ARMSTRONG&SONS
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Volume 1

AIRETROL MODELS 850 AND 900N

AIRETROL MODELS 850 AND 900N Manual

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Chapter 1

PNEUMATICALLY OPERATED TUBE EXPANSION CONTROL

OPERATING INSTRUCTIONS

Air Source Requirements

Recommended Air Pressure: 90 P.S.I. Minimum 125 P.S.I. Maximum

Air pressure fluctuation has no effect on the torque control unit, as the torque section of the control is independent of the motor section.

A low air pressure supply of approximately 75 P.S.I. will result in a slow rolling cycle. High air pressure, 90 P.S.I. or more, results in normal and faster tube rolling.

Lubrication of Airetrol

It is recommended that the Model L20-03 Lubricator be used for best results. A good grade of S.A.E. #10 lubricating oil is recommended. Set lubricator to 5 to 10 drops of oil per minute.

The gear section of the Control is equipped with a pressure type fitting and approximately once every four weeks pump in two shots from a hand type grease gun. **CAUTION: DO NOT OVER LUBRICATE THIS FITTING.** If excess grease is forced into the gear section, the grease will find it's away to the motor section and cause sluggish operation.

Tube Rolling Procedure

Set torque setting ring of control to correct torque setting for tubes in the condenser.

Then insert correct size Airetool ball bearing thrust type tube expander into the quick-change chuck of the control unit

The unit is turned on or off by means of a quick operating sleeve type valve which also serves as the dead handle of the tool. The direction of rotation of the motor is controlled by the position the rear handle. Pushing forward on the handle causes the motor to run clockwise and pulling back on the handle causes it to run in reverse.

An additional feature of this tool is that any time the operating handle is released, the motor will stop operation.

Insert expander into the tube and start the rolling cycle by pushing forward on the rear handle. Hold in forward position until torque control shuts off the motor automatically. Tube should be properly rolled if torque setting ring has been set to proper setting.

To withdraw the tube expander from the tube, reverse the motor by pulling back on the rear handle and hold back until the expander is withdrawn from the tube, then insert the tube expander into the next tube to be rolled.

It is not necessary to shut off the motor during this period, as the tube expander can be inserted into the next tube while motor is running in reverse direction, then following rolling cycle as described above. (You will save quite a lot of time by it being unnecessary to stop the motor when changing from one tube to another.)

Lubrication of Tube Expanders

A light good quality lubricating oil of S.A.E. #10 grade is popular for tube rolling in normal average tube sizes. For severe rolling of heavy gauge tubes, a viscous heavy oil of approximately S.A.E. #60 grade lubricating oil is recommended.

If a water soluble lubricant is required, we recommend "Lube-a-Tube KS Compound", which can be obtained from Armstrong & Sons.

Tube rolling set up guide

The following suggestions are offered to aid in the setting up process for rolling tubes into a heat exchanger or boiler. A good start precludes good end results:

1. Pick 3 to 5 tubes in the unit to be rolled and complete the worksheet on the back of this page. It is important that the measurements used in the set- up are actual, never use averaged dimensions.
2. After the worksheet is finished, start setting up the torque control motor by test rolling the first of the 5 tubes. The first test roll must be done with the Airetrol or electric rolling motor set for low torque to avoid over rolling.
3. Measure the tube i. D. After rolling. If more expansion is needed, increase the torque setting on the control and roll the second tube. Check the finished i. D. This step may have to be repeated on tube #3. By this time, the torque setting should be correct.
4. Roll tubes 4 and 5 to double check the set-up. These tubes should measure as calculated within the allowable tolerance.

   Condenser tubes 10 to 17 gage--plus/minus. 001"

   Condenser tubes 18 to 24 gage--plus/minus. 0005"

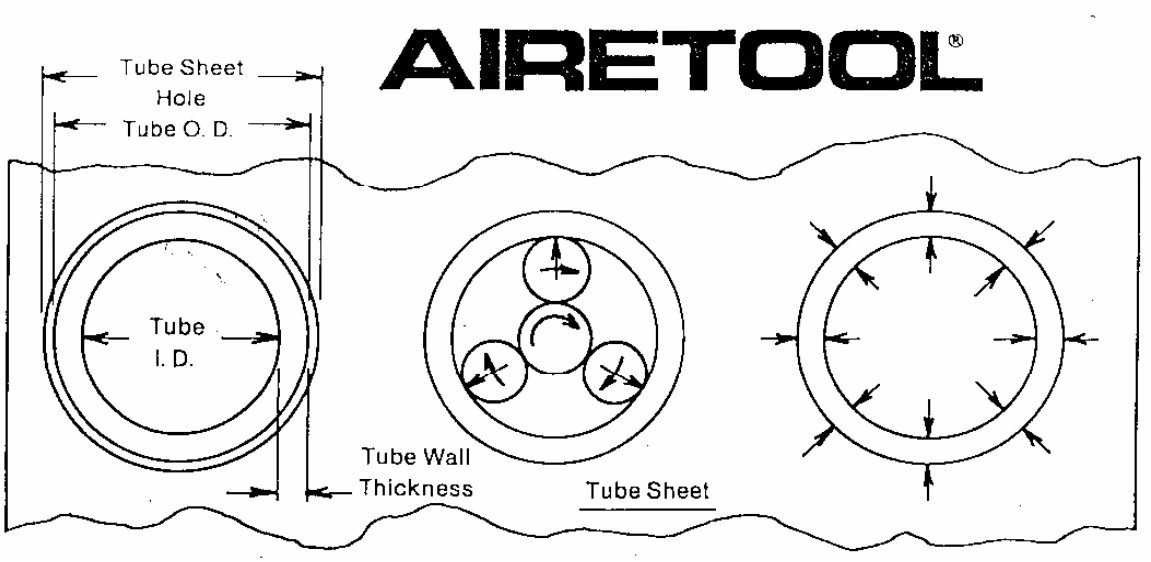
   Boiler tubes 4 to 10 gage--plus/minus. 002"

