Tube Fabricating Equipment

Catalog 4290

June 2011R1

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**Tube Fabricating Equipment**

At Parker, we feel that the correct tube selection and installation are key ingredients to building leak-free, reliable systems. Within this catalog is a full compliment of tube cutters, deburring, bending, and assembly equipment for use in installing tubing systems in all types of materials.

Dedication to quality at Parker is second to none. Our resources and vast product line, supported by an ISO 9000 Certified Quality Management System, is available through our worldwide distribution network. For more information regarding our tube fabrication equipment and other products and services, please contact your authorized Parker Instrumentation Distributor or your nearest Parker Sales Office, details found on back page.

So what value does this bring you? Supplying fittings, tube and other complementary products, Parker can be your sole supplier. A single purchase order will streamline your process and bring added value.
# Tube Benders

Parker PTB heavy duty 180° tube bender with a unique indexing handle for 1/4" to 1/2" and 6mm to 12mm tube

- Rollers Reduce Effort and Eliminate Scoring Marks
- Indexing Lever
- Releasing Collar
- Ergonomically Molded Cushion Grips
- Pivoting Tube Lock Hook
- Optimized Tight Bend Radius

For bending soft copper, aluminum, brass, steel stainless steel and other tubing
Features

- New design for accurate and tight bends up to 180° in stainless steel and other tougher metals
- Rollers in bending handle reduce friction and bending effort; eliminate scoring of tubing
- Comfortable and durable ergonomically molded cushion grips
- Vise lug for mounting in vise
- Clamshell packaging available for 1/4", 3/8", 6mm, 8mm and 10mm models
- Patented, quick action trigger release repositions two-stage handle midway through a bend when both handles meet

Dimensions

<table>
<thead>
<tr>
<th>Tube O.D.</th>
<th>Bend Radius</th>
<th>Weight (Kg)</th>
<th>Part Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Imperial</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1/4</td>
<td>9/16</td>
<td>0.54</td>
<td>PTB-4T</td>
</tr>
<tr>
<td>3/8</td>
<td>15/16</td>
<td>1.68</td>
<td>PTB-6T</td>
</tr>
<tr>
<td>1/2</td>
<td>1 1/2</td>
<td>3.45</td>
<td>PTB-8T</td>
</tr>
<tr>
<td>Metric</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>14.3</td>
<td>0.54</td>
<td>PTB-6M</td>
</tr>
<tr>
<td>8</td>
<td>23.8</td>
<td>1.00</td>
<td>PTB-8M</td>
</tr>
<tr>
<td>10</td>
<td>23.8</td>
<td>1.68</td>
<td>PTB-10M</td>
</tr>
<tr>
<td>12</td>
<td>38.1</td>
<td>3.45</td>
<td>PTB-12M</td>
</tr>
</tbody>
</table>

Dimensions in inches (millimeters) are for reference only, subject to change.

How to Order

The correct part number is easily derived from the following number sequence. The two product characteristics required are coded as shown below.

<table>
<thead>
<tr>
<th>Code</th>
<th>Code</th>
<th>Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>PTB</td>
<td>4T</td>
<td>1/4&quot;</td>
</tr>
<tr>
<td></td>
<td>6T</td>
<td>3/8&quot;</td>
</tr>
<tr>
<td></td>
<td>8T</td>
<td>1/2&quot;</td>
</tr>
<tr>
<td></td>
<td>6M</td>
<td>6 mm</td>
</tr>
<tr>
<td></td>
<td>8M</td>
<td>8 mm</td>
</tr>
<tr>
<td></td>
<td>10M</td>
<td>10 mm</td>
</tr>
<tr>
<td></td>
<td>12M</td>
<td>12 mm</td>
</tr>
</tbody>
</table>
Cutting & Deburring Tools

Parker PTC tube cutter for 1/8" to 1-1/8" and 4mm to 28mm O.D. tubing

All tube cutters are 100% factory tested to ensure accurate spiral-free cutting.

The Parker tube cutter cuts stainless steel, soft copper, and aluminium tubing from 1/8" to 1-1/8" and 4 mm to 28 mm O.D.

Features

- Lower profile swing radius – 4-1/4"
- Rollers feature flare cut-off groove to reduce tube loss when damaged flare is removed
- Lightweight die-cast solid aluminium body
- Enclosed hardened steel, thrust bearing feed mechanism for smoothest cutting action and trouble free operation
- Cutter wheels are made of the highest quality wear and abrasion-resistant chromium steel and precision machined to exacting specifications for accurate cutting and long life
- Unique design eliminates spiraling for clean right angle cuts

Mini-Tube Cutter

For those customers working in tight areas or with small size tubing, our Mini-Tube Cutter is the answer. It will work in close spaces on tubing from 1/8" to 5/8". It will work on all materials and the cutterwheel is replaceable.

For tubing sizes 2(1/8" O.D.) to 10 (5/8" O.D.)

