dynaflex®
tube expanders

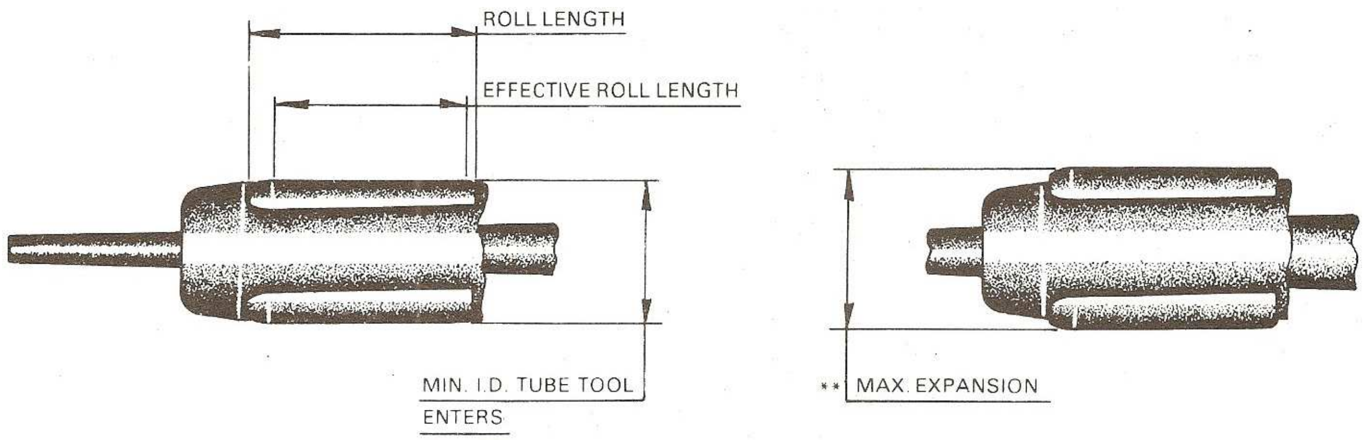
Dynaflex micro processor controlled fully automatic torque controller, tube expander, tube maintenance tools and tube processing tools are used to fabricate and maintain heat-exchangers, condensers, chillers, firetube and watertube boilers, sugar vacuum pans and other tubular type equipments.

Dynaflex serves heat-exchanger, condenser and boiler manufacturers, petro-chemical plants, nuclear power plants, air conditioning and refrigeration industry, oil and refinery industry, thermal power station, shipyards etc.

Realising the necessity of accurate and quality tools and equipments, we at Dynaflex strive continuously to produce efficient & quality tools, that will do the job better, faster and easier and at the time improve the life expectancy of the Tools.

Dynaflex manufactures Tube Expanders from special analysis alloy tool steels found by considerable experience to be the best obtainable, for each part and are carefully heat treated for optimum service under severe operating conditions. Dynaflex's tube expanders and rolling motors are the perfect pair for your tube rolling job.

Tube Expanders are self feeding and Parallel Rolling type. The expanding Rolls are suitably tapered to produce uniform expansion and tightness of the Tubes. The Rolls have a gradual radius on the front end to avoid a sharp offset inside the tube.



Basic Principles of Tube Expanding

Tube Expanding is the art of reducing a tube wall by compressing the outer diameter of the tube against a fixed container… such as rolling tubes into tube sheets, drums, ferrules or flanges. Construction of heat exchangers, boilers, and surface condenser tubes is mainly limited to copper, steel, stainless steel, and cast iron with exceptions such as the use of titanium in ultra high pressure vessel applications. To assure a proper tube joint, the tube wall must be reduced by a predetermined percentage dependent upon the material the tube is constructed of.

Pneumatic or hydraulic torque rolling devices with an expander (consisting of a mandrel, cage with rolls, case assembly with a thrust collar) are used to expand the end of the tube so it seals against the tube sheet of the vessel. It is important to note that the type of tool has to be with paired not only with material but also the inner and outer dimensions of the tube as well. Thickness of the tube sheet (what each individual tube is inserted into) has to be taken into consideration during tube removal or installation procedures.

The following chart can be used for determining the correct tube wall reduction. This chart shows a typical 3/4" – 16 gauge tube. Before rolling this tube you would find the proper rolling dimension as shown.