   Boiler tubes 12 to 16 gage--plus/minus. 001"

   NOTE: REROLL ALL TEST TUBES THAT WERE UNDER SIZE.
5. The rolling control is now set and ready to roll the rest of the tubes in the unit. The use of the torque control system will ensure the uniform tightness of all tubes.

Note: To ensure the best tool life and the highest quality tube to tube sheet contact, periodic cleaning of the expander is, necessary. Proper lubrication of the rolls, mandrel and thrust bearing is a must!

Rolling Setup Worksheet



CONDENSER TUBES 5% REDUCTION

BOILER TUBES 10% REDUCTION

TESTS PROVE THAT SATISFACTORY JOINTS ARE PRODUCED USING THE ABOVE LISTED PERCENTAGE OF TUBE WALL REDUCTION

STEP A - Measure tube sheet hole STEP B - Measure tube 0. D.

STEP C - Subtract "B" from "A"

STEP D - Measure tube I.D.

STEP E - Subtract tube I.D. from tube O.D. Multiply by 5% or 10%

STEP F - Add "'C", "D" and "E" for finished rolled I.D.

STEP	TUBE #	Example	1	2	3	4	5
A	Tube Sheet Hole	.760”					
B	-Tube O.D.	.750"					
C	=Clearance	.010"					
D	+ Tube 1. D.	.620"					
E	+ 5% Reduction	.006"					
F	Finished 1. D.	.636"					

Tube Expansion Control- Fact Sheet No.1

Decrease in the tube joint strength caused by under or over expansion of the tubes.

