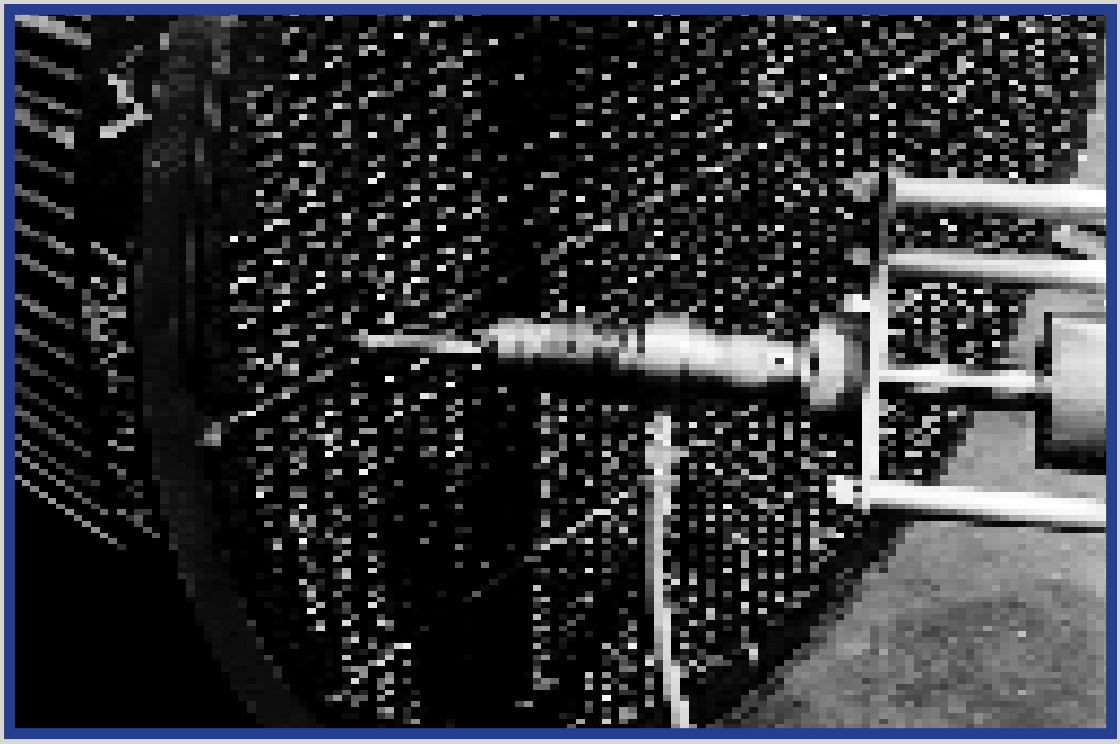
VERNON



Tool Selection Guide

Vernon Tool Company
503 Jones Road, Oceanside, CA 92054
Phone: 619.433.5860 • Fax: 619.757.2233
http://www.vernontool.com

THE CONCEPT OF TUBE EXPANDING

Tube expanding (also referred to as tube rolling) is the cold working of the metal of the tube ends into contact with the tubesheet holes to achieve a pressure tight joint. A tube expander is used to increase the circumference of the tube ends until a proper joint is produced. This can be related to the rolling of steel, since the steel sheet is made thinner and longer. The tube is an endless sheet and the tube expander enlarges the outside and inside diameter of the tube.

A completed tube joint must have the tube larger than the containing metal in the tubesheet hole. The expanded tube joint contains a force trying to make the tube smaller and a force trying to make the tubehole in the tubesheet larger.

As the tube is expanded, the tube wall is thinned and the tube circumference is increased. The tightness at the tube joint will be measured by the increase of the inside diameter or the tube. The following variables determine the proper expansion of a tube.

Clearance between the O.D. of the tube and tubesheet hole
Original tube I.D.
Amount of expansion after tube-to-tubesheet contact
Prethinning of tube wall before tube-to-tubesheet contact

Each of these factors can be measured and determined before the rolling operation begins.

IMPROVED TUBE EXPANDING

The tube of a tubejoint must be larger than the tubehole. The tubejoint contains equal forces trying to make the tube larger and the tubehole smaller. These forces are always equal. A “best” tubejoint is one in which the weaker member is stressed to give a maximum expanding or shrinking force. The equal and opposite force in the other member could be greater.

Expanding beyond the point that develops maximum force in the weaker member of the tube joint is over-rolling. Over-rolling thins the tube more than necessary making a weaker tubejoint, and produces excessive stressing and growth of the tubesheet. Excessive working of the tube also causes undesirable changes in its grain structure, creates excessive work-hardening, and may even produce cracks in the tubes. Flaking of the tubes usually indicates over-rolling. Flakes are thin layers of the tube metal being sheared from the inner surface of the tube by excessive working of the tube.

Expanding tubes thins the tube wall and increases its circumference. If the tightness of the tubejoint is measured by an increase in the tube I.D., it is necessary to consider and compensate for prethinning the tube wall. Prethinning is defined as “tubewall-thinning produced when a tube is enlarged to make it exactly fit in its tubehole.” Prethinning varies with the initial tube-to-tubesheet clearance and with the tubewall thickness.

The tubewall is additionally thinned when the tube is enlarged beyond the metal-to-metal fit in the tubehole to create the interference-fit condition of the tubejoint. This additional thinning is a constant amount when each tubejoint is made to have the same amount of interference-fit beyond the metal-to-metal condition of its members.

