-B

WARNING!

The jumper board should be used for temporary diagnostic purposes only and was not designed to permanently bypass the main circuit panel. USE OF THE JUMPER BOARD alters the foot switch controls to high voltage. NEVER operate the machine in or around water or damp environments. This machine contains high voltage. Disconnect power at the receptacle before performing any electrical repairs. Secure plug so that it cannot be accidentally plugged in during service.

To remove and install the jumper board, follow the steps outlined below.

1. With the machine unplugged, remove the four allen screws that secure the front display panel.
2. Reach in and carefully pull up on the main circuit panel using the white handle, until it disconnects from the connector located within the front upright.
3. Remove the jumper board from the back side of the main circuit panel and check the fuse.
4. Install the jumper board narrow end down with THE FUSE TO THE REAR by gently sliding it down between the card guides until it plugs into the connector. The jumper board MUST be plugged firmly into the connector to function properly.

WARNING!

If the machine continues to malfunction with the jumper board in place, discontinue use immediately and consult factory.

5. With the jumper board in place, movement of the radius die will be controlled by the twin foot switches only. There will be no provision for depth-of-bend readings.

IMPORTANT NOTE!

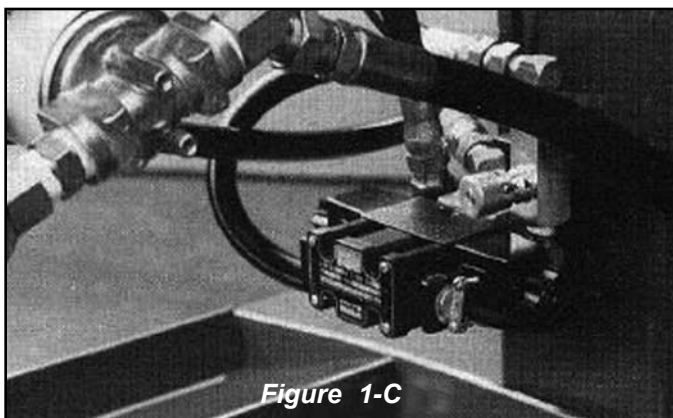
The top micro switch will be inactive with the jumper board in place. NEVER retract the top cylinder so that it is in a "bottomed out" condition.

SERVICE NOTE:
WHEN RETURNING THE DIGITAL CONTROL BOARD FOR REPAIR, REMEMBER TO INCLUDE ALL COMPONENTS: FRONT DISPLAY PANEL, MAIN CIRCUIT PANEL AND WIRE RIBBON.

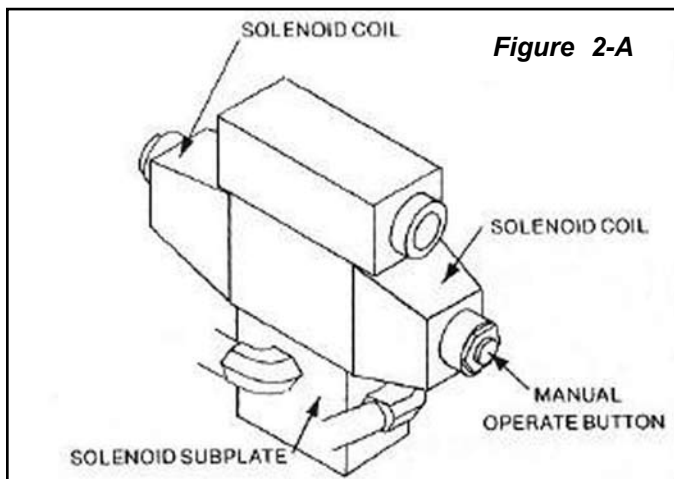
OPERATING THE MACHINE MANUALLY USING THE ELECTRIC SOLENOID VALVE

All "BA" and "BAS" models incorporate an electronic solenoid valve that controls operation of the top cylinder for all bending functions. The solenoid valve is located to the rear of the machine, just below the oil filter.

(See figure 1-C)



The solenoid valve is an electric spool valve that uses electric-magnets (coils) to activate the valve spool. You can use the manual "buttons" on the end of each coil to temporarily activate the top cylinder should a malfunction occur with the automatic controls or the solenoid valve itself. (See figure 2-A)



The manual buttons control the top cylinder as follows;
To advance the radius die - Press the right button inward using an insulated tool or non-conducting rod.
To retract the radius die - Press the left button inward using an insulated tool or non-conducting rod.

NOTE:

The manual control function of the solenoid valve should effectively advance or retract the radius die under all conditions. The manual button should be pressed firmly to activate.

SOLENOID VALVE MAINTENANCE

Certain symptoms and suggested repair procedures are explained below.

- ◆ **The valve inadvertently "sticks" causing the top cylinder to uncontrollably advance or retract.** Operating the valve manually will often dislodge foreign particles that may have become trapped in the valve spool. If this does not free the valve, remove the solenoid coil covers and make sure there is no foreign matter that could interfere with the moving parts. Clean and reassemble.
- ◆ **The valve spool is free but still does not activate with the control board or twin foot switches.-** Remove the solenoid valve coils and check for an open or shorted circuit. Check all electrical connections.
- ◆ **The valve spool is free and the coils are not open or shorted, but it still does not activate with the control board or twin foot switches.** - Check the incoming voltage to the valve. Proper incoming voltage should be between 208 - 230 volts A.C.
- ◆ **There is no voltage to the solenoid valve or the voltage is too low.** - Check the fuse on the control board or see electrical diagrams on pages 4

ELECTRICAL REPAIR

WARNING!
 Electrical equipment should be serviced by certified electrician's only. This manual should not be viewed as sufficient instructions for those who are not otherwise qualified to operate, service or maintain the equipment discussed. Although reasonable care has been taken to provide accurate and authoritative information in this manual, no responsibility is assumed by the manufacturer for any consequences arising out of the use of this material.

The following section contains instructions and illustrations to aid in electrical repair. Most electrical components cannot be repaired and require only removal and installation of new components. If replacement parts are to be installed, refer to the wiring diagrams found on pages 49 & 50.

DANGER!
 This machine contains high voltage. Disconnect power at the receptacle before performing any electrical repairs. Secure plug so that it cannot be accidentally plugged in during servicing.