Part Number: 635B-MINI TUBE CUTTER

Replacement Part for Tube Cutters

Cutter Wheel for Mini-Tube Cutter: 635B-MINI TUBE CUTTER
Inner-Outer Reaming and Deburring Tools, for 3/16" to 1-1/2" O.D. tubing

A quick twist of the wrist will deburr either the O.D. or the I.D. of the tube end. Parker's deburrer can be used on annealed steel, stainless steel, copper or aluminium, for tube sizes 3/16" to 1-1/2" O.D.

Insert the tube into the convexed end of the deburrer for inside deburring and the opposite end for outside deburring. Rotate in either direction.

Features

- Reams both inside and outside edges of tube with 3 hollow ground cutters
- Tough die cast body
- Deburr both clockwise and counter-clockwise
- Fluted body is shaped to fit comfortably in palm

How to Order – Cutters and Deburrers

The correct part number is easily derived from the number sequence shown at the right.

The two product characteristics required are coded as shown.

<table>
<thead>
<tr>
<th>Code</th>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>PT</td>
<td>C-1010</td>
<td>Cutter</td>
</tr>
<tr>
<td></td>
<td>D</td>
<td>Deburrer</td>
</tr>
<tr>
<td></td>
<td>CE</td>
<td>Exotic Cutter</td>
</tr>
<tr>
<td></td>
<td>CES</td>
<td>Exotic Spare Wheel</td>
</tr>
<tr>
<td></td>
<td>CS</td>
<td>Spare Wheel</td>
</tr>
</tbody>
</table>

Weight: 280g/10oz

Hardened Steel Cutter Blades
Gaugeability Tools

Preassembly Tool

How To Use: Slide nut and ferrule(s) onto tube. Set tube into presetting tool, and bottom tube against shoulder tool. Finger tighten the nut and then tighten the nut 1 turn with a wrench. Remove tube from tool. Advance the nut so it is finger-tight.

Advance the nut 1/2 turn. If torque rise is not felt in 1/4 turn, turn the nut to torque rise, loosen the nut to finger-tight, and makeup nut 1/2 turn.

How to Order

The correct part number is listed in the chart shown at the right.

<table>
<thead>
<tr>
<th>Part Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>4 HAND PRESET TOOL</td>
</tr>
<tr>
<td>6 HAND PRESET TOOL</td>
</tr>
<tr>
<td>8 HAND PRESET TOOL</td>
</tr>
</tbody>
</table>

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Par-Lok Wrench Set

The Par-Lok Wrench Kit includes four 360° snap-action ratchet wrenches that allow fitting installation in tight, hard-to-access locations. Par-Lok wrenches are designed for tightening 7/16, 9/16, 11/16, and 7/8-inch hex nuts (for use with No. 2, 4, 6, and 8 size instrumentation tubing). The wrench handles have the make-up instructions on them.

Part Number: ICD QUICK SET-I

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Inspection Gauge

This compact C-Ring gap gauge is for imperial and metric sizes. It effectively checks the gap dimensions for correct initial make-up. All sizes can be combined on a key ring for easy handling.

How to Order

The correct part number is listed in the charts shown at the right.

<table>
<thead>
<tr>
<th>Part Number</th>
<th>Tube Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 Gap Gauge</td>
<td>1/8</td>
</tr>
<tr>
<td>3 Gap Gauge</td>
<td>3/16</td>
</tr>
<tr>
<td>4 Gap Gauge</td>
<td>1/4</td>
</tr>
<tr>
<td>5 Gap Gauge</td>
<td>5/8</td>
</tr>
<tr>
<td>6 Gap Gauge</td>
<td>3/8</td>
</tr>
<tr>
<td>M10 Gap Gauge</td>
<td>-</td>
</tr>
<tr>
<td>8 Gap Gauge</td>
<td>1/2</td>
</tr>
<tr>
<td>10 Gap Gauge</td>
<td>5/8</td>
</tr>
<tr>
<td>12 Gap Gauge</td>
<td>3/4</td>
</tr>
<tr>
<td>14 Gap Gauge</td>
<td>7/8</td>
</tr>
<tr>
<td>16 Gap Gauge</td>
<td>1</td>
</tr>
</tbody>
</table>

Dimensions in inches (millimeters) are for reference only, subject to change.
Assembly & Remake

1. Parker instrument tube fittings are sold completely assembled and ready for immediate use. Simply insert the tube as illustrated until it bottoms in the fitting body. (If the fitting is disassembled, note that the small tapered end of the ferrule(s) go into the fitting body.)

2. Tighten nut finger tight. Then tighten nut with wrench an additional 3/4 or 1-1/4 turns indicated at left. Hold fitting body with a second wrench to prevent body from turning. It is helpful to mark the nut to facilitate counting the number of turns.

For maximum number of remakes, mark the fitting and nut before disassembly. Before retightening, make sure the assembly has been inserted into the fitting until the ferrule seats in the fitting. Retighten the nut by hand. Rotate the nut with a wrench to the original position as indicated by the previous marks lining up. (A noticeable increase in mechanical resistance will be felt indicating the ferrule is being re-sprung into sealing position.)

