NASA SP-5903 (02)

TECHNOLOGY UTILIZATION

PIPING AND TUBING TECHNOLOGY

A COMPILATION

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

Foreword

The National Aeronautics and Space Administration has established a Technology Utilization Program for the dissemination of information on technological developments which have potential utility outside the aerospace community. By encouraging multiple application of the results of its research and development,. NASA earns for the public an increased return on the investment in aerospace research and development programs.

This publication is part of a series intended to provide such technical information. The devices, methods, and techniques presented have resulted from the great variety of requirements that have been encountered in the aerospace program. The handling of fluids has encompassed a wide range of materials, and has covered a spectrum from low to high pressures and from cryogenic to elevated temperatures.

The document is divided into four sections. The first section includes a number of fittings, couplings, and connectors that have been useful in joining tubing and piping and various systems. Section two presents a family of devices used where flexibility and/or vibration damping are necessary. The third section contains a number of devices found useful in the regulation and control of fluid flow. In the last section, shop hints to aid in maintenance and repair procedures such as cleaning, flaring and swaging of tubes, etc., are presented.

Additional technical information on individual tools and techniques can be requested by circling the appropriate number on the Reader Service Card included in this compilation.

Unless otherwise stated, NASA contemplates no patent action on the technology described.

We appreciate comment by readers and welcome hearing about the relevance and utility of the information in this compilation.

Ronald J. Philips, *Director*
Technology Utilization Office
National Aeronautics and Space Administration

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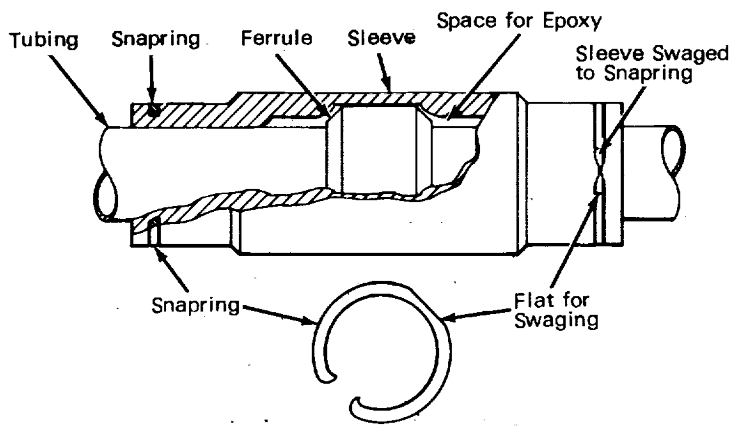
Contents

Section 1. Fittings, Couplings, and Connectors

PIPE JOINTS REINFORCED IN PLACE WITH FITTED ALUMINUM SLEEVES



A new technique can be used to reinforce solder-sealed ferrule joints in installed small-diameter aluminum tubing. A fitted aluminum sleeve is placed over the joint using specially designed tools.

The reinforcement sleeve (see fig.) is made in two longitudinal halves for easy installation over the joint ferrule and a contiguous section of tubing. Epoxy cement is used to seal and bond the sleeve tightly around the joint assembly. Snaprings inserted in circumferential grooves position and hold the sleeve halves together. Each snapring is ground to a flat at the crown, allowing the shield metal to be swaged over the ring at the flat area. The snaprings are quickly and accurately installed in one of the sleeve halves by means of a special die and swaging punch, the free ends of the rings protrude equally beyond the cut edges of the sleeve half.

The inside of the sleeve is machined to the contour of the ferrule joint, with clearance to accommodate the epoxy cement. A sufficient length of sleeve is provided to allow an ample contact surface for sealing and bonding between the sleeve and tubing on both sides of the ferrule. Grooves for the snaprings are cut around the outside diameter of the sleeve near each end. The sleeve is then cut in half lengthwise with a 0.05 cm (0.02 in.) mill saw to form two identical shells.

