C-67-03

PIPING AND TUBING TECHNOLOGY

A COMPILATION

Technology Utilization Division
OFFICE OF TECHNOLOGY UTILIZATION 1967
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
Washington, D.C.

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Foreword

The Administrator of the National Aeronautics and Space Administration has established a technology utilization program for "the rapid dissemination of information . . . on technological developments . . . which appear to be useful for general industrial application." From a variety of sources, including NASA Research Centers and NASA contractors, space-related technology is collected and screened, and that which has potential industrial use is made generally available. Information from the nation's space program is thus made available to American industry, including the latest developments in materials, processes, products, techniques, management systems, and analytical and design procedures.

This compilation is part of a series intended to provide such technical information. A collection of piping and tubing techniques developed by NASA Centers and their contractors to solve problems in these areas is presented in summary form. No claim is made for the novelty of these techniques and implements, but all are believed to be useful and practical.

Additional technical information may be obtained by writing the Technology Utilization Officer listed in the item of interest. Include the reference number (e.g., MFS-639) given at the end of each item, with the inquiry.

GEORGE HOWICK, *Director*
Technology Utilization Division
National Aeronautics and Space Administration

Contents

Section 1—Piping and Tubing Tools

TUBE STRIPPING AND PLATING SYSTEM

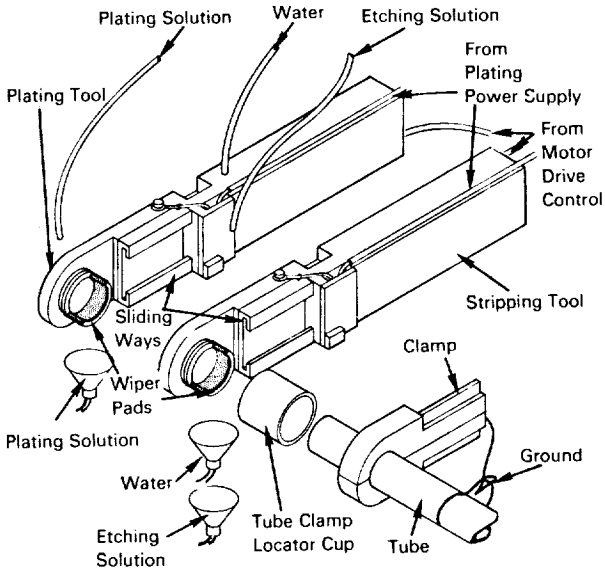
A portable system permits the stripping of plating or solder from tube ends without removing the section from the tubing assembly. Conventional methods have required that the section of tubing be removed and sent to a shop area where the various operations are performed with separate apparatus being needed for each.

To strip the tube end, it is placed in a clamp that is positioned in sliding ways on an assembly that features a power-driven wiper pad and a dc power supply connected to the work area. The wiper pad is moistened with etching solution and rotates in intimate contact about the tube end. The dc power supply imposes a current flow that assists the etchant in removing the plating or solder from the parent metal. After a water rinse, a second etching solution is used in the same manner to assure complete stripping. A second water rinse is used to remove all traces of etchant and prepare the tube end for plating.

The tube end is replated with the desired metal by placing the tube in the plating tool, reversing the dc current polarity, and feeding the plating solution to the wiper pad. Following the plating operation, a water rinse is again used to prepare the wiper pad for the next operation.

Patent status:

Inquiries about obtaining rights for the commercial use of this invention may be made to



NASA, Code GP, Washington, D.C. 20546.
Source: A. V. Millett
of North American Aviation, Inc.
under contract to
Manned Spacecraft Center

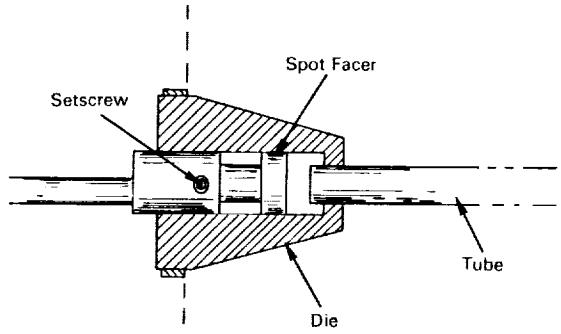
For additional information:
Technology Utilization Officer
Manned Spacecraft Center
Houston, Texas 77058
Reference: MSC-511

EXTENDED DIES IMPROVE FLARE QUALITY

A conical-shaped flaring die permits facing and deburring of tubing close to a bend line, with clearance away from the operating machine. Previously, flat dies were used to hold the metal tubing in the flaring machine. However, tubes with complex return bend configurations could not be processed because of interference with the machine face. Such tubes had to be faced by hand with a file and knife. The new conical-shaped die extends the tube clamping position away from the machine face so that return bend tubing can be accommodated. Benefits include better quality flares, less time consumed in the operation, and a higher safety factor.

The new holding die is a modification of the existing flat-die method of tube flaring. A new shaft is made to hold the spot facer. The spot facer is held in the shaft by a setscrew. The holder is not concentric to the shaft; however, the machine is adjusted to a complementary eccentric motion that causes the spot facer to rotate without any wobble.

This information would be of particular interest to boilermakers and heat-exchanger manufacturers.



Patent status:

Inquiries about obtaining rights for the commerical use of this invention may be made to NASA, Code GP, Washington, D.C. 20546.