The following formulas may be used to figure the amount of prethinning produced in any tubejoint and with any amount of initial clearance between the tube O.D. and the tubehole I.D.

The tube cross-section has a specific area. The area remains constant when the tube is enlarged; therefore, the tube I.D. must increase more than the tube O.D.

If a tube is enlarged so the tube O.D. is exactly the same as the tubehole I.D., then the remainder, subtracting the increase in tube O.D. from the increase in tube I.D., is the amount prethinned. This can be computed by using a table of areas of circles.

1. Tube Area = (Area of circle with diameter the same as tube O.D.) Less (area of circle with diameter the same as tube I.D.)
2. Area of I.D. of Enlarged Tube = (Tubehole area) Less (tube area)
3. I.D. of Enlarged Tube = Diameter of circle having same area as area of I.D. of enlarged tube.
4. Prethinning = (I.D. of enlarged tube) Less (original tube I.D.) minus (tubehole I.D.) less (original tube O.D.)

EXAMPLE #1 - The prethinning for a .625 O.D. x .459 I.D. (5/8 - 14 ga) tube expanded into a .639 I.D. (re-reamed) tubehole is:

1. Tube Area = .3060 - .1655 = .141
2. Area of I.D. of Enlarged Tube = .3207 - .1413 = .1794
3. I.D. of Enlarged Tube = .478
4. Prethinning = (.478 - .459) - (.639 - .625) = .005 inches.

EXAMPLE #2 - Prethinning for same tube expanded into a .631 tubehole is .002 inches.

These results can be verified by expanding a tube when the tube is not inserted into a tubehole. Measuring changes in I.D. and O.D. will show this amount of thinning.

If tubes in Examples #1 and #2 are expanded to get a .006 enlargement of tube I.D., beyond the metal-to-metal fit, to produce the tubejoint tightness. The .006 “additional enlargement” forces some of the joint members to develop the tubejoint-grip.

The actual increase in I.D. for these tubejoints is:

	Example # 1	Example # 2
Clearance	.014	.006
Prethinning	.005	.002
Interference allowance	.006	.006
Total increase in tube I.D.	.025	.014

These examples illustrate the variations in I.D. of properly expanded tubejoints that might occur in any average bundle of tubes. Of particular significance is the range of tube I.D.'s and the difference in actual tightness if prethinning is ignored and tube I.D.'s are enlarged the sum of the clearance and interference allowance without allowance for prethinning.

The following formula simplifies the prethinning calculation.

Prethinning = (T/D-1)(H-T) where T = Tube O.D.
D = Tube I.D.
H = Tubehole I.D.

Using this formula on Example #1,

Prethinning = (.625/.459-1)(.639 - .625)
= (1.362-1)(.014)
= (.362)(.014)
= .005 inches

Further examination of this formula reveals that the first factor can be reduced to a percentage and the second factor reduces to initial clearance; thinning is a percentage of initial clearance. Prethinning for the example shown is 36% of the clearance.

Examination also reveals the “T over D” for a group of same gage tubes will be nearly constant. The percentage, as calculated for one specific tube, will be reasonably precise for any tube in a group of same O.D., same gage tubes. The percentage gives adequately precise results for the usual inspection and quality-control needs.

This formula is useful for verifying the settings on a Vernon Hydraulic Tube Expanding Machine. If inspection shows a tubejoint with minimum clearance and a tubejoint with maximum clearance and both have the same interference-fit; then all tubejoints with clearance between the two limits will also have the same interference-fit, the same tightness.

VERNON TUBE EXPANDING SYSTEM

The Vernon Hydraulic Tube Expanding Machine produces uniformly expanded tubes to any preselected degree of tube joint tightness regardless of tube hole size, variation of the tube dimension or tube material.

Vernon tube expanders have roll slots “in-line” with the length of the tube. A unique feature of in-line rolls is that they provide a significant reduction in the axial extrusion of the tube material. In-line rolls eliminate the hourglass form produced in soft metal tubes and the barrel shape often produced in high strength tubes by self-feeding expanders. Longer tube life is attained with the in-line expanders used by the Vernon system.