CHECKING THE MICRO SWITCHES / AUTOMATIC MODELS

The micro switches shown below play a very important part in the control features of your machine. These switches remain in the circuit at all times in order for the controls to function properly.

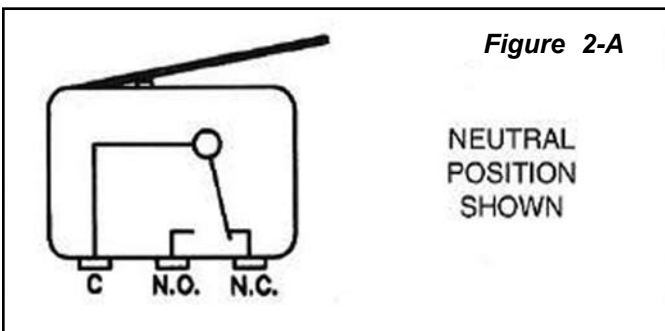
MICROSWITCH DESCRIPTION	"BA" MODELS	"BAS" MODELS
Top Micro Switch	X	X
Right Foot Switch	X	X
Left Foot Switch	X	X
Depth -of-Bend Switch		X
Zero Angle Micro Switch	X	

Each micro switch has three terminals for connecting the necessary wires. These terminals will be labeled as follows;

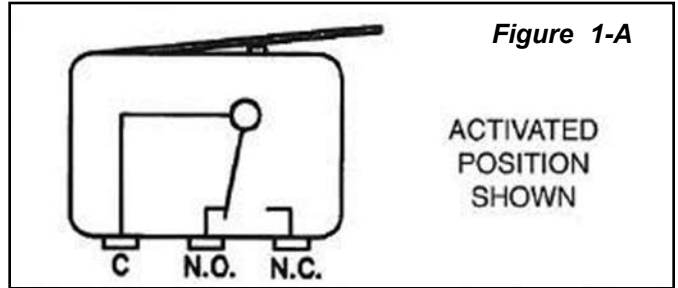
- "C" or Common
- "NO" or Normally Open
- "NC" or Normally Closed

To tell if the micro switch is good, remove it from the machine and use an ohmmeter to check the circuits as follows;

WITH THE SWITCH IN THE NEUTRAL POSITION - Place one of the prongs from your ohmmeter on the "common" terminal of the switch and the other on the "normally closed" terminal. At this time there should be continuity between the two. There should be no continuity between the "common" and "normally open" at this time. (See Fig. 2-A)



WITH THE LEVER OR BUTTON DEPRESSED - Place one of the prongs from your ohmmeter on the "common" terminal of the switch and the other on the "normally open" terminal. At this time there should be continuity between the two. There should be no continuity between the "common" and "normally closed" terminals at this time. (See figure 1-A)



CAUTION:
 Replace ALL faulty switches immediately. NEVER attempt to bypass or "hot-wire" any of the micro switches.

MOTOR CONNECTIONS

For motor lead connections, refer to the charts below. In addition, to the motor lead wires it is necessary to connect the green ground wire. Electric motor MUST be grounded at all times.

220 Volt 60HZ Single Phase	
<i>Incoming Power</i>	<i>Motor Leads</i>
Line 1	5 and 1
Line 2	8 and 4
To reverse rotation, interchange lines 5 and 8	
220 Volt 60HZ Three Phase	
<i>Incoming Power</i>	<i>Motor Leads</i>
Line 1	3 and 9
Line 2	2 and 8
Line 3	1 and 7
Twist together	4, 5, 6
To reverse rotation, interchange any two line leads	
440 Volt 60HZ Three Phase	
<i>Incoming Power</i>	<i>Motor Leads</i>
Line 1	1
Line 2	2
Line 3	3
Twist together	6 and 9
Twist together	5 and 8
Twist together	4 and 7
To reverse rotation, interchange any two line leads	
220 Volt 50HZ Three Phase	
<i>Incoming Power</i>	<i>Motor Leads</i>
Line 1	1, 6, 7, 12
Line 2	2, 4, 8, 10
Line 3	3, 5, 9, 11
To reverse rotation, interchange any two line leads	

MANUAL ELECTRIC STARTER

The electric starter box on your bender uses movable contacts activated by a push button mechanism. This style of electric starter is equipped with "Heaters" to prevent damage to the starter switch or motor in the event of an over-current situation. Single phase machines use one (1) #B-36 heater while three phase machines use three (3) #B-25 heaters. Continued over-current through the thermal unit will raise its temperature and melt the alloy allowing the ratchet wheel to rotate. This releases the pawl assembly, allowing the toggle spring to retract the contacts. Before resetting the relay, allow one to two minutes for the alloy to solidify. **DO NOT** disassemble the overload relay block because motor protection could be disabled and cause possible damage to motor and/or other components. Thermal units must be installed and the device reset before the starter contacts will operate. Install thermal units so that the type face can be read and the pawl is positioned just above the ratchet wheel.

LOCK OFF MECHANISM - The starter can be locked only in the OFF position by lifting the metal tab labeled "LOCK" on the contact actuator and placing a padlock through the center of the hole in the tab.

HYDRAULIC CYLINDERS

As with all hydraulic cylinders, age and wear will reduce the effectiveness of the cylinder seals. Proper maintenance and care will result in a prolonged service life.

RECOMMENDED MAINTENANCE

- ◆ Use a small file to remove any small nicks or scratches on the chrome cylinder rods.
- ◆ ALWAYS keep the chrome cylinder rods clean.
- ◆ ALWAYS remove expander tooling from the swager area on 1302 models before using the internal expander to prevent damaging the cylinder rod.
- ◆ NEVER "bang" the adapter collars on the cylinder shaft to release them from the tubing.
- ◆ Be sure to change the hydraulic fluid after every 1500 hours of operation or yearly, whichever comes first.
- ◆ Keep the ST-1 and Arbor tight at all times.

NOTE:

Under normal operating conditions all of the cylinders will seep oil around the area of the wiper seal. This is a normal condition.

