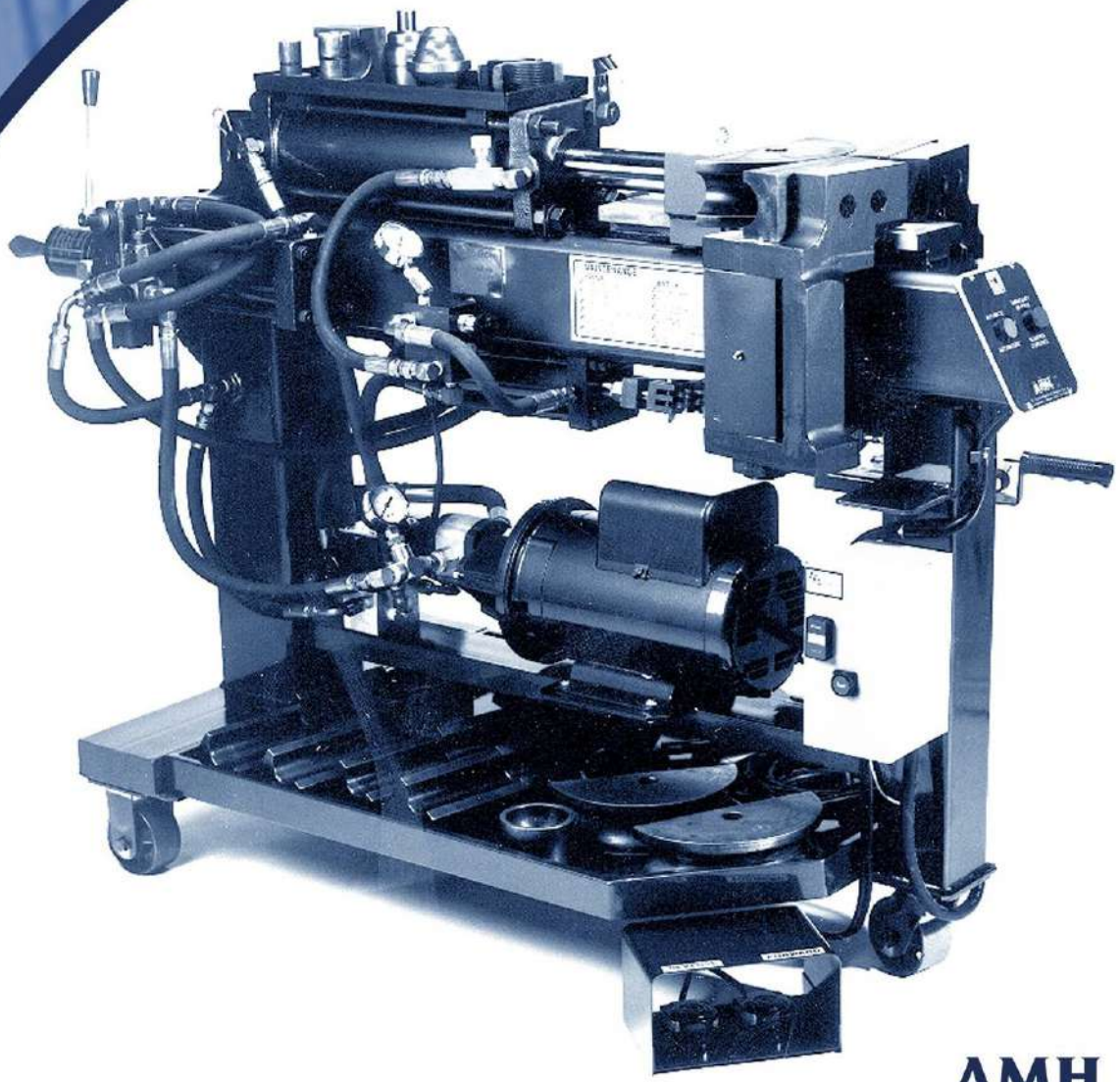
Pipe Bender

INSTRUCTION MANUAL



AMH

Blue Boy

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YOUR BLUE BOY TUBE BENDER

Your Tube Bender is a product of thirty years of continuous research, development, and product improvement. Following the simple installation and maintenance instructions given herein will insure you long, efficient, and trouble-free service.

Our Tube Benders are manufactured with the finest materials and components available. They are equipped with rugged precision tooling, designed for day-to-day production in your shop.

Though there are detail differences from model to model, the basic machine design is the same for all models. This manual covers the installation maintenance, and use of all models of Tube Benders. Skip over parts of the manual that tell about features your machine does not have.

Basic Design

Bending Head

The tube benders perform two functions:

(1) They bend tubing of diameters within their tooling capacity to specified angles and radii.

(2) They form the ends of tubes to specified configurations.

Tube bending is done with a hydraulically-driven ram die and a matching pair of back shoes. Tubing is held in place prior to bending by spring pressure on the ram die. When the operator is sure the tubing is positioned, he actuates the machine.

The ram die moves smoothly forward. The back shoes swing smoothly back, continually exerting pressure against the ram die while allowing it to pass between them, making a uniform bend. The precision contours of the matching ram die and back shoes hold the tubing securely. They cause the tubing to maintain its round cross-section while bending it through the correct angle. After the desired depth of bend is reached, the ram die retracts, releasing the bent tubing.

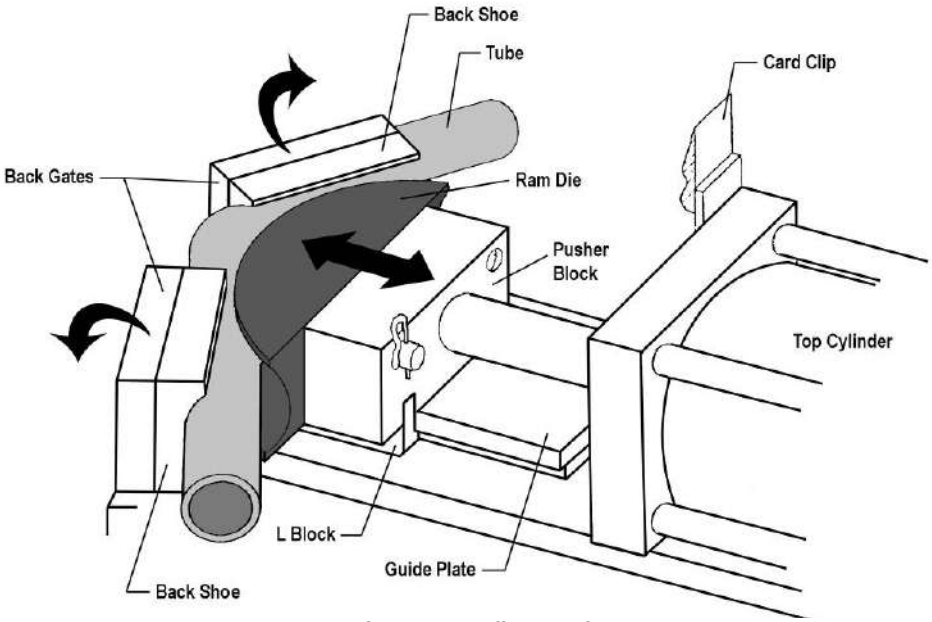


Figure 1. Bending Head

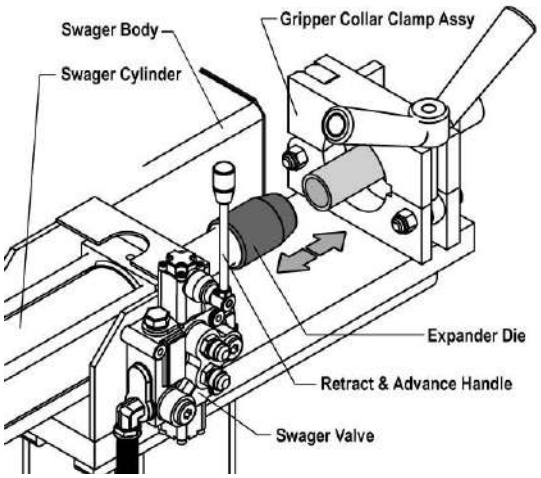


Figure 2. Swager

Gripper Clamp Swager

In the swaging operation the tubing is clamped securely in the gripper clamp assembly. A precision contour expanding die is pushed hydraulically into the open tube end to a specified depth, enlarging the tubing inner diameter as it moves into the tube. (see page 24 for detailed operation)

Expander

Tube end connections may also be made using the Expander. Two types of tooling are available: micro-dial and limit ring type tooling. Their operation is described as follows:

Micro-Dial Type Expander

This unique design utilizes an adjustable sleeve or spacer, tapered arbour, and expandable segment sets. Expanding is accomplished by placing the tube over the segment set and hydraulically pulling the arbour through the segment fingers. The various joints are precision formed by adjusting the micro-dial sleeve with corresponding lines as described on page 25.

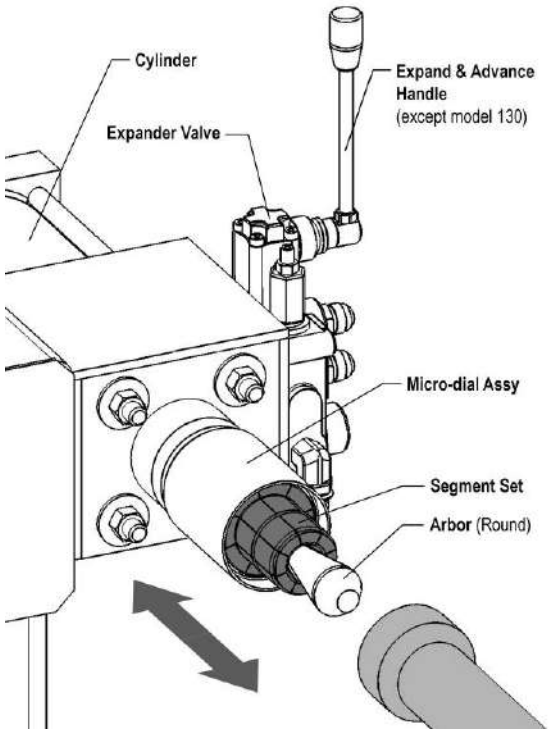


Figure 3A. Micro-dial Type Expander

Limit Ring Type Expander

With the limit ring type expander, the tubing is placed over the expanding tool with its end flush to the limit ring, and the limit ring flush to the segment set. Within the limit ring are a set of segments which make up an expandable head. Inside the segments is a tapered arbour. With the tubing in place, the arbour is hydraulically withdrawn through the segments, forcing them outward to meet the limit ring.

Since the hydraulic action is a pulling one, there is no need to clamp it in place for an expanding operation. (See page 25 for detailed operation)

Because clamping is not needed, expanding is basically a faster operation than swaging. However, the swaging device makes use of a more durable and versatile set of tooling.

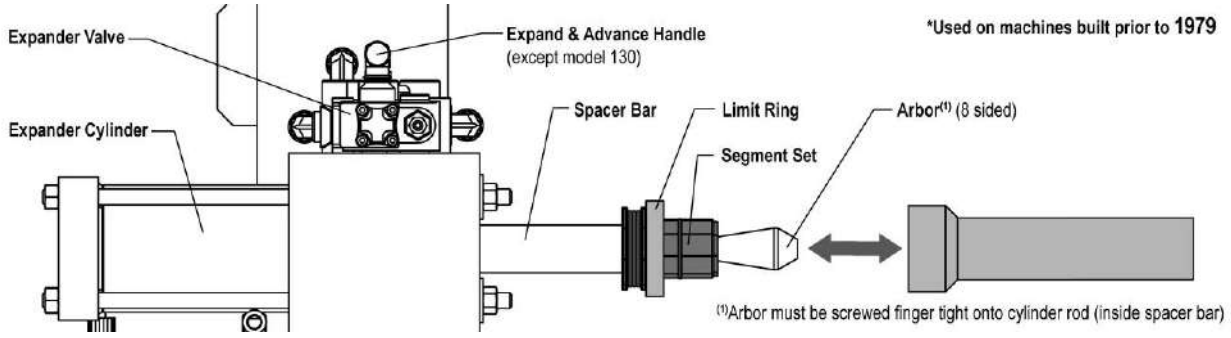


Figure 3B. Limit Ring Type Expander

Definition of Terms

The front of the machine is the end with the single swivel caster where the operator customarily stands to do his bending work. This front end of the machine also carries the controls for the bending operation.

When you stand in front facing the machine, the left side of the machine is to your left, the right side of the machine is to you right, and the back of the machine is farthest away from you.

Installing your Machine

Always use your Tube Bender on a solid, level floor, sturdy enough to support the weight of the machine properly.

Every Tube Bender is built using the same basic design. All the machine frames are equipped with three heavy duty casters which simplify levelling of the machine.

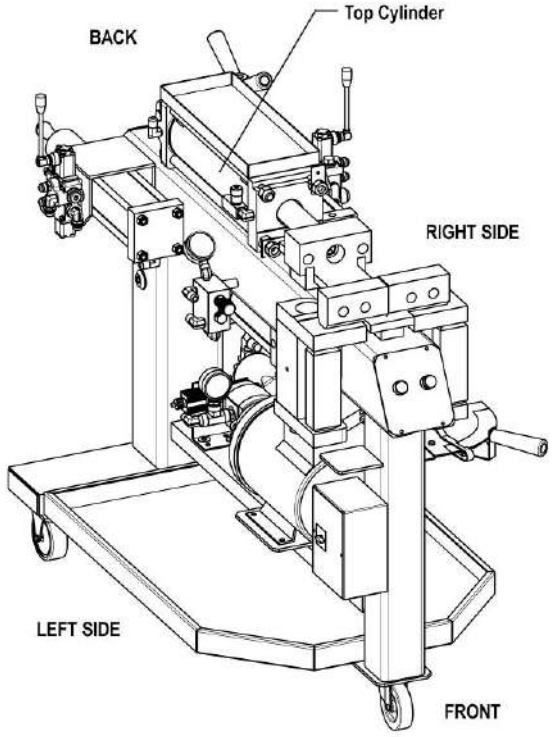


Figure 4. Terms

While all actions of Tube Benders are hydraulic, primary power is electric. The machine makes use of a hydraulic pump driven by an electric motor. The pump is always located on the cross channel, coupled to the motor shaft.

Two kinds of electric motors are available on customer specification: single-phase and three-phase.

Electrical Hook-up, Single-Phase

All single-phase Tube Benders are factory pre-wired with 3-prong "crow-foot" type plug. No receptacle is shipped with the machine. The standard receptacle for this plug is found in many commercial and industrial buildings. It is also readily obtained at hardware or electrical supply stores.

The receptacle should be wired into a junction box which supplies full 220-volts, single-phase, 60-cycles, properly fused or breaker-protected. Your tube bender is equipped with a 5 horse-power electric motor. It is recommended that a 30 Amp. circuit breaker (or fuse) be used to protect the electrical circuit. This hook-up is best done by a qualified electrician.