Immediately prior to permanent installation over a joint, both shells of the sleeve are completely coated on the inside cleared surfaces with a commercial epoxy resin. The clamping action of the snaprings aids in distributing the epoxy resin, and any excess expelled from the sleeve can be removed before jelling occurs (within 8 hours at room temperature). The epoxy resin normally cures to standard test strength in approximately 24 hours. Centering and installation of the shielding over joints in constricted working areas are greatly facilitated with specially designed centering and insertion tools. The insertion tool positions the sleeve halves over the tubing joint and locks them in place in a single, one-handed operation.

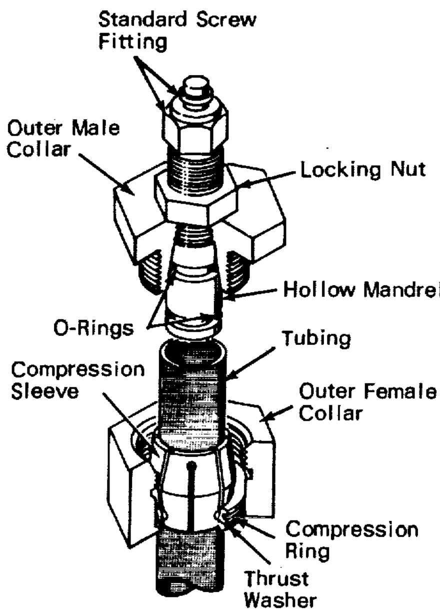
Although the method was specifically designed for solder-sealed ferrule joints in small-diameter aluminum tubing, the approach is adaptable to a variety of tubing sizes, materials, and joints. Tubing joints reinforced by this method have withstood considerable torsion, tension, and vibration stresses at moderately elevated temperatures. In tests for resistance to mechanical abuse, tubing and joint assemblies were bent to failure. All failures occurred in the tubing rather than in the reinforced joint.

Source: I. Cortex, Jr., J. Siegfried, and O. Wobig
Manned Spacecraft Center
(MSC-11109)

Circle 1 on Reader Service Card.

HIGH-PRESSURE COUPLING FOR UNTHREADED, UNFLARED TUBES

A high-pressure coupling connects to any straight, unflared, and unthreaded tubing, without deforming or otherwise damaging the tubing. The coupling (see fig.) grips the tube wall tightly



between an external compression sleeve and an internal hollow mandrel, and is adaptable to standard screw fittings for test stand attachment.

The mandrel portion is inserted in the tubing with two O-rings installed. The outer female collar, thrust washer, and compression ring are then placed over the tubing. The tapered and slotted compression sleeve is slid onto the tubing, with its forward taper fitting inside the compression ring taper and the tube end flush with the rear portion of the sleeve. The outer male collar is threaded onto that portion of the hollow mandrel which extends from the tube and into the female threads of the outer female collar.

As the male collar advances into the female collar, its internal taper forces the compression sleeve to deform because of the longitudinal slots in the sleeve. The resultant compressive radial force on the tube outer wall, supported from within the tube by the hollow mandrel, causes the tube to be gripped firmly by the coupling.

A locking nut is then threaded onto the plug thus formed, and the test stand adapter or connector is attached. Pressure is transmitted from the test apparatus to the tubing through the hollow mandrel.

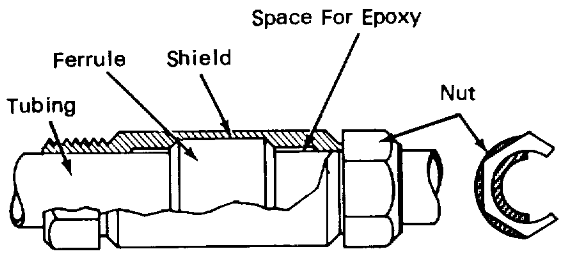
Source: J. A. Stein of
North American Rockwell Corp.
under contract to
Manned Spacecraft Center
(MSC-600)

No further documentation is available.

METHOD FOR REINFORCING TUBING JOINTS

A joint repair technique permits resealing or reinforcing leaking or weak tubing joints without removing the failing member from the system. A split longitudinal aluminum shield with an epoxy resin coating is used in conjunction with sectioned nuts that slip over the tubing and mate with the threaded ends of the split shield.