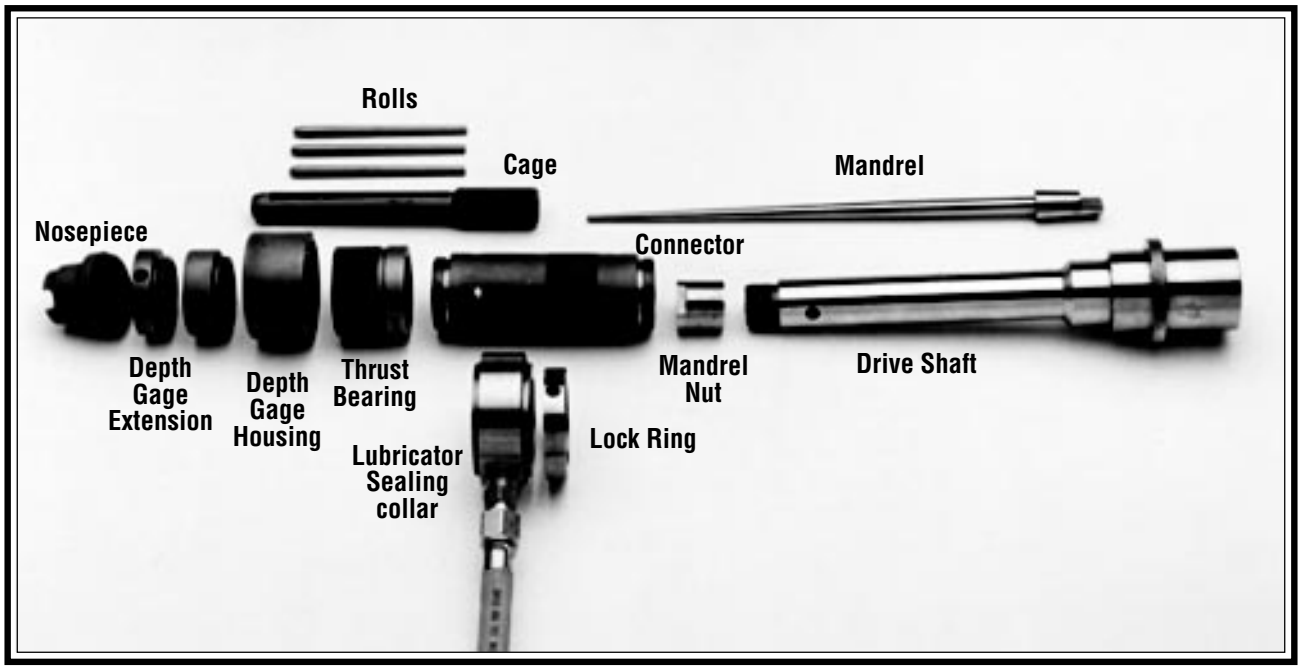
With the Vernon system the mandrel in the tube expander always rotates in one direction and at a constant speed. The mandrel does not stop and its rotation is never reversed. The constantly rotating mandrel is hydraulically moved forward to expand, then back to retract when the expansion is completed.

The tube expanders shown in this guide are standard tools used by the Vernon Hydraulic Tube Expanding Machine. Extended reach or special 4- and 5-roll expanders are available upon request.

Please consult your local representative or the factory for additional information.

VERNON "A" TYPE TUBE EXPANDERS

RANGE - TUBE O.D. - ½" THRU 1¼"



SELECTION GUIDE

TUBE O.D.	G.A.	I.D. Ave. Wall	Effective Roll Length / Maximum Rolling Depth	Expander Part No.	Collapsed Dia.	Expanded Dia.	Roll Part No.	DEPTH GAGE Mandrel Part No.	Housing Part No.	Extensions	Nose Piece
	17	.384	2 3/16	5-11A	.374	.424	½A	3A	L5	E5	4NPA
½	18	.402	↓	4-18A	.387	.450	0A	↓	↓	↓	↓
	19	.416	↓	4-18A	.387	.450	0A	↓	↓	↓	↓
	11	.385	2 3/16	5-11A	.374	.424	½A	3A	L5	E5	5NPA
	12	.407	↓	4-18A	.387	.450	0A	↓	↓	↓	↓
	13	.435	2 7/8	5-13A	.422	.502	1A	5A	↓	↓	↓
	14	.459	↓	5-14A	.452	.515	2A	↓	↓	↓	↓
	15	.481	↓	5-15A	.462	.525	3A	↓	↓	↓	↓
⅝	16	.495	↓	5-16A	.472	.537	4A	↓	↓	↓	↓
	17	.509	↓	5-17A	.488	.551	5A	↓	↓	↓	↓
	18	.527	↓	5-18A	.512	.575	6A	↓	↓	↓	↓
	19	.541	↓	5-18A	.512	.575	6A	↓	↓	↓	↓
	20	.555	3 3/8	6-13A	.534	.611	9A	6A	↓	↓	↓
	21	.561	↓	6.13A	.534	.611	9A	↓	↓	↓	↓
	22	.567	↓	6-13A	.534	.611	9A	↓	↓	↓	↓
	10	.482	2 7/8	5-15A	.462	.525	3A	5A	L5	E6	6NPA
¾	11	.510	↓	5-17A	.488	.551	5A	↓	↓	↓	↓
	12	.532	↓	5-18A	.512	.575	6A	↓	↓	↓	↓

VERNON "A" TYPE TUBE EXPANDERS

TUBE										DEPTH GAGE	
O.D.	G.A.	I.D. Ave. Wall	Effective Roll Length / Maximum Rolling Depth	Expander Part No.	Collapsed Dia.	Expanded Dia.	Roll Part No.	Mandrel Part No.	Housing Part No.	Extensions	Nose Piece
	13	.560	3⅜	6-13A	.534	.611	9A	6A	L5	E6	6NPA
	14	.584		6-14A	.550	.625	10A				
	15	.606		6-15A	.574	.651	11A				
	16	.620		6-16A	.598	.675	12A				
¾	17	.634		6-17A	.610	.687	9A	8A			
	18	.652		6-18A	.626	.703	10A				
	19	.666		6-18A	.626	.703	10A				
	20	.680		6-20A	.652	.729	11A				
	21	.686		6-20A	.652	.729	11A				
	22	.694		6-20A	.652	.729	11A				
	9	.579	3⅜	6-14A	.550	.625	10A	6A	L5	E6	6NPA
	10	.607		6-15A	.574	.651	11A	6A			
	11	.635		6-17A	.610	.687	9A	8A			
	12	.657		6-18A	.626	.703	10A	8A			7NPA
	13	.685		8-9A*	.668	.730	13A	7A			
	14	.709		8-9A	.680	.742	13A				
⅞	15	.731		8-10A	.700	.762	14A				
	16	.745		8-11A	.724	.786	15A				
	17	.759		8-11A	.724	.786	15A				
	18	.777		8-12A	.773	.835	16A				
	19	.791		8-13A	.766	.843	20A	8A			
	20	.805		8-13A	.766	.843	20A				
	21	.811		8-13A	.766	.843	20A				
	22	.819		8-14A	.800	.877	18A				
	8	.670	3⅜	8-8A	.650	.712	12.5A	7A	L8	E6	8NPA
	9	.704		8-9A	.680	.742	13A				
	10	.732		8-10A	.700	.762	14A				
	11	.760		8-11A	.724	.786	15A				
1	12	.782		8-12A	.773	.833	16A				
	13	.810		8-13A	.766	.843	20A	8A			
	14	.834		8-14A	.800	.877	18A				
	15	.856		8-15A	.823	.900	19A	8A			
	16	.870		8-16A	.844	.921	20A	10A	L8	E8	8NPA
	17	.884		8-18A*	.869	.921	18A				