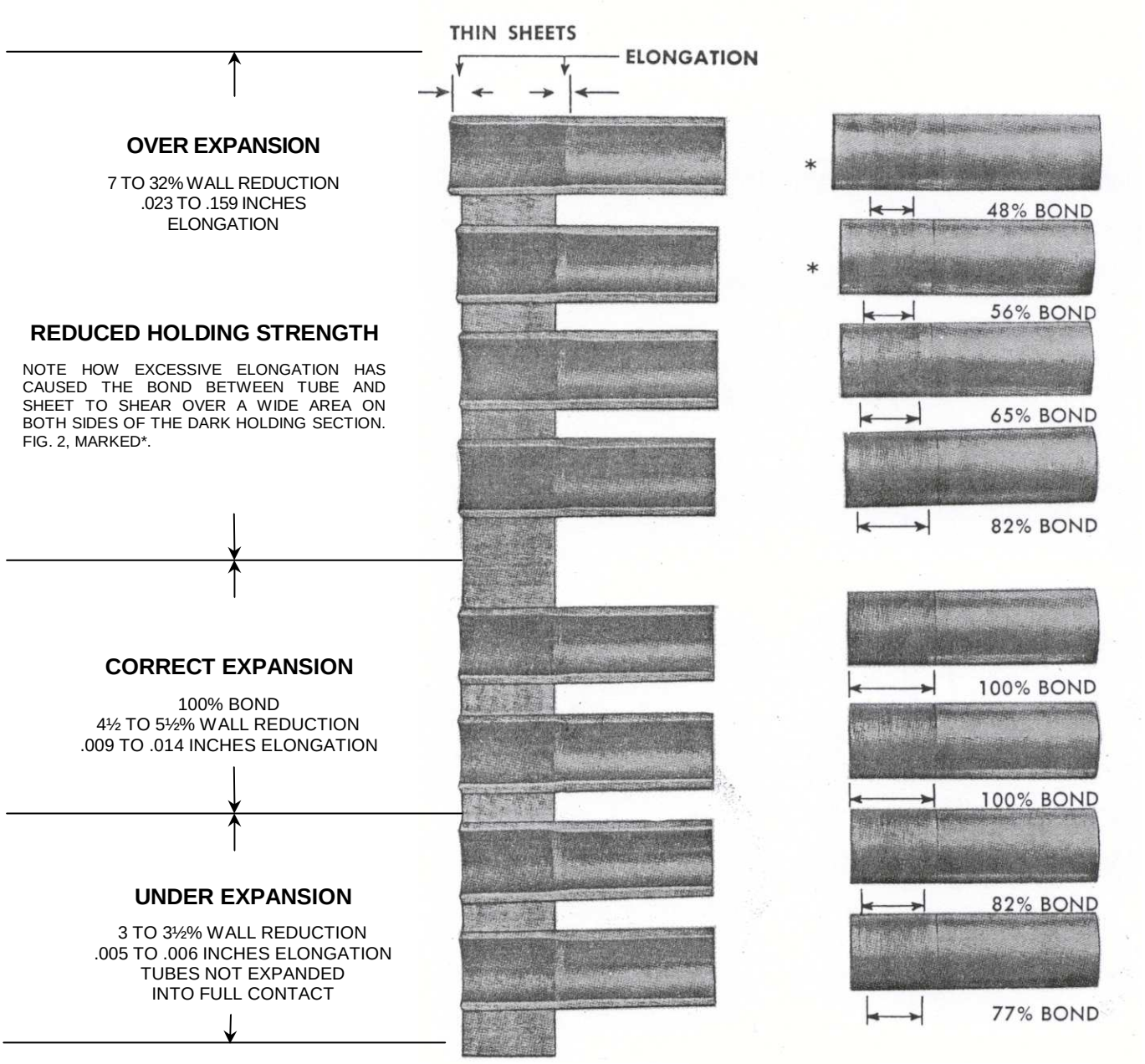


Fig. I
Sectional View of
Tube Bores

Fig. 2
Tubes Removed
From Sheet

⅝" 16 BWG ADMIRALTY TUBES EXPANDED IN ¾" INCH THICK STEEL SHEET. THE DARK SECTIONS OF THE TUBES, FIG. 2, ARE IN EXPANDED CONTACT WITH THE SHEET HOLE GIVING THE JOINT ITS STRENGTH. THE SECTIONS ON EITHER SIDE HAVE SHEARED THEIR BOND AND THE METAL SHOWS UP POLISHED. DRILL MARK IMPRESSIONS FROM THE TUBE SHEET HOLE APPEAR IN THE DARK BONDED SECTIONS BUT ARE OBLITERATED IN THE SHEARED AREAS.

Tube Expansion Control- Fact Sheet No.2

Decrease in the tube joint strength caused by under or over expansion of the tubes.

OVER EXPANSION

7 TO 15% WALL REDUCTION
.048 TO .157 INCHES ELONGATION

REDUCED HOLDING STRENGTH

NOTE HOW EXCESSIVE ELONGATION HAS CAUSED THE BOND BETWEEN TUBE AND SHEET TO SHEAR OVER A WIDE AREA ON BOTH SIDES OF THE DARK HOLDING SECTION. FIG. 2, MARKED*.