The shield is threaded on each end with standard pipe threads and is designed with a small space adjacent to each side of the ferrule location to ensure a continuous circumferential epoxy seal. The



aluminum shield is halved longitudinally with a slit saw, and a generous coating of epoxy resin is applied to the inner surfaces of each half. Nuts to fit the pipe-threaded ends of the shield are sectioned (see fig.) to just slip over the tubing, the shield halves are clamped together over the joint, and the nuts are attached and drawn up on the shield and threads. For increased strength and clamping action, two such nuts can be applied at each end of the shield. In this case, the nuts should be so sectioned that their open portions lie on opposite sides of the shield.

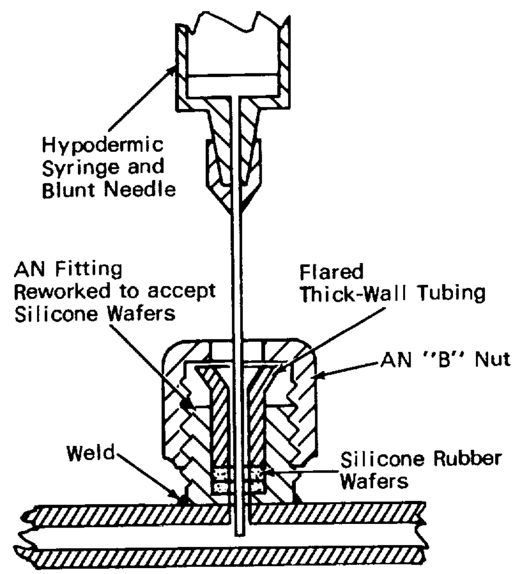
Source: W. S. Lee and J. Kinzler
Manned Spacecraft Center
(MSC-11108)

Circle 2 on Reader Service Card.

SELF-SEALING FITTING FOR INJECTION AND SAMPLING OF LIQUIDS

A standard AN fitting has been modified to accept a blunt-ended hypodermic needle for insertion into a liquid system so that material may be either introduced into or withdrawn from the system without danger of contamination. This technique greatly reduces the quantities required to obtain representative system samples, and has been successfully used for taking contamination control samples from a fluid system located in an unclean area.

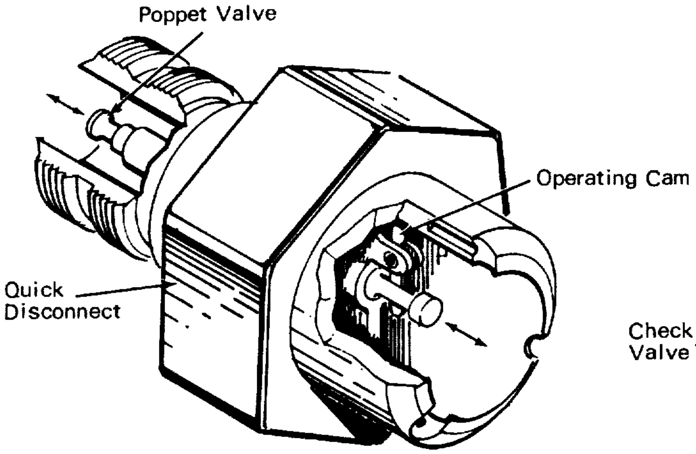
As shown in the sketch, a standard AN fitting is modified by the introduction of two compression wafers of silicone rubber with a durometer hardness of approximately 40. Each washer is punctured through its center by a very short slit. The wafers are then installed in the fitting so that the slits are at right angles to each other to form a cross. A short piece of flared thick-wall tubing is inserted into the fitting on top of the compression wafers, and a standard AN "B" nut is installed and tightened to compress the wafers. The blunt needle is then inserted through the wafer slits, without permitting any leakage or contamination.

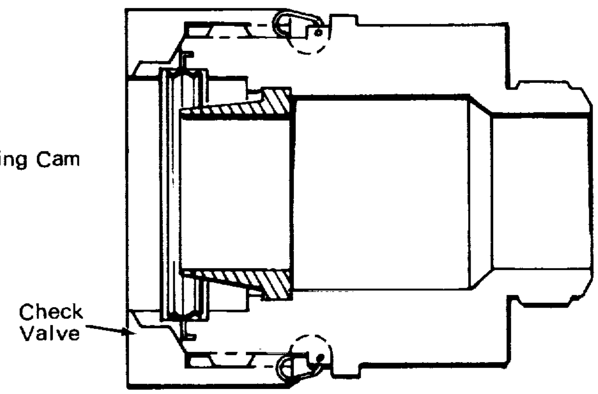


Source: C. W. Overbey of
North American Rockwell Corp.
under contract to
Manned Spacecraft Center
(MSC-15005)

No further documentation is available.