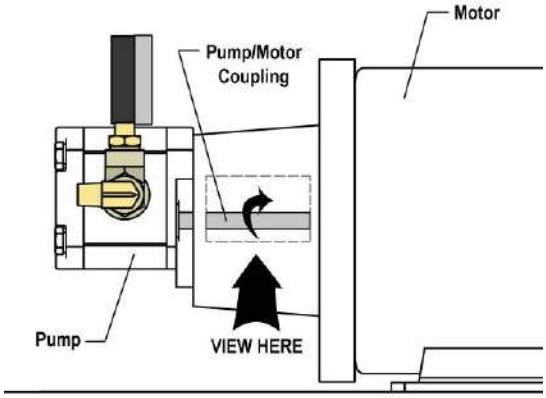


Figure 5. Check Pump Rotation

Checking Rotation Direction - Single-Phase

Rotation is pre-set at the factory for all single-phase motors. No rewiring should be necessary. However, if, for any reason, motor wiring is adjusted, immediately check the motor shaft to insure counter-clockwise rotation as viewed facing the motor shaft.

CAUTION
If the shaft turns in the wrong direction, shut the machine off immediately. Prolonged running in clockwise rotation will badly damage the pump shaft seals. Unplug the machine and correct the internal motor wiring by referring to the motor schematic.

Electrical Hook-up, Three-Phase

Three-phase Benders are factory pre-wired with a standard bayonet-type plug. A receptacle for this plug is shipped with the machine. This receptacle should be wired into a junction box which supplies three-phase current, properly fused or breaker-protected. All Blue Boy Tube Benders must be wired to a full 220-volt, 60-cycle power source, unless special motors are specifically ordered. Your tube bender is equipped with a 5 horse-power electric motor. It is recommended that a 20 Amp. circuit breaker (or fuse) be used to protect the electrical circuit. This hook-up is best done by a qualified electrician.

The bayonet plug can be put into the receptacle in only one position. You can determine the right position by matching the keyways on the plug and the receptacle. The three-phase plug must be turned after insertion into the receptacle to lock it into place. Turn it clockwise to lock it securely.

Checking Rotation Direction - Three-Phase

All Tube Benders are equipped with pumps which must rotate in a counter-clockwise direction as viewed by the operator while he is facing the motor shaft. After electrical hook-up is complete and the machine reservoir has been checked for proper fluid level, start the machine momentarily by pushing the START switch. Immediately check the motor shaft for proper rotation direction.

CAUTION
If the shaft turns in the wrong direction, shut the machine off immediately. The pump does not lubricate itself when running backwards. Prolonged running in clockwise rotation will badly damage the pump shaft seals.

To Correct Reverse Rotation – Three-Phase

First, make sure the machine is unplugged from wall receptacle. Direction of rotation in three-phase machines is determined by the relative lag of each phase. Open the starter box located on the front leg of the machine and reverse the leads to connections L1 (1) and L2 (3), located above the START-STOP switch. Do not alter any other wiring. Have your electrician do this if possible.

Restart the machine as above and again check the rotation which should now have correct direction.

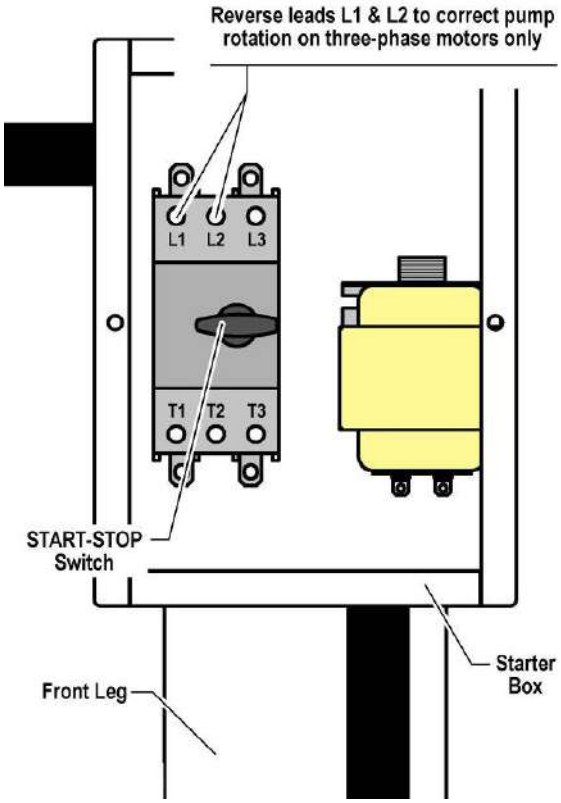


Figure 6. To Correct Reverse Rotation – Three Phase Only

Operating Your Machine for the First Time

All Tube Benders make use of the rear pedestal of the machine as the hydraulic fluid reservoir. This reservoir is filled to the proper level at the factory.

Check the sight gauge on the rear pedestal to make sure that the reservoir is filled with fluid to the proper level. At any time that the level of fluid visible in the sight gauge, is less than ½ of the way to the top of the gauge, refill the reservoir with one of the approved hydraulic fluids, listed on page 23, of this manual. NEVER start or operate the machine unless the hydraulic reservoir is filled to the proper level.

Model Features

Our various models of Tube Benders are similar in design and operation. But the hydraulics and controls vary somewhat from model to model. It is important that you become familiar with the particular model you are using prior to checking out the hydraulic circuits and machine operation.

Models vary first of all in the bending capacity or size range of tubing which they can bend. They also vary by model in swaging or expanding equipment. Lastly, they vary in mode of operation.

The first, or numeric, part of the model number indicates the bending capacity and expanding units of the model. The second, or alphabetic, part of the model number indicates the mode of operation.

The characteristics of each available model of Tube Bender are given in Table 1 which follows on the next page.

Machine Familiarization & Operation

After you have completed electrical set-up and acquainted yourself with its particular model features, you are ready to check out the machine operation.

Your Tube Bender has been thoroughly factory tested. All adjustments have been made for proper operation. However, it is good practice to familiarize yourself with hydraulic system pressures and machine operation. While you do this you will assure yourself that your machine is set up correctly.

Five Port Valve

Every tube bender with expanding capability has a five port valve mounted near of the machine. All hydraulic fluid output of the pump is directed to this valve which regulates pressure for the entire hydraulic system.

The valve has five ports, each with hydraulic connection. However, design and appearance of the valve will vary somewhat among various machines and models due to different component suppliers.

The five port valve always has a pressure gauge associated with it. This gauge is mounted on the pump outlet. Since the five port valve regulates pressure for the whole machine, its output is applied directly to the top cylinder. This is the basic pressure beyond the valve, thus the name, "Power-Beyond" valve.

Full pressure will register on the gauge with the top cylinder or expander cylinder fully extended or "bottomed out".

Checking Five Port Valve Adjustment

To check operation of the five port valve, proceed as follows:

1. Install a 5" radius ram die (never a bumper die) in your machine. Install a matching set of back shoes.

2. If you have an automatic or semi-automatic model (SAF, SAL, or MSA), move the depth-of-bend limit switch to its farthest position beyond the end of the scale.

3. Now actuate the bend control valve (on Model MSA depress the forward foot pedal). The ram should extend fully and smoothly until the top cylinder bottoms out. NOTE: Do note stand in front of the machine. Read the pressure gauge near the pump. The gauge should read 2800 to 3000 PSI.

If the gauge does not register correctly within plus or minus 50 PSI, adjust the pressure following these steps:

1. On or adjacent to the five port valve there is an adjustment screw. See Figure 7.

2. Loosen the lock nut. Turn the adjustment screw clockwise to increase pressure or counter-clockwise to decrease pressure.

3. Tighten the lock nut holding the threaded screw in position when you have made the correct adjustment.

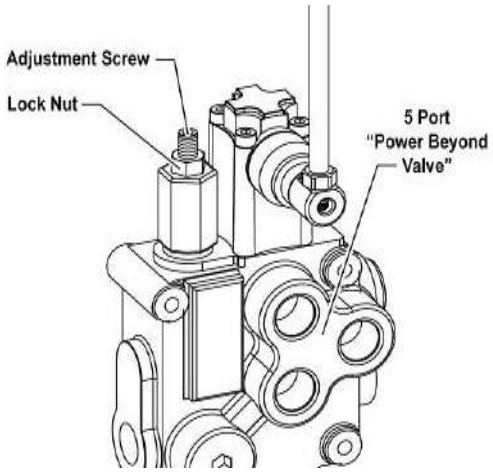


Figure 7. Five Port Valve

Table 1. Summary of Available Models and Options

MODE OF OPERATION	TYPE OF EXPANDER: NONE	SWAGER ONLY	EXPANDER ONLY	TWO-WAY SWAGER / EXPANDER ONLY	BOTH SWAGER AND EXPANDER
MANUAL HAND OPERATED	103 MS	113 MS	123 MS	133 MS	153 MS
MANUAL FOOT OPERATED	103 MSF	113 MSF	123 MSF	133 MSF	153 MSF
SEMI-AUTOMATIC FOOT OPERATED	103 SAF	113 SAF	123 SAF	133 SAF	153 SAF
SEMI-AUTOMATIC KNEE OPERATED	103 SAL	113 SAL	123 SAL	133 SAL	153 SAL
FULLY AUTOMATIC	103 MSA	113 MSA	123 MSA	133 MSA	153 MSA
	3" MAXIMUM BENDING CAPACITIES				

MODEL XXX - XXX

OPERATING MODE
MS - Manual, hand operated
MSF - Manual, foot operated
SAF - Semi-Automatic, foot operated
SAL - Semi-Automatic, knee operated
MSA - Fully Automatic

TYPES OF END FORMING EQUIPMENT
103 - NONE
113 - K-100 Gripper-Clamp Swager
123 - P-100 Micro-Dial Expander
133 - KP-100 Two-Way Swager/Expander
153 - Both K-100 Gripper-Clamp Swager and P-100 Micro-Dial Expander

Sequence Valve Adjustment

The sequence valve regulates the amount of pressure in the bottom cylinder. This cylinder holds pressure on the back shoes through two chains attached to its piston rod.

The sequence valve is located in the center of the left side of the machine. The sequence valve pressure gauge is mounted on the valve itself and is supplied with a pressure adjustment knob. To check sequence valve pressure (see Figure 8A) take the following steps:

1. Read the sequence valve gauge while running the ram die out to a depth-of-bend between 40° to 60°.

2. The sequence valve pressure should be between 1100 and 1200 PSI in order to bend tubing of 2-1/2" or less in diameter.

3. If adjustment is required, turn the adjustment knob clockwise to increase pressure, or counter-clockwise to decrease pressure.

Note: It is important to understand that while excessive sequence valve pressure will not adversely effect the quality of bends, it will greatly reduce the life of bending dies.

To Correct Fluttering Sequence Valve Gauge

Air trapped in the Sequence Valve can cause excessive pressure gage flutter (see Figure 8A), this can be easily corrected by following the steps below:

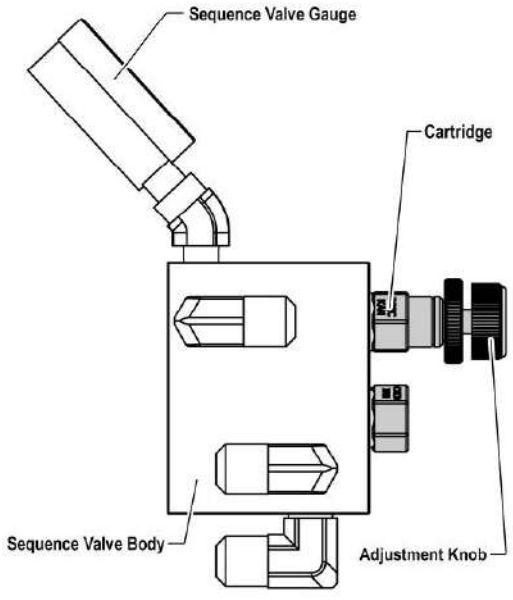


Figure 8A. Sequence Valve

1. Install 5" radius ram die (preferably 1-1/2" or 1-3/4" dia.) with a matched pair of back shoes.

2. Advance top cylinder and adjust sequence valve pressure to 2,000 PSI.

3. Stop the cylinder. DO NOT RETRACT.

4. While holding cartridge in place with 7/8” wrench, loosen end cap with a second 7/8” wrench. Allow fluid and air to bleed until gage drops to 0 PSI.

5. Retighten end cap and retract top cylinder.

6. Readjust sequence valve as described previously.

3" Tube Bending Procedure

High initial back gate pressure is required when bending 3" tubing in order to get good, uniform bends. Good bends will normally result only when 13 gauge (.095" wall thickness) tubing is used. 14 gauge may be used, but some tube damage or inconsistency may result.

When bending 3" diameter tubing, use the following special procedure. (NOTE: Use either the manually-operated front control valve or the forward and reverse foot pedals. DO NOT USE automatic push button controls.)

1. Install 3" bending dies. Set the sequence valve pressure between 1600 and 1800 PSI by turning the sequence valve adjustment knob clockwise to increase pressure. CAUTION: Do not attempt to turn beyond the jam nut position. Further adjustment may cause valve stem leakage.

2. Position the tubing in the bender and begin the bend. Be sure to use only the front control valve or the foot pedals.

3. At a depth of bend between 30° and 40° start to reduce sequence valve pressure by turning the sequence valve adjustment knob counter-clockwise until you have a gauge reading of about 400 PSI.

4. If the bender bogs down, further reduce the sequence valve pressure on the back gates, and continue bending and reducing pressure until the desired depth of bend is reached (maximum depth of bend is 140°).

5. If further 3" diameter bends are required, repeat the procedure, starting with step one. Otherwise, set the sequence valve pressure between 1100 and 1200 which is normal setting for 2-1/2" and smaller diameter tubing.

Flow Control Valve Adjustment

The flow control valve regulates gate return or back pressure on the bottom cylinder by creating a slight pressure differential between the top and bottom cylinders. This is the pressure that closes the back shoe gates after a bend. This valve is the metallic colored, hexagon shaped valve located on the center left side of the machine directly above the sequence valve on all models. See Figure 8A. To set the gate return pressure:

1. Run the ram out until the ram die engages the back shoes and the gates open to between 40° and 50°.

2. Retract the ram.

3. At the instant the bottom cylinder bottoms out (about the moment when the ram die disengages from the back shoes) the pressure should register 250 to 400 PSI on the sequence valve gauge.

4. If the pressure is not within these limits, loosen the lock nut. See Figure 8B.

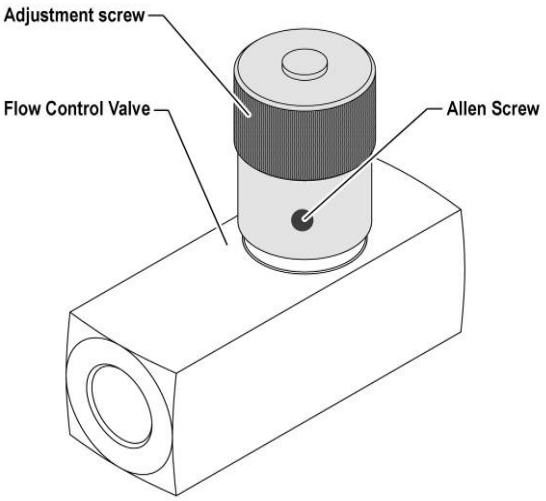


Figure 8B. Flow Control Valve (Automatic models only)

5. Turn the adjustment screw clockwise to increase pressure, or counter-clockwise to decrease pressure.

6. If the back gates hesitate or remain open after retracting the ram, increase the flow control pressure.

7. If the back gates and ram hesitate when returning while still contact, decrease the flow control pressure. If the back shoes dig into the tube when returning, decrease the flow control pressure.