CORRECT EXPANSION

100% BOND
4 TO 5% WALL REDUCTION
.018 TO .025 INCHES ELONGATION

UNDER EXPANSION

2 ½ TO 3% WALL REDUCTION
.011 TO .013 INCHES ELONGA TION
TUBES NOT EXPANDED
INTO FULL CONTACT

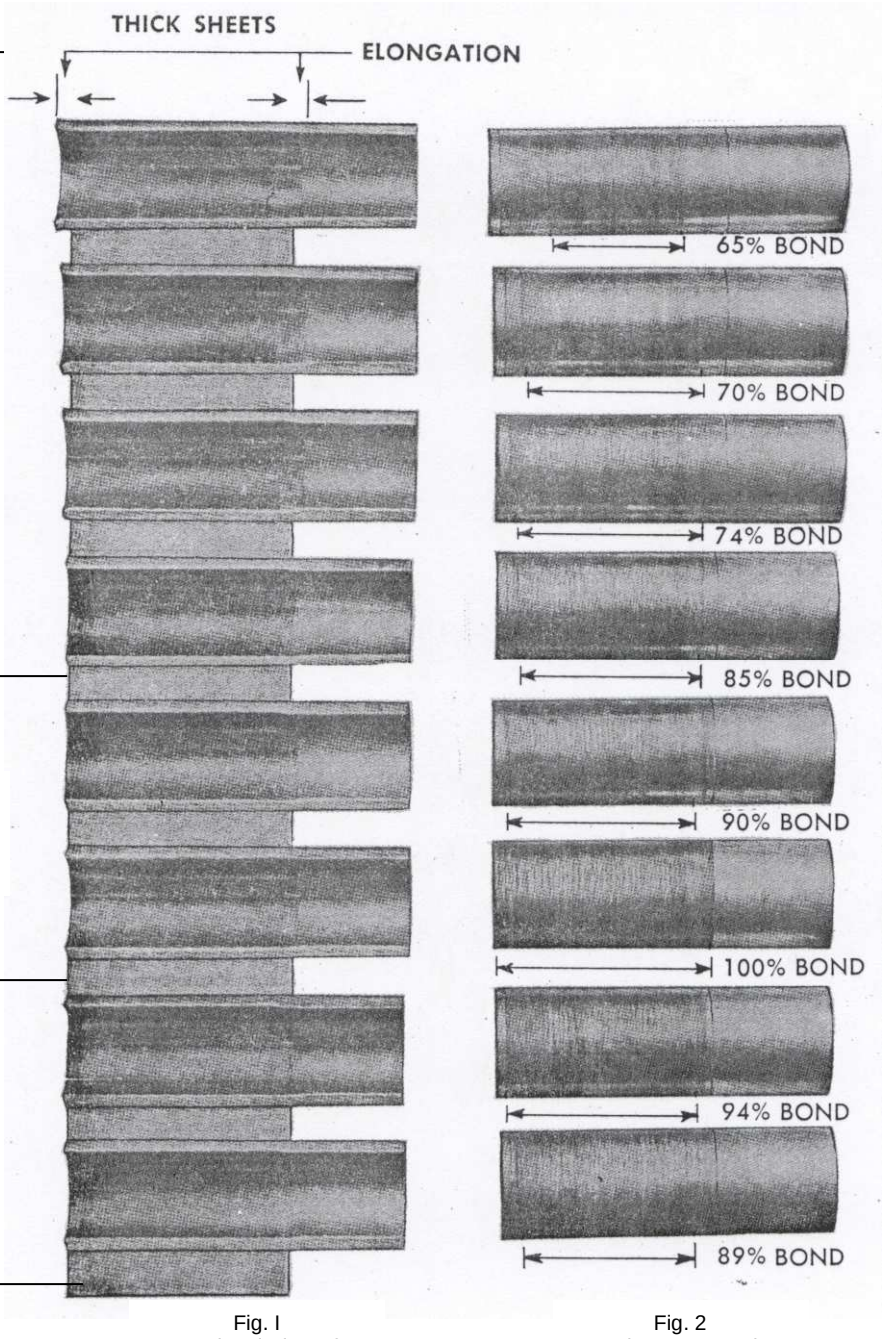


Fig. I
Sectional View of
Tube Bores

Fig. 2
Tubes Removed
From Sheet

¾" -14 BWG ADMIRALTY TUBES EXPANDED IN 1½ INCH THICK STEEL SHEET. THE DARK SECTIONS OF THE TUBES, FIG. 2, ARE IN EXPANDED CONTACT WITH THE SHEET HOLE GIVING THE JOINT ITS STRENGTH. THE SECTIONS ON EITHER SIDE HAVE SHEARED THEIR BOND AND THE METAL SHOWS UP POLISHED. DRILL MARK IMPRESSIONS FROM THE TUBE SHEET HOLE APPEAR IN THE DARK BONDED SECTIONS BUT ARE OBLITERATED IN THE SHEARED AREAS.

Recommended Expansion of Tubes for Optimum Joint Strength in Heat Exchangers and Condensers

Use expansion listed in tube expansion column plus .clearance between tube O.D. and sheet hole I.D.
Recommended expansion may be plus or minus .001"

O.D SIZE	GA.	TUBE EXPANSION	O.D SIZE	GA.	TUBE EXPANSION	O.D SIZE	GA.	TUBE EXPANSION
½"	14	.006	¾"	12	.008	⅞"	19	.004
½"	15	.006	¾"	13	.008	⅞"	20	.003
½"	16	.006	¾"	14	.008	⅞"	21	.003
½"	27	.005	¾"	15	.007			
½"	18	.005	¾"	16	.006	1"	8	.009
½"	19	.004	¾"	17	.005	1"	9	.009
½"	20	.004	¾"	18	.005	1"	10	.009
½"	21	.004	¾"	19	.005	1"	12	.009
			¾"	20	.005	1"	13	.008
⅝"	12	.006	¾"	21	.004	1"	14	.008
⅝"	13	.006				1"	15	.007
⅝"	14	.006	⅞"	8	.016	1"	16	.006
⅝"	15	.006	⅞"	9	.015	1"	17	.005
⅝"	16	.006	⅞"	10	.013	1"	18	.005
⅝"	17	.005	⅞"	11	.012	1"	19	
⅝"	18	.005	⅞"	12	.011	1"	20	
⅝"	19	.004	⅞"	13	.010	1"	21	
⅝"	20	.004	⅞"	14	.008	1"	22	
⅝"	21	.004	⅞"	15	.007			
			⅞"	16	.006			
¾"	10	.008	⅞"	17	.006			
¾"	11	.008	⅞"	18	.005			

ADDITIONAL SIZES

1/4" O.D. tube - expand all gauges .003" after contact with tube sheet hole
3/8" O.D. tube - expand all gauges .004" after contact with tube sheet hole

EXAMPLE

¾" O.D. X 14 gauge tubes

Recommended expansion	.008"
Tube sheet hole	.760"
*****	
Therefore, expand as follows:	
Tube I.D. before expanding	.584"
Recommended expansion	.008"
Clearance between tube & tube sheet hole	.010"
FINISH I.D.	.602"

The above recommendation is based on our experience. However, this does not constitute a guarantee because of the great variety of materials, tubes and tube sheets used. Some conditions will require experimental rolling to be certain that the rolled joints will be satisfactory.

Airetool Tube Expansion Control

The proper expansion of tubes into tube sheets by means of the roller tube expander involves considerable technical information, much more so than would appear necessary, due to the simplicity of the tool and its operation. Many companies have a rule of thumb working knowledge that has been sufficient in the past for the usual methods of hand or power operation of expanders. However, with the increased demand for longer tube life and greater resistance to corrosion, better expanding equipment and greater understanding is required.

A few highlights on tube rolling is advisable before taking up a description of the "AIRETOOL TUBE EXPANSION CONTROL." The control is simple and easy to operate but the correct tube rolling that insures long tube life and avoids injury to tube sheets must of necessity take into consideration a number of factors.

In expanding the tube into the sheet, the outside diameter is enlarged until it makes contact with the sheet hole. This increased diameter of the tube is the result of partially compressing and partially stretching it. A slight decrease in the thickness of the tube wall will result.