A QUICK DISCONNECT FOR CRYOGENIC FLUID LINES





A cam-operated valve can be used for handling fluids at cryogenic temperatures and at very low pressures. The valve (see fig.) is part of a quick-disconnect coupling designed to implement the separation of a space vehicle liquid fluid system and its umbilically connected ground supply facility.

The cam-lever actuated poppet valve has been used in conjunction with a ground half-disconnect to overcome LOX tank ullage pressure decay caused by "cryo-pumping" resulting from the temperature differential across the LH_2/LOX tanks and He-pressurized common bulkhead. The cam actuates the normally closed airborne half-poppet to the open position when the ground half-disconnect coupling is engaged, and maintains an evacuated system while providing a thermal barier in the disengaged position.

Source: E. J. Castaldo and P. J. Formolo of North American Rockwell Corp. under contract to Marshall Space Flight Center (MFS-16622)

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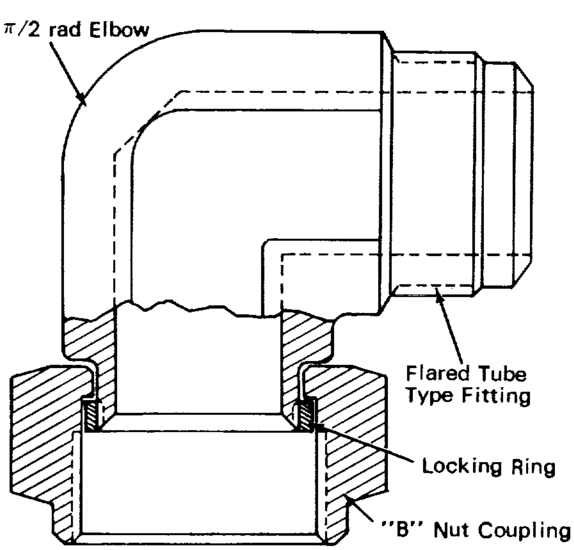
ELBOW FITTING WITH SELF-LOCKING COUPLING NUT



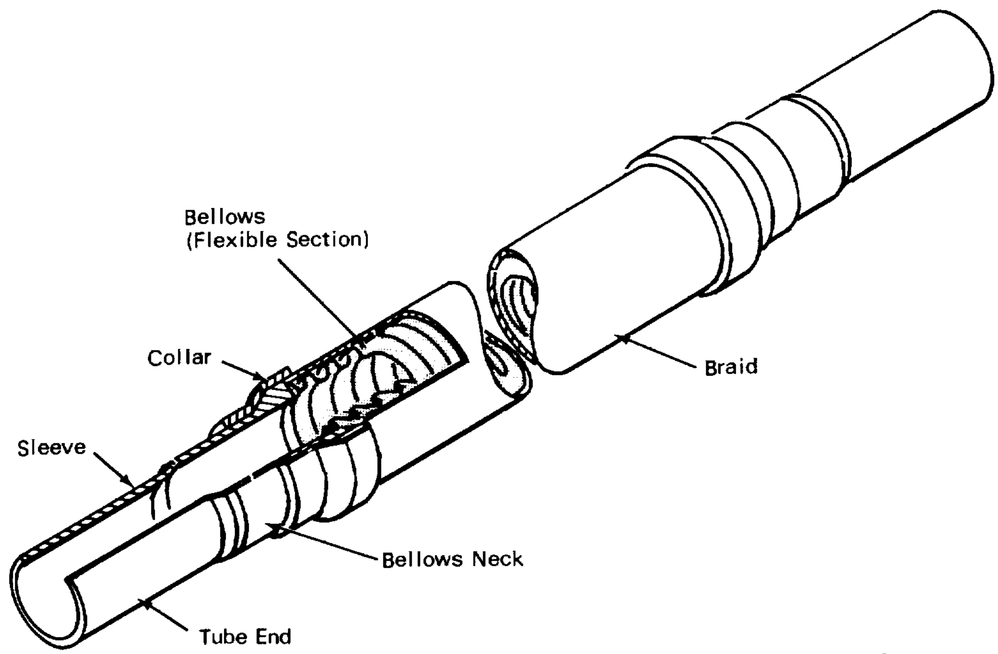
A $\pi/2$ rad (90°) elbow fitting can swivel 2π rad (360°) in one plane for more effective alignment with mating hardware, yet may be secured in place without the usual locking devices. On existing elbow assemblies, the fitting and locknut are secured by means of a locking wire inserted through a hole in the nut and a channel in the fitting. When torqued beyond a certain point, such an arrangement will shear the wire, swage the fitting groove, or mutilate the channel, all of which are undesirable.