380 Volt 50HZ Three Phase

Incoming Power	Motor Leads
Line 1	1 and 7
Line 2	2 and 8
Line 3	3 and 9
Twist together	10, 11, 12
Twist together	4, 5, 6
To reverse rotation, interchange any two line leads	

440 Volt 50 HZ Three Phase

Incoming Power	Motor Leads
Line 1	1 and 12
Line 2	2 and 10
Line 3	3 and 11
Twist together	4 and 5
Twist together	5 and 8
Twist together	6 and 9
To reverse rotation, interchange any two line leads	

CAUTION!

All "BA" and "BAS" models wired for more than 220 volts are factory equipped with a transformer to reduce the incoming voltage to the circuit board down to 220 volts AC.

TO CHECK FOR PROPER ROTATION

On initial start up of a three phase motor, check for proper rotation. It should rotate *counterclockwise*. To check motor/pump rotation, proceed as follows:

1. Plug in bender.
2. Turn bender on.
3. Depress the swager control handle. If the swager cylinder extends, then the rotation is correct. If the swager cylinder does not extend, then the rotation is wrong.
4. If the rotation is wrong, unplug the bender.
5. Disassemble the plug and reverse any two power wires.
6. Test again.
7. If the swager cylinder still does not activate, check the motor lead wiring as shown on the previous page.

ELECTRIC FOOT SWITCH

On a regular basis, inspect the electric foot switch assembly for wear or damage. Inspect the entire length of the connecting cord for wear or deterioration. **DO NOT OPERATE** the foot switch if any of the above is observed.

TROUBLESHOOTING

Introduction;

The troubleshooting procedures shown on the following pages contain certain systems and/or conditions, possible causes and the corrective actions required. The chart gives the easiest corrective action first, then proceeds with more difficult procedures. Be certain that the person(s) working on the machine have the ability to do the service. Only certified electricians should work on electrical components. ALWAYS unplug the machine before servicing.

SYMPTOM / CONDITION	POSSIBLE CAUSE	CORRECTIVE ACTION
The motor does not run	Circuit breaker(s) is off	Turn breaker(s) on
	Incorrect wiring.	Check voltage supply, phase and wiring. Refer to wiring instructions found on pages 49-50
	Heater in switch box has been tripped.	Check thermal heaters(s) See page 44.
	Defective electric starter / motor.	Test and replace as needed.
The motor smokes.	Power supply incorrect.	Check voltage supply, phase and wiring. Refer to wiring instructions found on pages 7 & 43
The motor shuts off.	Thermal overload tripping.	Check voltage supply, phase and wiring. Refer to wiring instructions found on pages 7 & 43. If problem persists, check wiring for short circuits. Check amp draw. Refer to motor nameplate.
The bender gives off shocks.	The plug has been wired wrong. Power is connected to the ground wire.	Check plug. Make sure that the green wire on the power cord is used for grounding purposes only. NO POWER should be connected to the green ground wire.
	Power wire has become disconnected in the switch box or motor.	Check all connections.
The tubing wrinkles or kinks.	Incorrect guide plate alignment, worn barrel bushings or pusher block. Tubing gauge is not adequate for that particular size or radius.	See page 48 for improving bend quality.
The bender experiences loss of power. The motor stalls even though the system pressure is showing less than 2000 psi.	Incorrect wiring. Voltage or amperage too low.	Check voltage supply, phase and wiring. Refer to wiring instructions found on pages 7 & 43.
BA / BAS models - Bending ram will retract with the button controls but not with the left foot switch.	Left foot switch is inoperative or wire has become disconnected	Check connections on micro switch. Refer to diagrams on pages 49-50. Check micro switch with ohmmeter. See page 43. Check for broken or disconnected wires.
BA / BAS models - The top cylinder will advance with the button controls but not with the right foot switch.	Right foot switch is inoperative or wire has become disconnected	Check connections on micro switch. Refer to diagrams on pages 49-50 Check micro switch with ohmmeter. See page 43. Check for broken or disconnected wires.
The sequence valve pressure surges high when trying to retract the bending ram.	The return pressure is set too high. The top cylinder is trying to overcome the bottom cylinder which is not retracting simultaneously	Adjust return pressure as shown on page 33.
The back gates remain in the open position even after the bending ram is retracted.	Tubing is not sliding back with the radius die after the bend is made, causing the gates to remain open.	Clean and thoroughly grease bending dies before use. Wipe tubing clean.
	Return pressure is set too low.	Adjust return pressure as shown on page 33.
The swager cylinder does not expand the tubing straight.	The swager cylinder is not aligned correctly.	Shim the swager cylinder as required. See page 37.
	The swager cylinder is bent.	Remove and replace swager cylinder

SYMPTOM / CONDITION	POSSIBLE CAUSE	CORRECTIVE ACTION
BAS models - The bending ram continues retracting even after the rear limit switch is activated. Pressure builds up on the sequence valve gauge.	The rear limit switch is malfunctioning.	Check wire connections on the rear limit switch. Refer to diagram on page 50. Check micro switch with ohmmeter as described on page 43. Check for broken or disconnected wires. Replace if faulty.
	The solenoid valve spool is stuck.	Manually operate the solenoid valve using the manual control buttons. This should dislodge any debris that may have become stuck in the valve body.
BAS models - Both foot switches function properly. The BLUE control button works only when held in. The GREEN control button does not function at all.	The RED control button or relay is stuck, shorted, malfunctioning.	Remove and replace the RED control button or faulty relay.
BAS models - Both foot switches are inoperative. The bending die retracts past the rear limit switch and the system pressure builds up and the bender groans. If the RED control button is pushed, then the ram will advance automatically until reaching the depth-of-bend switch. At this time it will then retract past the rear limit switch again and the system pressure will build.	The GREEN control button or relay is stuck, shorted, malfunctioning.	Remove and replace the GREEN control button or faulty relay.
BAS models - The GREEN control button retracts the top cylinder when held in. Does not advance with right foot switch control.	The depth-of-bend switch is stuck, shorted, malfunctioning.	Check wire connections on depth-of-bend limit switch. Refer to diagram on page 50. Check micro switch with ohmmeter as described on page 43. Check for broken or disconnected wires. Replace if faulty.
BAS models - (Stuck in forward mode) The BLUE and RED control buttons are inoperative. The GREEN control button retracts the top cylinder when held in. When the GREEN control button is released, the top cylinder will advance then retract upon reaching the depth-of-bend switch.	The right foot switch is stuck, shorted, malfunctioning.	Check wire connections on right foot switch. Refer to diagram on page 50. Check micro switch with ohmmeter as described on page 43. Check for broken or disconnected wires. Replace if faulty.
BAS models - (Stuck in reverse) The top cylinder will advance with the right foot switch or if the GREEN control button is held in, but immediately retract if either is released.	The left foot switch is stuck, shorted, malfunctioning.	Check wire connections on the left foot switch. Refer to diagram on page 50. Check micro switch with ohmmeter as described on page 43. Check for broken or disconnected wires. Replace if faulty.
BAS models -The motor runs but the cylinders are inoperative.	The fuse is blown on the control board.	Remove control board and check fuse.
	3-Phase models - The motor is running backwards.	Check motor rotation. See page 44.
	The power supply is incorrect.	Check voltage supply, phase and wiring. Refer to wiring instructions found on page 7 & 43.