VERNON "A" TYPE TUBE EXPANDERS

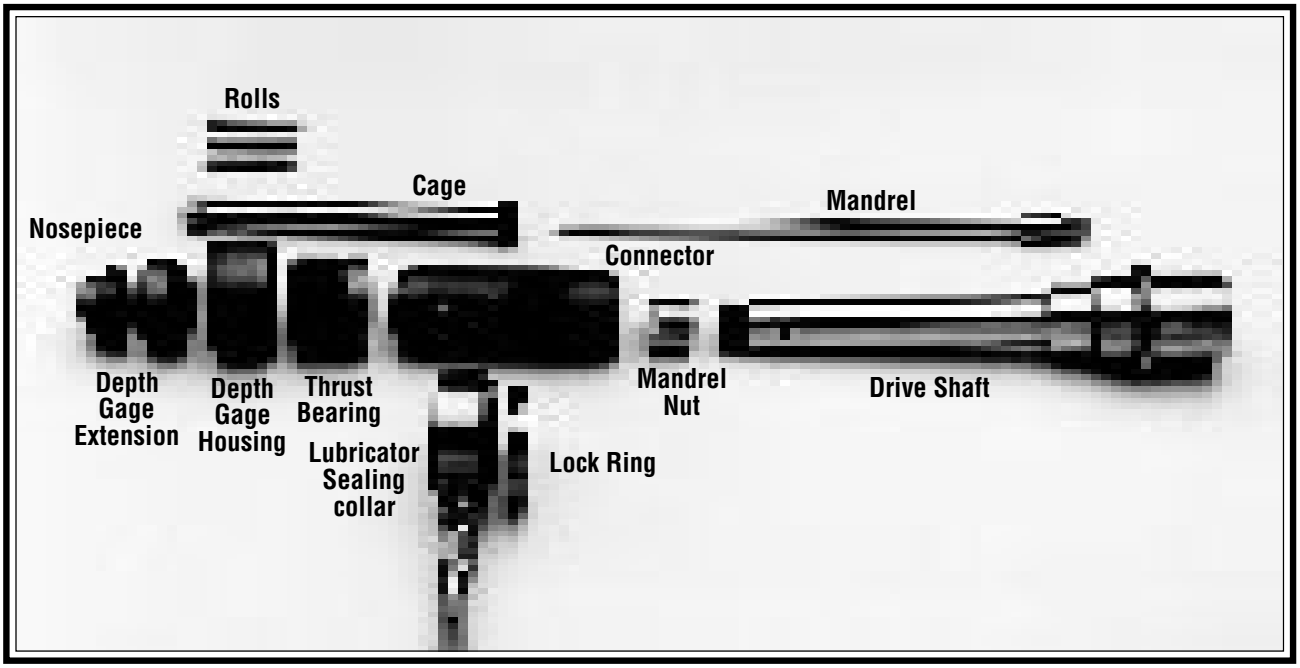
TUBE								DEPTH GAGE			
O.D.	G.A.	I.D. Ave. Wall	Effective Roll Length \ Maximum Rolling Depth	Expander Part No.	Collapsed Dia.	Expanded Dia.	Roll Part No.	Mandrel Part No.	Housing Part No.	Extensions	Nose Piece
	18	.902	3⅜	8-18A	.881	.953	18A	10A	L8	E8	8NPA
	19	.916		8-18A	.881	.958	18A				
1	20	.930		8-20A	.901	.978	19A				
	21	.936		8-20A	.901	.978	19A				
	22	.944		8-20A	.901	.978	19A				
	8	.795	3⅜	8-13A	.766	.843	20A	8A	L8	E8	9NPA
	9	.829		8-14A	.800	.877	18A				
	10	.857		8-15A	.823	.900	19A				
	11	.885		8-18A*	.869	.921	18A	10A			
	12	.907		8-18A	.881	.958	18A				
1⅛	13	.935		10-9A	.923	1.000	21A				
	14	.959		10-9A	.923	1.000	21A				
	15	.981		10-10A	.943	1.020	22A				
	16	.995		10-11A	.975	1.052	23A				
	17	1.009		10-11A	.975	1.052	23A				
	18	1.027		10-12A	.999	1.076	24A				
	8	.920	3⅜	8-18A	.881	.953	18A	10A	L8	E8	10NPA
	9	.954		10-9A	.923	1.000	21A				
	10	.982		10-10A	.943	1.020	22A				
	11	1.010		10-11A	.975	1.052	23A				
1¼	12			10-12A	.999	1.076	24A				
	13	1.060		10-14A	1.047	1.124	26A				
	14	1.084		10-14A	1.047	1.124	26A				
	15	1.106		10-16A	1.095	1.172	28A				

All take Thrust Bearing LTB -¾

Larger sizes available on request.