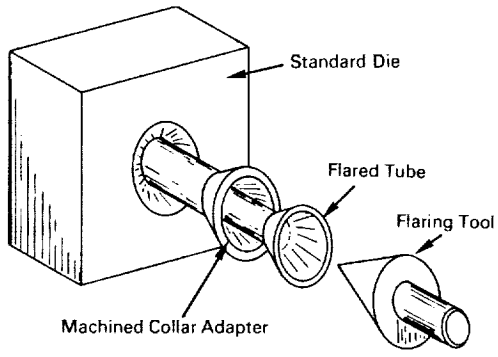
Source: C. W. Seiple and M. Daggett
of North American Aviation, Inc.
under contract to
Marshall Space Flight Center

For additional information:
Technology Utilization Officer
Marshall Space Flight Center
Huntsville, Alabama 35812
Reference: MFS-11208

TUBE FLARING ADAPTER

A new tube flaring die insert adapter prevents cracking and distortion of the tube and ensures correct flare angles during fabrication of nonstandard tubing connections. The adapter permits standard die flaring equipment to be used for tubing of nonstandard size or for flares of various degrees. This eliminates the expense of designing nonstandard flaring dies.

The steel adapter collar is machined to fit over the special sized tubing, and is inserted into a standard die, as shown in the drawing. The collar



also can be machined long enough to shim up the existing gap between an odd size tubing and the next larger standard hole in the die. The tubing to be flared is inserted in the collar and the flare held in the proper position in relation to the flaring tool. The tubing is then flared to the desired degree.

Patent status:

Inquiries about obtaining rights for the commercial use of this invention may be made to NASA, Code GP, Washington, D.C. 20546.

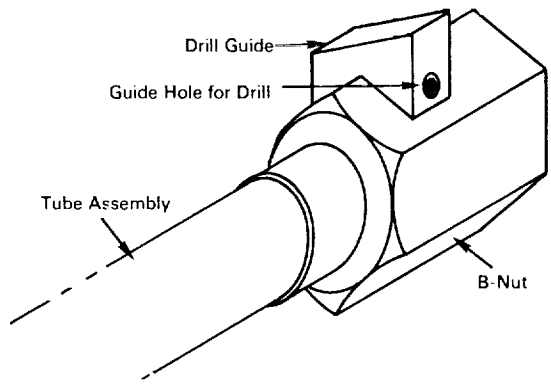
Source: Gordon R. Marray
of North American Aviation, Inc.
under contract to
Manned Spacecraft Center

For addition information:
Technology Utilization Officer
Manned Spacecraft Center
Houston, Texas 77058
Reference: MSC-10034

PORTABLE DRILL GUIDE

A portable drill guide has been produced for drilling holes in B-nuts and fittings where safety wire holes have been omitted or damaged. Hand-drilled holes often are inaccurate and a specific edge distance is difficult to maintain.

The drill guide enables the drill operator to accurately and easily bore the holes in B-nuts. The size of the drill guide is determined by the nut or fitting to be drilled.



Patent status:

Inquiries about obtaining rights for the commercial use of this invention may be made to NASA, Code GP, Washington, D.C. 20546.

Source: G. S. Hollabaugh and W. Farmer
of North American Aviation, Inc.
under contract to
Marshall Space Flight Center

For additional information:
Technology Utilization Officer
Marshall Space Flight Center
Huntsville, Alabama 35812
Reference: MFS-12909

INSTRUMENT TUBING FERRULE PULLER

An impact tool designed to remove sealing ferrules from instrument tubing without damaging them even permits resuse of ferrules which have been crimped onto the tubing.

The flat, yoke-shaped tool has a slot of varying width which accommodates three sizes of ferrules. The tool is made of a material that is softer than that of the ferrule. Soft aluminum is used to make the tool for stainless steel or brass ferrules and Lucite or micarta material is used for copper or aluminum ferrules. The contacting edges of the yoke are slightly rounded to prevent local deformation of the ferrule at the first point of contact.

The user simply positions the tool over the ferrule and makes several light taps on it with a hammer, rotating the tool 30 to 45 degrees with

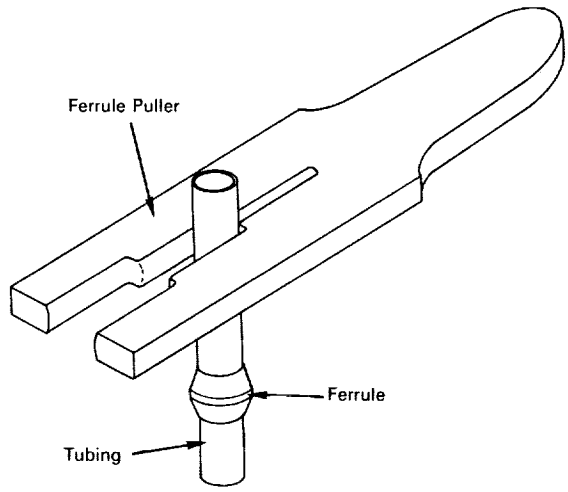
each impact. The impact loosens the ferrule for removal or repositioning.

Patent status:

Inquiries about obtaining rights for the commercial use of this invention may be made to NASA, Code GP, Washington, D.C. 20546.