HELPFUL DIAGNOSTIC TIPS FOR DIGITAL MODELS

If you feel a control problem exists with the main circuit panel, the jumper board can be used to temporarily bypass the complete control board assembly until repairs are made. (See page 41)




If the top cylinder advances or retracts by itself without activating any controls and you feel the problem exists with the front display panel due to cuts or other damage, disconnect it from the main circuit panel by unplugging it from the blue wire ribbon. With the front display panel taken out of the circuit, the foot switch controls should operate normally.

SYMPTOM / CONDITION	POSSIBLE CAUSE	CORRECTIVE ACTION
BA models - Motor runs but digital board does not light up. All controls are inoperative.	Fuse is blown on control board.	Remove control board and check the fuse. See page 41.
BA models - The top cylinder continues forward by itself without activating any controls. The keypad or foot switch have no effect.	Solenoid valve spool is stuck.	Manually operate the solenoid valve using the manual control buttons. This should dislodge any debris that may have become stuck in the valve body.
	The AUTO key on the control board is stuck, shorted, malfunctioning.	Visually check the control board for any possible wear or cuts. Remove the front display panel by disconnecting it from the wire ribbon or install the jumper board as described on page 41. This will confirm if the problem is related to the front display panel or not. If the top cylinder operates normally with the front display panel removed or the jumper board in place, then return the complete digital control board assembly to the factory for repair.
BA models - The top cylinder continues forward by itself without activating any controls. The top cylinder stops when the left foot switch is depressed but will continue when released.	The right foot switch or JOG/ FWD button is stuck, shorted, malfunctioning.	Visually check the control board for any possible wear or cuts. Remove the front display panel by disconnecting it from the wire ribbon or install the jumper board as described on page 41. This will confirm if the problem is related to the front display panel or not. If the problem persists, check wire connections on the right foot switch. Refer to diagram on page 49. Check micro switch with ohmmeter as described on page 43. Check for broken or disconnected wires. Replace if faulty.
BA models - The top cylinder retracts by itself without activating any controls. The top cylinder will advance when the AUTO button is depressed, but immediately retract when released. The STOP / REVERSE button is inoperative. The top cylinder will stop retracting when the JOG / FWD button or right foot switch is depressed, but will continue reversing when released.	The left foot switch is stuck, shorted, malfunctioning.	Check wire connections on the left foot switch. Refer to diagram on page 49. Check micro switch with ohmmeter as described on page 43. Check for broken or disconnected wires. Replace if faulty.
BA models - The STATION window never advances even after the top cylinder has fully retracted.	The trip arm is not properly tripping the zero angle micro switch.	Adjust the trip arm as described on page 40.
BA models - The top cylinder doesn't stop at the degree setting that was programmed into the SET ANGLE window.	The encoder is malfunctioning, probably due to contamination or moisture.	In most case the encoder will have to be replaced. You may temporarily correct the problem by cleaning the encoder as described on page 40.
	The solenoid valve spool is stuck.	Manually operate the solenoid valve using the manual control buttons. This should dislodge any debris that may have become stuck in the valve body.