A. First determine the tube hole size.
B. Then determine the tube outside diameter.
C. Subtract the tube outside diameter from the tube hole dimension.
D. With a Tube Gauge, determine the inside diameter of the tube before rolling.
E. By adding the dimension found in "D" to the clearance between the tube O.D. and the tube hole, you will then know the tube's inside diameter at metal to metal contact.
F. Roll the tube to what you feel is a good tube joint. This example was rolled and then the I.D. of the tube was checked with a Tube Gauge.
G. By subtracting "E" from the rolled diameter you determine the actual amount of expansion (tube wall reduction) on the inside diameter of your tube. This can be converted to a % of wall reduction by dividing the actual wall thickness ("B minus D").130" into the amount of roll .009.

Dial Setting Test Chart For Determining Proper Amount Of Tube Expansion With Automatic Torque Control Unit

	Tube Test Number	**1**	**2**	**3**	**4**	**5**	**6**
A	Tube Sheet Hole Size	.757					
B	Tube Outside Diameter	.750					
C	Clearance (A Minus B)	.007					
D	Tube Inside Diameter	.620					
E	Tube Inside Diameter When Metal-To-Metal Contact is Reached (D Plus C)	.627					
F	Tube Inside Diameter After Rolling	.636					
G	Actual Amount of Roll on Diameter (F Minus E)	.009					
H	Dial Setting						

Note:
1) Take all measurements in thousands
2) Take "A" in middle of area to be rolled
3) Take "B", "D" and "F" in same position as No. 2
4) Take both horizontal and vertical diameters as tubes may be out of round show mean diameter

Customer: ____________________

Location: ____________________

Unit: ____________________

Tube Alloy: ____________________

Date: ____________________

You can use this chart to your advantage by predetermining both the % of wall reduction required and the actual inside diameter which should be rolled. After the completion of “E” you realize any additional increase of the inside diameter of the tube will result in actual wall reduction. Since the amount of wall reduction greatly determines the quality of the tube joint, you should arrive at the % required for your application prior to tube rolling.

By subtracting the tube inside diameter “D” from “B”, you determine actual wall thickness. This example would therefore be .130”. If you then take the 7% wall reduction times the wall thickness, you arrive at .0091”. Adding .0091” (“G”) to .627” (“E”) we get “F” the inside diameter of the tube after rolling (.636”).

This technique is an excellent way to set torque rolling devices. Once you have arrived at the rolled dimension for four or five tubes, you can roll them and very simply determine if more or less wall reduction is required. Knowing how to determine wall reduction is important; however it is equally important to know the characteristics of the popular tubing materials. We should know the proper wall reduction which would apply to each metal. A simple rule of thumb is the harder the material, the less wall reduction is required to obtain a tube joint. For example, you can assign these as approximate percentages of wall reduction when rolling pressure vessels:

Tubing Material:

- Copper & Cupro Nickel 8 - 10%
- Steel, Carbon Steel & Admiralty Brass 7 - 8%
- Stainless Steel & Titanium 4 - 5%

These materials and percentages can be your guideline to rolling tubes of like materials.

Here is a summary of important factors in rolling certain alloys: When rolling 3003 or 4004 Aluminum you should not reduce the walls over 5%. When rolling 6061-T Aluminum, which is one of the most popular materials used in aircraft fittings, you can reduce the wall 10 to 12% for a mechanical joint.

There is a tube process called Alonizing. It is stated that Alonized steel combines the heat and corrosion resistant properties of the iron aluminum alloy with the strength and rigidity of steel. When rolling this tubing it is extremely important to lubricate each tube end and make certain that the tube expanders are kept clean. Remove all particles of the tubing materials from the expanders to decrease tool fatigue. When rolling Alonized tubing, abrasive particles are removed from the inside diameter of the tubing and gathered in the expander. It is recommended that two expanders be used. One should be cleaned and lubricated while the other is being used.

Admiralty Brass is widely used in condensers. This material should be well lubricated. The tube wall is reduced approximately 7% to 8% for optimum tube joints. In general, only a 4% to 10% reduction in wall thickness is necessary to produce a tight tube in a serrated hole. On the other hand, reduction in excess of 15% may cause leaking, splits or flaked tubes.