Source: R. B. Schaus
of North American Aviation, Inc.
under contract to
Marshall Space Flight Center

For additional information:
Technology Utilization Officer
Marshall Space Flight Center
Huntsville, Alabama 35812
Reference: MFS-11533



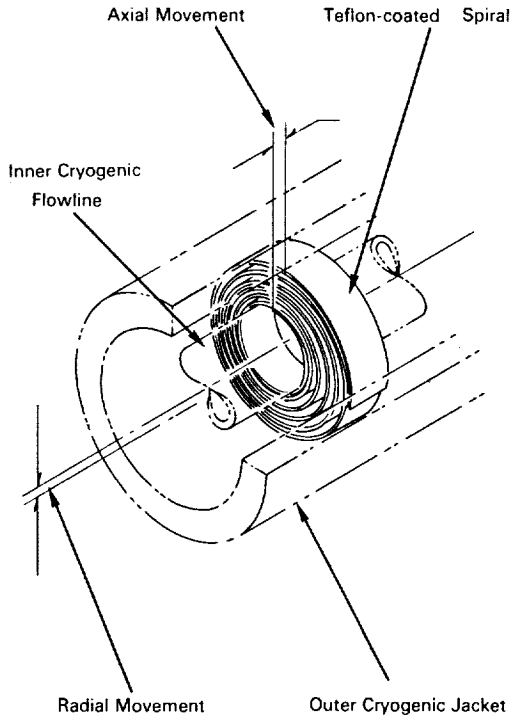
Section 2—Special Piping and Tubing Devices

SPIRAL WOUND STRIPS SUPPORT JACKETED PIPE

A spiral spacer-support for small vacuum-jacketed pipelines has been designed that permits an inner pipe to move axially and radially independently of its vacuum jacket. The spiral also provides thermal insulation between the inner and outer pipelines, even during contraction and expansion, or other movement which might cause the inner pipe to bottom out.

The spiral is fabricated from a 1/2-inch wide strip of 1/16-inch thick stainless steel coated on both sides with Teflon. For a 1-inch pipe inside a 2-inch jacket, a 20-inch strip is wound around a 3/4-inch diameter mandrel with a 5/8-inch deep saw cut (to hold the stainless strip during winding). A sizing guide made from a 1/2-inch wide strip of paper pad cardboard is wound with the stainless steel strip and later removed. Final sizing of the spacer to the piping is accomplished by trimming the exposed end.

A number of the spiral spacers are installed at distances appropriate to support the weight of the inner line. The spiral spacers also can be scaled up to fit larger diameter lines.



Patent status:

Inquiries about obtaining rights for the commercial use of this invention may be made to NASA, Code GP, Washington, D.C. 20546.

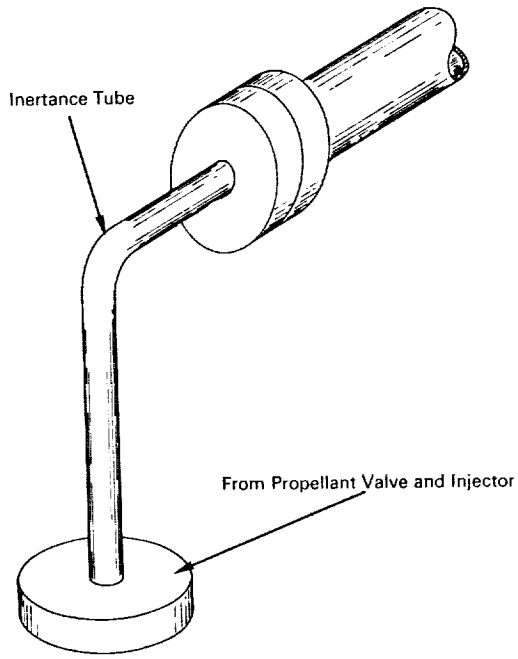
Source: W. M. Bowers
of North American Aviation, Inc.
under contract to
Marshall Space Flight Center

For additional information:
Technology Utilization Officer
Marshall Space Flight Center
Huntsville, Alabama 35812
Reference: MFS-12566

INERTANCE TUBE FOR GAS GENERATOR SYSTEMS

An inertance tube consisting of a length of small cross-section tubing has been designed to reduce buzz-type combustion instabilities associated with gas generator operation. The tube uses the high velocity of the fluid to cancel the force of the pressure waves, and thus does not propagate oscillation energy in either direction. Previously, oscillation problems were reduced by redesigning the injector and feed system.

The inertance tube is installed in the line so that it reflects any pressure waves back to the injector without resonating at any of the natural frequencies of the flame system. The tube is not a tuned device, but the compressibility of the high velocity fluid negates the inertance when the tube is 1/2-wavelength long, so that the highest wave frequency which it will damp fully is that for which the tube is 1/4-wavelength long. The tube has a range instead of just single wavelength capability in the case of a quarter-wave tube.



Patent status:

Inquiries about obtaining rights for the commercial use of this invention may be made to NASA, Code GP, Washington, D.C. 20546.

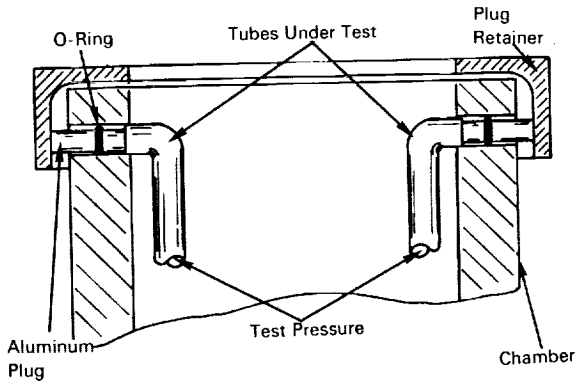
Source: F. A. Jennings
of North American Aviation, Inc.
under contract to
Marshall Space Flight Center

For additional information:
Technology Utilization Officer
Marshall Space Flight Center
Huntsville, Alabama 35812
Reference: MFS-1842

PLUG FIXTURE USED TO LEAK TEST MULTIPLE PORTS

A fixture for hydrostatic pressure testing of tubes uses elastic O-rings to temporarily seal multiple open ports positioned radially in the same plane within the pressure chamber. For such tests, the smooth bore of the tube ports must not be defaced, and no mechanical attachments can be made to the exterior of the ports.