VERNON "S" TYPE TUBE EXPANDERS

RANGE - TUBE O.D. - ½" THRU 2"



SELECTION GUIDE

TUBE								DEPTH GAGE					
O.D.	G.A.	I.D. Ave. Wall	Effective Roll Length	Maximum Rolling Depth	Expander Part No.	Collapsed Dia.	Expanded Dia.	Roll Part No.	Mandrel Part No.	Housing Part No.	Extensions	Nose Piece	Thrust Bearing
	14	.334	1⅛	5	4.14S	.324	.374	001S	4S	L5	E5	4NP	LTB-¾
½	16	.402			4-16S	.360	.422	½S	3S				
	17	.416			5-11S	.373	.435	½S					
	18	.416			4-18S	.393	.455	0S					
	19	.407			4-18S	.393	.455	0S					
	20	.435	1 3⁄16		5-13S	.426	.485	1S	5S				
	11	.385	1⅛	5	5-11S	.373	.435	½S	3S	L5	E5	5NP	LTB-¾
	12	.407			5-12S	.393	.455	0S					
	13	.435	1 3⁄16		5-13S*	.426	.485	1S	5S				
	14	.459			5-14S	.453	.515	2S					
⅝	15	.481			5-15S	.462	.525	3S					
	16	.495			5-16S	.472	.537	4S					
	17	.509			5-17S	.490	.553	5S					
	18	.527			5-18S	.512	.575	6S					
	*19	.541			5-18S*	.512	.575	6S					
	20	.555	1 7⁄16	5½	6-13S	.534	.611	9S	6S				

**Use ½" Connector Extension*

VERNON "S" TYPE TUBE EXPANDERS

TUBE									DEPTH GAGE				
O.D.	G.A.	I.D. Ave. Wall	Effective Roll Length	Maximum Rolling Depth	Expander Part No.	Collapsed Dia.	Expanded Dia.	Roll Part No.	Mandrel Part No.	Housing Part No.	Extensions	Nose Piece	Thrust Bearing
5/8	21	.561	1 7/16	5 1/2	6-13S	.534	.611	9S	6S	L5	E5	5NP	LTB-3/4
	22	.569	↓	↓	6-13S	.534	.611	9S	↓	↓	↓	↓	↓
	10	.482	1 3/16	5	5-15S	.462	.525	3S	5S	L6	E6	6NP	LTB-3/4
	11	.510	↓	↓	5-17S	.490	.553	5S	↓	↓	↓	↓	↓
	12	.532	↓	↓	5-18S	.512	.575	6S	↓	↓	↓	↓	↓
3/4	13	.560	1 7/16	5 1/2	6-13S	.534	.611	9S	6S	↓	↓	↓	↓
	14	.584	↓	↓	6-14S	.550	.627	10S	↓	↓	↓	↓	↓
	15	.606	↓	↓	6-15S	.574	.651	11S	↓	↓	↓	↓	↓
	16	.620	↓	↓	6-16S	.598	.675	12S	↓	↓	↓	↓	↓
	17	.634	↓	↓	6-17S	.610	.687	9S	8S	↓	↓	↓	↓
	18	.652	↓	↓	6-18S	.626	.703	10S	↓	↓	↓	↓	↓
3/4	19	.666	↓	↓	6-18S	.626	.703	10S	↓	↓	↓	↓	↓
	20	.680	↓	↓	6-20S	.650	.727	11S	↓	↓	↓	↓	↓
	21	.686	↓	↓	6-20S	.650	.727	11S	↓	↓	↓	↓	↓
	22	.964	↓	↓	6-20S	.650	.727	11S	↓	↓	↓	↓	↓
7/8	9	.579	1 7/16	5 1/2	6-14S	.550	.627	10S	6S	L6	E6	7NP	LTB-3/4
	10	.607	↓	↓	6-15S	.574	.651	11S	↓	↓	↓	↓	↓
	11	.635	↓	↓	6-17S	.610	.687	9S	8S	↓	↓	↓	↓
	12	.657	↓	↓	6-18S	.626	.703	10S	↓	↓	↓	↓	↓
	13	.685	↓	↓	8-9S*	.668	.730	13S	7S	↓	↓	↓	↓
	14	.709	↓	↓	8-9S	.680	.742	↓	↓	↓	↓	↓	↓
7/8	15	.731	↓	↓	8-10S	.700	.762	14S	↓	↓	↓	↓	↓
	16	.745	↓	↓	8-11S	.724	.787	15S	↓	↓	↓	↓	↓
	17	.759	↓	↓	8-11S	.724	.787	15S	↓	↓	↓	↓	↓
	18	.777	↓	↓	8-12S	.773	.835	16S	↓	↓	↓	↓	↓
	19	0.791	↓	↓	8-13S	.766	.843	20S	8S	↓	↓	↓	↓
	20	.805	↓	↓	8-13S	.766	.843	↓	↓	↓	↓	↓	↓
	21	.811	↓	↓	8-13S	.766	.843	↓	↓	↓	↓	↓	↓
	22	.819	↓	↓	8-14S	.800	.877	18S	↓	↓	↓	↓	↓
	8	.670	1 7/16	5 1/2	8-8S	.650	.712	12 1/2S	7S	L8	E8	8NP	LTB-3/4
	9	.704	↓	↓	8-9S	.680	.742	13S	↓	↓	↓	↓	↓
1	10	.732	↓	↓	8-10S	.700	.762	14S	↓	↓	↓	↓	↓
	11	.760	↓	↓	8-11S	.724	.787	15S	↓	↓	↓	↓	↓
	12	.782	↓	↓	8-12S	.773	.835	16S	↓	↓	↓	↓	↓