Carbon Steel is used in almost every type of pressure vessel built today. Tube wall reduction should be approximately 7% to 8%. Heavy lubrication is a must. If the tube is cracking or tooling shows excessive wear, tube hardness should be checked. Carbon Steel tubes should be 90 to 120 Brinnel hardness for rolling. It is possible to roll tubes up to 150 Brinnel; however, flaking and cracking are more likely to occur as the tube hardness increases.

When rolling Copper and Cupro Nickel, consider approximately 8 - 10% wall reduction to be a proper tube joint. Copper, since it is one of the softer tubes used in pressure vessels, can be easily rolled. Use plenty of lubrication because copper has an abrasive action on tube expanders.

When rolling Stainless Steel and Titanium, approximately 4 to 5% wall reduction is sufficient to produce a tight tube in a serrated hole. When rolling these alloys the entire wall reduction should be done quickly. These materials have a greater tendency to work harden; therefore, minimal or no rerolling should done. Motor speeds should be 400 to 750 RPM.

When rolling Titanium, it is recommended to use an expander with four rolls or more. This will decrease diaphragm of a thin wall and help eliminate tube end cracking. There are, however, exceptions to the above rule.

This discussion of alloys has been related to those used in pressure vessels such as boilers, heat exchangers, and condensers. These factors would be approximately the same in a mechanical joint for industrial use. However, a greater percent of wall reduction is usually considered when making a mechanical joint. Higher quality tubes are used in industrial applications.

Major Causes of Tube Leaks

Tube rolling leakage is usually caused by one of the following: under-rolling, over-rolling, improper preparation of tube sheets and differential thermal expansion. Improper expansion can lead to serious difficulties for both the manufacturer and the repair service men.

Under-Rolling

Under-Rolling as the word would imply is when the tube is not expanded to fill the tube sheet hole and the proper amount of wall reduction is not obtained. It is better to under-roll than to over-roll.

Over-Rolling

Over-rolling is when the expansion of the inside diameter of the tube surpasses the expansion required for the proper percentage of wall reduction for the ultimate tube joint. Over-rolling can do considerable damage to a vessel. Overrolling will decrease the dimensions of the ligament between tubes and weaken this bridge. Once a ligament is weakened, it will cause a reaction in all ligaments surrounding that weak ligament. If we decrease the strength of the ligament the tube next to the tube being rolled will leak.

Over-rolling also causes distortion in tube sheets or drums, such as egg-shaped holes. It will also cause diametrical expansion which is the overall increase of a tube sheet or drum. Over-rolling has been known to cause a tube sheet to bow or warp to the point where the standard length tube could not be used in the vessel until the bowing or warpage is returned to normal. This is usually corrected by placing stay rods in the vessel and pulling the tube sheets back to their original position.

Improper Preparation of Tube Holes

Improper preparation of tube holes is another major cause in tube leakage. If the tube sheet or drum is gouged, it is extremely hard to expand the tube to fill these gouges or tears without over-rolling. The smoother the tube seat or tube hole the easier it is to roll an optimum tube joint. The ligaments and light tube walls make it more important that the finish of the tube hole be in the low micro range. We find many manufacturers today are drilling, reaming and sizing or burnishing to get the microfinish desired for tube holes.

Differential Thermal Expansion

Differential thermal expansion can result with thicker tube sheets. When the expansion due to heat varies noticeably between the thinner tube and tube sheet, a shift of the tube results. One of the most important steps for ensuring a safe and permanent tube joint is to thoroughly clean the surfaces of the tube end and the tube hole wall. These two surfaces must be clean and free of all dust, mill scale and pits or scratches. It is extremely important to eliminate any longitudinal scoring in the tube hole wall. These longitudinal lines will cause leaky tubes.

Preparation of Tube Holes

Preparation of tube holes in heat exchangers and condensers is as follows:

1. Drill and ream tube sheet holes to .007” to .010” over the outside diameter of the tube to be used.
2. Be certain the ligaments are sufficient to guarantee a safe and permanent tube joint.
3. When conditions permit, utilize a sizing or burnishing tool to further assure a good finish in the tube hole. This will also increase the tensile strength of the ligament.
4. The serrations or grooves to be used will determine the holding power of the tube.
5. It is extremely important when retubing that the grooves be cleared of all metals or any foreign material.