Each tube being tested is fitted with an aluminum plug insert grooved to receive an O-ring. The O-ring forms a seal between the plug and chamber port wall during testing. The plugs are long



enough so that they protrude from the chamber ports for easy removal. To hold the plugs securely in position under the hydrostatic pressure, a circular angle iron retainer ring is placed over the ends of all the plugs. A similar test fixture can be adapted for use with pressure chamber vessels of almost any shape or size.

Patent status:

Inquiries about obtaining rights for the commercial use of this invention may be made to NASA, Code GP, Washington, D.C. 20546.

Source: D. Milanovitch
of Aerojet-General Corporation
under contract to
AEC-NASA Space Nuclear Propulsion Office

For additional information:

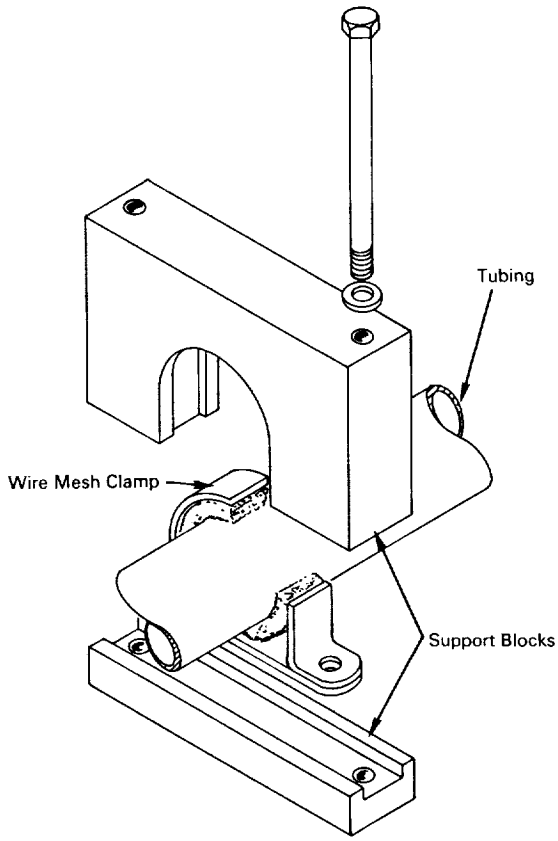
Technology Utilization Officer
AEC-NASA Space
Propulsion Office
U.S. Atomic Energy Commission
Washington, D.C. 20545
Reference: NU-0056

TUBING SUPPORT ACTS AS VIBRATION DAMPER

A tubing support has been designed to protect tubing in pressurized systems that are subjected to high vibrations and high temperatures. Previout methods for supporting tubing of 1/4- to 1-inch diameter under these conditions employed rigid support blocks, often resulting in damage to the lines and tubing. The new technique uses a wire mesh material having a high coefficient of friction which provides sufficient damping capability to prevent tube damage in a high-vibration, high-temperature application.

The new support, shown in the figure, has wire-mesh clamps encircling the tubing within the support blocks. The clamps are secured to the tubing before the support is assembled.

This design was developed as a result of work on rocket engines and has application for similar high-vibration tubing support requirements in nonaerospace applications.



Patent status:

Inquiries about obtaining rights for the commercial use of this invention may be made to NASA, Code GP, Washington, D.C. 20546.

Source: D. E. Kleinert
of North American Aviation, Inc.
under contract to
Marshall Space Flight Center

For additional information:

Technology Utilization Officer
Marshall Space Flight Center
Huntsville, Alabama 35812
Reference: MFS-11920

CABLE-TO-TUBE FASTENER PROTECTS BOTH

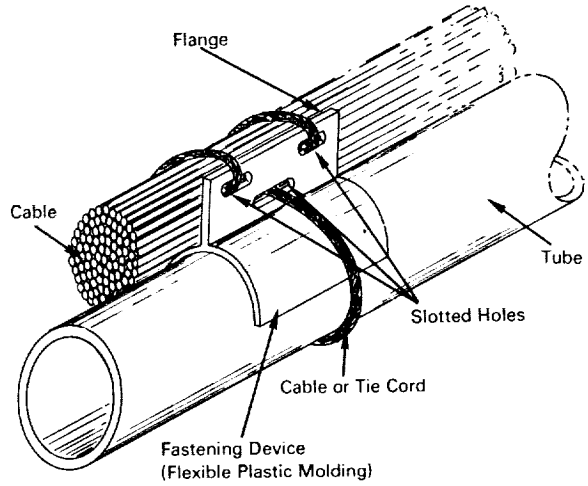
A fastener made of molded flexible plastic permits cable to be held snugly to tubing thereby reducing or preventing damage to either which might occur when the assembly is subjected to torsional stresses. The design and flexibility of the plastic fastener permit it to be used to hold any size of tubing and cable.

There are two ways in which the fastener can be used. It can be fastened first to a tube by means of a tie cord passed through a slotted hole in its vertical flange, then the cable may be attached alongside the flange. When used in this way, the fastener provides some insulation between the cable and the tube. The fastener also can be used to encompass both the cable and the tube, when they are attached to each other, to act as a suspension medium from a structure.