8. After the proper setting is obtained, tighten the lock nut while holding the adjustment screw in position with your wrench.

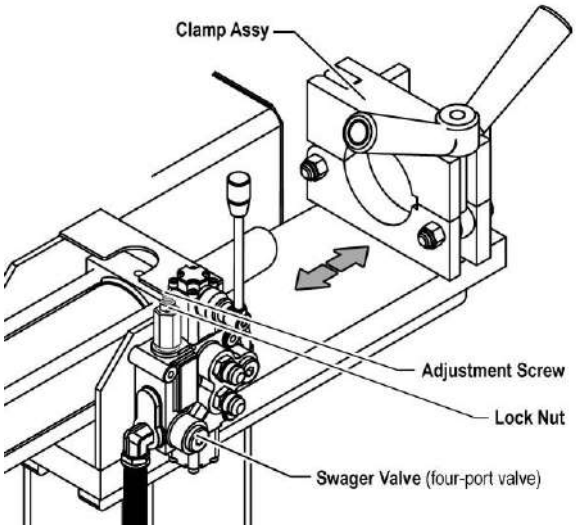


Figure 9. Setting Swager Pressure

Setting Swager Pressure*

Models 150 and 153 are equipped with a swager cylinder regulated by a 4-port valve which is adjusted in the same fashion as the five port valve. To determine swager pressure proceed as follows:

1. Remove all swager tooling.

2. Fully advance or retract the swager cylinder until it bottoms out.

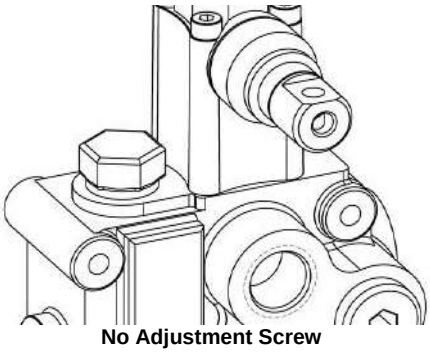
3. While bottoming out the cylinder read the pressure gauge on the pump outlet. The gauge should read 2800 to 3000 PSI.

If gauge does not register correctly within plus or minus 50 PSI, adjust the pressure as follows:

1. Loosen the lock nut. Turn the adjustment screw clockwise to increase pressure or counter-clockwise to decrease pressure.

2. Tighten lock nut while holding adjustment screw in position.

*Some 4-Port Valve design has no adjustment screw. The adjustment is not necessary in this case.



No Adjustment Screw

Setting Top Cylinder Pressure for Manual and Semi-Automatic Models

For manual and semi-automatic models (operating models MS, MSF, ML, SA, SAL and SAF) the front bending valve relief pressure is set as follows.

1. Loosen the lock nut.

2. Turn the adjustment screw clockwise until it bottoms.

3. Next turn the adjustment screw counter-clockwise one quarter turn.

4. Holding the adjustment screw, tighten the lock nut.

Back Gate Alignment

The gates should be regularly checked to make sure they are level with each other and the guide plate, and are closing evenly. If the gates are not level with each other and the guide plate, tighten the shaft nuts as follows:

1. Seat shaft using a lead hammer.

2. Tighten shaft nut.

3. Clean Top Plate of dirt, grease, chips, burrs, hammer indentations, etc.

Checking Chain Tension

If the back gates do not close evenly, check tension on the two chains (located under the body near the front) as follows to avoid severe bottom cylinder rod damage:

1. Fully retract and disengage the ram die from the back shoes.

2. Let the machine set idle with the power off for 2 to 3 hours. This will allow pressure remaining in the bottom cylinder to be relieved.

3. If one of the chains has more slack, tighten the lock nut which fastens the chain connector to the chain return on the cylinder rod end. Both chains should be equally snug so that the gates work evenly. See Figure 10.

4. If gates hesitate when closing, increase the bottom cylinder pressure by adjusting the flow control valve as previously described.

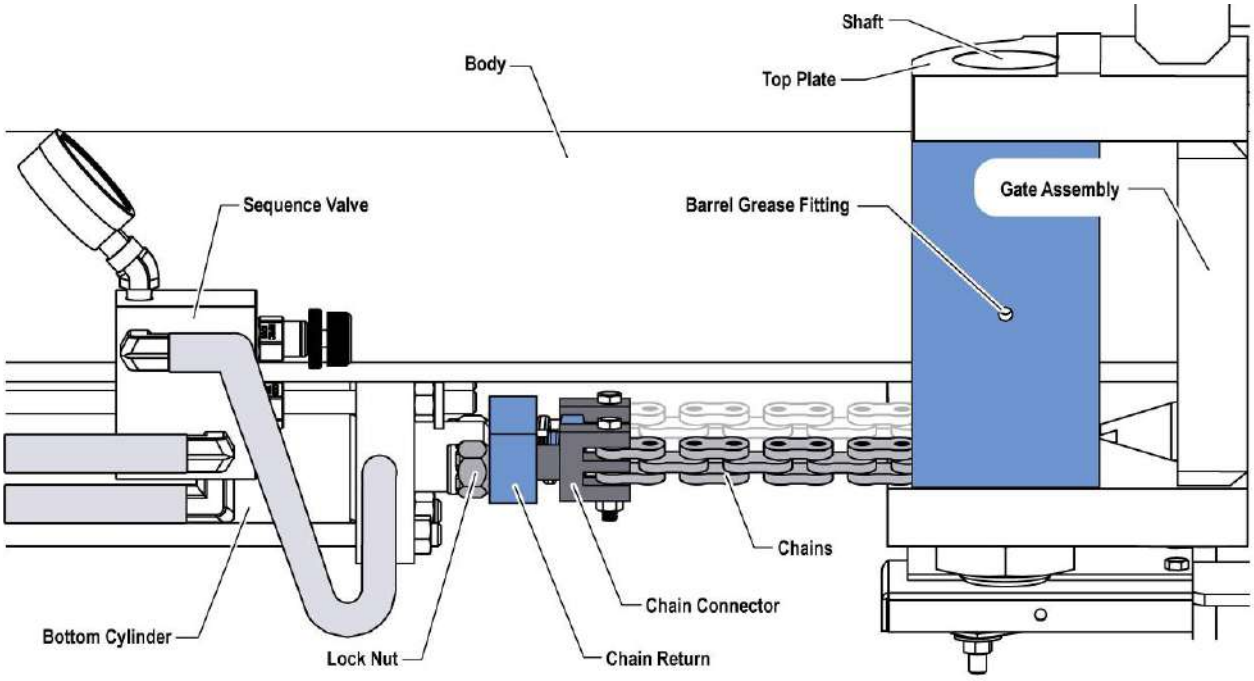


Figure 10. Back Gate Alignment

Depth-of-Bend Adjustment

To check depth-of-bend adjustment, use a carpenter's square, or equivalent 90° square. Proceed as follows:

1. Run the gates out manually, holding the square against the back of the gates.

2. Jog the gates back and forth until the square rests flush against the back of each gate. The back gates are now set physically at 90°. See Figure 11.

For Automatic or Semi-Automatic Machines
If you have an automatic or semi-automatic machine (operating model SA, SAL, SAF and MSA), adjust the depth-of-bend indicator as follows:

1. Check the depth-of-bend indicator which should read exactly 90°. See Figure 12.

2. If it does not, loosen the lock nut on the axis of the indicator arm, and move the arm until it is aligned with the 90° mark exactly.

3. Tighten the lock nut, holding the indicator arm in proper position relative to the depth-of-bend plate scale.

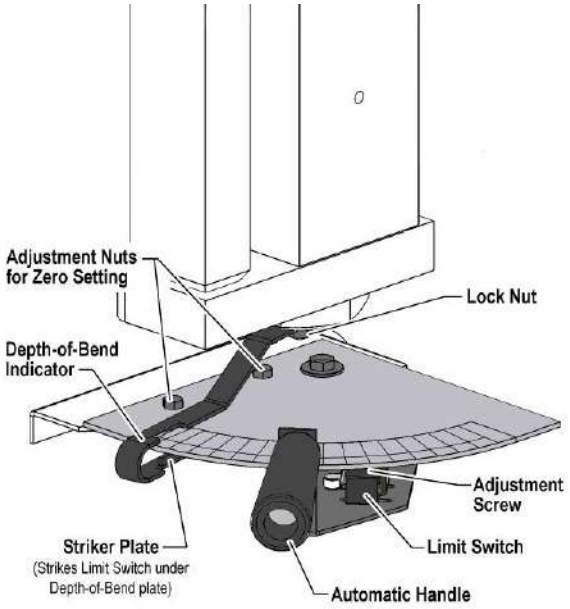


Figure 12. Depth-of-Bend Adjustment

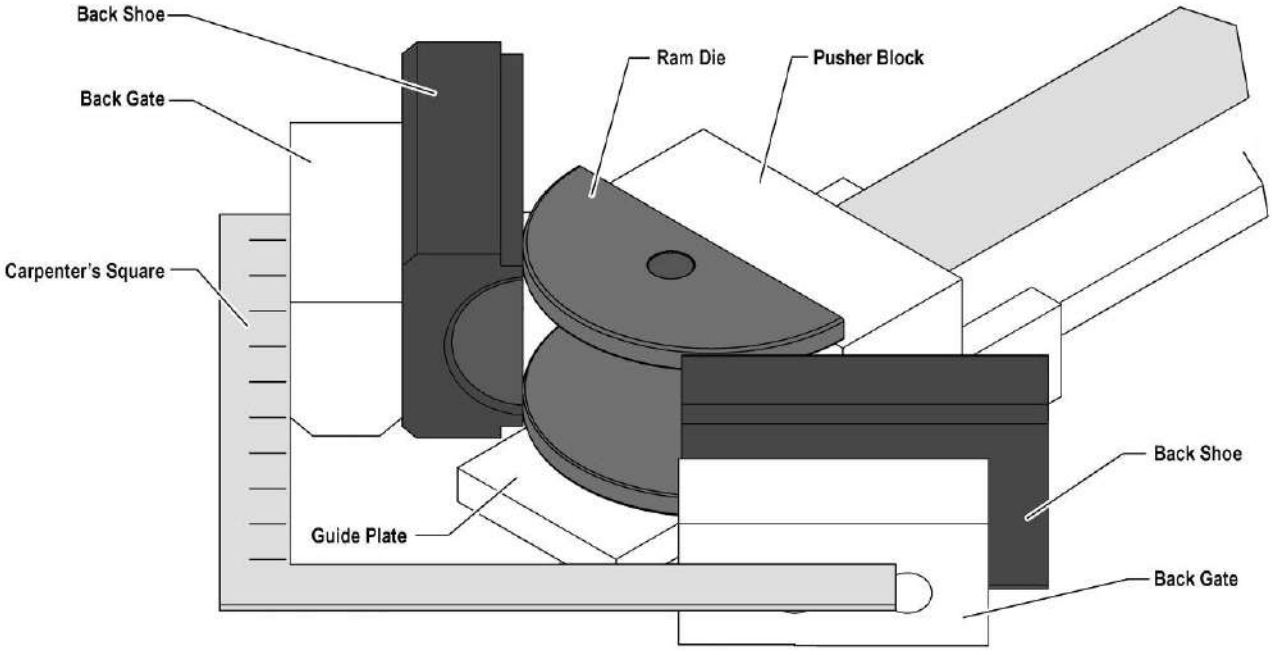


Figure 11. Setting Bend Angle

Following adjustment of the depth-of-bend indicator, adjust the forward limit switch. To adjust the forward limit switch:

1. Retract the top cylinder.

2. Set automatic handle to 90°. See Figure 12.

3. Press and hold in forward automatic button (or appropriate valve on semi-automatic models).

4. The machine will cycle in a forward direction, the striker plate on the depth-of-bend indicator will strike the forward limit switch and the machine will stop.

5. Check the depth on the depth-of-bend indicator which should read 90°.

6. If the limit switch does not trip at exactly 90° adjust the switch as required by loosening the two adjustment screws and slide the switch toward or away from the striker plate to get the proper position.

7. Now cycle the machine and check operation of the limit switch. Readjust if necessary.

For Manual Machines
If you have a manual model (operating models MS and MSF) adjust the depth-of-bend pointer as follows:

1. Check to insure the pointer is tightly bolted in the right back gate.

2. With the back gates set at 90° using a carpenter's square, tap the pointer lightly, if necessary, to read exactly 90° of the depth-of-bend plate.

Troubleshooting

Properly used, your **Tube Bender** will give you continuous and reliable service. There are minor problems which may occur from time to time which you can readily correct, as well as good operating practices which help you avoid problems.

Familiarity with use and operation of your bender includes knowledge of good operating practices, and trouble-shooting minor problems.

Bending

ALWAYS have a full set of dies in place whenever you operate the top cylinder. Operating without dies will cause severe damage.

Always use die pusher (DP-100) when bending with 3-1/2" and 4" radius bumper dies.

NEVER extend the bending die beyond the back shoes. Avoid bending beyond the following depths with the bend radii given when possible:

- 130° with 3-1/2 inch bumper die
- 150° with 4 inch bumper die
- 160° with 5 inch ram die

If bends indicate die mismatch: (Figure 13)

Check the back gate alignment as described on page 12.

If the outside Diameter is flattened after bending: (Figure 14)

The sequence valve bend pressure is too low. Adjust as described on page 10 NOTE: High sequence valve pressures can cause bottom cylinder rod damage if the chains do not have equal tension. Do not exceed recommended pressures and be sure to check chain tension weekly to avoid problems.

If the tubing is crimped on the bend inside diameter: (Figure 15)

Check back gate alignment as described on page 12. Increase sequence valve pressures as described on page 10. If this does not cure the problem, check the thickness of the tubing you are using. Minimum thicknesses for consistently good bends are:

Up to 2-1/4-inch diameter	16-gauge, (.065 inch)
2-1/1 to 2-1/2-inch diameter	14-gauge, (.083 inch)
3-inch diameter	13-gauge, (.095 inch)

If the tubing is sucked in on the bend outside diameter: (Figure 16)

While this is almost always an indication that tubing wall is too thin, also check back gate alignment, sequence and flow control pressures.

If the back gates do not close evenly:

Check chain tension as described on page 12.

If the back gates hesitate when closing or back shoes dig into the tube when closing:

Adjust the flow control valve as described on page 11.

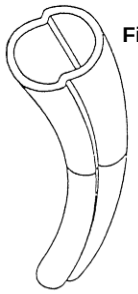


Figure 13. Die Mismatch

Figure 14. Flattening On Outside Diameter of Bend

Figure 15. Crimping On Inside Diameter of Bend

Figure 16. Sucking In On Outside Diameter of Bend

Swaging

Always check to make sure you have a matched set of collars. Make sure you install the lower collar parting edge flush with the top of the fixed block. Install the upper collar to match. Misalignment of the collars with the block will result in broken collars. Be sure that the tapers on the adaptor collars match the tapers on the clamp. (See Figure 17)

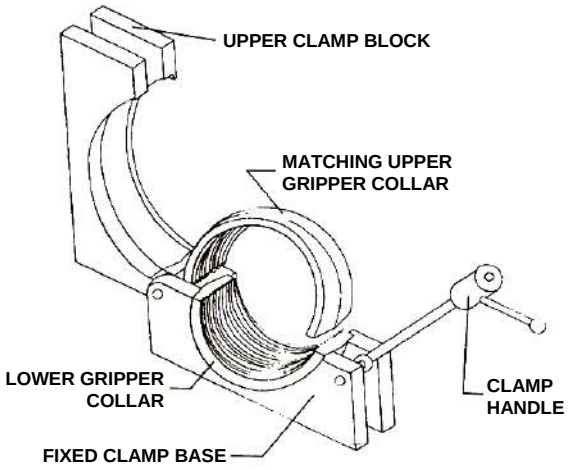


Figure 17. Swaging

Thread all tooling securely on to the piston rod. Loose tooling will result in broken tools or stripped threads.