Preparation of Tube Seats

Preparation of tube seats in drums, tube sheets, and headers are as follows:

1. Tube holes are normally drilled and reamed to approximately 1/32” larger than the nominal outside diameter of the tubes.
2. It is extremely important during this operation that there are no longitudinal scorings left in the tube seat.
3. In cases where out-of-roundness is extreme, prerolling of the tube holes is advised.

4. Be certain that the tube hole walls and the grooves in the tube walls are cleaned down to bare metal before tubes are inserted. Be certain all foreign material such as oil, grease, rust, or just plain dirt are removed. Special attention during this cleaning will prevent serious trouble later.

After tube holes have been prepared they are usually coated with a rust preventative compound. Before inserting any tube it is important to remove all traces of this coating. It is extremely important that great care be taken in handling the tubes for insertion in all of the vessels discussed above. Be certain that the tube ends are clear of any foreign material. Be especially certain that there are no chips on the tubing which may gouge the tube sheet or tube seat when the tube is placed in the vessel.

In some cases it will be necessary to force a tube into a tube hole. This should be done with extreme care. It is better to spring the tube than to try to force it with a hammer. If a tube end is kinked or damaged before rolling, the expanded end will be damaged and a leaky roll joint will result. Attention at this time to the tube ends and the tube alignment will prevent future troubles.

What is Tube OD, ID, and Gauge?

Tube OD refers to the measured Outside Diameter of tube.

Tube ID refers to the measured Inside Diameter of tube.

(BWG) Gauge: Birmingham wire gauge is the wall thickness of the tube.
All tube ODs and IDs are listed in both inches and millimeters. Birmingham wire gauges are listed with their equivalent inch and metric conversions.

What is Correct Expansion of Tubes?

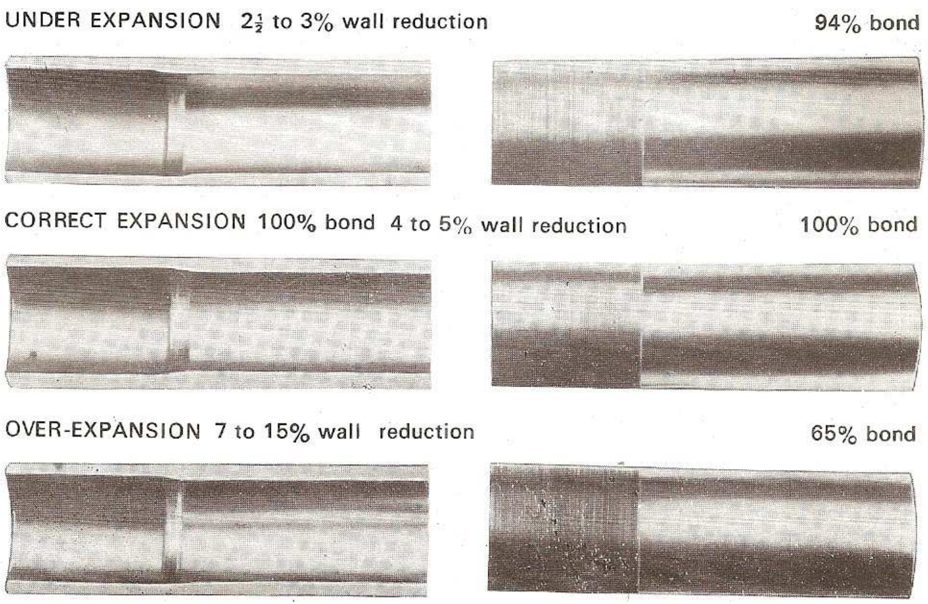
Correct expansion of tubes is the forming of a 100% bond between the tube and tube sheet, a result of reducing the tube wall by 4 to 5%.Anything less or more will result in under or over-expansion.

By using Dynaflex controlled rolling motors with the proper tube expander, correct expansion can be assured automatically.

The basic purpose of tube expansion is to obtain a good hydraulic and mechanical joint. A secondary, but equally important, purpose is to obtain a seal that is durable, resistant to corrosion and essentially free of longitudinal stress.

During tube expansion we must take care of "**Over Expansion**" and we do take care of "**Under Expansion**". The under expansion is detected during hydraulic test and can be corrected by re-expanding. But, over expansion cannot be detected easily and it imposes excessive stresses in the material of the tube and tube sheet. This results in damage to the ligament and a poor joint.