Only after several remakes will it become necessary to advance the nut slightly past the original position. This advance (indicated by B) need only be 10°-20° (less than 1/3 of a hex flat).

For Sizes above 16 (1"), the Parker IPD Hydraulic Presetting Tool or Rotary Wrench Tool should be used. Cat. 4290-INST.

**Gaugeability Instructions**

1. From “finger tight” position, wrench 1-1/4 turns for 1/4” to 1” size fittings (6mm to 25mm) (1/16", 1/8", 3/16", 2mm 3mm and 4mm size tube fittings only wrench 3/4 turn from finger tight position). Hold fitting body hex with second wrench to prevent body from turning as you tighten. It is a good idea to mark the nut (scribe or ink) to help you count the turns.

2. Now select the proper size inspection gauge and try to place it, as shown, between the nut and the body hex. If gauge DOES NOT FIT AT ANY POINT between them, you have correctly tightened the nut. If you can slip the gauge into the space, the fitting is not properly made up, and you must repeat the assembly procedure.

*For initial make up only.
Ferrule Presetting Tool

Parker IPD Ferrule Presetting Tool

Ferrule Presetting Components

<table>
<thead>
<tr>
<th>Threads</th>
<th>Size</th>
<th>Part Numbers</th>
<th>Hy-Fer-Set Kit Components</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Body Die</td>
<td>Nut Die</td>
</tr>
<tr>
<td>1/4&quot;</td>
<td>4</td>
<td>4</td>
<td>Size 4 Nut Die</td>
</tr>
<tr>
<td>3/8&quot;</td>
<td>6</td>
<td>6</td>
<td>Size 6 Nut Die</td>
</tr>
<tr>
<td>1/2&quot;</td>
<td>8</td>
<td>8</td>
<td>Size 8 Nut Die</td>
</tr>
<tr>
<td>5/8&quot;</td>
<td>10</td>
<td>10</td>
<td>Size 10 Nut Die</td>
</tr>
<tr>
<td>3/4&quot;</td>
<td>12</td>
<td>12</td>
<td>Size 12 Nut Die</td>
</tr>
<tr>
<td>7/8&quot;</td>
<td>14</td>
<td>14</td>
<td>Size 14 Nut Die</td>
</tr>
<tr>
<td>1&quot;</td>
<td>16</td>
<td>16</td>
<td>Size 16 Nut Die</td>
</tr>
<tr>
<td>1-1/4&quot;</td>
<td>20</td>
<td>20</td>
<td>Size 20 Nut Die</td>
</tr>
<tr>
<td>1-1/2&quot;</td>
<td>24</td>
<td>24</td>
<td>Size 24 Nut Die</td>
</tr>
<tr>
<td>2&quot;</td>
<td>32</td>
<td>32</td>
<td>Size 32 Nut Die</td>
</tr>
</tbody>
</table>

Note: To preset 1" with “B” tool, a size 16 body die adapter must be used

IPD Ferrule Presetting Tool Assembly Instructions

Coupler body in hydraulic ram and pump, is a high pressure, screw together coupler. Thread coupler body onto nipple and each end of hose assembly. No tools required.

Presetting CPI™ /A-LOK® Tube Fitting Ferrules Sizes 1/4" Through 1"

1. Assemble CPI™/A-LOK® nut, CPI™/A-LOK® Ferrule(s) and body die onto tubing as shown in Figure 1. Be sure that the tapered end of the Ferrule(s) point toward the body die.

2. Insert “U-shaped” Nut Die into the back-up plate of the Hydraulic Ram as shown in Figure 2.

3. Insert Tube Assembly, Figure 1 into Nut Die as shown in Figure 3.

4. Close the pressure relief valve on the side of the hand pump. Pump the hand pump until the ram reaches a positive stop. At this point an increase in resistance of the handle will be felt and the nut will bottom against the shoulder of the body die (Figure 4).

5. Release the hydraulic pressure by opening the relief valve on the side of the pump. The ram will automatically return to the original position.

6. The ferrule(s) are now preset on the tubing. Remove the preset assembly and pull the body die off the end of the tubing. (If the body die does not pull off by hand, clamp on the outside of the body die and move the tubing back and forth while pulling.) Do not clamp or pull on the preset ferrule(s) as this could damage a sealing surface.

7. Insert the preset assembly into a fitting body, and make sure the ferrule seats in the fitting. Tighten the nut on the fitting body until finger tight.

8. Tighten the nut with a wrench the additional amount shown in the table at the right for each connection size. (If an increase in torque is not felt early in wrench make-up the preset assembly was not properly seated.) If this happens, tighten the nut with a wrench until the torque increase is felt. Then, loosen nut to the finger tight position, tighten the nut the additional amount shown in the table.