Our patented quick release tooling (see Figure 18) is a popular option on any model equipped with a swager. Caution must be taken to install tooling properly to avoid damaging tooling. To install tooling read and follow the procedure below:

To install swager tool align “Pin” on quick release adaptor with “Groove” in swager tool and push firmly. When properly install pin must be fully extended into slot in swager tool. You are now ready to swage pipe. DO NOT TWIST SWAGER TOOL. This can cause die to stick in pipe as the swager cylinder retracts. If for any reason the swager tool gets stuck inside the tube DO NOT attempt to re-attach the tool by advancing the cylinder rod back into the tool, such action will result in a broken pin. Re-attach tool as follows.

1. Remove the tube and collars from the clamp.

2. Advance the cylinder rod to the desired position.

3. Align the quick release adaptor with the tool inside the tube and attach securely.

4. Install the correct set of adaptor collars and clamp the tube firmly.

5. Retract the cylinder rod with the swaging tool attached.

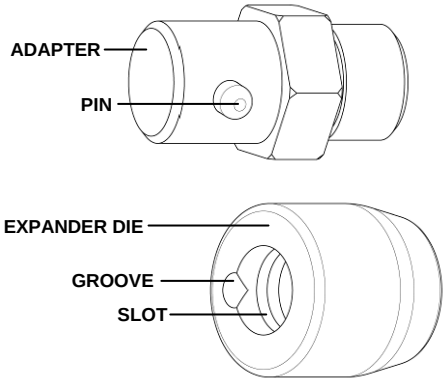


Figure 18. Quick Release Tooling

DO NOT expand into the collars. Expanding into the collars is the greatest single reason for broken collars. Make sure you have sufficient clearance. KEEP HANDS CLEAR OF THE SWAGER WHILE IN OPERATION. FAILURE TO DO SO MAY RESULT IN OPERATOR INJURY.

Expanding

Be sure that you have the arbor screwed securely onto the piston rod. Check its tightness frequently during a series of operations. Because the action in hydra-sizing is a pulling one, the tool has a tendency to unthread itself. A loose arbor will result in broken tools or stripped threads. ALWAYS KEEP YOUR ARBOR AND SEGMENTS LUBRICATED WITH LIGHT GREASE SPRAY. NEVER STAND IN FRONT OF EXPANDER ARBOR WHILE IN OPERATION.

CAUTION: *Whenever inspecting or repairing the electrical system, UNPLUG YOUR BENDER.*

Solenoid Valve

The solenoid valve controls the direction of the bending operation for automatic models. It is located near the rear of the machine behind the motor. (See Figure 19) If the solenoid fails to sequence properly, check as follows:

1. Operate the valve manually by using an insulated tool, or equivalent wooden or non-conducting rod to push the armature in. Manually operating the switch will often dislodge foreign particles which may become trapped in the valve spool and cause the spool to stick. If this does not free the solenoid valve, remove solenoid coil covers and make sure there is no foreign matter interfering with the moving parts. If valve spool is stuck, disassemble, clean, and reassemble.

2. If the spool (3) is free and the valve still does not sequence properly, remove solenoid coil covers (1) and check coils for an open or short circuit.

3. If the spool (3) is free and the coils are not opened or shorted, check the voltage coming into the solenoid which should be between 210 and 230 volts A.C. (This should be done by a qualified electrician if possible.)

4. If there is no voltage to the solenoid or the solenoid voltage is low, see the trouble-shooting procedures for the Automatic control box.

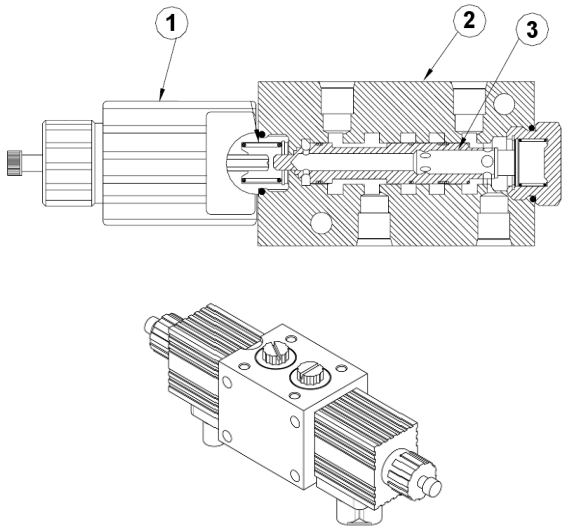


Figure 19. Solenoid Valve

Automatic Control Box

If the foot pedals or the automatic buttons do not function properly, determine the symptom and refer to the trouble-shooting procedures on the following pages. A component failure can cause a number of different symptoms depending on the nature of the failure. To prevent improper diagnosis, component inspection procedures should be made by a qualified electrician whenever possible. When inspecting components with an ohm meter, all power must be off and the component disconnected. When taking voltage readings or checking relay operation, the power must be on.

CAUTION: *The motor, solenoid, and parts of the printed circuit board operate on 220 volts. Use caution while inspecting electrical components when the power is on.*

SYMPTOM/CONDITION	PROBABLE CAUSE	INSPECTION PROCEDURE	REPAIR PROCEDURE
1. Ram will retract but will not advance:			
CONDITIONS **1A**. Forword foot pedal works but automatic button does not.	**A1**. Faulty automatic button.	**A1**. Check button with ohm meter, check for broken or disconnected wires.	**A1**. Repair or replace.
	A2. Faulty reverse foot pedal.	**A2**. Check foot pedal with ohm meter, check for broken or disconnected wires.	**A2**. Repair or replace.
	A3. Defective Silicon Controlled Rectifier Q1.	**A3**. Check the voltage across the capacitor that is associated with Q1. There should be 12 volts D.C. with the ram stopped and O volts when the automatic button is depressed.	**A3**. Replace Q1 if necessary.

SYMPTOM/CONDITION	PROBABLE CAUSE	INSPECTION PROCEDURE	REPAIR PROCEDURE
1B. Automatic button works but forward foot pedal does not.	**B1**. Faulty forward foot pedal	**B1**. Check foot pedal with ohm meter, check for broken or disconnected wires.	**B1**. Repair or replace.
1C. Both Automatic button and forward foot pedal do not work.	**C1**. Faulty forward limit switch.	**C1**. Check limit switch with ohm meter, check for broken or disconnected wires.	**C1**. Repair or replace.
	C2. Faulty emergency reverse button.	**C2**. Check reverse button with ohm meter, check for broken or disconnected wires.	**C2**. Repair or replace.
	C3. Faulty forward K1 relay	**C3**. Depress and release the forward foot pedal while visually checking K1 relay for clapper movement.	**C3**. Replace if clapper does not make contact when activated.
	C4. Solenoid spool stuck, or solenoid coil stuck or burned out.	**C4**. Inspect solenoid as described on page 16.	**C4**. Clean, repair or replace.
	C5. Blocked sequence or flow control valve.	**C5**. Manually activate the solenoid while checking the pressure gauge on the pump outlet. If pressure is available and ram does not advance one of these valves is blocked.	**C5**. Disassemble, check moving parts for smooth operation, remove dirt or foreign particles and reassemble.
2. Ram will advance but will not retract:			
CONDITIONS **2A**. Reverse foot pedal works but emergency reverse button dos not.	**A1**. Faulty emergency reverse button.	**A1**. Check button with ohm meter, check for broken or disconnected wires.	**A1**. Repair or replace.
	A2. Faulty forward foot pedal.	**A2**. Check foot pedal with ohm meter, check for broken or disconnected wires.	**A2**. Repair or replace.
	A3. Defective Silicon Controlled Rectifier Q2.	**A3**. Check the voltage across the capacitor that is associated with Q2. There should be 12 volts D.C. with the ram stopped and 0 volt when the emergency reverse button is depressed.	**A3**. Replace Q2 if necessary.
2B. Emergency reverse button works but reverse foot pedal does not.	**B1**. Faulty reverse foot pedal	**B1**. Check foot pedal with ohm meter, check for broken or disconnected wires.	**B1**. Repair or replace

SYMPTOM/CONDITION	PROBABLE CAUSE	INSPECTION PROCEDURE	REPAIR PROCEDURE
(SYMPTOM 2 CONT.)			
2C. Both emergency reverse and reverse foot pedal do not work.	**C1**. Faulty Reverse limit switch.	**C1**. Check limit switch with ohm meter, check for broken or disconnected wires.	**C1**. Repair or replace.
	C2. Faulty automatic button.	**C2**. Check automatic button with ohm meter, check for broken or disconnected wires.	**C2**. Repair or replace.
	C3. Faulty reverse K2 relay.	**C3**. Depress and release the reverse foot pedal while visually checking K2 relay for clapper movement.	**C3**. Replace if clapper does not make contact when activated.
	C4. Solenoid spool stuck, or solenoid coil stuck or burned out.	**C4**. Inspect solenoid as described on page 16.	**C4**. Clean, repair or replace.
	C5. Blocked Sequence or flow control valve.	**C5**. Manually activate the solenoid while checking the pressure gauge on the pump outlet. If pressure is available and ram does not retract one of these valves is blocked.	**C5**. Disassemble, check moving parts for smooth operation, remove dirt or foreign particles and re-assemble.
3. Ram will not advance or retract with foot pedals or with automatic buttons:	**A**. Manually advance the ram with solenoid valve. (See page 16)	**A**. Check machine for reverse operation.	**A**. If reverse operates normally go to symptom number 1.
	B. Forward and reverse foot pedals unplugged, open, or disconnected.	**B**. Check foot pedals with ohm meter, check for loose or broken wires, or bad connections.	**B**. Repair or replace.
	C. Solenoid spool stuck, or solenoid coils stuck or burned out.	**C**. Inspect Solenoid as described on page 16.	**C**. Clean, repair or replace.
	D. Low voltage to solenoid and automatic box.	**D**. Check output voltage from starter box. Should be between 210 and 230 volts A.C.	**D**. Move machine to a location near the shop fuse box, or boost the voltage available to the machine.
	E. Low voltage on transformer secondary coil.	**E**. Check the voltage between the inputs of D3 and D4. There should be approximately 16 volts A.C.	**E**. If symptom 3D does not exist, replace step down transformer.

SYMPTOM/CONDITION	PROBABLE CAUSE	INSPECTION PROCEDURE	REPAIR PROCEDURE
(SYMPTOM 3 CONT.)	**F**. Low voltage on printed circuit board.	**F**. Check voltage across R5, should be 12 volts A.C.	**F**. If voltage is low, and symptom 3D or 3E does not exist, check diodes D3 and D4, Capacitor C1, and Resistor R5. Replace as necessary.
4. Ram advances when machine is turned on or ram continues advancing after the forward foot pedal is released:			
	*While ram is stuck in a forward direction, depress the reverse foot pedal and note the conditions to determine the problem.		
CONDITIONS **4A**. Ram continues advancing with the reverse foot pedal depressed.	**A1**. Forward foot pedal stuck or defective.	**A1**. Check foot pedal with ohm meter, check wires for short circuits.	**A1**. Repair or replace.
	A2. Forward K1 relay stuck.	**A2**. Check relay visually, the clapper should be closed with ram advancing and should open when reverse foot pedal is depressed.	**A2**. Replace K1 Relay if it does not open and close correctly.
	A3. Solenoid spool or solenoid coil sticking.	**A3**. Inspect solenoid as described on page 16.	**A3**. Clean, repair or replace.
4B. Ram stops or retracts with the reverse foot pedal depressed and advances when released.	**B1**. Automatic button stuck closed or short circuited.	**B1**. Check automatic button with ohm meter, check for short circuit.	**B1**. Repair or replace.
	B2. Defective Silicon Controlled Rectifier Q1.	**B2**. Check the voltage across the capacitor that is associated with Q1. There should be 12 volts D.C. with the ram stopped and 0 volt when the automatic button is depressed.	**B2**. Replace Q1 if necessary.
	B3. Forward foot pedal stuck or defective.	**B3**. Check foot pedal with ohm meter, check wires for short circuits.	**B3**. Repair or replace.
	B4. Forward K1 relay stuck.	**B4**. Check relay visually, the clapper should be closed with ram advancing and should open when reverse foot pedal is depressed.	**B4**. Replace K1 relay if it does not open and close correctly.

SYMPTOM/CONDITION	PROBABLE CAUSE	INSPECTION PROCEDURE	REPAIR PROCEDURE
(SYMPTOM 4 CONT.)			
4C. Ram stops or retracts with reverse foot pedal depressed and stops when released.	**C1**. Solenoid spool or solenoid coil sticking.	**C1**. Inspect solenoid as described on page 16.	**C1**. Clean, repair or replace.
	C2. Intermittent stickey forward foot pedal.	**C2**. Depress and release forward foot pedal several times while checking operation with ohm meter.	**C2**. Replace.
5. Ram retracts when machine is turned on or ram continues retracting after the reverse foot pedal is released:			
	*While ram is stuck in a reverse direction, depress the forward foot pedal and note the conditions to determine the problem.		
CONDITIONS **5A**. Ram continues retracting with the forward foot pedal depressed.	**A1**. Reverse foot pedal stuck or defective.	**A1**. Check foot pedal with ohm meter, check wires for short circuits.	**A1**. Repair or replace.
	A2. Reverse K2 relay stuck.	**A2**. Check relay visually, the clapper should be closed with the ram retracting and should open when forward foot pedal is depressed.	**A2**. Replace K2 Relay if it does not open and close correctly.
	A3. Solenoid spool or solenoid coil sticking.	**A3**. Inspect solenoid as described on page 16.	**A3**. Clean, repair or replace.
5B. Ram stops or advances with the forward foot pedal depressed and retracts when released.	**B1**. Emergency reverse button stuck closed or short circuited.	**B1**. Check reverse button with ohm meter, check for short circuit.	**B1**. Repair or replace.
	B2. Defective Silicon Controller Rectifier Q2.	**B2**. Check the voltage across the capacitor that is associated with Q2. There should be 12 volts D.C. with the ram stopped and 0 volt when the emergency reverse button is depressed.	**B2**. Replace Q2 if necessary.
	B3. Reverse foot pedal stuck or defective.	**B3**. Check foot pedal with ohm meter, check wires for short circuits.	**B3**. Repair or replace.
	B4. Reverse K2 relay stuck.	**B4**. Check relay visually, the clapper should be closed with ram retracting and should open when forward foot pedal is depressed.	**B4**. Replace K2 relay if it does not open and close correctly.