VERNON "S" TYPE TUBE EXPANDERS

TUBE									DEPTH GAGE				
O.D.	G.A.	I.D. Ave. Wall	Effective Roll Length	Maximum Rolling Depth	Expander Part No.	Collapsed Dia.	Expanded Dia.	Roll Part No.	Mandrel Part No.	Housing Part No.	Extensions	Nose Piece	Thrust Bearing
	13	.810	1 7/16	5½	8-13S	.766	.843	20S	8S	L8	E8	8NP	LTB-¾
	14	.834			8-14S	.800	.877	18S	8S				
	15	.856			8-15S	.823	.900	19S	8S				
	16	.870			8-16S	.844	.921	20S	10S				
	17	.884			8-18S*	.869	.946	18S					
1	18	.902			8-18S	.881	.958						
	19	.916			8-18S	.881	.958						
	20	.930			8-20S	.901	.978	19S					
	21	.936			8-20S	.901	.978						
	22	.944			8-20S	.901	.978						
	8	.795	1 7/16	5½	8-13S	.766	.843	20S	8S	L8	E8	9NP	LTB-¾
	9	.829			8-14S	.800	.877	18S					
	10	.857			8-15S	.823	.900	19S					
	11	.885			8-18S*	.869	.946	18S	10S				
	12	.907			8-18S	.881	.958						
1⅛	13	.935	2⅛		10-9S	.923	1.000	21S					
	14	.959			10-9S	.923	1.000	21S					
	15	.981			10-10S	.944	1.017	22S					
	16	.995			10-11S	.975	1.052	23S					
	17	1.009			10-11S	.975	1.052						
	18	1.027			10-12S	.999	1.076	24S					
	8	.920	2⅛	5½	10-9S*	.905	.983	21S	10S	L8	E8	10NP	LTB-¾
	9	.954			10-9S	.923	1.000						
	10	.982			10-10S	.944	1.017	22S					
	11	1.010			10-11S	.975	1.052	23S					
	12	1.032			10-12S	.999	1.076	24S					
1¼	13	1.060			10-14S	1.047	1.124	26S					
	14	1.064			10-14S	1.047	1.124						
	15	1.106			10-16S	1.095	1.172	28S					
	16	1.120			10-16S	1.095	1.172						
	17	1.134			10-17S	1.109	1.186	29S					
	18	1.152			10-18S	1.127	1.204	30S					
1⅜	8	1.045	2⅛	5½	10-12S	.999	1.076	24S	10S	L8	E8	10NP	LTB-¾
	9	1.079			10-14S	1.047	1.124	26S					

VERNON "S" TYPE TUBE EXPANDERS

TUBE									DEPTH GAGE				
O.D.	G.A.	I.D. Ave. Wall	Effective Roll Length	Maximum Rolling Depth	Expander Part No.	Collapsed Dia.	Expanded Dia.	Roll Part No.	Mandrel Part No.	Housing Part No.	Extensions	Nose Piece	Thrust Bearing
	10	1.107	2⅛	5½	10-16S	1.095	1.172	28S	10S	L8	E8	11NP	LTB-¾
	11	1.135			10-17S	1.109	1.186	29S					
1⅜	12	1.157			10-13S	1.127	1.204	30S					
	13	1.185			12-8S	1.161	1.238	32S					
	14	1.209			12-10S	1.200	1.277	33S					
	15	1.231			12-10S	1.200	1.277	33S					
	16	1.245			12-11S	1.226	1.303	34S					
	8	1.170	2⅛	5½	12-8S	1.161	1.238	32S	10S	L8	E8	12NP	LTB-¾
	9	1.204			12-8S	1.161	1.238	32S					
	10	1.232			12-10S	1.200	1.277	33S					
	11	1.260			12-11S	1.226	1.303	34S					
	12	1.282			12-12S	1.250	1.327	35S					
	13	1.310			12-13S	1.266	1.343	36S					
1½	14	1.334			12-14S	1.303	1.380	37S					
	15	1.356			12-15S	1.326	1.403	39S					
	16	1.370			12-16S	1.340	1.417	40S					
	17	1.384			12-16S	1.340	1.417	40S					
	18	1.402			12-18S	1.374	1.451	42S					
	19	1.416			12-18S	1.374	1.451	42S					
	20	1.430			14-9S	1.419	1.579	40S	12S				LTB-1
	8	1.295	2⅛	5½	12-13S	1.266	1.343	36S	10S	L8	E13	13NP	LTB-3/4
	9	1.329			12-14S	1.303	1.380	37S					
	10	1.357			12-15S	1.326	1.403	39S					
	11	1.385			12-18S	1.374	1.451	42S					
1⅝	12	1.407			12-18S	1.374	1.451						
	13				14-9S	1.419	1.579	40S	12S	L15	E14		LTB-1
	14	1.459			14-9S	1.419	1.579						
	15	1.481			14-9S	1.419	1.579						
	16	1.495			14-9S	1.419	1.579						
1¾	9	1.454	2⅛	5½	14-9S	1.419	1.579	40S	12S	L15	E14	14NP	LTB-1
	10	1.482			14-9S	1.419	1.579						
	11	1.510			14-11S	1.491	1.651	41S					