As soon as metal-to-metal contact is made between the entire tube OD and tube hole, the metal in the tube wall is heavily compressed between the expander rolls and tube sheet. A slight enlargement of the tube OD takes place and the compression forces are transmitted to the surrounding material of the tube sheet. An appreciable reduction in the tube wall thickness occurs and offers a method by which the required expansion can be checked. Upon release of the expander the tube and surrounding material of the sheet spring back, the sheet shrinking tightly around the tube to form a leak- proof joint. Excessive expansion of the tube will not increase the tightness of the joint or its resistance to leakage.

The heavy compression of the tube wall displaces the metal axially, indicated by the appreciable wall reduction and only slight increase in outside diameter of the tube. The axial metal displacement elongates the tube in both directions: between the sheets causes bending due to the compressive stresses set up in the tube; on the outside of sheet, the tube end projection is increased.

The correct effective expansion for different sizes and gauges of tube is readily obtained by ascertaining the tube wall reduction. The effective expansion is not obtained by measuring the increase of the inside diameter of the tube as the initial clearance between tube and sheet will not be accounted for.

To obtain the correct wall reduction and assuming it to be 5%, determine the inside diameter to which the tube must be expanded as follows: obtain the initial clearance between tube and tube sheet hole by measuring the hole and outside of tube. Add this clearance to the original inside diameter of the tube plus 5% of the thickness of the two walls (for easy figuring take 10% of one wall thickness as this is the same as 5% of two walls). The result gives the final inside diameter to which the tube must be expanded to get 5% reduction of each wall.

Example:

A ¾”-14 B.W.G. tube may have a tube sheet hole diameter of	.757”
The outside diameter of the tube is	.750”
The clearance between tube and hole	**.007”**
The inside diameter of the tube is	.584”
Add the clearance	.007”
Add 5% of (2 x .083”=.166” thickness of two walls) or 10% of .083” one wall	.008”
Final inside diameter for tube to give 5% wall reduction.	**.599”**

The amount of expansion required for a tight joint, for non-ferrous tubes in tube sheets up to 1¾" thick, reduces the wall thickness approximately 5%. For tube sheets thicker than 1¾" the 5% wall reduction can be reduced gradually, according to the thickness of the sheet. Less wall reduction is required as thicker sheets are encountered, otherwise joints much stronger than the tube strength would be obtained. The additional strength beyond the tube strength is generally un-necessary and

results in unnecessary tube elongation and excessive enlargement of the tube hole.

Steel tubes require less wall reduction than the non- ferrous tubes as the metal of the tube wall does not displace axially as easily as with non-ferrous metals. For the same degree of enlargement in the ID of a steel and a non-ferrous tube, the OD will be increased to a greater extent in a steel tube. It is assumed the expansion is sufficient to produce axial displacement *or* elongation. In other words in steel tubes the expansion of the ID of the tubes is more completely translated to increasing the OD and compressing the surrounding metal of the tube sheet.

The torque used to drive the expander determines the amount of expansion given to the tube. Several factors affect the torque required to give sufficient expansion for a tight tube joint.

Size of tube governs torque; the larger the tube the more torque is needed.

Tube material is classified as follows in order of in- creasing torque requirement Copper and Arsenical Copper, Red Brass, Muntz Metal, Admiralty Alloy, Aluminum Brass, Cupro-Nickel, Super-Nickel, Monel Metal, Carbon Steel and Stainless Steel.

Heavier gauges require more expansion than light gauges as the percent of wall reduction remains fixed and the thicker wall is reduced more.

The tube sheet material must be considered in expansion of tubes. Steel sheets offer strong resistance to the expanding action whereas Cupro Nickel and Bronze sheets offer less. Enlarged tube holes will result if the same torque is used on Cupro Nickel and Bronze sheets as on steel.

A rough tube sheet hole compared with a smooth one requires more expansion to obtain a tight joint.

A smooth hole produces the best seal but a rough hole will produce a mechanically stronger joint.

The length of expanded tube section or effective length of rolls governed by thickness of tube sheet, directly determine torque requirements. Tubes should be expanded approximately 90% of the tube sheet thickness for sheets up to 2" thick. In no event should the tube be expanded beyond the inside face of the sheet. If the rolls of G-800 and G-1200 expanders are so set that the ends of rolls project half the bevel beyond the inside of sheet, the effective length of the rolls, exclusive of bevel, generally will be sufficient to expand a satisfactory length of tube into the sheet.

Airetool

Service Instructions
For 850 Rolling Control 1250 And 600 Rpm Models

To maintain efficient operation for continuous use, these tools should be adjusted and serviced periodically.

If accurate torque cannot be maintained, check the shut-off trip as follows:

Remove two screws no.1 000- 78 holding valve cover no. 850-1-C in place. Remove cover to expose trip. (During forward rotation the trip abuts valve no.850-21. See page 2 for trip adjustment illustration.)

Remove entire torque section as follows: Remove 4 socket head cap screws no.1 000-79. Using truarc pliers, remove lock ring no.900-24. Carefully remove driving cam no.900-54 and operating cam no.900-49. Care should be taken to prevent loss of the balls contained in the units. Clean drive spindle no.900-4 and inspect for wear in the ball spline grooves. If spline is worn or dimpled it should be replaced. If spline and front bearing no. 500-14 show no sign of wear, further disassembly of this unit is unnecessary. Check follower no. 900-1 7 for excessive wear.

In reassembly, carefully position regulating spring (no.850-44 or 900-44) on spring guide no. 900- 13. Place operating cam no.900-49 on spindle, aligning grooves of the spindle and grooves in the cam. Check condition of guide springs no. 900-47; place a spring in each groove. Install five 5/32” balls in each groove. (Note: as these are extra precision balls, no substitution should be made.)