SYMPTOM/CONDITION	PROBABLE CAUSE	INSPECTION PROCEDURE	REPAIR PROCEDURE
(SYMPTOM 5 CONT.)			
5C. Ram stops or advances with forward foot pedal is depressed and stops when released.	**C1**. Solenoid spool or solenoid coil sticking.	**C1**. Inspect solenoid as described on page 16.	**C1**. Clean, repair or replace.
	C2. Intermittent stickey reverse foot pedal.	**C2**. Depress and release reverse foot pedal several times while checking operation with ohm meter.	**C2**. Replace.
6. Automatic buttons and foot pedals operate nomally:			
CONDITIONS **6A**. Depth of bend indicator pushes automatic handle forward, (see fig.12) ram does not return at the set bend depth.	**A1**. Stricker plate and forward limit switch out of alignment.	**A1**. Operate ram with foot pedal and check the position of the striker plate and limit switch.	**A1**. Adjust.
	A2. Faulty forward limit switch.	**A2**. Check with ohm meter.	**A2**. Replace.
6B. Ram continues retracting when reverse limit switch is activated, pressure builds up in sequence valve.	**B1**. Faulty reverse limit switch.	**B1**. Check with ohm meter, check wires for short circuit.	**B1**. Repair or replace.
	B2. Solenoid spool or solenoid coil sticking.	**B2**. Inspect solenoid as described on page 16.	**B2**. Clean, repair or replace.

Noisy Motor / Pump Combination

A whining or growling noise from the motor / pump can be indicative of a damaged pump. Continued operation can cause serious damage to all the components in the hydraulic system. Always locate the source of unusual, new noises and correct them immediately for extended service life.

1. Check for counter-clockwise shaft rotation as described on page 6 and 7.

2. Check the fluid level. Low fluid will cause pump cavitation.

3. Check to insure that the motor and pump, are securely fastened to the mounting plate. If one of the above is loose, align the motor and pump shafts within .010 inches. Misalignment will cause reduced life due to excessive motor and/or pump bearing wear. After aligning, secure all mounting bolts, and recheck alignment.

4. Check for leakage from the pump. If leakage is noted, the pump seals should be replaced immediately to prevent damage to the balance of the system.

5. If none of the above steps eliminate unusual noises, the motor and/or pump bearings may be damaged and require replacement.

Smoke from the Motor

Check the motor box for shorts, frayed insulation, or loose connections. Replace wires and connections as required. Always check pump rotation after any motor repairs. If smoke continues, or if obviously from motor main case, motor may be worn out and need rebuilding or replacement.

Scheduled Maintenance

An important part of getting maximum use and long-term reliability from your Pipe Bender is to set up and adhere to a regular schedule of maintenance. It is a good idea to prepare a chart and a check-off list for regular maintenance functions. This may be kept at a conspicuous spot near the machine, such as on the wall adjoining the work area, and marked off by the person responsible as the maintenance functions are performed.

The following should be on the schedule:

Weekly

1. Clean and grease the wearing surface on the expander arbor and segment sets.

2. Clean and grease the guide plate, top, sides and bottom.

3. Check chain tension as described on page 12.

4. Clean the gate top plates, check gate alignment (see page 12) and check depth of bend adjustment. (see page 13).

5. Check sequence and flow control valve pressures and adjust as required. (see pages 10 and 11 respectively)

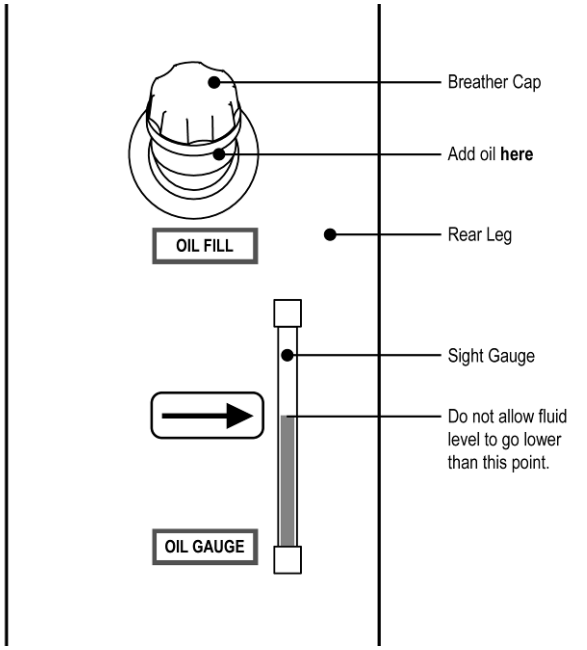


Figure 20. Oil Fill

Monthly

1. Grease the zirk fittings on the left and right barrels.

2. Check to ensure gates are in line when closed.

3. Tighten the mounting nuts on the pump, motor and all cylinders.

4. Clean the gripper clamp jaws.

5. Check the level of hydraulic fluid in the sight gauge and refill the reservoir as required.

WARNING
DO NOT USE TRANSMISSION FLUID

Transmission fluid often has additives which are harmful to the valve and the cylinder seals and often results in leaks. Use only one of the following approved oils in your machine's hydraulic system:

Mobil – DTE 24
Pennzoil – Medium #10
Union – R L Turbine 225
Shell – Turbo 29
Chevron – O C Turbine 11
Sinclair – Sinturlite C or DURO 200
Arco – Eagle Oil RSO – X Light
Texaco – Regal B R and O

If there is a visual change in the color of your hydraulic oil, particularly if the oil develops a greyish appearance, completely drain the hydraulic system and reservoir, clean the filter, and refill the machine with fresh hydraulic oil.

6. Check all fittings for leaks and tighten as required.

CAUTION: Teflon tape, known for its excellent lubricating properties is also an excellent selant. Unfortunately, because it lubricates so well, fittings sealed with teflon tape turns easily even after an effective seal has been accomplished. DO NOT attempt to bottom or effect a firm joint when using teflon tape. Overtightening will crack valve body and cylinder head castings causing costly repairs.

7. Spray lube on the wear surfaces of all dies and shoes.

Operating Procedures

Use of Expanders and Tooling

Now that you have **read and fully understand all forward sections** of this manual, you are ready to test your skills in the operation of your new bender. The following information will provide the necessary understanding required to safely and efficiently operate the bender utilizing our vast assortment of tools and dies.

This section is divided into three sections: Tube bending, Swaging and Expanding. It is essential that you read and understand each section as it pertains to your particular tube bender. Refer to the forward sections for any area or nomenclature that you do not fully understand.

Remember, any equipment is only as good as its operator and your new tube bender is no exception.

I. Tube Bending

The tube bending process is easily understood and is explained in the basic design section forward in this manual. Below are the “Do’s” and “Don’ts” recommended by this manufacturer.

“Do’s”

1. Keep guide plate and back gate top plates clean and properly lubricated.

2. Always bend with a matched pair of dies.

3. Keep hands clear while ram is in motion.

4. Use die pusher when using 3-1/2” and 4” radius dies.

“Don’ts”

1. Press forward and reverse foot pedal simultaneously. (MSA models only).

2. Exceed limits of the machine.

3. Become overconfident or careless.

4. Exceed recommended sequence valve pressure.

5. Bottom out top cylinder on the return stroke. (MS, MSF, and SAL models only).

II. Swager Operation

The swager is a universal tool used to form precision flares, flanges and slip connections. Operation of the swager is easily understood however a full understanding of its various applications is essential for effective and safe operation. Follow these precautions when operating the swager.

“Do’s”

1. Always thread tools on cylinder shaft until hand tight, (refer to page 16 & Figure 18 for proper quick release installation).

2. Use a matched pair of adaptor collars properly installed.

3. Keep hands clear while ram is in motion.

4. Use the proper tool for the job.

“Don’ts”

1. Extend cylinder into clamp.

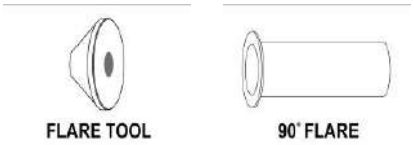
2. Become over-confident and place hands in working area.

3. Nick or ding shaft.

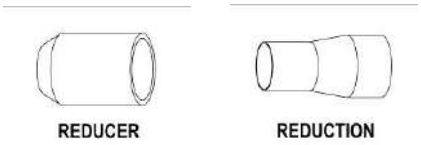
The following information will familiarize you with each available swager tool and its function.

Install matched pair of adaptor collars and proper size expander die. Extend die into tube to a depth of 2".

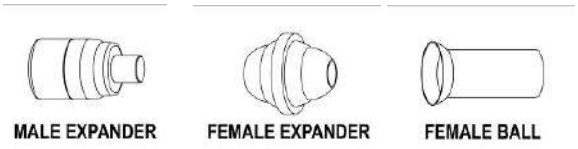
Install male expander, which is used as an adaptor for the flare tool. Extend flare tool into tube until desired flare is accomplished. A manifold gasket can be used as a template.



Proceed as if making a 45° flare, however, reverse flare tool and in a second operation, extend flat side of flare tool into previously formed flare.



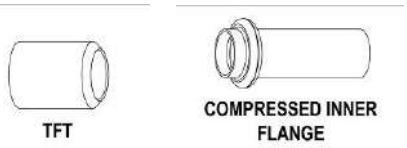
Install proper size reducer and extend over tube until the tube bottoms out against the inside of reducer.



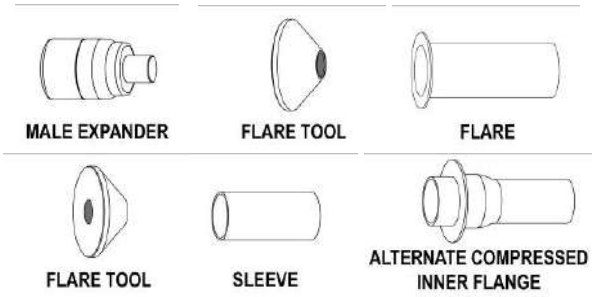
Install male expander which is used as an adaptor for female expander. Take note that female expander is used on 1-3/4", 2", 2-1/4" and 2-1/2" diameter tubes. Select proper size on tool which corresponds with tube diameter. Advance tool into tube end until desired ball is formed.

Select proper size male expander for tube to be formed. Extend tool into tube until tube end meets limit line machined around male expander. In a second operation, slip doming die over male expander and dome tube until desired ball is achieved.

Install male expander as an adaptor for doming die. Dome pipe end to suit appearance.



Install flange too securely. Clamp tube end approximately 1-1/3 inches from front edge of adaptor collars. Advance tool and form compressed inner flange.



Install male expander as an adaptor for flare tool. Clamp tube end approximately 1/2 inch from front edge of adaptor collars. Flare tube. Reverse flare tool and press previously cut sleeve (2" long) of the same diameter into tube. Use manifold gasket to determine proper protrusion of sleeve.

III. Expander Operation

The expander is an internal expansion device that may be equipped with either of two types of tooling.

Micro-Dial* type tooling or Limit Ring type tooling.

MICRO-DIAL TYPE TOOLING*

With the Micro-dial type tooling, four sizes of Slip Segments (SSS) are supplied. These segment sets are designed to expand tubes between 1-1/2" and 2-1/2" in diameter. Tooling is available for expanding 3" Diameter tubes. Slip joints are formed with this type of expander in the following manner:

1. Select the proper segment set from the expander tooling instruction table located on the machine. ** The segment sets are marked according to size by the number of grooves machined in the bottom surfaces. (No grooves-SSS112, One grooves-SSS134, etc.)

2. Install segment set on the expander arbour as seen in Figure 3A.

3. Determine proper setting for an I.D. (Inside Diameter) or O.D. (Outside Diameter) expansion from the expander tooling instruction table located on the machine.

**** Formely called hydra-sizer***

***** See samples on page 32***

4. Turn the Micro-dial assembly to match the desired line number (for I.D. Slip) or letter (for O.D. size) as determined from step 3. NOTE: When sizing to outside diameters the tube wall thickness must be accounted for. When sizing 16 gauge tube, (.065" wall) use the line to the left of the letter, when sizing 14 gauge tube, (.083" wall) use the line to the right of the letter. (See label on micro-dial.)

5. Place tube over segment set, withdraw arbor until cylinder bottoms out, extend arbor, rotate tube and repeat 2 to 3 times or until uniform expansion has been achieved.

Flares, ball joints and inner flanges can be formed on the expander with the corresponding optional tooling. To make flares and ball joints, refer to the expander tooling instruction table for settings and proceed as previously described.

NOTE: When making female ball joints, the tube is placed half way over the ball portion of the segment set.

Inner flanges are formed with the screw type expander tooling in the following manner:

1. Select proper inner flange segment set (ISS) and the corresponding limit ring.

2. Install segment set on expander arbor.

3. Set micro-dial assembly on line number four.

4. Place limit ring over tube until limit ring is flush with tube end.

5. Place tube over segment "fingers". Hold tube and limit ring flush against base of segments set.

6. Gradually withdraw arbor until a "lip" begins forming around the tube, advance arbor until segments release tube, rotate tube and repeat. Continue in this manner until arbor has been fully withdrawn and a uniform inner flange has been obtained.

7. Remove tube from expander, remove limit ring from tube. Inner flange is now ready for use on a six cylinder manifold.

8. An eight cylinder compressed inner flange may be obtained by clamping the tube in the swager, and extending the flat side of the flare tool against the tube end until the previously formed lip has been compressed.

*LIMIT RING TYPE TOOLING**

This type of tooling functions in the same manner as the previously described Micro-dial tooling, however, a ring is used to limit the expansion size. Three segment sets (SS), two expander arbors (HSA) and 9 assorted limit rings (LR) are supplied to expand tubes between 1-1/2" and 2-1/2" in diameter, tooling is available for expanding 3" diameter tubes. The HAS112 is used only in conjunction with the SS112 for expanding 1-1/2" and 1-5/8" diameter tubes, the HAS134 is used with all other segment sets for expanding larger diameter tubes. To operate this type of expander thread appropriate arbor onto cylinder rod until hand tight and install spacer bar as seen in Figure 3B.

To form I.D. expansions:

1. Install proper segment set onto expander arbor.

2. Place limit ring and tube over the segment fingers, hold the limit ring against base of segment set and tube against face of limit ring.

3. Withdraw arbor until segment fingers meet limit ring, extend arbor, rotate tube and repeat 2 to 3 times or until uniform expansion has been achieved.

To form O.D. expansions:

1. Install proper segment set onto expander arbor.

2. Place desired limit ring over tube, place tube and limit ring over segment fingers holding both parts flush against base of segment set.

3. Withdraw arbor until outside of tube meets limit ring, extend arbor, rotate tube and repeat 2 to 3 times or until uniform expansion has been achieved.

NOTE: To avoid difficulty removing limit ring from tube, do not expand tubing tightly against inside of limit ring.

**** Used on machines manufactured before 1979***

Inner flanges may be formed on the limit ring type expander with the corresponding optional tooling. This tooling is equipped with a special (thicker) limit ring which replaces the ring used in the expanding operation.

To form inner flange:

1. Install proper segment set and corresponding limit ring.

2. Install segment set on expander arbor.

3. Place limit ring over tube until limit ring is flush with tube end.

4. Place tube over segment fingers. Hold tube and limit ring flush against base of segment set.

5. Gradually withdraw arbor until a “lip” begins forming around the tube, advance arbor until segments release tube, rotate tube and repeat. Continue in this manner until a uniform inner flange has been obtained.