VERNON "S" TYPE TUBE EXPANDERS

TUBE								DEPTH GAGE					
O.D.	G.A.	I.D. Ave. Wall	Effective Roll Length	Maximum Rolling Depth	Expander Part No.	Collapsed Dia.	Expanded Dia.	Roll Part No.	Mandrel Part No.	Housing Part No.	Extensions	Nose Piece	Thrust Bearing
1¾	12	1.532	2⅛	5½	14-11S	1.491	1.651	41S	12S	L15	E14	14NP	LTB-1
	13	1.560			14-11S	1.491	1.651						
	14	1.584			14-11S	1.491	1.651						
	15	1.606			14-16S	1.591	1.751	46S					
	16	1.620			14-16S	1.591	1.751						
	8	1.545	2⅛	5½	14-11S	1.491	1.651	41S	12S	L15	E15	15NP	LTB-1
	9	1.579			14-11S	1.491	1.651						
	10	1.607			14-16S	1.591	1.751	46S					
	11	1.635			14-16S	1.591	1.751						
1⅞	12	1.657			14-16S	1.591	1.751	46S					
	13	1.685		5¼	16-9S	1.635	1.795	49S					
	14	1.709			16-9S	1.635	1.795						
	15	1.731			16-9S	1.635	1.795						
	16	1.745			16-9S	1.635	1.795						
	8	1.670	2⅛	5¼	16-9S	1.635	1.795	49S	12S	L15	E15	16NP	LTB-1
	9	1.704			16-9S	1.635	1.795						
	10	1.732			16-9S	1.635	1.795						
	11	1.760			16-11/15S	1.743	1.903	51S					
2	12	1.782			16-11/15S	1.743	1.903						
	13	1.810			16-11/15S	1.743	1.903						
	14	1.834			16-11/15S	1.743	1.903						
	15	1.856			16-11/15S	1.743	1.903						
	16	1.870			16-16S	1.841	2.001	56S					
	18				16-18S	1.908	2.068	63S					
	20			6	16-20S	1.940	2.160	63S					

**Use ½" Connector Extension*

Roll Overall Length	Effective Roll Length
1½	1¼
1⁹⁄₁₆	1⁵⁄₁₆
1¹³⁄₁₈	1⁹⁄₁₆
2½	2¼

Larger sizes available on request.

Vernon Tube Expanding Equipment

TUBE SIZES
(Birmingham Wire Gage)

O.D. OF Tube	00-.380	0-.340	1-.300	2-.284	3-.259	4-.238	5-.220	6-.203	7-.180	8-.165	9-.148	10-.134	11-.120	12-.109	13-.095	14-.083	15-.072	16-.065	17-.058	18-.049	19-.042	20-.035	21-.032	22-.028	23-.025	24-.022
1/4"																				.152	.166	.180	.186	.194	.200	.206
3/8"																.209	.231	.245	.259	.277	.291	.305	.311	.319	.325	.331
1/2"							.060	.094	.140	.170	.204	.232	.260	.282	.310	.334	.356	.370	.384	.402	.416	.430	.436	.444	.450	.456
5/8"							.185	.219	.265	.295	.329	.357	.385	.407	.435	.459	.481	.495	.509	.527	.541	.555	.561	.569	.575	.581
3/4"							.310	.344	.390	.420	.454	.482	.510	.532	.560	.584	.606	.620	.634	.652	.666	.680	.686	.694	.700	.706
7/8"							.435	.469	.515	.545	.579	.607	.635	.657	.685	.709	.731	.745	.759	.777	.791	.805	.811	.819	.825	.831
1"							.560	.594	.640	.670	.704	.732	.760	.782	.810	.834	.856	.870	.884	.902	.916	.930	.936	.944	.950	.956
1 1/4"							.810	.844	.890	.920	.954	.982	1.010	1.032	1.060	1.084	1.106	1.120	1.134	1.152	1.166	1.180	1.186	1.194	1.200	1.206
1 1/2"							1.060	1.094	1.140	1.170	1.204	1.232	1.260	1.282	1.310	1.334	1.356	1.370	1.384	1.402	1.416	1.430	1.436	1.444	1.450	1.456
1 3/4"							1.310	1.344	1.390	1.420	1.454	1.482	1.510	1.532	1.560	1.584	1.606	1.620	1.634	1.652	1.666	1.680	1.686	1.694	1.700	1.706
2"						1.524	1.560	1.594	1.640	1.670	1.704	1.732	1.760	1.782	1.810	1.834	1.856	1.870	1.884	1.902	1.916	1.930	1.936	1.944	1.950	1.956
2 1/4"	1.490	1.570	1.650	1.682	1.732	1.774	1.810	1.844	1.890	1.920	1.954	1.982	2.010	2.032	2.060	2.084	2.106	2.120	2.134	2.152						
2 1/2"	1.740	1.820	1.900	1.932	1.982	2.024	2.060	2.094	2.140	2.170	2.204	2.232	2.260	2.282	2.310	2.334	2.356	2.370	2.384	2.402						
2 3/4"	1.990	2.070	2.150	2.182	2.232	2.274	2.310	2.344	2.390	2.420	2.454	2.482	2.510	2.532	2.560	2.584	2.606	2.620	2.634	2.652						
3"	2.240	2.320	2.400	2.432	2.482	2.524	2.560	2.594	2.640	2.670	2.704	2.732	2.760	2.782	2.810	2.834	2.856	2.870	2.884	2.902						
3 1/4"	2.490	2.570	2.650	2.682	2.732	2.774	2.810	2.844	2.890	2.920	2.954	2.982	3.010	3.032	3.060	3.084	3.106	3.120	3.134	3.152						
3 1/2"	2.740	2.820	2.900	2.932	2.982	3.024	3.060	3.094	3.140	3.170	3.204	3.232	3.260	3.282	3.310	3.334	3.356	3.370	3.384	3.402						
3 3/4"	2.990	3.070	3.150	3.182	3.232	3.274	3.310	3.344	3.390	3.420	3.454	3.482	3.510	3.532	3.560	3.584	3.606	3.620	3.634	3.652						
4"	3.240	3.320	3.400	3.432	3.482	3.542	3.560	3.594	3.640	3.670	3.704	3.732	3.760	3.782	3.810	3.834	3.856	3.870	3.884	3.902						
4 1/4"	3.490	3.570	3.650	3.682	3.732	3.774	3.810	3.844	3.890	3.920	3.954	3.982	4.010	4.032	4.060	4.084	4.106	4.120	4.134	4.152						
4 1/2"	3.740	3.820	3.900	3.932	3.982	4.024	4.060	4.094	4.140	4.170	4.204	4.232	4.260	4.282	4.310	4.344	4.356	4.370	4.384	4.402						
4 3/4"	3.990	4.070	4.150	4.182	4.232	4.274	4.310	4.344	4.390	4.420	4.454	4.482	4.510	4.532	4.560	4.584	4.606	4.620	4.634	4.652						
5"	4.240	4.320	4.400	4.432	4.484	4.524	4.560	4.594	4.640	4.670	4.704	4.732	4.760	4.782	4.810	4.834	4.856	4.870	4.884	4.902						
5 1/4"	4.490	4.570	4.650	4.682	4.732	4.774	4.810	4.844	4.890	4.920	4.954	4.982	5.010	5.032	5.060	5.084	5.106	5.120	5.134	5.152						