The optimum expansion is the one that develops a tight joint with adequate strength and with minimum stress. The Torque needed for achieving optimum tube expansion varies with the tube diameter, tube thickness, tube sheet thickness, tube material and tube sheet material. Obviously we must determine some relation between the amount of tube expansion and the amount of torque required to achieve that. Many feel that the manufacturer should specify the torque needed for particular combination of various conditions. Since many preferential factors come into play like the desired amount of expansion, the lubricant used, the expansion length set on expander etc. it has to remain with the user to arrive at the torque figure. It is recommended that a group of about five tubes be expanded, measuring the results after every expansion. Comparison of the measurements with the calculated figures will enable decision making on the increase or decrease of the torque to be applied.



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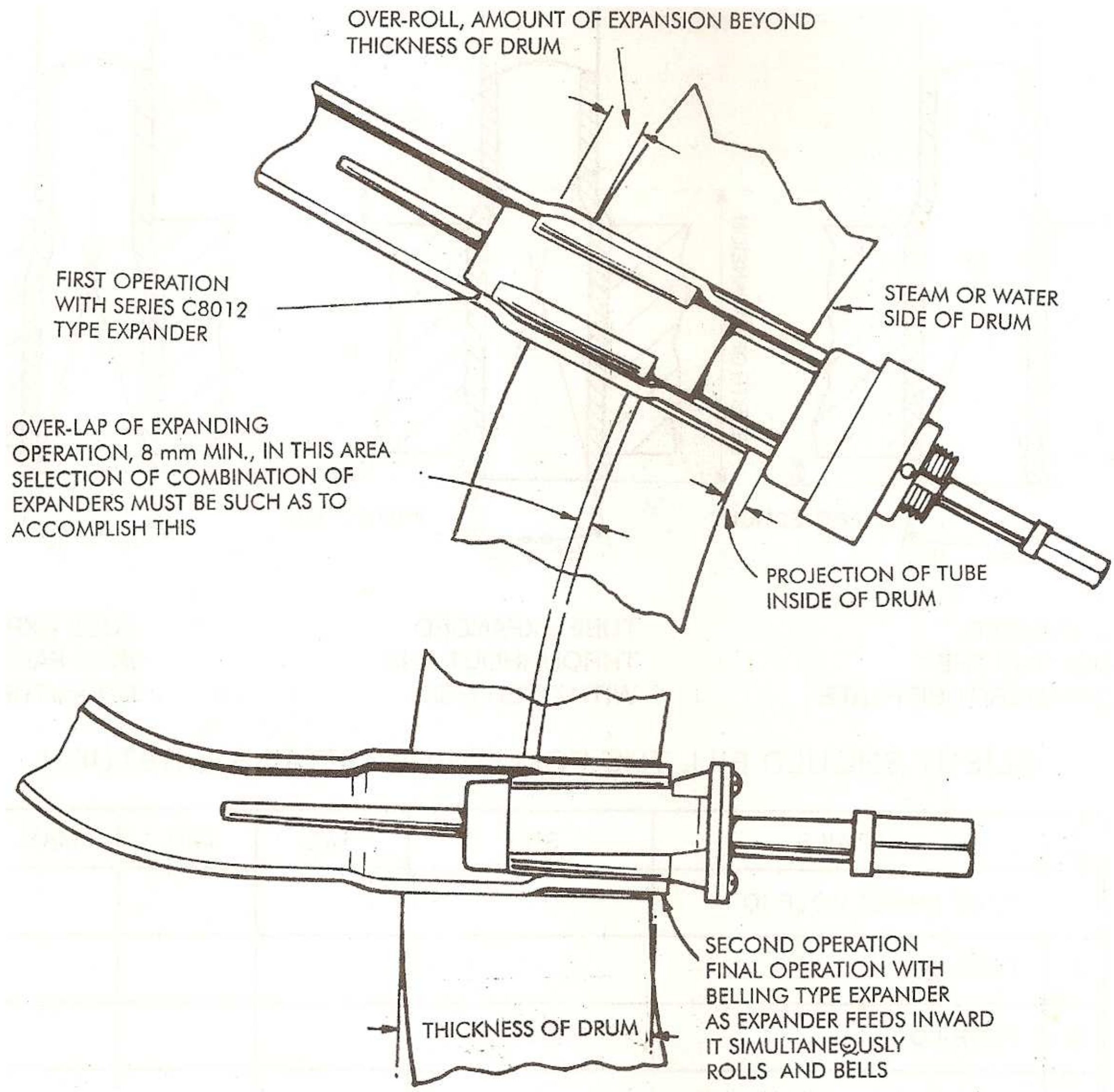
Once the correct torque is determined the same has to be repeatedly applied for all tubes.