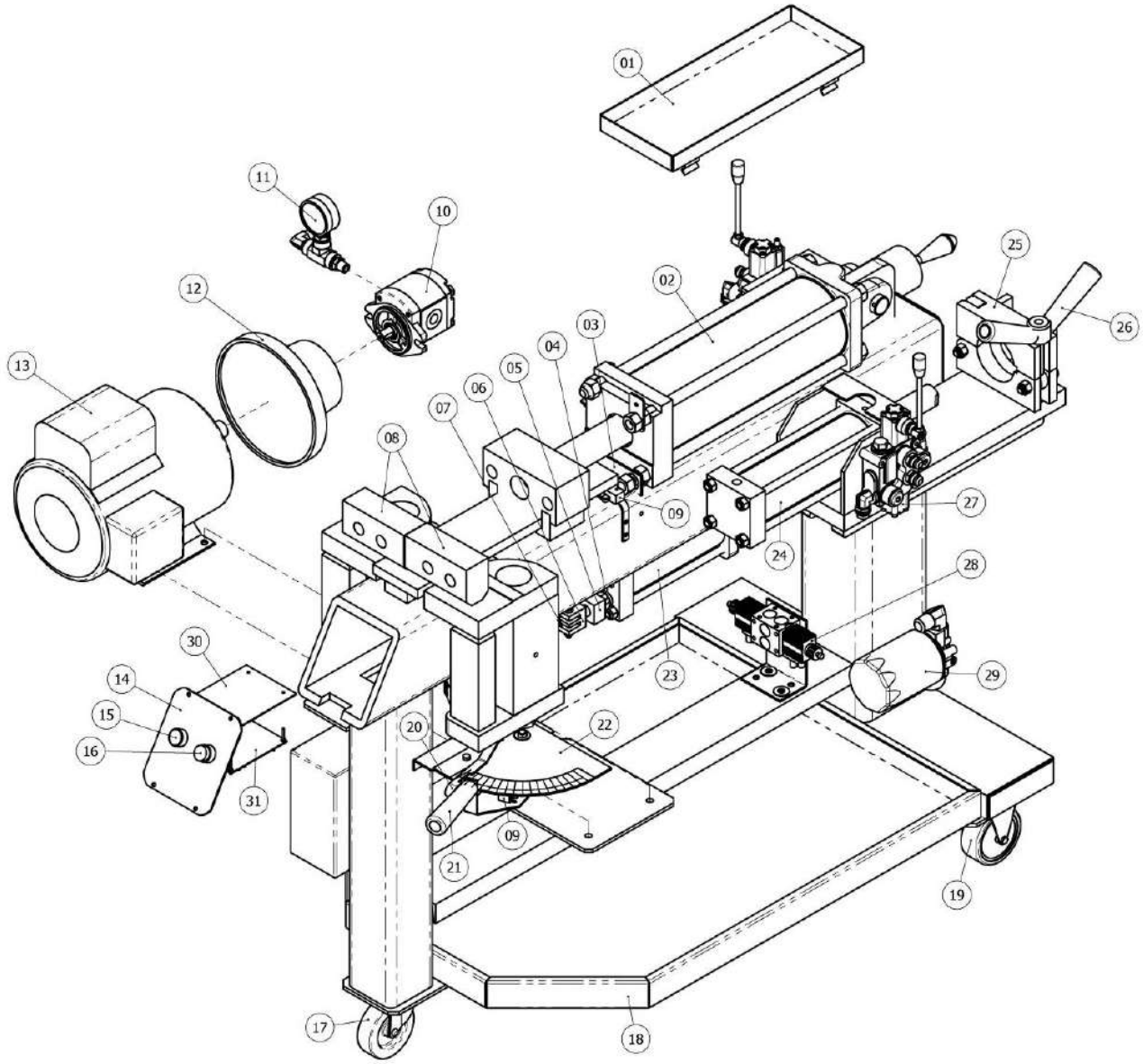
NOTE: To avoid difficulty removing limit ring from tube, do not expand tubing tightly against inside of limit ring.

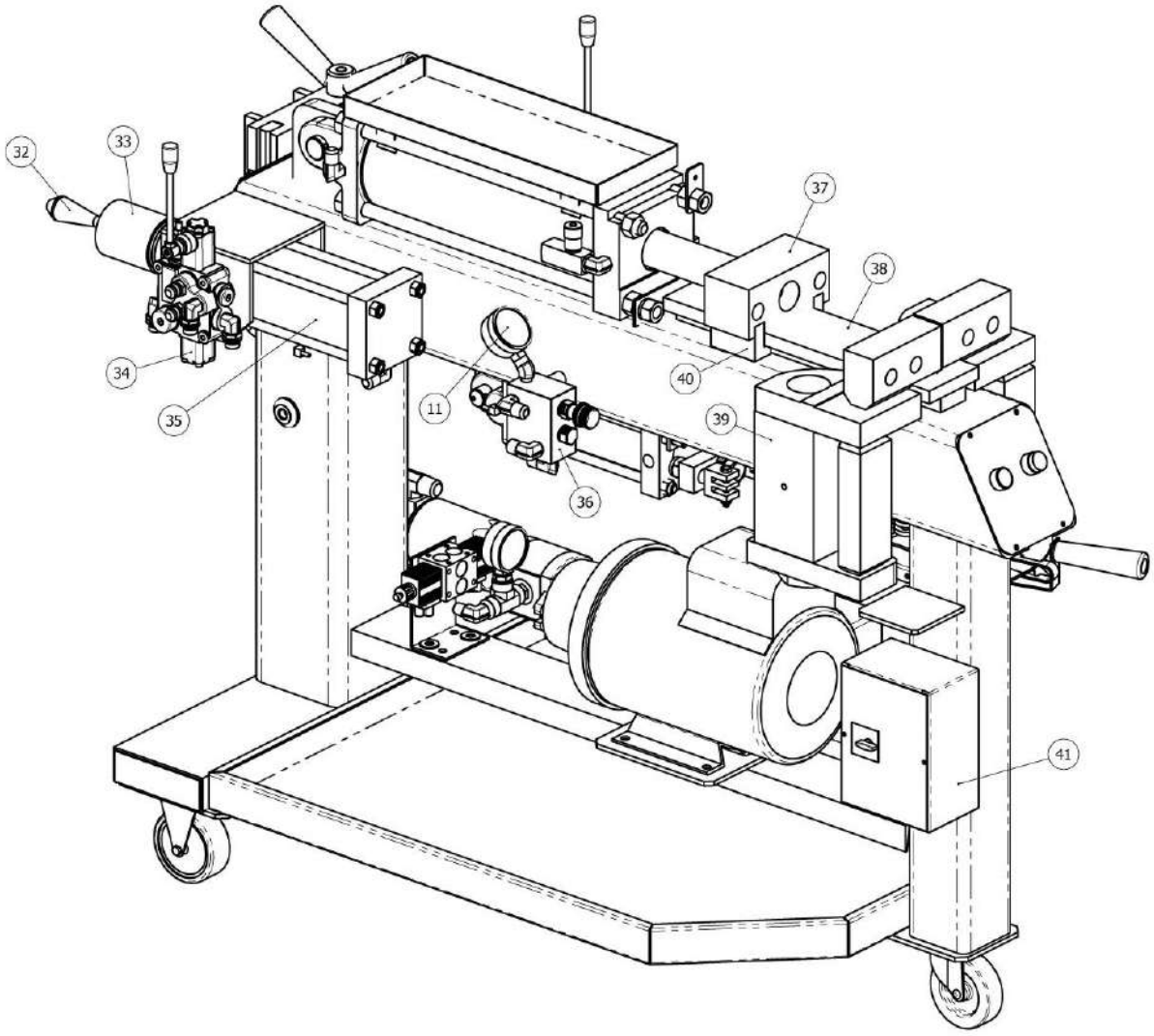
6. Remove tube from expander, remove limit ring from tube. Inner flange is now ready for use on a six cylinder manifold.

7. An eight cylinder compressed inner flange may be obtained by clamping the tube in the swager, and extending the flat side of the flare tool against the tube end until the previously formed lip has been compressed.

Exploded View

Reference Model: 153MSA

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NO	PART NUMBER	DESCRIPTION	QTY
1	38TT800	TOOL TOP TRAY	1
2	40.200.01.03	TOP CYLINDER	1
3	43.100.01.70	TOP CYLINDER BRACKET	1
4	08.142.11.50	CHAIN CONNECTOR LUCK NUT	2
5	43.100.01.90	CHAIN RETUNR BLOCK	1
6	43.100.03.15	CHAIN CONNECTOR	1
7	43.100.03.25	BACK GATE CHAIN	1
8	43.100.03.05	RIGHT AND LEFT GATE ASSEMBLIES	2
9	42.100.01.01	REVERSE LIMIT SWITCH	2
10	40.110.01.20	HYDRAULIC PUMP	1
11	40.110.01.30	SEQUENCE VALVE GAUGE 0-5000 PSI	2
12	42.100.03.10	BELL HOUSING	1
13	42.100.01.91	ELECTRIC MOTOR 5HP	1
14	51.600.04.25	AUTOMATIC CONTROL BOX FACE PLATE	1
15	51.600.02.24	AUTOMATIC BUTTON (GREEN)	1
16	51.600.01.24	EMERGENCY REVERSE BUTTON (RED)	1
17	43.100.02.60	RIGID CASTER	1
18	38TR810ST	BASE TRAY	1
19	43.100.02.30	RIGID CASTER	2
20	43.100.03.55	INDICATOR PART AUTOMATIC HANDLE	1
21	41.100.01.70B	AUTOMATIC HANDLE ASSEMBLY	1
22	43.100.03.40	DEPTH-OF-BEND PLATE	1
23	40.200.04.03	BOTTOM CYLINDER	1
24	40.200.02.03	SWAGER CYLINDER	1
25	43.100.04.10	DOUBLE TAPER CLAMP ASSEMBLY	1
26	41.100.01.70B	CLAMP HANDLE	1
27	40.110.01.01P	4 PORT VALVE	1
28	40.110.01.40	SOLENOID 4 WAY 24V	1
29	40.120.01.15	OIL FILTER	1
30	51.600.01.23	CIRCUIT BOARD SUPPORT	1
31	27.100.00.05	CIRCUIT BOARD	1
32	41.100.01.40	ARBOR	1
33	43.100.04.60	SHIELD SCRE HYDRA-SIZER	1
34	40.110.01.05P	5 PORT VALVE - BEYOND VALVE	1
35	40.200.05.03	EXPANDER CYLINDER	1
36	40.110.01.10	SEQUENCE VALVE ASSEMBLY	1
37	43.100.01.50	PUSHER BLOCK	1
38	43.100.01.25	GUIDE PLATE	1
39	43.100.01.05	BARREL ASSEMBLY	1
40	43.100.01.55	L BLOCK	2
41	42.100.01.75	STARTER BOX 1PH/3PH WITH 240V TRANSFO	1

General Maintenance

Our Pipe Bender machines have been designed for trouble free operation and long useful life providing they are regularly cleaned and maintained.

WARNING!

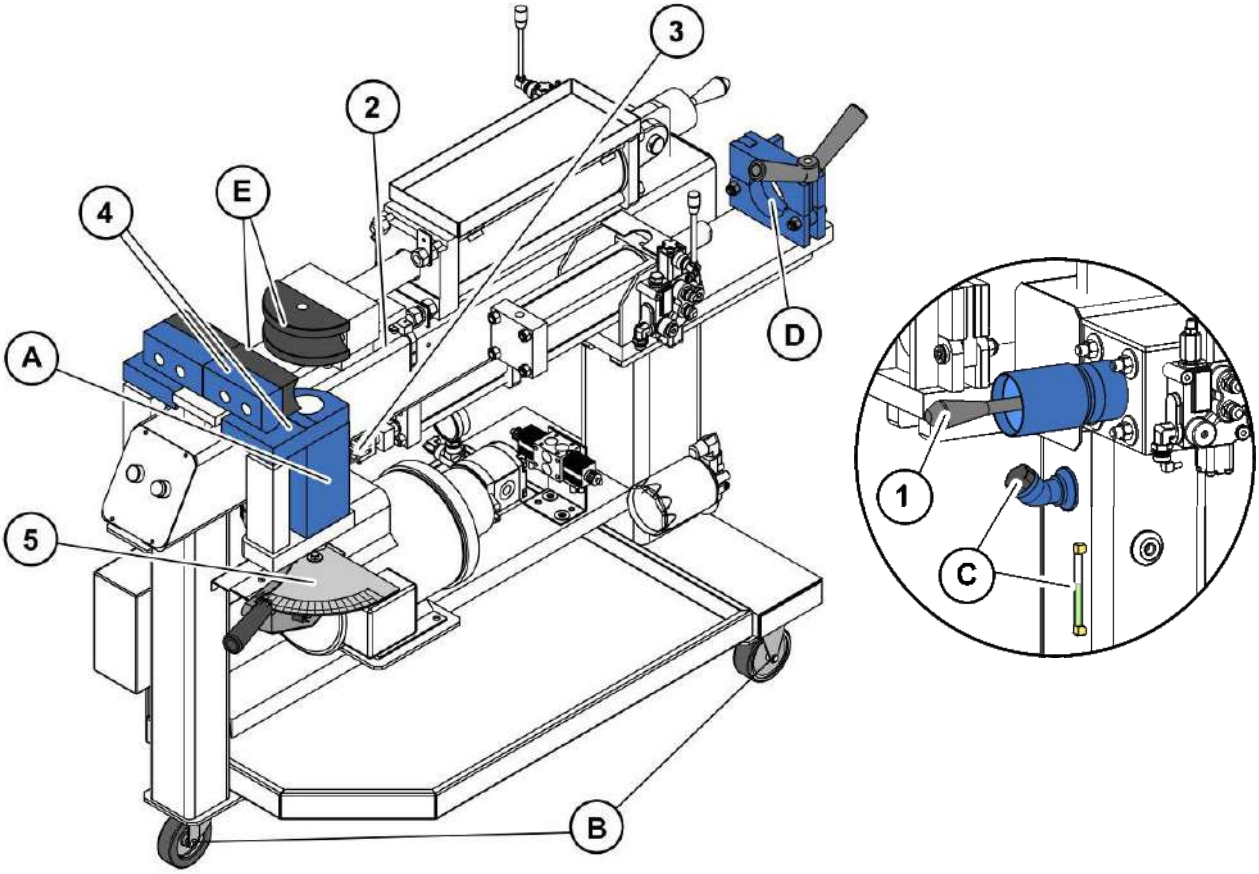
ELECTRIC SHOCK CAN KILL!
To reduce the risk of electric shock, always unplug the machine from the power source.

Electrical Connections - must be checked regularly for damage, wear, and tightness. Mechanical stress due to thermal shock can loosen connections. Worn or damaged power cords and connectors should be replaced. All connections should be regularly tightened.

General Cleaning - Periodically clean dust, dirt, and grease from the machine.

REFER TO THE FOLLOWING DIAGRAM TO ENSURE OPTIMUM PERFORMANCE OVER TIME.