Patent status:

Inquiries about obtaining rights for the commercial use of this invention may be made to NASA, Code GP, Washington, D.C. 20546.

Source: W. E. Pierce



For additional information:

Technology Utilization Officer
Jet Propulsion Laboratory
4800 Oak Grove Drive
Pasadena, California 91103
Reference: JPL-752

Section 3—Special Piping and Tubing Techniques

TUBE TAPERING BY ELECTROCHEMICAL PROCESS

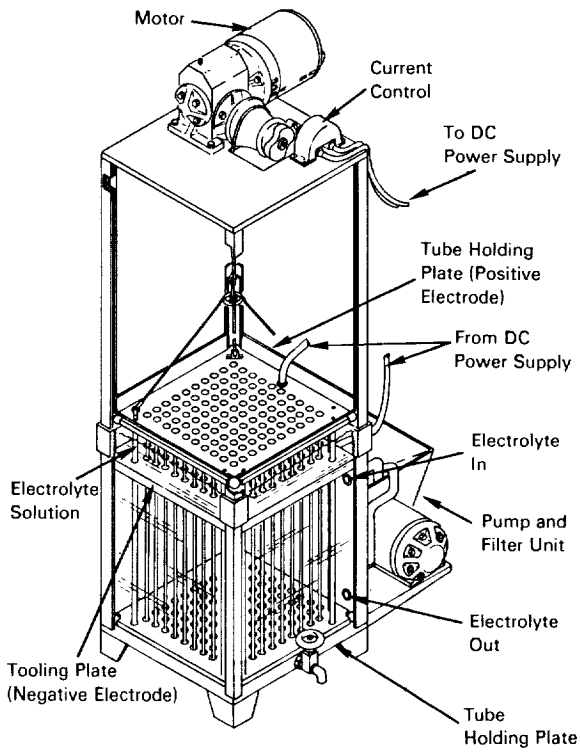
An electrochemical process tapers tubes on the outside diameter only, without inducing internal stresses and strains which result in distortions of the metal. Also, small diameter, thin-wall tubing is usually difficult to machine due to its lack of rigidity.

The lower portion of the tube tapering unit contains a watertight enclosure in which the tubes are inserted vertically through a tooling plate. The tubes are plugged at both ends and held to tube holding plates by O-rings. The top tube holding plate and tubes are electrically designated as the anode (or positive terminal), while the tooling plate is the cathode (or negative terminal). An electrolyte is circulated through the enclosure containing the tubes. By adjusting the current applied from the anode to the cathode, the metal is removed from the tubes at varying rates by a deplating process. Synchronizing the withdrawal rate of the tubes and the applied electrical current produces tapers of any desired configuration on the outside diameter of the tube.

Patent status:

Inquiries about obtaining rights for the commercial use of this invention may be made to NASA, Code GP, Washington, D.C. 20546.

Source: Howard D. Lesher
of North American Aviation, Inc.
under contract to
Marshall Space Flight Center



For additional information:

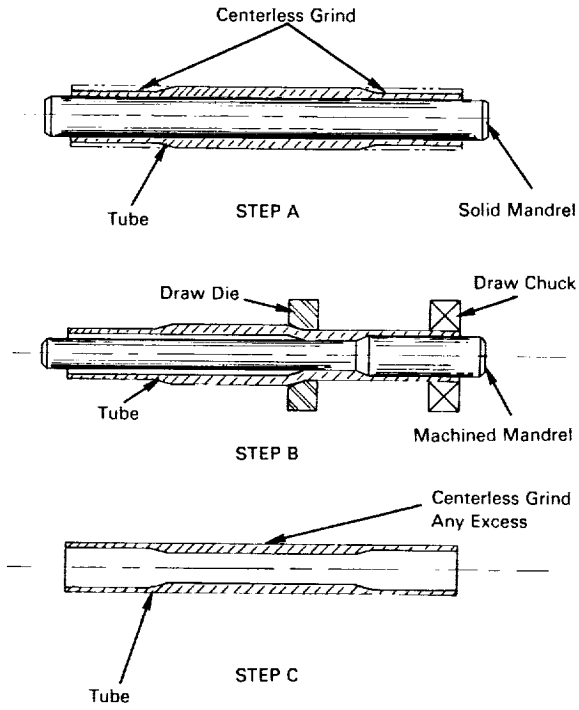
Technology Utilization Officer
Marshall Space Flight Center
Huntsville, Alabama 35812
Reference: MFS-747

TUBE SIZING PROCEDURE CHANGES INTERNAL CONFIGURATION

An economical tube sizing procedure has been devised for producing an accurate, constant outer-diameter tube having a stepped inner-diameter wall thickness. The method involves grinding the desired internal configuration on the outer diameter of the tube, and transferring it to the inner diameter by means of a drawing operation.

The procedure involves the three-step operation shown in the figure. A solid steel mandrel is inserted into the tube to remove any ovality or out-of-round variations, and the outer diameter is centerless ground to the desired specifications, as shown in Step A. A mandrel of the shape desired is then inserted in the tube, and the tube is pulled through a draw die to transfer the configurations from the outer diameter to the inner diameter (Step B). In the final operation (Step C), the tube is centerless ground to remove any extra wall thickness.

This method can be used by tube manufacturers (for metallic or plastic tubes) to produce accurate internal configurations.