One of the widest method of determining tube expansion is to determine the percentage of wall reduction of the tube being expanded. The wall reduction is due to thinning of the tube wall after the tube outer diameter comes into contact with the tube sheet bore during Tube Expansion. Tube walls of non-ferrous tubes in condensers are reduced by 3 to 4 % to get an optimum joint. A wall reduction of 8 to 10% in the case of ferrous tubes in Heat Exchangers is considered optimum, whereas non-ferrous tubes require to be reduced by 8 to 12% due to the pressure involved.

Tube expansion and bell mouthing in two stages in drums of thickness over 65mm



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
1/2”	14	.006”	3/4”	10	.008”	1-1/4”	8	.010”
1/2”	15	.006”	3/4”	11	.008”	1-1/4”	10	.010”
1/2”	16	.006”	3/4”	12	.008”	1-1/4”	12	.009”
1/2”	17	.005”	3/4”	13	.008”	1-1/4”	14	.008”
1/2”	18	.005”	3/4”	14	.008”	1-1/4”	16	.007”
1/2”	19	.004”	3/4”	15	.007”	1-1/4”	18	.006”
1/2”	20	.004”	3/4”	16	.006”			
1/2”	21	.004”	3/4”	17	.005”	1-1/2”	8	.012”
			3/4”	18	.005”	1-1/2”	10	.012”
5/8”	12	.006”	3/4”	19	.005”	1-1/2”	12	.010”
5/8”	13	.006”	3/4”	20	.005”	1-1/2”	14	.010”
5/8”	14	.006”	3/4”	21	.004”	1-1/2”	16	.008”
5/8”	15	.006”	1”	8	.009”	1-1/2”	18	.008”
5/8”	16	.006”	1”	9	.009”			
5/8”	17	.005”	1”	10	.009”	2”	8	.012”
5/8”	18	.005”	1”	11	.009”	2”	10	.012”
5/8”	19	.004”	1”	12	.009”	2”	12	.011”
5/8”	20	.004”	1”	13	.008”	2”	14	.010”
5/8”	21	.004”	1”	14	.008”	2”	16	.008”
			1”	15	.007”	2”	18	.008”
			1”	16	.006”			
			1”	17	.005”			
			1”	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

3/4” 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.

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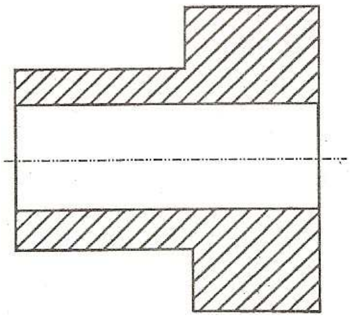
Selection Of Collar

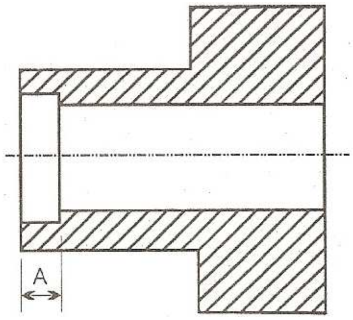
Tube expanders are supplied complete with an adjustable Thrust Collar to provide required adjustments in reach. To ensure smooth operation and long life a high performance Thrust Bearing is incorporated in the Thrust Collar. The Ball Bearing Thrust Collar when contacted with the Tube end, remains stationery, transmitting this thrust load to the ball thrust bearing contained in the Thrust Collar thus eliminating tube end cutting and frictional heating.

Recessed Thrust Collars (see collar chart) can be had at no extra cost. Specify Tube OD and depth of recess required. Small diameter Thrust Collar for tube rolling, in confined areas can be supplied against specific requirements.