<table>
<thead>
<tr>
<th>Size</th>
<th>Turns</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>1/2</td>
</tr>
<tr>
<td>6</td>
<td>1/2</td>
</tr>
<tr>
<td>8</td>
<td>1/2</td>
</tr>
<tr>
<td>10</td>
<td>1/2</td>
</tr>
<tr>
<td>12</td>
<td>1/2</td>
</tr>
<tr>
<td>14</td>
<td>1/2</td>
</tr>
<tr>
<td>16</td>
<td>1/2</td>
</tr>
</tbody>
</table>

Figure 1

Figure 2

Figure 3

Figure 4
Pre-setting the CPI™ Tube Fitting Ferrules Size 1-1/4", 1-1/2", and 2"

1. Assemble CPI™ nut, CPI™ Ferrule and body die onto tubing as shown in Figure 5. Be sure that the tapered end of the ferrule point toward the body die.

2. Insert “U-shaped” Nut die into the Nut Die Adapter of the Hydraulic Ram as shown in Figure 6.

   **NOTE:** For size 32 the nut die adapter is not needed and must be removed before inserting the nut die.

3. Insert Tube Assembly, Figure 5, into Nut Die as shown in Figure 7.

4. Close the pressure relief valve on the side of the hand pump. Pump the hand pump until the ram reaches a positive stop. At this point an increase in resistance of the handle will be felt and the nut will bottom against the shoulder of the body die Figure 8.

5. Release the hydraulic pressure by opening the relief valve on the side of the pump. The ram will automatically return to the original position.

6. The ferrule(s) are now preset on the tubing. Remove the preset assembly and pull the body die off the end of the tubing. (If the body die does not pull off by hand, clamp on the outside of the body die and move the tubing back and forth while pulling.) Do not clamp or pull on the preset ferrule(s) as this could damage a sealing surface.

7. Insert the preset assembly into a fitting body, and make sure the ferrule seats in the fitting. Tighten the nut on the fitting body until finger tight.

8. Tighten nut with a wrench the additional amount shown in the table at the right for each connection size. If an increase in torque is not felt early in wrench make up the preset assembly was not properly seated. If this happens, tighten the nut with a wrench until torque increase is felt. Then, loosen nut to the finger tight position, tighten nut the additional amount shown in the table.

**PLEASE NOTE:** Pressure ratings for all Parker Hannifin instrumentation fittings are different because tubing thickness can vary widely. All instrumentation fittings are designed so the tubing is always weaker than the fitting. Thus the pressure rating of the fitting is contingent on the pressure rating of the associated tubing.

### Minimum Tubing Lengths

![Diagram of minimum tubing lengths](image)

**Note:** You will need a minimum straight length of tubing ahead of any bend to fit into the presetting tool. See the “L” dimension in the chart for each tube O.D. size.

<table>
<thead>
<tr>
<th>Size</th>
<th>Turns</th>
</tr>
</thead>
<tbody>
<tr>
<td>20</td>
<td>5/8</td>
</tr>
<tr>
<td>24</td>
<td>5/8</td>
</tr>
<tr>
<td>32</td>
<td>3/4</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Tube O.D. (inches)</th>
<th>“L” (inches)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/4</td>
<td>2</td>
</tr>
<tr>
<td>3/8</td>
<td>2-1/8</td>
</tr>
<tr>
<td>1/2</td>
<td>2-3/8</td>
</tr>
<tr>
<td>5/8</td>
<td>2-3/8</td>
</tr>
<tr>
<td>3/4</td>
<td>2-3/8</td>
</tr>
<tr>
<td>7/8</td>
<td>2-1/2</td>
</tr>
<tr>
<td>1</td>
<td>2-5/8</td>
</tr>
<tr>
<td>1-1/4</td>
<td>3</td>
</tr>
<tr>
<td>1-1/2</td>
<td>3-3/8</td>
</tr>
<tr>
<td>2</td>
<td>4-1/4</td>
</tr>
</tbody>
</table>
Instrument Tubing Selection Guide

Parker's instrument tube fittings have been designed to work in a wide variety of applications that demand the utmost in product performance.

Although Parker's Instrument tube fittings have been engineered and manufactured to consistently provide this level of reliability, no systems integrity is complete without considering the critical link, tubing.

This booklet is intended to assist the designer to properly select and order quality tubing.

Proper tube selection and installation, we believe, are key ingredients in building leak-free reliable tubing systems.

General Selection Criteria

The most important consideration in the selection of suitable tubing for any application is the compatibility of the tubing material with the media to be contained. Table 1 lists common materials and their associated general application. Table 1 also lists the maximum and minimum operating temperature for the various tubing materials.

In addition, Parker instrument fittings are designed to work on like materials. Stainless steel fittings should be used only with stainless steel tubing, aluminum fittings with aluminum tubing, etc. The practice of mixing materials is strongly discouraged. The only exception is brass fittings with copper tubing.

Dissimilar materials in contact may be susceptible to galvanic corrosion. Further, different materials have different levels of hardness, and can adversely affect the fittings ability to seal on the tubing.