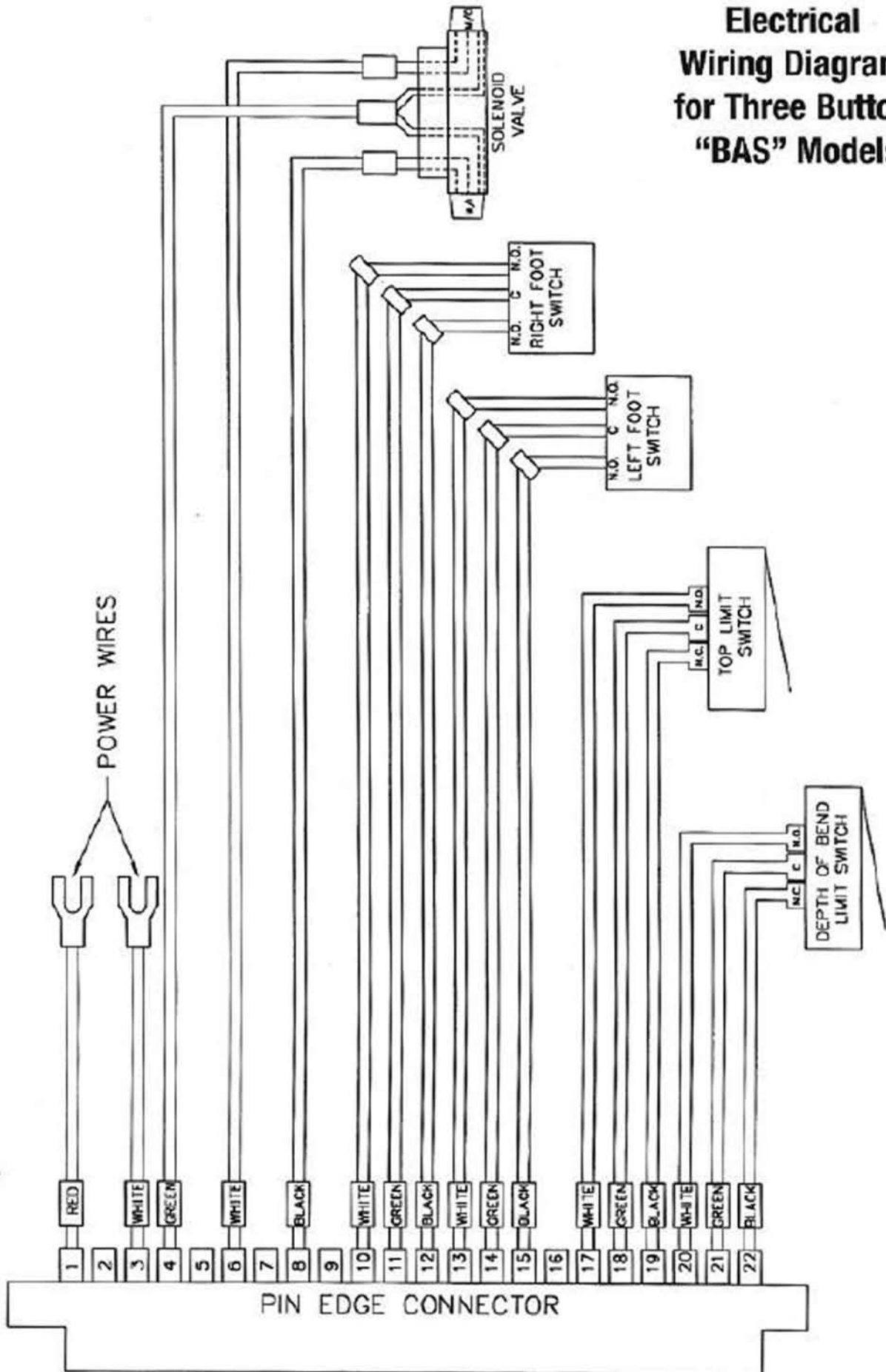
BENDING PROBLEMS

Bending complications can be usually attributed to tubing thickness, tubing quality or improper radius selection. The bigger the tubing diameter, the bigger the radius and wall thickness should be. See the chart below for minimum tubing thickness and proper radius selection.

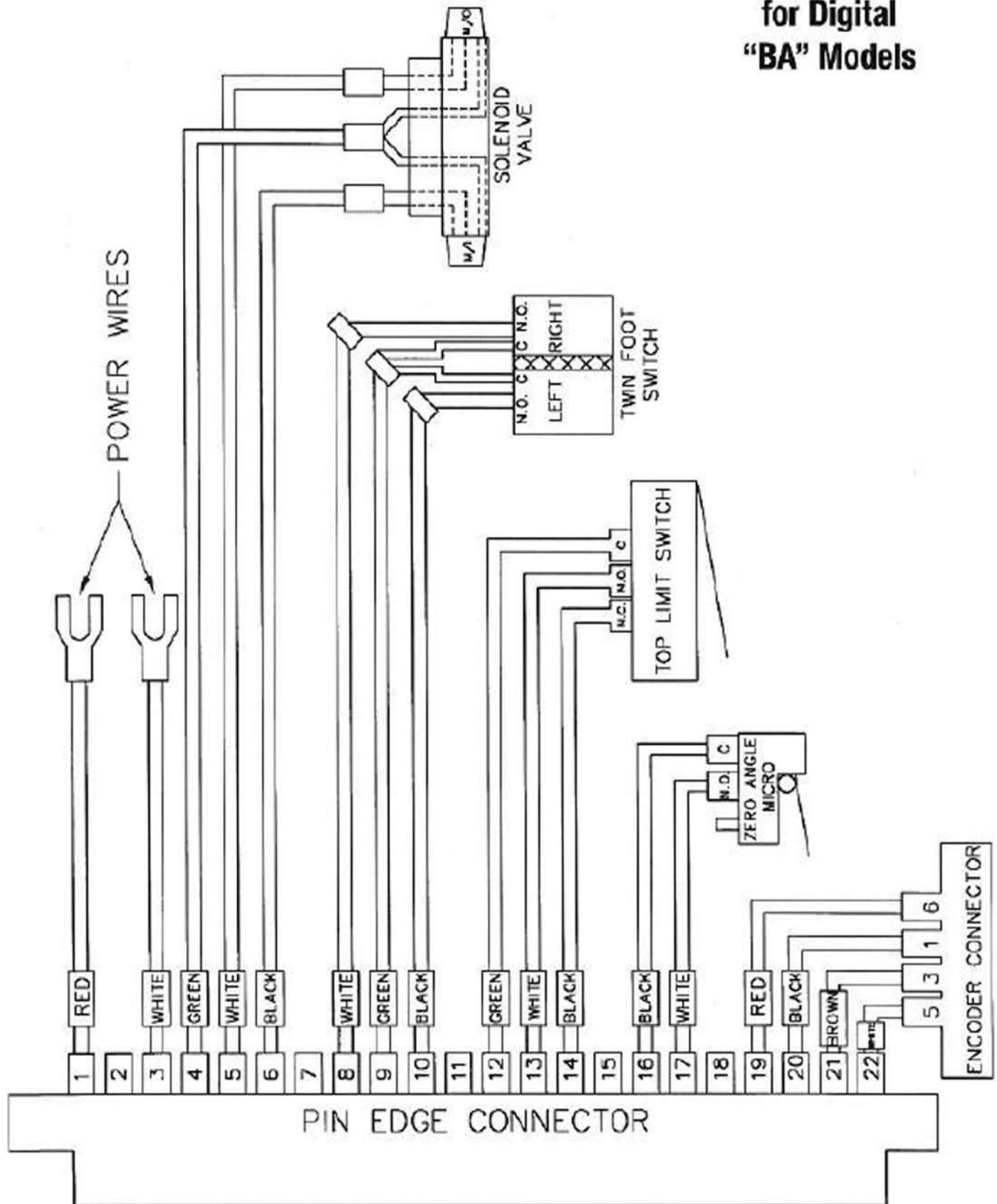
Tubing Diameter	Minimum Tubing Thickness 5" Radius	Minimum Tubing Thickness 4" Radius	Minimum Tubing Thickness 3 1/2" Radius
1"- 1-3/4"	18 Gauge / .049	16 Gauge / .065	16 Gauge / .065
1-7/8" - 2"	16 Gauge / .065	16 Gauge / .065	16 Gauge / .065
2-1/4"	16 Gauge / .065	14 Gauge / .083	14 Gauge / .083
2-1/2"	14 Gauge / .083	14 Gauge / .083	N/A
3"	13 Gauge / .095	N/A	N/A