Place a small amount of grease on each angled face of the operating cam; install inner ball retainer no.900-52 and ball retainer no.900-50. On each angled face of the cam, place two of the larger balls no.1000-48. Install driving cam no. 900-54. Do not dislodge the balls from the helical faces. Install large lock ring no.900-24. The unit can then be handled in a normal manner. "

To disassemble motor package: Hold the end of the drive spider of the motor, pull gear section from machine, and slide motor package from the unit. Disassemble motor package to check for wear in the cylinder liner and to examine the motor vanes. Install new vanes if old vanes show excessive wear.

Install cylinder on the end plate; check blades no. 1000-72-S for proper placement; install the front bearing support no.900-7-45. Reinstall gasket no. 900-82, in the bottom of the housing, and slide motor package in place, carefully dropping dowel pin no.1000-41 into the locating hole at the bottom of the case. The gear case of the 600 RPM tool is a standard two-stage planetary system and disassembly and reassembly of the unit is very simple. Slide the gears from the gear case, clean, inspect, regrease and reinstall in the gear case. Slide gear case into the housing and install dowel pin no. 900-19.

Reinstall the torque unit on the motor case. (When installing the cam section on the motor housing, be sure to depress the trip so the follower will not jam on the top side of the operating cam while aligning front case with the motor.) Once the torque case is aligned in the motor housing and the screws are installed, the trip can be released. Before reinstalling the valve cover, push forward on the operating lever no. 850-1-L, and manually depress the trip. In depressing the trip with the finger, valve 850-21 will slide forward, simulating the operation of the tool at shut-off. By pulling back on the 850-1-L lever, the outer valve that surrounds the valve no. 850-21, should slide into the rearward position before valve no.850-21 moves within. If the outer valve is tight to the degree of sticking in bushing no.850-27, the motor would run forward rather than in reverse, causing over-rolling of joints. It is therefore essential that the outer valve be free in the bushing.

After the above checks have been made, reinstall the valve cover. Ensure adequate lubrication of all parts during reassembly.

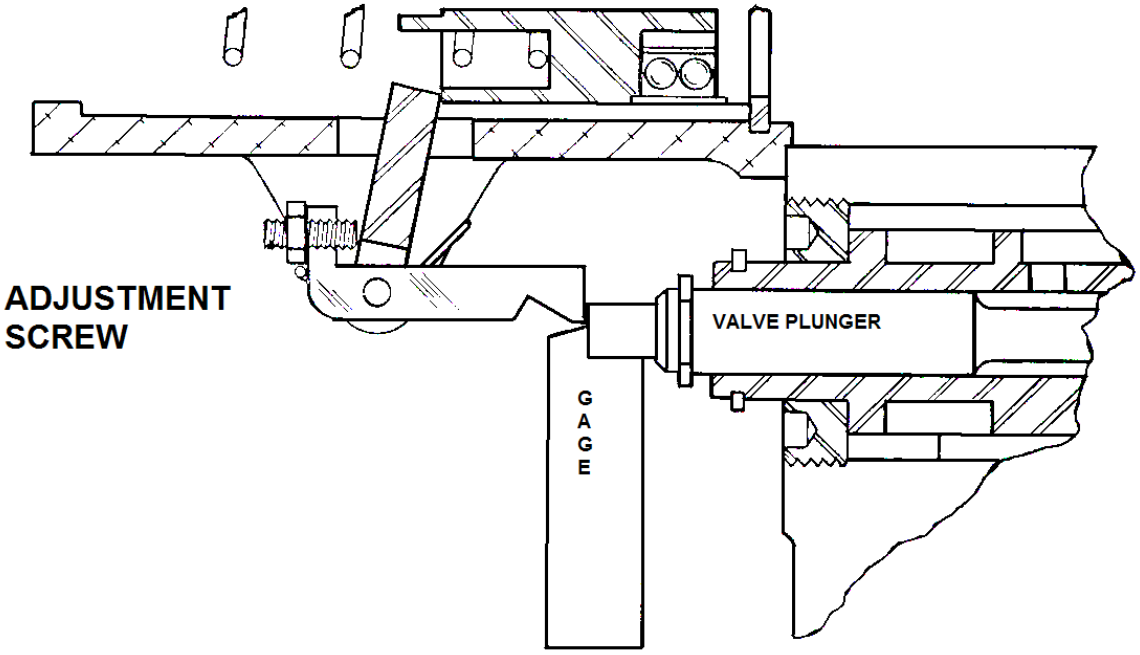
When retubing exchanger, clean all tubes and tube sheet holes. Use ball bearing thrust expander of proper size driven by an Airetool Tube Expander Control to ensure that all tubes

are expanded to same tightness. This eliminates the possibility of over-rolling or leakage.

Gear Section Of 1250 Rpm

If the 1250 RPM gears operate smoothly, relubricate and reinstall in the tool. However, if roughness is encountered, the gears should be disassembled. , **Note: use caution** in reassembly. Because of the nature of a compound planetary system, the gears must be timed in relation to the internal gear and on the sun pinion of the rotor. Each planet gear no. 900-12 shows a mark that aligns with one tooth of each gear. These marks must be aligned with a groove or a tooth space in the internal gear exactly 180 degrees apart. Once these teeth are aligned and slid into the internal gear, the alignment is complete and the gear package can be handled normally. Slide the gear package onto the sun pinion and install the torque unit.