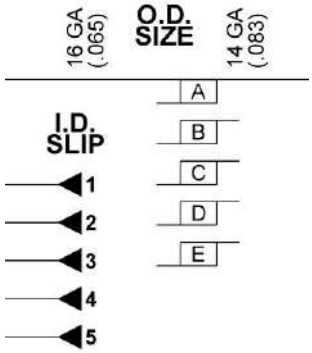
WEEKLY MAINTENANCE	MONTHLY MAINTENANCE
1. GREASE	A. GREASE
2. GREASE	B. GREASE
3. CHECK CHAIN TENSION *(see page 12)*	C. CHECK AND FILL AS REQUIRED
4. CLEAN TOP PLATES / CHECK GATE ALIGNMENT	D. CLEAN GRIPPER CLAMP JAWS
5. CHECK DEPTH-OF-BEND ACCURACY *(see page 13)*	E. SPRAY LUBE DIE EDGES



Micro-Dial Tooling Instructions Table

HYDRA-SIZER TOOLING INSTRUCTION TABLE

TYPE JOINT	SIZE FOR LINE NO.					SEGMENT SET	SIZE FOR LINE NO.					TYPE JOINT
	1	2	3	4	5		A	B	C	D	E	
I.D. SLIP	1-1/2		1-5/8		1-3/4	SSS112	1-1/2		1-5/8		1-3/4	O.D. SIZE
I.D. SLIP	1-3/4	1-13/16	1-7/8	1-15/16	2	SSS134	1-3/4	1-13/16	1-7/8	1-15/16	2	O.D. SIZE
I.D. SLIP	2		2-1/8		2-1/4	SSS200	2		2-1/8		2-1/4	O.D. SIZE
I.D. SLIP	2-1/4		2-3/8		2-1/2	SSS214	2-1/4		2-3/8		2-1/2	O.D. SIZE
I.D. SLIP	2-1/2		2-5/8		2-3/4	SSS212	2-1/2		2-5/8		2-3/4	O.D. SIZE
I.D. SLIP	2-3/4		2-7/8		3	SSS234	2-3/4		2-7/8		3	O.D. SIZE
I.D. SLIP	3		3-1/8		3-1/4	SSS300	3		3-1/8		3-1/4	O.D. SIZE
	1	2	3	4	5							
2-BALL		MALE		FEMALE		BSS200						
2-1/4 BALL		MALE		FEMALE		BSS214						
2-1/2 BALL		MALE		FEMALE		BSS212						
	1	2	3	4	5		1	2	3	4	5	
		LOWER HALF						UPPER HALF				
1-3/4 FLARE		1-3/4				FSS134-214		2-1/4				2-1/4 FLARE
2 FLARE		2				FSS200-212		2-1/2				2-1/2 FLARE

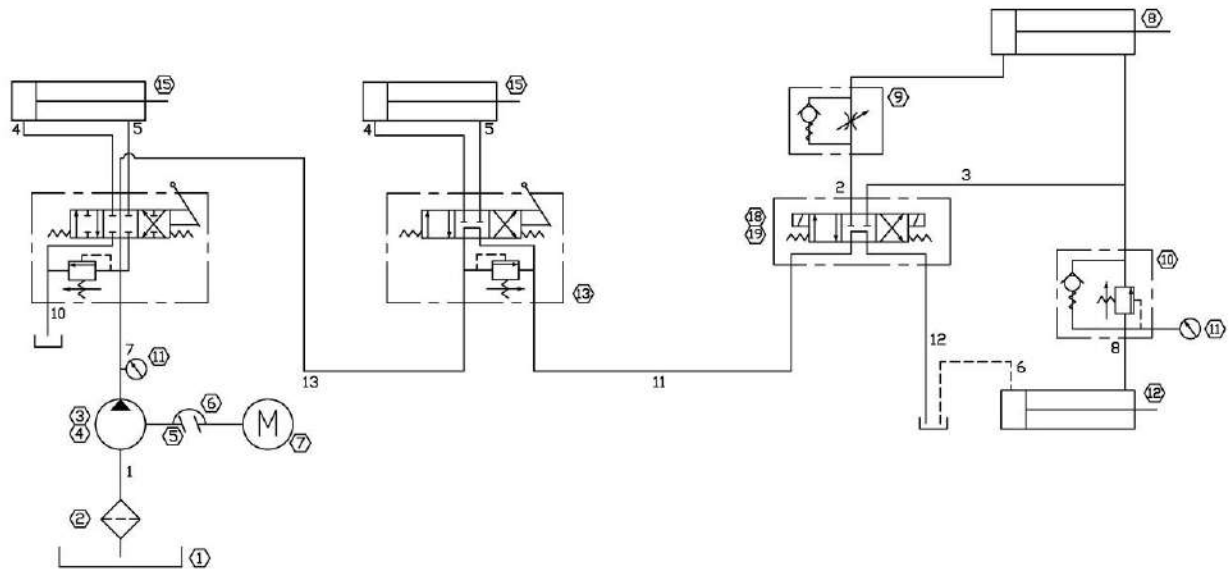


Hydraulic Schematics

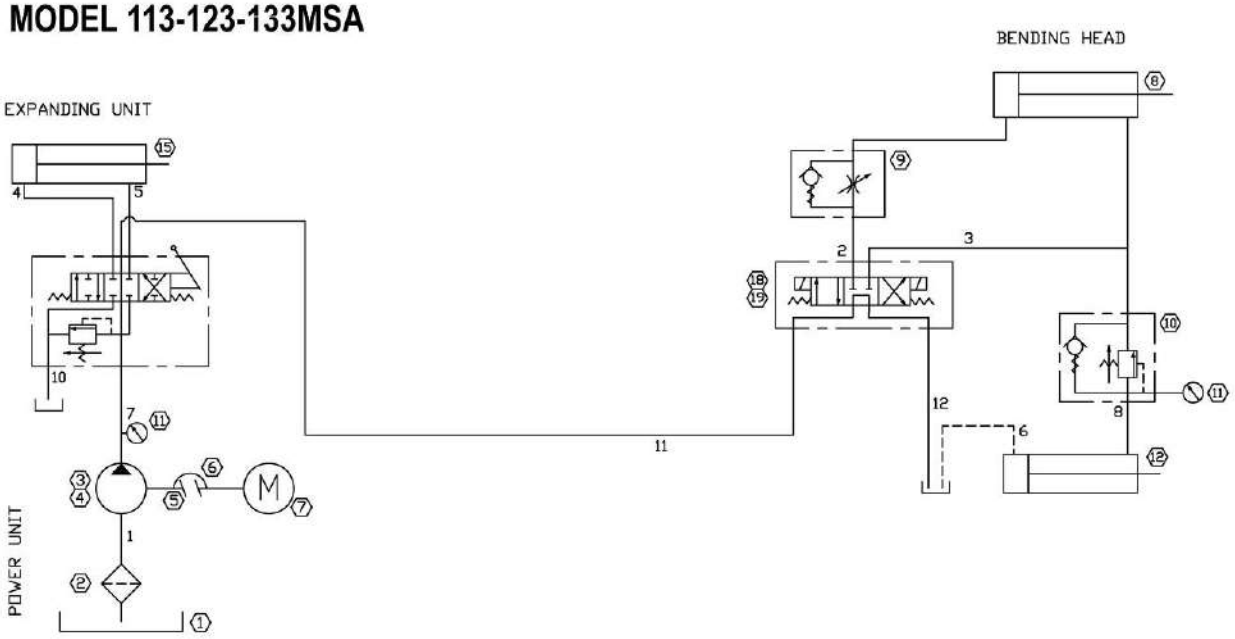
KEY TO HYDRAULIC SCHEMATICS			
ITEM	DESCRIPTION	ITEM	DESCRIPTION
1	Reservoir	11	Pressure Gauge
2	Suction Filter	12	Bottom Cylinder
3	Hydraulic Pump	13	4 Port Valve
4	Pump Mounting Bracket	14	5 Port Valve - Beyond Valve
5	Pump / Motor Coupling	15	Expander Cylinder
6	Bell Housing	16	2-Way Solenoid Valve
7	Open Drip-Proof Electric Motor	17	2-Way Subplate
8	Top Cylinder	18	4-Way Solenoid Valve
9	Flow Control Valve	19	4-Way Subplate
10	Sequence Valve	20	Relief Valve