SYMPTOM / CONDITION	POSSIBLE CAUSE	CORRECTIVE ACTION
Flattening or collapsing of pipe on outside of bend. 	Incorrect back pressure. Usually a low pressure problem.	Adjust back pressure as shown on page 33. For 3" diameter tube see bending instructions found on page 21
	Bending dies are not properly matched to the tubing diameter.	Select proper bending dies for the particular tubing diameter.
	Tubing diameter is actually less or more than what it is labeled.	Check the actual tubing diameter using a micrometer or similar measuring device.
	Gauge thickness is less than the recommended requirement. See chart above for minimum tubing thickness.	Check tubing for proper wall thickness. See chart above.
Dimpling of pipe on inside of bend. 	Incorrect back pressure.	Adjust back pressure as shown on page 33. For 3" diameter tube see bending instructions found on page 21
	Gauge thickness is less than the recommended requirement. See chart above for minimum tubing thickness.	Check tubing for proper wall thickness. See chart above.
	Bending dies are not properly matched to the tubing diameter.	Select proper bending dies for the particular tubing diameter.
	Tubing diameter is actually less or more than what it is labeled.	Check the actual tubing diameter using a micrometer or similar measuring device.
	Improper chain adjustment.	Adjust chains as described on page 34.
Crimping or wrinkling of pipe. 	Improper die alignment.	Check the following.
	Bronze barrel bushings may be worn.	Remove and replace the bushings as described on page 36.
	Guide plate may be mis-aligned. Check proper alignment as described on page 35.	Adjust and shim guide plate as described on page 35.
	Pusher block may be worn. Check for proper tolerance as described on page 38.	Remove and replace pusher block as required.
	Bending dies are not properly matched to the tubing diameter.	Select proper bending dies for the particular tubing diameter.
	Tubing diameter is actually less or more than what it is labeled.	Check the actual tubing diameter using a micrometer or similar measuring device.

Electrical Wiring Diagram for Three Button "BAS" Models



Electrical Wiring Diagram for Digital "BA" Models



SERVICE PARTS

PART NUMBER	DESCRIPTION
214	Oil Filter Element
215	Filter Head
219	Pressure Gauge
522	Leaf Chain Section
164	5/16" Chain Bolt
196	Chain Return Bolt
1040	Adjustable Chain Connector
585	Springs For Pusher Block
1022	Pusher Block
1024	Guide Plate
1041	Chain Return Block
1034	Depth-of-Bend Plate
1034-A	Rotation Dial Faceplate
541	Bearing For Rotation Dial
1049	Rotation Dial Pendulum Assembly
517	Rigid Caster Assembly
516	Swivel Caster Assembly
229	Valve Handle
227	Valve Top Bracket
228	Valve Linkage Assembly
1114	Buttress Assembly Complete
589	Breather Cap
213	3/4" Suction Hose
502	Top Tool Tray
501	Swager Tool Tray
1020-A	Swager Box Assembly
335	5 H.P. Single Phase Motor
303-1	5 H.P. Three Phase Motor
303	7.SH.P. Three Phase Motor
329	5 H.P. Single Phase Switch Box
330	5 H.P. Three Phase Switch Box
324	Twin Electric Foot Switch Assembly
300	Top Micro / Depth-Of-Bend Switch
317	0-Angle Micro Switch
304	Digital Control Board Complete
305	Three Button Control Board Complete
999	Digital Membrane / BA
999	Colored Control Buttons I BAS
1031-D	Plexiglas Faceplate Cover\
999	Wiring Harness
321	Encoder
323	U-Joint For Encoder
225	5-Port Control Valve
224	4-Port Control Valve
270	7-Port Control Valve
223	Sequence Valve
226	Electric/ Hydraulic Solenoid Valve
265	Flow Control Valve
203	5" X 14" Top Cylinder
210	3-1/2" x 7" Double End Cylinder
209	3-1/2" x 7" Single End Cylinder
207	3" x 7" Bottom Cylinder
220	Hydraulic Pump For Bender

DELUXE 302 DIE PACKAGE

QTY.	PART NO.	SIZE	TOOLING DESCRIPTION
BENDING TOOLING			
1	5R-212	2-1/2" / 63.5mm	5" / 127mm Radius Die
1	5R-214	2-1/4" / 57mm	5" / 127mm Radius Die
1	5R-200	2" / 50.8mm	5" / 127mm Radius Die
1	4R-214	2-1/4" / 57mm	4" / 102mm Radius Die
1	4R-200	2" / 50.8 mm	4" / 102mm Radius Die
1	4R-178	1-7/8" / 48mm	4" / 102mm Radius Die
1	35R-200	2" / 50.8mm	3-1/2" / 89 mm Radius Die
1	35R-134	1-3/4" / 44.5mm	3-1/2" / 89 mm Radius Die
1	35R-112	1-1/2" / 38mm	3-1/2" / 89 mm Radius Die
2	BS-212	2-1/2" / 63.5mm	Back Shoes
2	BS-214	2-1/4" / 57mm	Back Shoes
2	BS-200	2" / 50.8mm	Back Shoes
2	BS-178	1-7/8" / 48mm	Back Shoes
2	BS-134	1-3/4" / 44.5mm	Back Shoes
2	BS-112	1-1/2" / 38mm	Back Shoes
1	HS-212	2-1/2" / 63.5mm	Half Shoe
1	HS-214	2-1/4" / 57mm	Half Shoe
1	HS-200	2" / 50.8mm	Half Shoe
1	HS-178	1-7/8" / 48mm	Half Shoe
1	HS-134	1-3/4" / 44.5mm	Half Shoe
1	HS-112	1-1/2" / 38mm	Half Shoe
1	QS-214	2-1/4" / 57mm	Three Quarter Shoe
1	QS-200	2" / 50.8mm	Three Quarter Shoe
SWAGER TOOLING			
1	STED-212	2-1/2" / 63.5mm	Solid Expander Die / 2-1/4" Male Ball Expander
1	STED-214	2-1/4" / 57mm	Solid Expander Die / 2" Male Ball Expander
1	STED-200	2" / 50.8mm	Solid Expander Die / 1-3/4" Male Ball Expander
1	STED-178	1-7/8" / 48mm	Solid Expander Die
1	STED-134	1-3/4" / 44.5mm	Solid Expander Die
1	STED-112	1-1/2" / 38mm	Solid Expander Die
1	HAC-212	2-1/2" / 63.5mm	Hinged Adapter Collar
1	HAC-214	2-1/4" / 57mm	Hinged Adapter Collar
1	HAC-200	2" / 50.8mm	Hinged Adapter Collar
1	HAC-178	1-7/8" / 48mm	Hinged Adapter Collar
1	HAC-134	1-3/4" / 44.5mm	Hinged Adapter Collar
1	HAC-112	1-1/2" / 38mm	Hinged Adapter Collar
1	HPF-300	One Tool Fits All Sizes	45 Degree / 90 Degree Flaring Tool
1	DD-134/212	One Tool Fits All Sizes	Doming Die
1	BFED-134/214	1-3/4" & 2-1/4"	Female Ball Flaring Tool
1	BFED-200-212	2" & 2-1/2"	Female Ball Flaring Tool
1	B-212	2-1/2" / 63.5mm	Male Ball Tool
1	CFT-200	2" / 50.8mm	Manifold Flange Tool
SEGMENT EXPANDER TOOLING			
1	HSA-112	One Size Fits All Sizes	Arbor
1	SS-212	2-1/2" / 63.5mm	Segment Expander
1	SS-214	2-1/4" / 57mm	Segment Expander
1	SS-200	2" / 50.8mm	Segment Expander
1	SS-134	1-3/4" / 44.5mm	Segment Expander
1	SS-112	1-1/2" / 38mm	Segment Expander
ACCESSORIES			
1	TTA-1000		Tool Tray Kit
2	DPS-150		Radius Die Pusher Block Springs
1	Manual		Service Manual
1	OR-1		Small O-Ring Package
1	TC-30		Tubing Cutter
Other Sizes Are Available Upon Request			