850 Trip Adjustments



850 TRIP ADJUSTMENTS

The trip on the model 850 control has a total confined movement of ⅛". For proper operation, the trip should be set at a maximum engagement of .062" with the abutting valve plunger. With the adjustment made at .062", this allows shut-off of valve to occur at approximately mid-point of the total trip movement. This adjustment should be made with the tool running in a forward direction with the dial set at 5 and no load being exerted on the tool. Our gage can be used to facilitate the adjustment of the trip (see illustration). Set the trip at this location for satisfactory performance.

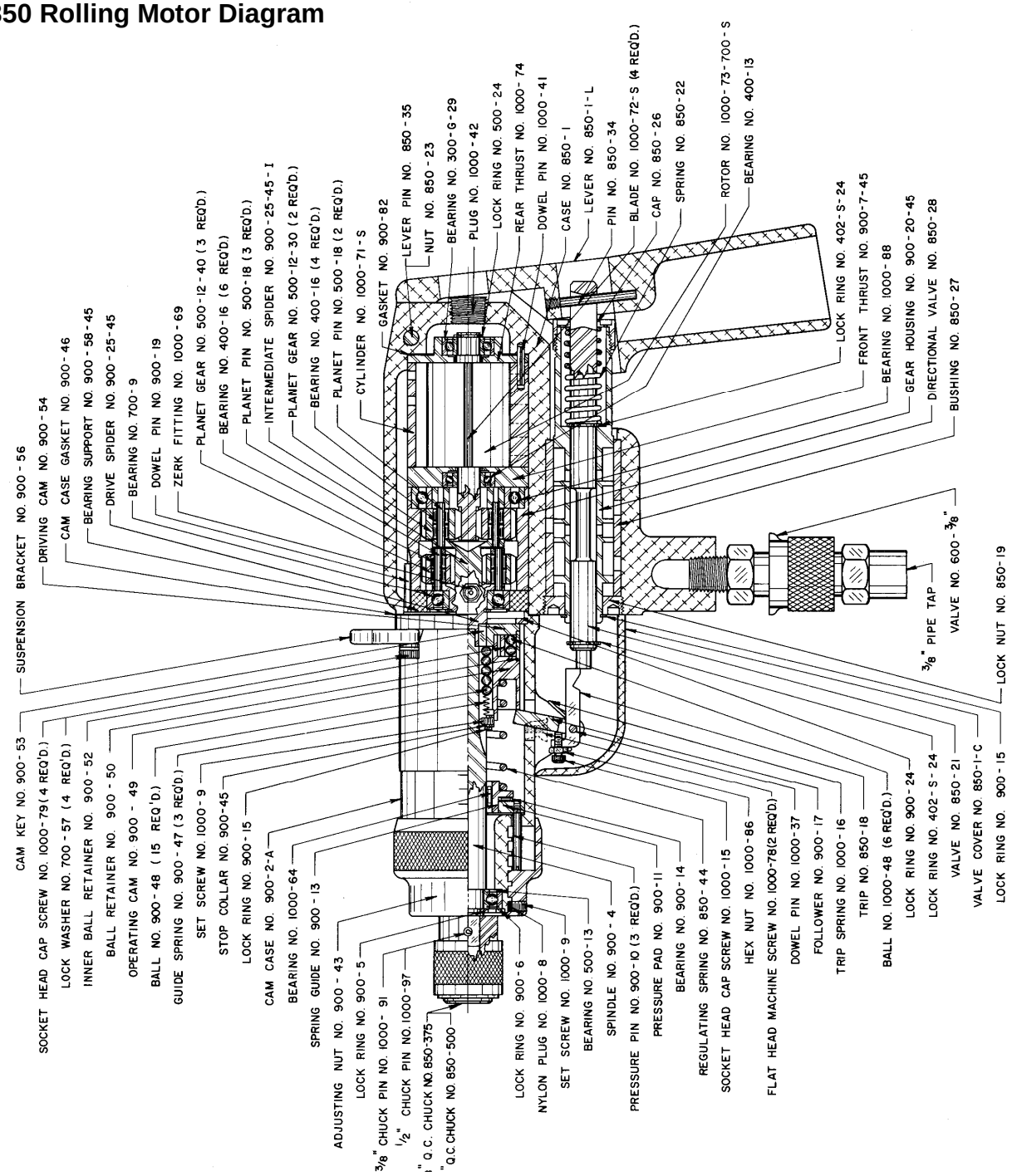
Parts List for Model 850-600 R. P. M. Airetrol