DECIMAL EQUIVALENTS

1/64	.015625	17/64	.265625	33/64	.515625	49/64	.765625
1/32	.03125	9/32	.28125	17/32	.53125	25/32	.78125
3/64	.046875	19/64	.296875	35/64	.546875	51/64	.796875
1/16	.0625	5/16	.3125	9/16	.5625	13/16	.8125
5/64	.078125	21/64	.328125	37/64	.578125	53/64	.828125
3/32	.09375	11/32	.34375	19/32	.59375	27/32	.84375
7/64	.109375	23/64	.359375	39/64	.609375	55/64	.859375
1/8	.125	3/8	.375	5/8	.625	7/8	.875
9/64	.140625	25/64	.390625	41/64	.640625	57/64	.890625
5/32	.15625	13/32	.40625	21/32	.65625	29/32	.90625
11/84	.171875	27/64	.421875	43/64	.671875	59/64	.921875
3/16	.1875	7/16	.4375	11/16	.6875	15/16	.9375
13/64	.203125	29/64	.453125	54/64	.703125	61/64	.953125
7/32	.21875	31/64	.484375	47/64	.734375	63/64	.984375
1/4	.25	1/2	.5	3/4	.75		

SCHEDULE NUMBER
NOMINAL WALL THICKNESS INCHES
NOMINAL INSIDE DIAMETER INCHES

NOMINAL PIPE SIZE INCHES	OUTSIDE DIAMETER INCHES	40	I.D.	80	I.D.	120	I.D.	160	I.D.
1/8	.405	.068	.269	.095	.215				
1/4	.540	.088	.364	.119	.302				
3/8	.675	.091	.493	.126	.423				
1/2	.840	.109	.622	.147	.546				
3/4	1.050	.113	.824	.154	.742			.187	.466
1	1.315	.133	1.049	.179	.957			.218	.614
1 1/4	1.660	.140	1.380	.191	1.278			.250	.815
1 1/2	1.900	.145	1.610	.200	1.500			.281	1.338
2	2.375	.154	2.067	.218	1.939			.343	1.689
2 1/2	2.875	.203	2.469	.276	2.323			.375	2.125
3	3.500	.216	3.068	.300	2.900			.437	2.626
3 1/2	4.000	.226	3.458	.318	3.364				
4	4.500	.237	4.036	.337	3.826	.437	3.626	.531	3.438
5	5.563	.258	5.047	.375	4.813	.500	4.563	.625	4.313
6	6.625	.280	6.065	.432	5.761	.562	5.501	.718	5.189
8	8.625	.322	7.981	.500	7.625	.718	7.189	.906	6.813
10	10.750	.365	10.020	.593	9.564	.843	9.064	1.125	8.500
12	12.750	.406	11.938	.687	11.376	1.00	10.750	1.312	10.126

SIZE	N.C. THREADS PER INCH	N.F THREADS PER INCH
1/4"	20	28
5/16"	18	24
3/8"	16	24
7/16"	14	20
1/2"	13	20
9/16"	12	18
5/8"	11	18
3/4"	10	16
7/8"	9	14
1	8	14
1 1/8"	7	12
1 3/8"	6	12