ECONOMY 202 DIE PACKAGE

QTY.	PART NO.	SIZE	TOOLING DESCRIPTION
BENDING TOOLING			
1	5R-212	2-1/2" / 63.5mm	5" / 127mm Radius Die
1	5R-214	2-1/4" / 57mm	5" / 127mm Radius Die
1	5R-200	2" / 50.8mm	5" / 127mm Radius Die
1	4R-214	2-1/4" / 57mm	4" / 102mm Radius Die
1	4R-200	2" / 50.8 mm	4" / 102mm Radius Die
1	35R-134	1-3/4" / 44.5mm	3-1/2" / 89 mm Radius Die
1	35R-112	1-1/2" / 38mm	3-1/2" / 89 mm Radius Die
2	BS-212	2-1/2" / 63.5mm	Back Shoes
2	BS-214	2-1/4" / 57mm	Back Shoes
2	BS-200	2" / 50.8mm	Back Shoes
2	BS-134	1-3/4" / 44.5mm	Back Shoes
2	BS-112	1-1/2" / 38mm	Back Shoes
1	HS-212	2-1/2" / 63.5mm	Half Shoe
1	HS-214	2-1/4" / 57mm	Half Shoe
1	HS-200	2" / 50.8mm	Half Shoe
1	HS-134	1-3/4" / 44.5mm	Half Shoe
1	HS-112	1-1/2" / 38mm	Half Shoe
SWAGER TOOLING			
1	STED-212	2-1/2" / 63.5mm	Solid Expander Die / 2-1/4" Male Ball Expander
1	STED-214	2-1/4" / 57mm	Solid Expander Die / 2" Male Ball Expander
1	STED-200	2" / 50.8mm	Solid Expander Die / 1-3/4" Male Ball Expander
1	STED-134	1-3/4" / 44.5mm	Solid Expander Die
1	STED-112	1-1/2" / 38mm	Solid Expander Die
1	HAC-212	2-1/2" / 63.5mm	Hinged Adapter Collar
1	HAC-214	2-1/4" / 57mm	Hinged Adapter Collar
1	HAC-200	2" / 50.8mm	Hinged Adapter Collar
1	HAC-134	1-3/4" / 44.5mm	Hinged Adapter Collar
1	HAC-112	1-1/2" / 38mm	Hinged Adapter Collar
1	HPF-300	One Tool Fits All Sizes	45 Degree / 90 Degree Flaring Tool
1	DD-134/212	One Tool Fits All Sizes	Doming Die
1	BFED-134/214	1-3/4" & 2-1/4"	Female Ball Flaring Tool
1	BFED-200-212	2" & 2-1/2"	Female Ball Flaring Tool
1	B-212	2-1/2" / 63.5mm	Male Ball Tool
SEGMENT EXPANDER TOOLING			
1	HSA-112	One Size Fits All Sizes	Arbor
1	SS-212	2-1/2" / 63.5mm	Segment Expander
1	SS-214	2-1/4" / 57mm	Segment Expander
1	SS-200	2" / 50.8mm	Segment Expander
1	SS-134	1-3/4" / 44.5mm	Segment Expander
1	SS-112	1-1/2" / 38mm	Segment Expander
ACCESSORIES			
1	TTA-1000		Tool Tray Kit
2	DPS-150		Radius Die Pusher Block Springs
1	Manual		Service Manual
1	OR-1		Small O-Ring Package
Other Sizes Are Available Upon Request			