Patent status:

Inquiries about obtaining rights for the commercial use of this invention may be made to NASA, Code GP, Washington, D.C. 20546.

Source: C. F. Kennedy
of North American Aviation, Inc.
under contract to
Marshall Space Flight Center

For additional information:
Technology Utilization Officer
Marshall Space Flight Center
Huntsville, Alabama 35812
Reference: MFS-12158

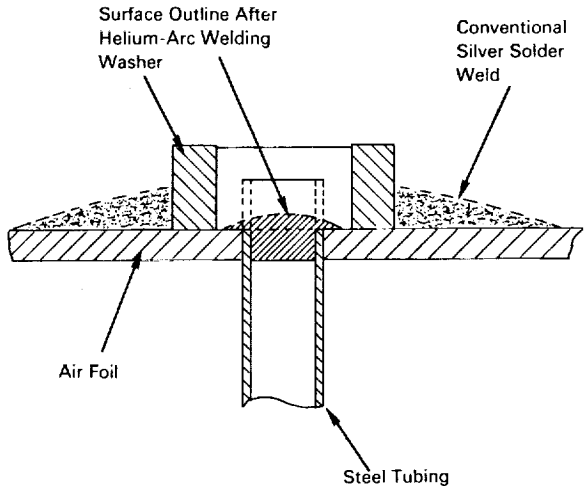
ORIFICE TUBING INSTALLATION SIMPLIFIED

A method using helium arc welding has been devised to permit air-flow orifice tubing to be installed in wind-tunnel airfoil models, without causing dimples or distortions in the airfoil surface. The previous method of tubing installation used silver-soldering techniques. These techniques resulted in airfoil surface distortion, poor mechanical bonding, and excessive slag deposits.

The drawing shows the difference between helium arc welding over the silver soldering technique. In the helium arc method, a small metal washer is employed as a welding guide or dam. The washer restricts the amount of welding residue which is deposited on the airfoil surface, and also functions as a heat sink.

The tubing is inserted through the drilled orifice in the airfoil. The washer is positioned around the orifice and the projecting tubing is melted by the heat of the helium arc process into the orifice. A hole, corresponding to the inside diameter of the tubing, then is drilled through the welded area. The airfoil surface surrounding the drilled hole is then machined to the proper plane.

Source: C. Thiele



For additional information:

Technology Utilization Officer
Langley Research Center
Langley Station
Hampton, Virginia 23365
Reference: LAR-10029

ROLLING TUBING INTO COILS

A quick and efficient method has been developed for rolling long lengths of small diameter soft copper tubing into small diameter coils. The method permits sections of tubing of up to 50 feet in length to be rolled into coils without damage to the tube.

The former procedure of rolling coils included filling and packing the small diameter tubing with sand, prior to the bending operation. This procedure thereby limited the tubing length to no more than 25 feet. Also, extensive cleaning was required to remove the sand from the formed coil.

In the new method, the tubing is filled with water and hydrostatically pressurized. A pressure of 1000 psi is used for tubing having 0.035-inch wall thickness, and 3/8- to 1/2-inch outer diameter. The tubing then can be rolled without distortion or crimping. Also, the new method eliminates the need for cleaning the coiled tubing.

Source: M. E. Call

For additional information:
Technology Utilization Officer
Langley Research Center
Langley Station
Hampton, Virginia 23365
Reference: LAR-216

Section 4—Piping Joints and Disconnects

MACHINED BELLOWS FOR HIGH PRESSURE SYSTEMS

A low height bellows has been designed for high pressure, large flowrate, connector systems to provide greater flexibility in gimbal joints.

The compact bellows is constructed from stainless steel alloy to provide a gimbal joint which permits manual operation in a corrosive environment. The bellows convolution is machined for heavy roots and crests to withstand hoop pressures (figure A); and the sidewalls are thin to allow a higher cycle life. In addition, the bellows is compressed axially at approximately 35,000 psig to give it a permanent set that lowers operating stresses and increases stability.

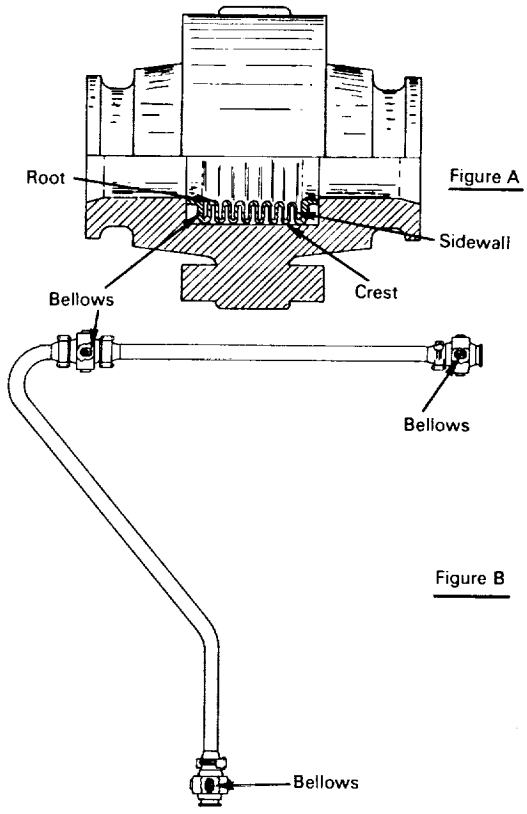
Figure B shows a configuration of three gimbal joints, each using the bellows to provide the major portion of angulation for the entire connector system. The system provides an angulation capability equivalent to a twelve inch cube, with each bellows able to withstand 50,000 angulations at 10,000 psig operating pressure.