Table 1

<table>
<thead>
<tr>
<th>Tubing Material</th>
<th>General Application</th>
<th>Recommended Temperature Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stainless Steel</td>
<td>High Pressure, High Temperature, Generally Corrosive Media</td>
<td>-425°F to 1,200°F (-255°C to 605°C)</td>
</tr>
<tr>
<td>(Type 316)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Carbon Steel</td>
<td>High Pressure, High Temperature Oil, Air, Some Specialty Chemicals</td>
<td>-20°F to 800°F (-29°C to 425°C)</td>
</tr>
<tr>
<td>Copper</td>
<td>Low Temperature, Low Pressure Water, Oil, Air</td>
<td>-40°F to 400°F (-40°C to 205°C)</td>
</tr>
<tr>
<td>Aluminum</td>
<td>Low Temperature, Low Pressure Water, Oil, Air</td>
<td>-40°F to 400°F (-40°C to 205°C)</td>
</tr>
<tr>
<td>Monel 400</td>
<td>Recommended for Sour Gas Applications Well Suited for Marine and General Chemical Processing Applications</td>
<td>-325°F to 800°F (-198°C to 425°C)</td>
</tr>
<tr>
<td>Hastelloy C-276</td>
<td>Excellent Corrosion Resistance to Both Oxidizing and Reducing Media and Excellent Resistance to Localized Corrosion Attack</td>
<td>-325°F to 1000°F (-198°C to 535°C)</td>
</tr>
<tr>
<td>Carpenter 20</td>
<td>Applications Requiring Resistance to Stress Corrosion Cracking in Extreme Conditions</td>
<td>-325°F to 800°F (-198°C to 425°C)</td>
</tr>
<tr>
<td>Inconel Alloy 600</td>
<td>Recommended for High Temperature Applications with Generally Corrosive Media</td>
<td>-205°F to 1200°F (-130°C to 650°C)</td>
</tr>
<tr>
<td>Titanium</td>
<td>Resistant to Many Natural Environments such as Sea Water, Body Fluids and Salt Solutions</td>
<td>-75°F to 600°F (-59°C to 315°C)</td>
</tr>
</tbody>
</table>

1. For operating temperatures above 800°F (425°C), consideration should be given to media. 300 Series Stainless Steels are susceptible to carbide precipitation which may lead to intergranular corrosion at elevated temperatures.

2. Consideration should be given to maximum temperature ratings if fittings and/or tubing are coated or plated. All temperature ratings based on temperatures per ASME B31.3 Chemical Plant and Petroleum Refinery Piping Code, 1999 Edition.

The information listed in Table 1 is general in scope. For specific applications, please contact Parker's Instrumentation Products Division, Product Engineering Department (256) 881-2040.

NOTE: Hastelloy® is a registered trademark of Haynes International. Inconel®, and Monel® are registered trademarks of Special Metals Corporation. Carpenter® is a registered trademark of CRS Holdings Inc.
Gas Service

Special care must be taken when selecting tubing for gas service. In order to achieve a gas-tight seal, ferrules in instrument fittings must seal any surface imperfections. This is accomplished by the ferrules penetrating the surface of the tubing. Penetration can only be achieved if the tubing provides radial resistance and if the tubing material is softer than the ferrules.

Thick walled tubing helps to provide resistance. Tables 2–7 indicate the minimum acceptable wall thickness for various materials in gas service. The ratings in white indicate combination of diameter and wall thickness which are suitable for gas service.

Acceptable tubing hardness for general application is listed in Table 9. These values are the maximum allowed by ASTM. For gas service, better results can be obtained by using tubing well below this maximum hardness. For example, a desirable hardness of 80 Rb is suitable for stainless steel. The maximum allowed by ASTM is 90 Rb.

System Pressure

The system operating pressure is another important factor in determining the type, and more importantly, the size of tubing to be used. In general, high pressure installations require strong materials such as steel or stainless steel. Heavy walled softer tubing such as copper may be used if chemical compatibility exists with the media. However, the higher strength of steel or stainless steel permits the use of thinner tubes without reducing the ultimate rating of the system. In any event, tube fitting assemblies should never be pressurized beyond the recommended working pressure.

The following tables (2–7) list by material the maximum suggested working pressure of various tubing sizes. Acceptable tubing diameters and wall thicknesses are those for which a rating is listed. Combinations, which do not have a pressure rating, are not recommended for use with instrument fittings.

### Maximum Allowable Working Pressure Tables

**Table 2**  
316 or 304 Stainless Steel (Seamless)

<table>
<thead>
<tr>
<th>Tube O.D. Size</th>
<th>0.010</th>
<th>0.012</th>
<th>0.014</th>
<th>0.016</th>
<th>0.020</th>
<th>0.028</th>
<th>0.035</th>
<th>0.049</th>
<th>0.065</th>
<th>0.083</th>
<th>0.095</th>
<th>0.109</th>
<th>0.120</th>
<th>0.134</th>
<th>0.156</th>
<th>0.188</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/16</td>
<td>5600</td>
<td>6900</td>
<td>8200</td>
<td>9500</td>
<td>12100</td>
<td>16800</td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1/8</td>
<td>8600</td>
<td>10900</td>
<td>13200</td>
<td>15500</td>
<td>19000</td>
<td>25000</td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3/32</td>
<td>4000</td>
<td>5100</td>
<td>7500</td>
<td>10300</td>
<td></td>
<td></td>
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<tr>
<td>5/32</td>
<td>4100</td>
<td>5000</td>
<td>6400</td>
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<td>7/32</td>
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<tr>
<td>1/4</td>
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<tr>
<td>3/8</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>1/2</td>
<td></td>
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<td></td>
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</tr>
</tbody>
</table>