HYDRAULIC SCHEMATICS FOR AUTOMATIC MODELS

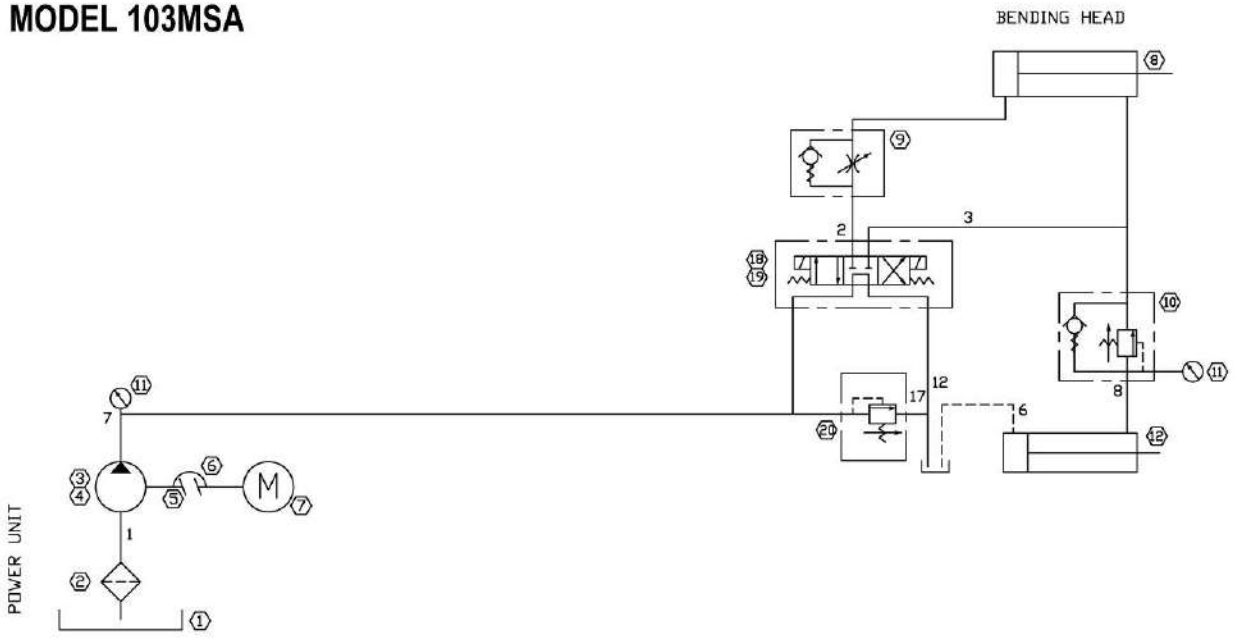
MODEL 153MSA



MODEL 113-123-133MSA

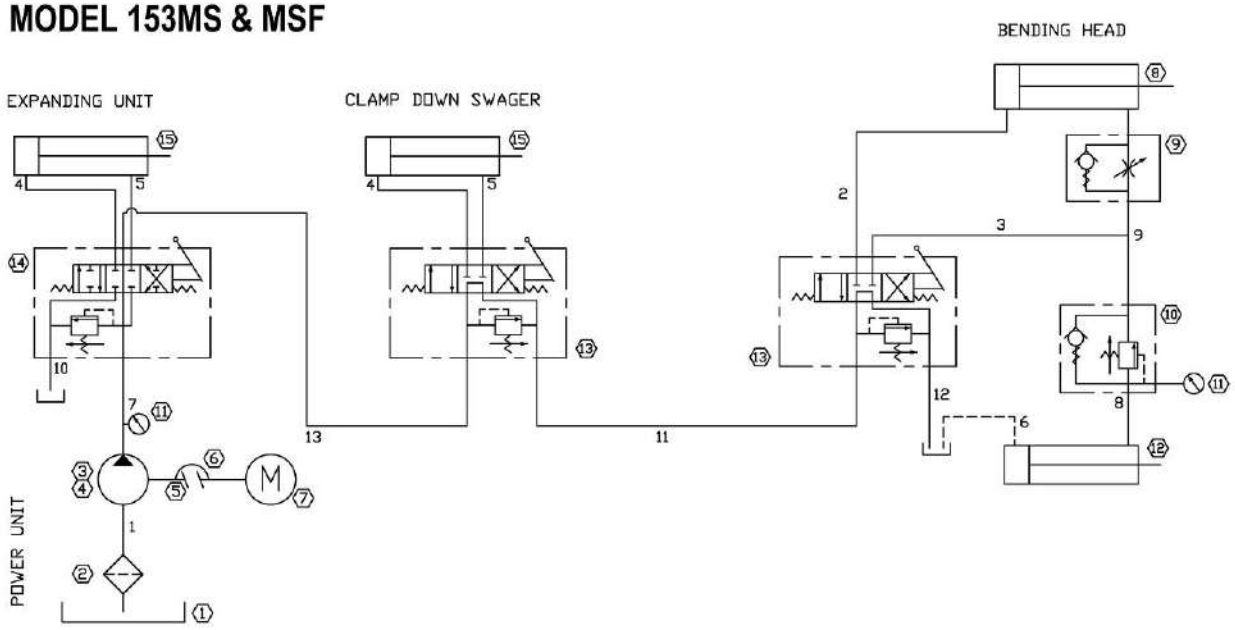


MODEL 103MSA

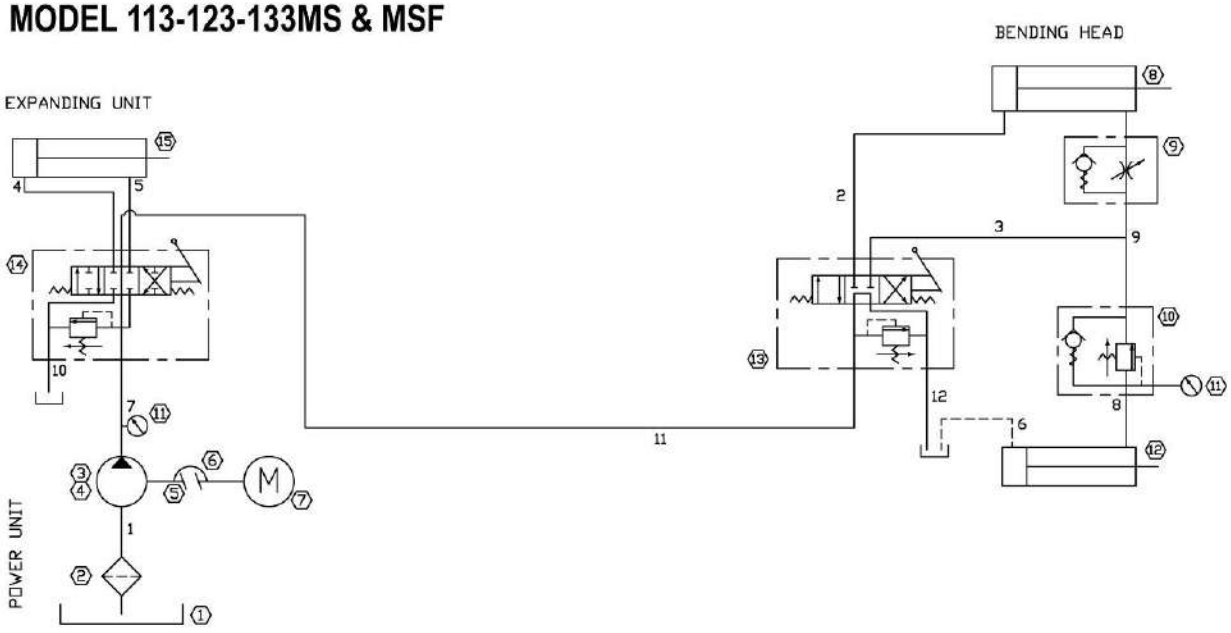


HYDRAULIC SCHEMATICS FOR MANUAL MODELS

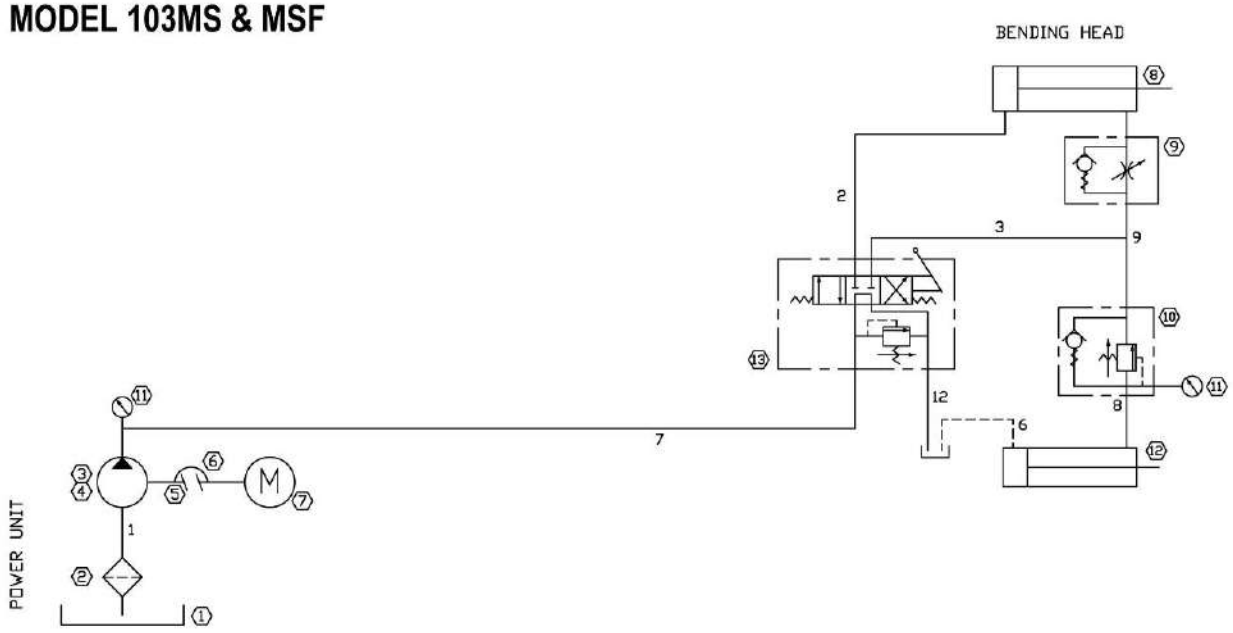
MODEL 153MS & MSF



MODEL 113-123-133MS & MSF

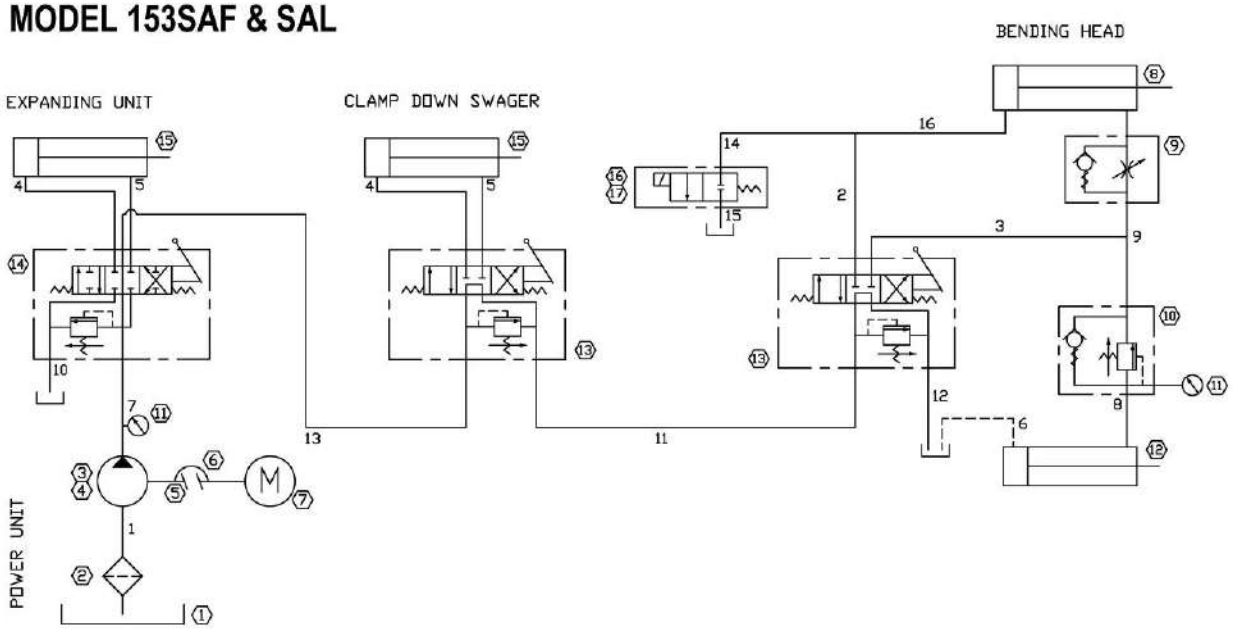


MODEL 103MS & MSF

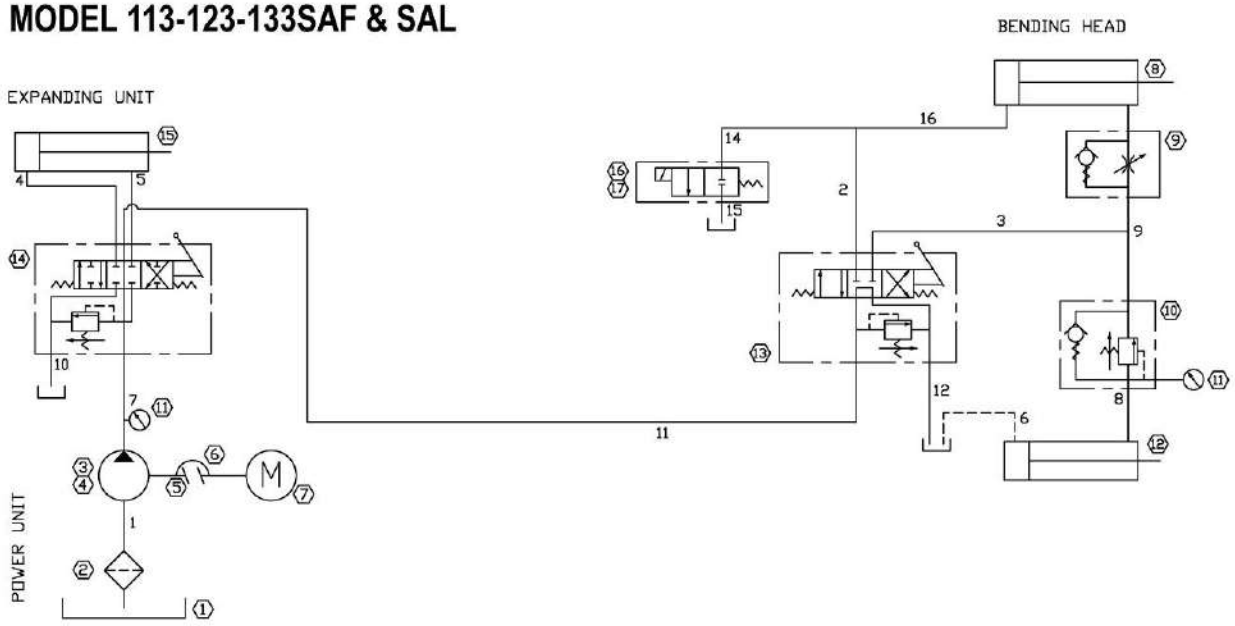


HYDRAULIC SCHEMATICS FOR SEMI-AUTOMATIC MODELS

MODEL 153SAF & SAL



MODEL 113-123-133SAF & SAL



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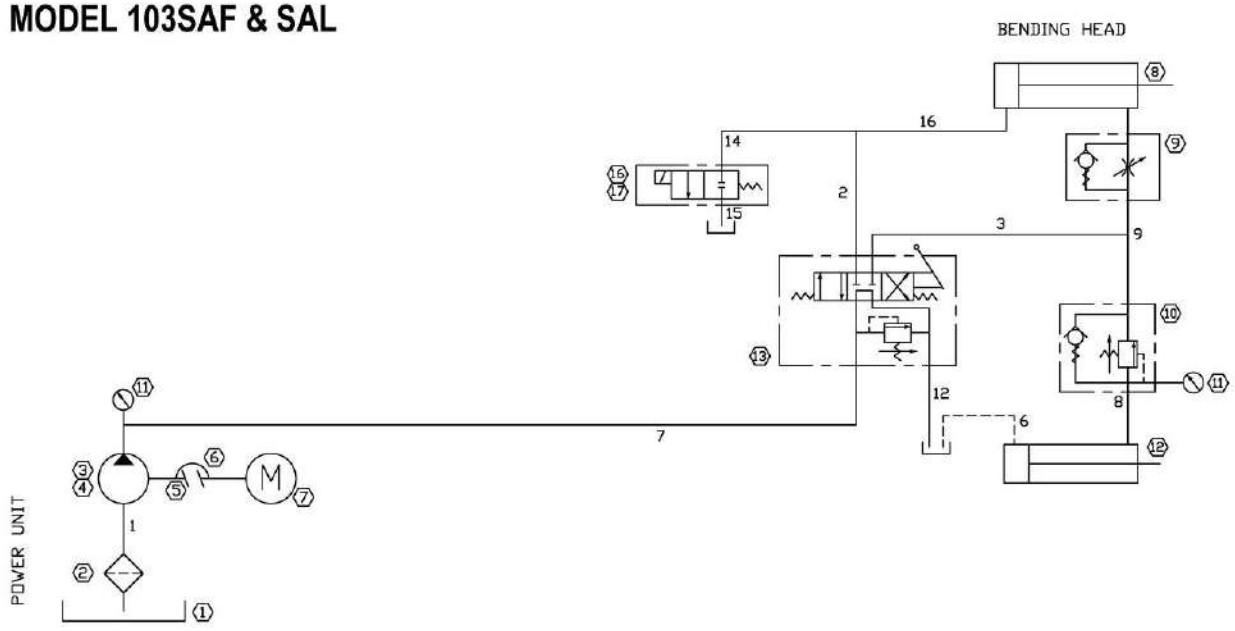
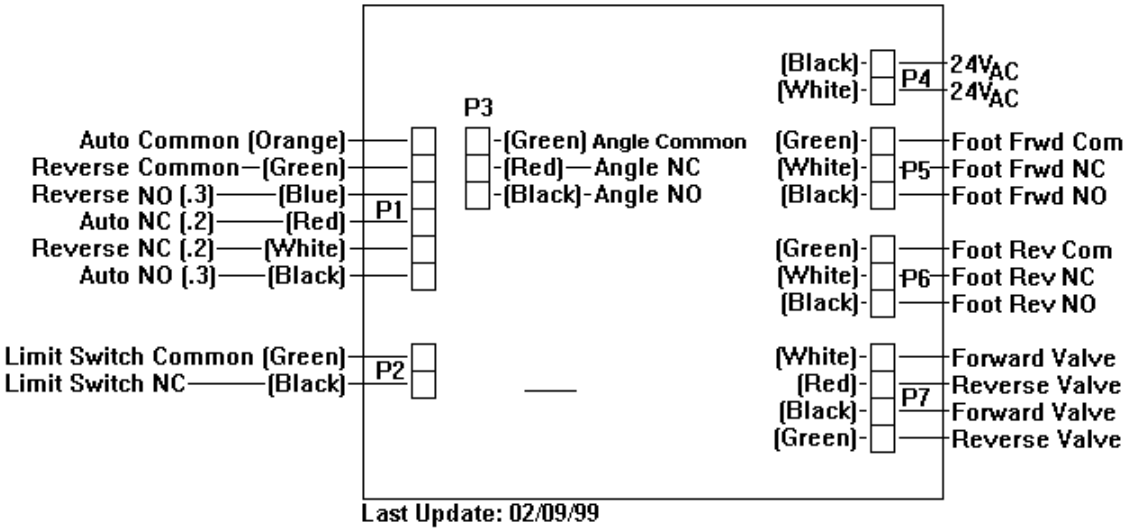
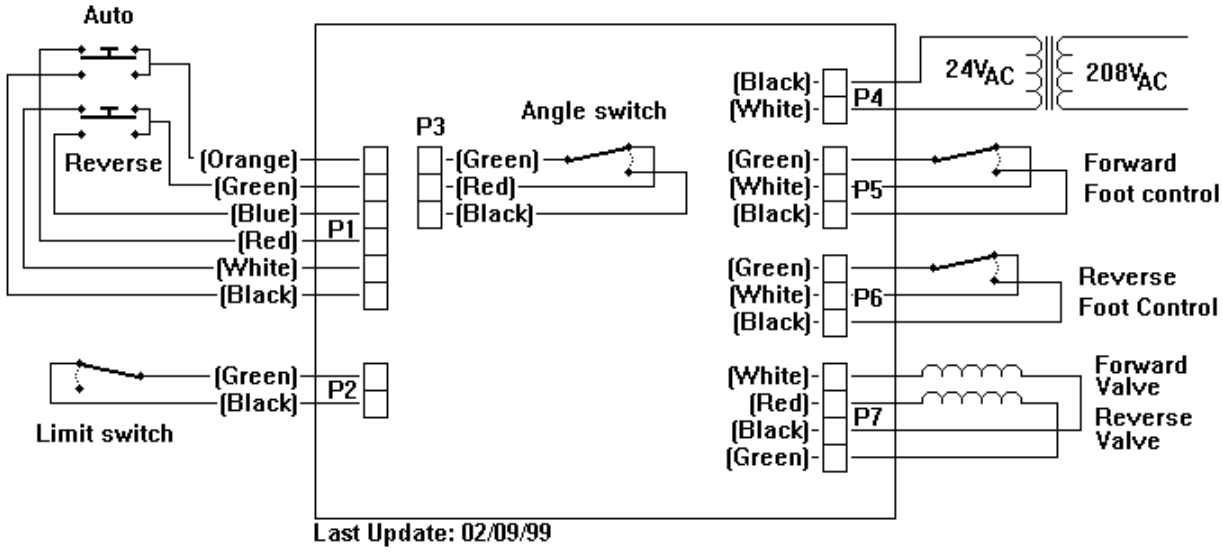


Electrical Schematic

Automatic Models





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