Bellows of this type could be used in gimbal joints and pressure balance compensators of high pressure piping systems, such as those used in the chemical and petroleum industries.

Patent status:

Inquiries about obtaining rights for the commercial use of this invention may be made to NASA, Code GP, Washington, D.C. 20546.

Source: International Harvester Company
under contract to
Kennedy Space Center



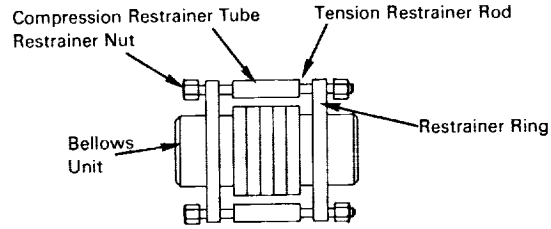
For additional information:

Technology Utilization Officer
Kennedy Space Center
Kennedy Space Center, Florida 32899
Reference: KSC-09952

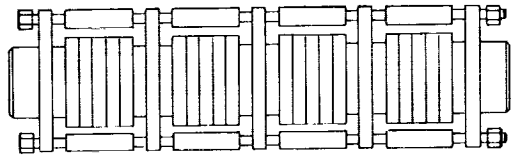
MODULAR EXPANSION JOINT REPAIR KIT

A modular repair kit for expansion joints in cryogenic transfer lines permits replacement in the line while requiring a minimum amount of spares to be kept in stock. With the modular kit, a determined number of "building block" bellows can be used singly or in multiples to replace any joint in the system. Previously, to minimize system downtime for the replacement of joints, a complete set of spares had to be kept on inventory, involving a high investment.

Content of the kit is determined by the characteristics of each expansion joint in the system and the "lowest common denominator" bellows that satisfies the smallest travel requirement when used singly, or the largest travel requirement when used in multiples. For example, the figure shows both the simplest and most complex joints in a particular 6-inch liquid oxygen transfer line containing 13 dissimilar expansion joints. The modular repair kit for this system consists of the following components: two single bellows units, each with one restrainer ring; one dual bellows unit with three restrainer rings; and one separate restrainer ring. These components, used singly or all welded together, can be used to make either joint shown in the figure or a joint intermediate to either.



Simple Joint



Complex Joint

Patent status:

Inquiries about obtaining rights for the commercial use of this invention may be made to NASA, Code GP, Washington, D.C. 20546.

Source: R. M. Kuhar
of North American Aviation, Inc.
under contract to
Marshall Space Flight Center

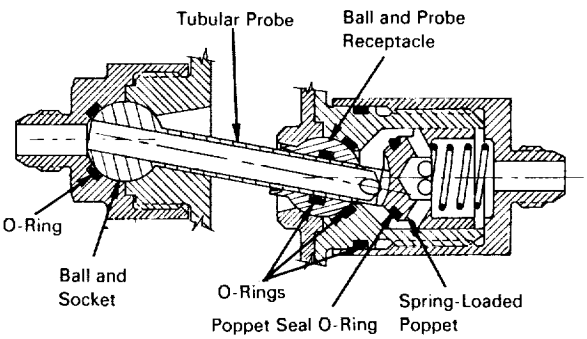
For additional information:
Technology Utilization Officer
Marshall Space Flight Center
Huntsville, Alabama 35812
Reference: MFS-11758

DISCONNECT JOINT PERMITS HIGH MISALIGNMENT

A new disconnect joint provides uninterrupted high-pressure fluid flow past a large relative movement interface. The joint accommodates angular misalignments, and replaces the less rugged flexible hose which usually is applied in such case.

The disconnect, constructed of aluminum, is a double ball and socket spherical joint arrangement. One ball is attached to a tubular probe. The probe fits into a receptacle in the other ball and socket which also is equipped with a spring loaded poppet. The poppet is controlled by the probe, being forced open for fluid flow when the two parts are mated and closed when the probe is removed so that further fluid flow is stopped.

The prototype joints which were tested have ±10 degree angular, and 0.58-inch lateral misalignment capability. The ball, socket, and other working parts have a hard anodic coating 0.001 inch in thickness. Standard O-rings are used for all seals. The poppet conical seal, installed under 35% diametral compression was found to be 100% effective at pressures of up to 3360 psi. This type of joint may be used in many applications as a quick disconnect device or where misalignment in pneumatic or hydraulic pressure lines may occur.



Patent status:

Inquiries about obtaining rights for the commercial use of this invention may be made to NASA, Code GP, Washington, D.C. 20546.

Source: E. H. Bock
of General Dynamics Corporation
under contract to
Lewis Research Center

For additional information:
Technology Utilization Officer
Lewis Research Center
21000 Brookpark Road
Cleveland, Ohio 44135
Reference: LEW-10002

MOUNTING ASSEMBLY AIDS INSTALLATION OF FLUID LINE DISCONNECTS

An adjustable mounting assembly for fluid line disconnects has clearances to provide for misalignment or differential movement between the support and the mating parts of the disconnect, and thereby facilitates its mounting or installation. The assembly also provides a mechanical means of pushing together the mating parts of the disconnect.