**Table 3**  
316 or 304 Stainless Steel (Welded)

| Tube O.D. Size | 0.010 | 0.012 | 0.014 | 0.016 | 0.020 | 0.028 | 0.035 | 0.049 | 0.065 | 0.083 | 0.095 | 0.109 | 0.120 | 0.134 | 0.156 | 0.188 |
|---------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| 1/16          | 4800  | 5900  | 7000  | 8100  | 10300 | 14300 |
| 1/8           | 7300  | 9300  | 11300 | 13300 | 17000 |       |
| 3/32          | 4700  | 6400  | 9000  |       |       |       |
| 5/32          | 3400  | 5000  | 6900  |       |       |       |
| 7/32          |       |       |       |       |       |       |
| 1/4           |       |       |       |       |       |       |
| 3/8           |       |       |       |       |       |       |
| 1/2           |       |       |       |       |       |       |
| 5/8           |       |       |       |       |       |       |
| 3/4           |       |       |       |       |       |       |
| 7/8           |       |       |       |       |       |       |
| 1             |       |       |       |       |       |       |
| 1-1/4         |       |       |       |       |       |       |
| 1-1/2         |       |       |       |       |       |       |
| 2             |       |       |       |       |       |       |

*p Parker Hannifin Corporation  
Instrumentation Products Division  
Huntsville, AL USA  
http://www.parker.com/ipdus*
NOTE:
- All working pressures have been calculated using the maximum allowable stress levels in accordance with ASME B31.3, Chemical Plant and Petroleum Refinery Piping Code, 1999 Edition.
- All calculations are based on maximum outside diameter and minimum wall thickness.
- All working pressures are ambient (72°F or 22°C) temperature.

System Temperature
Operating temperature is another factor in determining the proper tubing material. Copper and aluminum tubing are suitable for low temperature media. Stainless steel and carbon steel tubing are suitable for higher temperature media. Special alloys such as Alloy 600 are recommended for extremely high temperatures (see Table 1). Table 8 lists derating factors which should be applied to the working pressures listed in Tables 2–7 for elevated temperature conditions. Simply locate the correct factor in Table 8 and multiply by the appropriate value in Tables 2–7 for elevated temperature working pressure.

EXAMPLE: 1/2 inch x .49 wall seamless 316 stainless steel tubing has a working pressure of 3700 psi @ room temperature. If the system were to operate @ 800°F (425°C), a factor of .80 or (.80) would apply (see Table 8 above) and the “at temperature” system pressure would be 3700 PSI x .80 = 2960 PSI.
Instrument Tubing Selection Guide

Tubing Ordering Suggestions

Tubing for use with Parker instrument fittings must be carefully ordered to insure adequate quality for good performance. Each purchase order must specify the material nominal outside diameter, and wall thickness. Ordering to ASTM specifications insures that the tubing will be dimensionally, physically, and chemically within strict limits. Also, more stringent requirements may be added by the user. All tubing should be ordered free of scratches and suitable for bending.

A purchase order meeting the above criteria would read as follows:

“1/2 x .049 316 stainless steel, seamless, or welded and redrawn per ASTM A-249. Fully annealed, 80 Rb or less. Must be suitable for bending; surface scratches, and imperfections (incomplete weld seams) are not permissible.”

Table 9 lists specific ordering information for each material.

<table>
<thead>
<tr>
<th>Material</th>
<th>Type</th>
<th>ASTM Tubing Spec.</th>
<th>Condition</th>
<th>Max. Recommended Hardness</th>
</tr>
</thead>
<tbody>
<tr>
<td>Copper</td>
<td>K or L</td>
<td>ASTM-B75 B68, B88 (K or L)*</td>
<td>Soft Annealed Temper 0</td>
<td>60 Max. Rockwell 15T</td>
</tr>
<tr>
<td>Carbon Steel</td>
<td>1010</td>
<td>SAE-J524b, J525b, ASTM-A-179</td>
<td>Fully Annealed</td>
<td>72 Rb</td>
</tr>
<tr>
<td>Aluminum</td>
<td>Alloy 6061</td>
<td>ASTM B-210</td>
<td>T6 Temper</td>
<td>56 Rb</td>
</tr>
<tr>
<td>Monel® 400</td>
<td>400</td>
<td>ASTM B-165</td>
<td>Fully Annealed</td>
<td>75 Rb</td>
</tr>
<tr>
<td>Hastelloy® C-276</td>
<td>C-276</td>
<td>ASTM B-622, B-626</td>
<td>Fully Annealed</td>
<td>90 Rb</td>
</tr>
<tr>
<td>Inconel® Alloy 600</td>
<td>600</td>
<td>ASTM B-167</td>
<td>Fully Annealed</td>
<td>90 Rb</td>
</tr>
<tr>
<td>Carpenter® 20</td>
<td>20CB-3</td>
<td>ASTM B-468</td>
<td>Fully Annealed</td>
<td>90 Rb</td>
</tr>
<tr>
<td>Titanium</td>
<td>Commercially Pure Grade 2</td>
<td>ASTM B-338</td>
<td>Fully Annealed</td>
<td>99 Rb 200 Brinell Typical</td>
</tr>
</tbody>
</table>