ITEM	STOCK NUMBER	PART NUMBER	PART NAME	REQ'D
CASE	8565820-5	850-I-RE	CASE	1
1	3214480-1	850-27	BUSHING	1
2	3214465-8	850-19	LOCK NUT	1
3	3097800-4	SH-I-A-21	SNAP RING	1
4	3214471-2	850-22	SPRING	1
5	3214468-2	850-21	VALVE	1
6	3154600-1	402-S-24	LOCK RING	1
7	3214477-1	850-26	CAP	1
8	3214486-1	850-34	PIN	1
9	3214454-2	850-1-B	BUSHING	2
10	3214483-6	850-28	DIRECTION VALVE	1
11	3214459-3	850-1-L	LEVER	1
12	3214489-5	850-35	LEVER PIN	1
13	8010037-1	1/4-28	HEX NUT	1
14	3215900-1	900-15	TRU ARC	1
15	3220800-1	900-82	GASKET	1
16	3114600-2	300-G-29	BEARING	1
17	3230600-3	1000-74	REAR THRUST	1
18	3230400-1	1000-73-700-S	ROTOR	1
19	3165900-0	500-24	TRU ARC	1
20	3230200-8	1000-72-S	BLADES	4
21	3230100-1	1000-71-S	CYLINDER	1
22	3216300-2	900-7-45	FRONT THRUST	1
23	3126500-1	400-13	BEARING	1
25	3127700-0	400-16	BEARING	4
26	3164100-3	500-12-30	PLANET GEAR	2
27	3165200-5	500-18	PLANET PIN	2
28	3217100-1	900-25-45-1	SPIDER	1
29	3231800-1	1000-88	BEARING	1

ITEM	STOCK NUMBER	PART NUMBER	PART NAME	REQ'D
30	3127700-0	400-16	BEARING	6
31	3164200-0	500-12-40	PLANET GEAR	3
32	3165200-5	500-16	PLANET PIN	3
33	3217000-4	900-25-45	GEAR SPIDER	1
34	3216500-1	900-20-45	GEAR HOUSING	1
35	3219900-2	900-56-45	BEAR SUPPORT	1
36	3202000-6	700-9	REAR BEARING	1
37	3215900-1	900-15	TRU ARC	1
39	3216300-6	900-19	PIN	1
40	3219500-7	900-53	CAM KEY	1
41	3164400-2	500-13	BEARING	1
42	3215100-0	900-6	TRU ARC	1
43	3215400-9	900-10	PRESSURE PIN	3
44	3215500-5	900-11	PRESSURE PAD	1
45	3229300-9	1000-64	BEARING	1
46	3215700-8	900-13	SPRING GUIDE	1
47	3215800-4	900-14	FRONT BEARING	1
49	3215900-1	900-15	TRU ARC	1
50	3218700-4	900-45	LOCK RING	1
51	8009700-1	8-32X1/8	SET SCREW	1
52	3214800-9	900-4	SPINDLE	1
53	3215000-3	900-5	TRU ARC	1
54	3214498-4	850-44	SPRING	1
55	3219100-I	900-49	OPERATING CAM	1
56	3219200-8	900-50	RETAINER	1
57	3219400-1	900-52	BALL RETAINER	1
58	3218900-7	900-47	GUIDE SPRING	3
59	3219000-5	900-4B	STEEL BALL	15
60	3227200-1	1000-48	STEEL BALL	6

ITEM	STOCK NUMBER	PART NUMBER	PART NAME	REQ'D
61	3219500-7	900-54	CAM KEY	1
62	3216800-0	900-24	TRU ARC	1
63	3214462-3	850-18	TRIP	1
64	3216100-5	900-17	Follower	1
65	3223500-9	1000-16	SPRING	1
CAM CASE	3214600-6	900-2-A	CAM CASE	1
67	3226000-3	1000-37	PIN	1
68	8010079-6	6.32	HEX NUT	1
69	8010058-3	6-32x1/2	SOC SET SCR	1
70	8400100-8	850-375	CHUCK	1
71	8010136-9	1/8X7/8	GROOVE PIN	1
72	3218400-5	900-43	AOJ NUT	1
73	8010134-2	8-32X3/16	NYLON TIP SET SC	1
74	3218800-1	900-46	GASKET	1
77	3219700-0	900-56	BRACKET	1
78	8010038-9	10-32X1/2	SOC HD CAP SC	4
78a	8010085-1	10 HI COLLAR	LOCK WASHER	4
79	3214456-9	850-1-C	COVER	1
80	8010026-5	6-32X1/4	SOC HD CAP SC	2
81	3194000-1	600-3/8	VALVE	1
82	1716200-1	37988	CLOSE NIPPLE	1
83	8404450-5	850-61	MUFFLER	1
84	3226200-6	1000-42	PLUG	1
85	3230000-5	1000-69	ZERK	1
TRIP GAGE	3415282-8	415282	TRIP GAUGE	1

850 Rolling Motor Diagram



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STEP	TUBE #	Example	1	2	3	4	5
A	Tube Sheet Hole	.760”					
B	-Tube O.D.	.750"					
C	=Clearance	.010"					
D	+ Tube 1. D.	.620"					
E	+ 5% Reduction	.006"					
F	Finished 1. D.	.636"					
STEP	**TUBE #**	**Example**	**1**	**2**	**3**	**4**	**5**
A	Tube Sheet Hole	.760”					
B	-Tube O.D.	.750"					
C	=Clearance	.010"					
D	+ Tube 1. D.	.620"					
E	+ 5% Reduction	.006"					
F	Finished 1. D.	.636"					
STEP	**TUBE #**	**Example**	**1**	**2**	**3**	**4**	**5**
A	Tube Sheet Hole	.760”					
B	-Tube O.D.	.750"					
C	=Clearance	.010"					
D	+ Tube 1. D.	.620"					
E	+ 5% Reduction	.006"					
F	Finished 1. D.	.636"					
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