The mounting assembly, shown in the figure along with the mating sections of a fluid line disconnect, consists of a mounting bushing, an adjusting support ring, a lock ring, a boot, and a boot retainer. The parts are used to install a disconnect onto a plate by the following procedure: First, the mounting bushing is bolted onto the plate. The adjusting support ring is then screwed into the mounting bushing until its threads bottom out. The lock ring and boot are positioned onto the disconnect receptacle and the receptacle is inserted through the adjusting support ring and engaged with the disconnect socket. The adjusting support ring is then backed out (rotated counterclockwise) until its flange touches the disconnect flange on the disconnect receptacle. The adjusting support ring is screwed back in two turns so that enough clearance is provided for thermal shrinkage which may occur during the loading of cryogenic fluids. While the adjusting support ring is

held firmly, the lock ring is screwed into it until the lock ring just touches the disconnect flange. The boot is then bolted to the lock ring by the boot retainer.

The contact between the lock ring and disconnect flange prevents inadvertent unlocking of the disconnect by vibration. If the disconnect is difficult to lock together, it may be mated to the socket by screwing the lock ring into the adjusting support ring.

The mounting assembly may be used in any piping system where disconnects are used.

Patent status:

Inquiries about obtaining rights for the commercial use of this invention may be made to NASA, Code GP, Washington, D.C. 20546.

Source: P. L. Clemensen and J. P. Doelger of North American Aviation, Inc. under contract to Marshall Space Flight Center

For additional information:

Technology Utilization Officer
Marshall Space Flight Center
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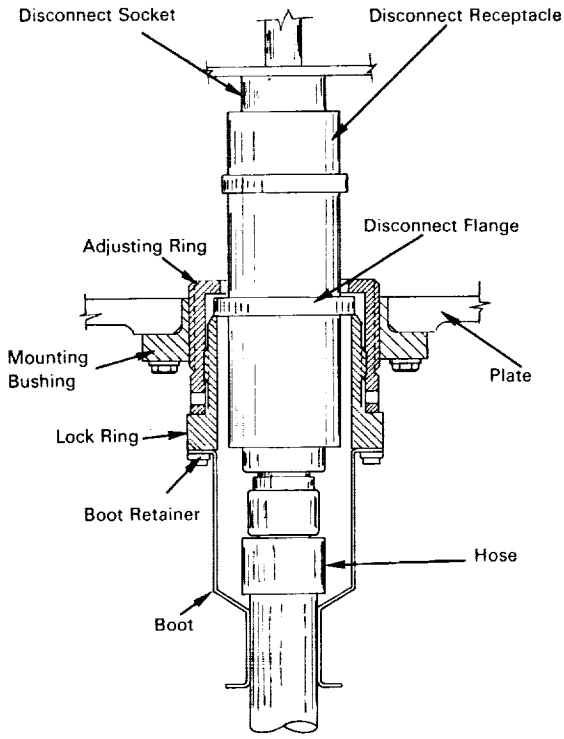
Reference: MFS-11565



LOW PRESSURE PNEUMATIC QUICK DISCONNECT

A quick release device disconnects soft plastic tubing from rigid metal tubing in vacuum or low-pressure lines. A simple version consists of a hard washer that has an outer diameter large enough to be pushed by a workman's fingers, as shown in Figure A. This disconnect is useful especially in cases where base clamps have partially fused the soft tubing or hose to the rigid surface of the mating tubing.

Figure B shows a quick disconnect that uses a formed wire stripper and a lanyard to release the soft tubing from a metal mating surface. A short section of plastic tubing is attached permanently

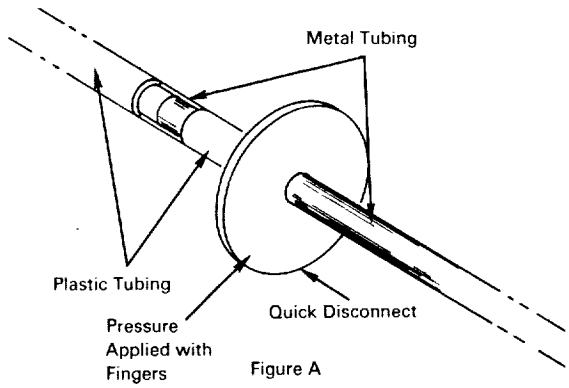


Figure A

with a clamp to one end of an open tube line. The stripper and lanyard are placed on the connecting tube line so that when the lanyard is pulled, the stripper compresses the plastic tubing against the clamp. This causes the inner diameter of the plastic to stretch and increase, thereby permitting it to slide off the mating metal tube.

Variations of this device can be used on tubing in situations that require frequent dissassembly, cleaning, or sterilizing.

Source: R. M. Overdeer
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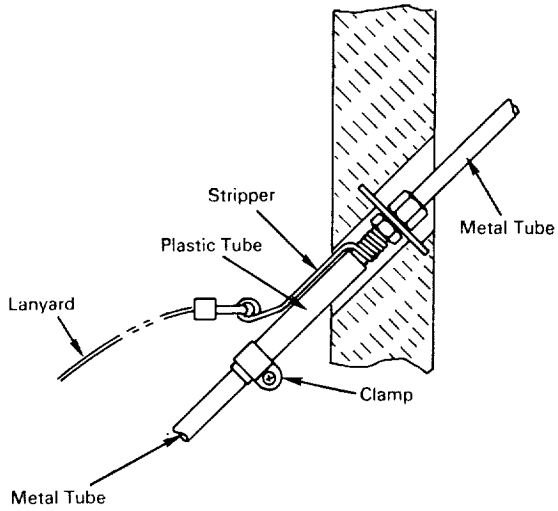

Figure B

NASA-Langley, 1967