*B88 Copper Tube to be ordered non-engraved

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9. Loss to Buyer's Property. Any designs, tools, patterns, materials, drawings, confidential information or equipment furnished by Buyer or any other items which become Buyer's property may be considered confidential and may be destroyed by Seller after two consecutive years have elapsed without Buyer placing an order for the items which are manufactured using such property. Seller shall not be responsible for any loss or damage to such property while it is in Seller's possession or control.

10. Special Tools. The purchase price for such tools may be imposed for any special tooling, including without limitation, dies, fixtures, molds and patterns, acquired to manufacture Products. Such special tooling shall be and remain Seller's property notwithstanding payment of any consideration to Buyer. In no event will Seller be required to acquire any interest in such apparatus belonging to Seller which is utilized in the manufacture of the Products, even if such apparatus has been specially converted or adapted for such manufacture and notwithstanding any charges paid by Buyer. Unless otherwise agreed, Seller shall have the right to alter, discard or otherwise dispose of any special tooling or other property in its sole discretion at any time.

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12. Improper use and Indemnity. Buyer shall indemnify, defend, and hold Seller harmless from any claim, liability, damages, lawsuits, and costs (including attorney fees), whether for personal injury, property damage, patent, trademark or copyright infringement or any other claim, brought by or incurred by Buyer, Buyer's employees, or any other person, arising out of: (a) improper selection, improper application or operation of the Product; (b) Buyer's or any other party's negligence or otherwise, of Buyer; (c) Seller's use of patterns, plans, drawings, or specifications furnished by Buyer to manufacture Product; or (d) Buyer's failure to comply with these terms and conditions. Seller shall not indemnify Buyer under any circumstance except as provided herein.

13. Cancellations and Changes. Orders shall not be subject to cancellation or change by Buyer for any reason, except with Seller's written consent and upon terms that are fair to Buyer, indemnify and hold Seller harmless against all direct, incidental and consequential loss or damage. Seller may change product features, specifications, designs and availability with notice to Buyer.

14. Limitation on Assignment. Buyer may not assign its rights or obligations under this agreement without the prior written consent of Seller.

15. Entire Agreement. This agreement contains the entire agreement between the Buyer and Seller and constitutes the final, complete and exclusive expression of the terms of the agreement. All prior or contemporaneous written or oral agreements or negotiations with respect to the subject matter are herein merged.

16. Waiver and Severability. Failure to enforce any provision of this agreement will not waive that provision nor will any such failure prejudice Seller's right to enforce that provision in the future. Invalidation of any provision of this agreement by legislation or other rule of law shall not invalidate any other provision herein. The remaining provisions of this agreement will remain in full force and effect.

17. Termination. This agreement may be terminated by Seller for any reason and at any time by giving Buyer thirty (30) days written notice of termination. In addition, Buyer may by written notice immediately terminate this agreement for the following: (a) Buyer commits a breach of any provision of this agreement (b) the appointment of a trustee, receiver or custodian for all or any part of Buyer's property (c) the filing of a petition for relief in bankruptcy of the other Party on its own behalf, or (d) an assignment for the benefit of creditors, or (e) the dissolution or liquidation of the Buyer.

18. Governing Law. This agreement and the sale and delivery of all Products hereunder shall be deemed to have taken place in and shall be governed and construed in accordance with the laws of the State of Ohio, as applicable to contracts executed and wholly performed therein and without regard to conflicts of laws principles. Buyer irrevocably agrees and consents to the exclusive jurisdiction and venue of the courts of Cuyahoga County, Ohio with respect to any dispute arising out of or relating to this agreement. Disputes between the parties shall not be settled by arbitration unless, after a dispute has arisen, both parties expressly agree in writing to arbitrate the dispute.

19. Indemnity for Infringement of Intellectual Property Rights. Seller shall have no liability for infringement of any patents, trademarks, copyrights, trade dress, trade secrets or similar rights except as provided in this Section. Seller will defend and indemnify Buyer against allegations of infringement of U.S. patents, copyrights, trade dress and trade secrets ("Intellectual Property Rights"). Seller will defend at its expense and will pay the cost of any settlement or damages awarded in an action brought against Buyer based on an allegation that a Product sold pursuant to this Agreement infringes the Intellectual Property Rights of a third party. Seller's obligation to defend and indemnify Buyer is contingent upon Buyer notifying Seller within (10) days after Buyer becomes aware of such allegations of infringement, and Seller having sole control over the defense of any allegations or actions including all negotiations for settlement or compromise. If a Product is subject to a claim that it infringes the Intellectual Property Rights of a third party, Seller may, at its sole expense and option, purchase or Buyer the right to continue using the Product, replace or modify the Product so as to make it noninfringing, or offer to accept return of the Product and return the purchase price less a reasonable allowance for depreciation. Notwithstanding the foregoing, Seller shall have no liability for claims of infringement based upon information provided by, or directed to Products delivered hereunder for which the designs are specified in whole or part by Buyer, or infringements resulting from the modification, combination or use in a system of any Product sold hereunder. The foregoing provisions of this Section shall constitute Seller's sole and exclusive liability and Buyer's sole and exclusive remedy for infringement of Intellectual Property Rights.