BB-1 DIE PACKAGE FOR BLUE BULLET BENDER

QTY.	PART NO.	SIZE	TOOLING DESCRIPTION
BENDING TOOLING			
1	5R-212	2-1/2" / 63.5mm	5" / 127mm Radius Die
1	5R-214	2-1/4" / 57mm	5" / 127mm Radius Die
1	5R-200	2" / 50.8mm	5" / 127mm Radius Die
1	4R-214	2-1/4" / 57mm	4" / 102mm Radius Die
1	4R-200	2" / 50.8 mm	4" / 102mm Radius Die
1	35R-134	1-3/4" / 44.5mm	3-1/2" / 89 mm Radius Die
1	35R-112	1-1/2" / 38mm	3-1/2" / 89 mm Radius Die
2	BS-212	2-1/2" / 63.5mm	Back Shoes
2	BS-214	2-1/4" / 57mm	Back Shoes
2	BS-200	2" / 50.8mm	Back Shoes
2	BS-134	1-3/4" / 44.5mm	Back Shoes
2	BS-112	1-1/2" / 38mm	Back Shoes
1	HS-212	2-1/2" / 63.5mm	Half Shoe
1	HS-214	2-1/4" / 57mm	Half Shoe
1	HS-200	2" / 50.8mm	Half Shoe
1	HS-134	1-3/4" / 44.5mm	Half Shoe
1	HS-112	1-1/2" / 38mm	Half Shoe
SWAGER TOOLING			
1	STED-212	2-1/2" / 63.5mm	Solid Expander Die / 2-1/4" Male Ball Expander
1	STED-214	2-1/4" / 57mm	Solid Expander Die / 2" Male Ball Expander
1	STED-200	2" / 50.8mm	Solid Expander Die / 1-3/4" Male Ball Expander
1	STED-134	1-3/4" / 44.5mm	Solid Expander Die
1	STED-112	1-1/2" / 38mm	Solid Expander Die
1	HAC-212	2-1/2" / 63.5mm	Hinged Adapter Collar
1	HAC-214	2-1/4" / 57mm	Hinged Adapter Collar
1	HAC-200	2" / 50.8mm	Hinged Adapter Collar
1	HAC-134	1-3/4" / 44.5mm	Hinged Adapter Collar
1	HAC-112	1-1/2" / 38mm	Hinged Adapter Collar
1	HPF-300	One Tool Fits All Sizes	45 Degree / 90 Degree Flaring Tool
1	DD-134/212	One Tool Fits All Sizes	Doming Die
1	BFED-134/214	1-3/4" & 2-1/4"	Female Ball Flaring Tool
1	BFED-200-212	2" & 2-1/2"	Female Ball Flaring Tool
1	B-212	2-1/2" / 63.5mm	Male Ball Tool
SEGMENT EXPANDER TOOLING			
1	HSA-112	One Size Fits All Sizes	Arbor
1	SS-212	2-1/2" / 63.5mm	Segment Expander
1	SS-214	2-1/4" / 57mm	Segment Expander
1	SS-200	2" / 50.8mm	Segment Expander
1	SS-134	1-3/4" / 44.5mm	Segment Expander
1	SS-112	1-1/2" / 38mm	Segment Expander
ACCESSORIES			
1	TTA-1000		Tool Tray Kit
2	DPS-150		Radius Die Pusher Block Springs
1	Manual		Service Manual
1	OR-1		Small O-Ring Package
Other Sizes Are Available Upon Request			

BB-2 DIE PACKAGE FOR BLUE BULLET BENDER

QTY.	PART NO.	SIZE	TOOLING DESCRIPTION
BENDING TOOLING			
1	5R-212	2-1/2" / 63.5mm	5" / 127mm Radius Die
1	5R-214	2-1/4" / 57mm	5" / 127mm Radius Die
1	5R-200	2" / 50.8mm	5" / 127mm Radius Die
1	4R-214	2-1/4" / 57mm	4" / 102mm Radius Die
1	4R-200	2" / 50.8 mm	4" / 102mm Radius Die
1	4R-178	1-7/8" / 48mm	4" / 102mm Radius Die
1	35R-134	1-3/4" / 44.5mm	3-1/2" / 89 mm Radius Die
1	35R-112	1-1/2" / 38mm	3-1/2" / 89 mm Radius Die
2	BS-212	2-1/2" / 63.5mm	Back Shoes
2	BS-214	2-1/4" / 57mm	Back Shoes
2	BS-200	2" / 50.8mm	Back Shoes
2	BS-178	1-7/8" / 48mm	Back Shoes
2	BS-134	1-3/4" / 44.5mm	Back Shoes
2	BS-112	1-1/2" / 38mm	Back Shoes
1	HS-212	2-1/2" / 63.5mm	Half Shoe
1	HS-214	2-1/4" / 57mm	Half Shoe
1	HS-200	2" / 50.8mm	Half Shoe
1	HS-178	1-7/8" / 48mm	Half Shoe
1	HS-134	1-3/4" / 44.5mm	Half Shoe
1	HS-112	1-1/2" / 38mm	Half Shoe
SWAGER TOOLING			
1	STED-212	2-1/2" / 63.5mm	Solid Expander Die / 2-1/4" Male Ball Expander
1	STED-214	2-1/4" / 57mm	Solid Expander Die / 2" Male Ball Expander
1	STED-200	2" / 50.8mm	Solid Expander Die / 1-3/4" Male Ball Expander
1	STED-178	1-7/8" / 48mm	Solid Expander Die
1	STED-134	1-3/4" / 44.5mm	Solid Expander Die
1	STED-112	1-1/2" / 38mm	Solid Expander Die
1	HAC-212	2-1/2" / 63.5mm	Hinged Adapter Collar
1	HAC-214	2-1/4" / 57mm	Hinged Adapter Collar
1	HAC-200	2" / 50.8mm	Hinged Adapter Collar
1	HAC-178	1-7/8" / 48mm	Hinged Adapter Collar
1	HAC-134	1-3/4" / 44.5mm	Hinged Adapter Collar
1	HAC-112	1-1/2" / 38mm	Hinged Adapter Collar
1	HPF-300	One Tool Fits All Sizes	45 Degree / 90 Degree Flaring Tool
1	DD-134/212	One Tool Fits All Sizes	Doming Die
1	BFED-134/214	1-3/4" & 2-1/4"	Female Ball Flaring Tool
1	BFED-200-212	2" & 2-1/2"	Female Ball Flaring Tool
1	B-212	2-1/2" / 63.5mm	Male Ball Tool
SEGMENT EXPANDER TOOLING			
1	HSA-112	One Size Fits All Sizes	Arbor
1	SS-212	2-1/2" / 63.5mm	Segment Expander
1	SS-214	2-1/4" / 57mm	Segment Expander
1	SS-200	2" / 50.8mm	Segment Expander
1	SS-134	1-3/4" / 44.5mm	Segment Expander
1	SS-112	1-1/2" / 38mm	Segment Expander
ACCESSORIES			
1	TTA-1000		Tool Tray Kit
2	DPS-150		Radius Die Pusher Block Springs
1	Manual		Service Manual
1	OR-1		Small O-Ring Package
Other Sizes Are Available Upon Request			

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