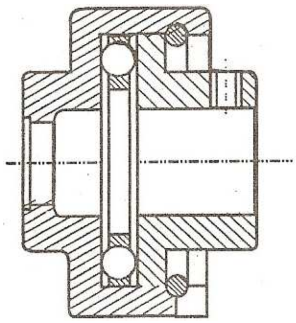
FLUSH COLLAR



RECESS COLLAR

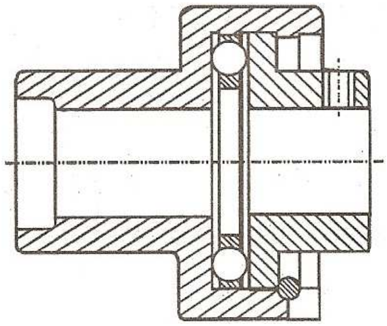


SMALL TUBE COLLAR



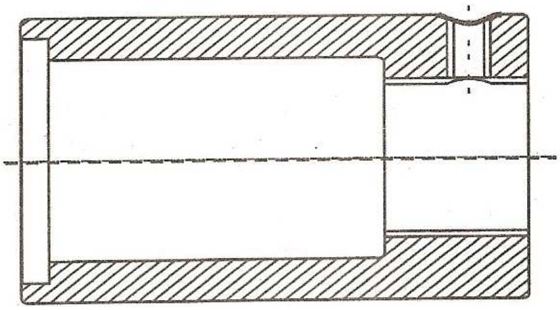
1/4" OD to 3/8" OD Tubes Supplied with Flush

STANDARD BASIC COLLAR



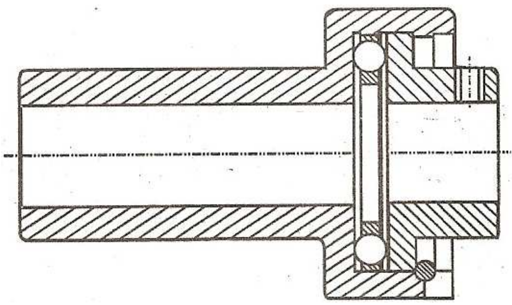
1/2" OD and above Recess Deep 0 to 5.0 mm

CLOSE COLLAR



Small diameter thrust collar which is installed in place of the regular collar, when expanding too close to shell side tubes.

DEEP RECESS COLLAR



Deep recess collars available for all sizes of tube expanders. Projection upto 125 mm

These collars do not contain the thrust bearing but have a ground finish.

Conversion Table

Gauge Number	Imperial Standard		Birmingham Wire & Studs	
	Inches	Mm	Inches	Mm
4/0	.400	10.100	.454	11.530
3/0	.372	9.448	.425	10.795
2/0	.348	8.839	.380	9.652
0	.324	8.229	.340	8.636
1	.300	7.620	.300	7.620
2	.276	7.010	.284	7.213
3	.252	6.409	.259	6.578
4	.232	5.892	.238	6.045
5	.212	5.384	.220	5.588
6	.192	4.876	.203	5.156
7	.176	4.470	.130	4.572
8	.160	4.064	.165	4.190
9	.144	3.657	.148	3.759
10	.128	3.251	.134	3.403
11	.116	2.946	.120	3.048
12	.104	2.640	.109	2.768
13	.092	2.336	.095	2.413
14	.080	2.032	.083	2.108
15	.072	1.828	.072	1.828
16	.064	1.625	.065	1.651
17	.056	1.422	.058	1.473
18	.048	1.219	.049	1.244
19	.040	1.016	.042	1.066
20	.036	0.914	.035	0.889
21	.032	0.812	.032	0.812
22	.028	0.711	.028	0.711
23	.024	0.609	.025	0.635
24	.022	0.558	.022	0.558
25	.020	0.508	.020	0.508
26	.018	0.457	.018	0.457
27	.0164	0.416	.016	0.406
28	.0148	0.375	.014	0.355
29	.0136	0.345	.013	0.230
30	.0124	0.314	.012	0.204
31	.0116	0.294	.010	0.251
32	.0108	0.274	.009	0.228
33	.0100	0.254	.008	0.203
34	.0092	0.233	.007	0.177
35	.0084	0.213	.005	0.127
36	.0076	0.193	.004	0.101

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