20. Taxes. Unless otherwise indicated, all prices and charges are exclusive of excise, examination, use, transfer, and other taxes which may be imposed by any taxing authority upon the manufacture, sale or delivery of Products.

21. Equal Opportunity Clause. For the performance of government contracts and where dollar value of the Products exceed $10,000, the equal employment opportunity clauses in Executive Order 11246, VEVRAA, and 41 C.F.R. §§ 60-1.4(a), 60-741.5(a), and 60-250.4, are hereby incorporated.

01/09
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- Business & general aviation
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- Missiles & launch vehicles
- Regional transports
- Unmanned aerial vehicles

Key Products
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- Fluid conveyance systems
- Fluid metering delivery & atomization devices
- Fuel systems & components
- Hydraulic systems & components
- Inert nitrogen generating systems
- Pneumatic systems & components
- Wheels & brakes

CLIMATE CONTROL

Key Markets
- Agriculture
- Air conditioning
- Food, beverage & dairy
- Life sciences & medical
- Precision cooling
- Processing
- Transportation

Key Products
- CO2 controls
- Electronic controllers
- Filter driers
- Hand shut-off valves
- Hose & fittings
- Pressure regulating valves
- Refrigerant distributors
- Safety relief valves
- Solenoid valves
- Thermostatic expansion valves

ELECTROMECHANICAL

Key Markets
- Aerospace
- Factory automation
- Life science & medical
- Machine tools
- Packaging machinery
- Paper machinery
- Plastics machinery & converting
- Primary metals
- Semiconductor & electronics
- Textile
- Wire & cable

Key Products
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- Electric actuators, gantry robots & slides
- Electrohydraulic actuation systems
- Electromechanical actuation systems
- Human machine interface
- Linear motors
- Stepper motors, servo motors, drives & controls
- Structural extrusions

FLUID & GAS HANDLING

Key Markets
- Aerospace
- Agriculture
- Bulk chemical handling
- Construction machinery
- Food & beverage
- Fuel & gas delivery
- Industrial machinery
- Mobile
- Oil & gas
- Transportation
- Welding

Key Products
- Brass fittings & valves
- Diagnostic equipment
- Fluid conveyance systems
- Industrial hose
- PTFE & PFA hose, tubing & plastic fittings
- Rubber & thermoplastic hose & couplings
- Tube fittings & adapters
- Quick disconnects

HYDRAULICS

Key Markets
- Aerospace
- Aerial lift
- Agriculture
- Construction machinery
- Forestry
- Industrial machinery
- Mining
- Oil & gas
- Power generation & energy
- Truck Hydraulics

Key Products
- Diagnostic equipment
- Hydraulic cylinders & accumulators
- Hydraulic motors & pumps
- Hydraulic systems
- Hydraulic valves & controls
- Power take-offs
- Rubber & thermoplastic hose & couplings
- Tube fittings & adapters
- Quick disconnects

PNEUMATICS

Key Markets
- Aerospace
- Conveyor & material handling
- Factory automation
- Life science & medical
- Machine tools
- Packaging machinery
- Transportation & automotive

Key Products
- Air preparation
- Brass fittings & valves
- Manifolds
- Pneumatic accessories
- Pneumatic actuators & grippers
- Pneumatic valves & controls
- Quick disconnects
- Rotary actuators
- Rubber & thermoplastic hose & couplings
- Structural extrusions
- Thermoplastic tubing & fittings
- Vacuum generators, cups & sensors

PROCESS CONTROL

Key Markets
- Chemical & refining
- Food, beverage & dairy
- Medical & dental
- Microelectronics
- Oil & gas
- Power generation

Key Products
- Analytical sample conditioning products & systems
- Fluoropolymer chemical delivery fittings, valves & pumps
- High purity gas delivery fittings, valves & regulators
- Instrumentation fittings, valves & regulators
- Medium pressure fittings & valves
- Process control manifolds

SEALING & SHIELDING

Key Markets
- Aerospace
- Chemical processing
- Consumer
- Energy, oil & gas
- Fluid power
- General industrial
- Information technology
- Life sciences
- Military
- Semiconductor
- Telecommunications
- Transportation

Key Products
- Dynamic seals
- Elastomeric o-rings
- EMI shielding
- Extruded & precision-cut, fabricated elastomeric seals
- Homogeneous & inserted elastomeric shapes
- High temperature metal seals
- Metal & plastic retained composite seals
- Thermal management

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