This improved technique (see fig.) uses a left-hand threaded locking ring to ensure secure attachment of the locknut to the fitting. Sufficient surface area is obtained on the face of the locking ring to support the compression surface of the locknut, thus maintaining a 2π rad (360°) pressure on the sealing areas of the fitting. This eliminates the requirement for the locking wire.

Source: F. L. Broadwick of
The Chrysler Corp.
under contract to
Marshall Space Flight Center
(MFS-14366)

Circle 4 on Reader Service Card.

LIGHTWEIGHT HOSE ASSEMBLY WITH HIGH FLEXIBILITY AND STRENGTH



A new hose design incorporates flexible sections fastened to reinforcement braid. The assembly is lightweight and flexible, is useful in high- and low-pressure oxygen, helium, and hydrogen systems, and can withstand pressures from 689.5 kN/m^2 (100 psi) to 22,064 kN/m^2 (3200 psi) and temperatures from 294.25 K (70° F) to 58.15 K (−423° F).

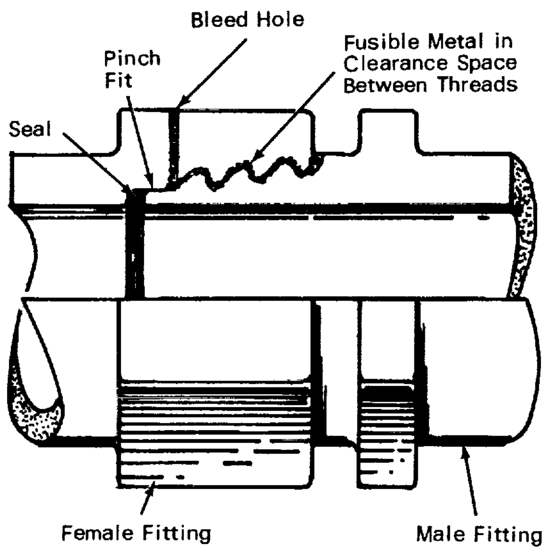
The all-metal hose assembly consists of a flexible section, sleeves, reinforcement braid, collars, and tube ends (see fig.). The flexible section is an annular, continuous convoluted bellows. An overlapping, double-row resistance weldment joins the end sleeves to the bellows neck, which fits snugly within the inside diameter of the sleeve. The weldment is trimmed, still leaving a pressure-tight joint, and the resulting end is subsequently butt welded to the tube ends. The stainless steel braid is then assembled over the flexible section which is compressed in a fixture to its required length. The braid is formed over the sleeve conical shoulder, and a collar is positioned over and against the braid at the sleeve cone area. This provides a clamping action which is maintained by swaging and heliarc welding the collar and the braid to the sleeve.

Source: L. L. Bessing of
North American Rockwell Corp.
under contract to
Marshall Space Flight Center
(MFS-1831)

Circle 5 on Reader Service Card.

FUSIBLE METAL USED IN HIGH-PRESSURE PIPE JOINT

A simple method increases the pressure handling capabilities of threaded pipe joints and renders them practically impervious to thermal



transient conditions. Conventional flanged joints usually fail in the extremes of these two areas.

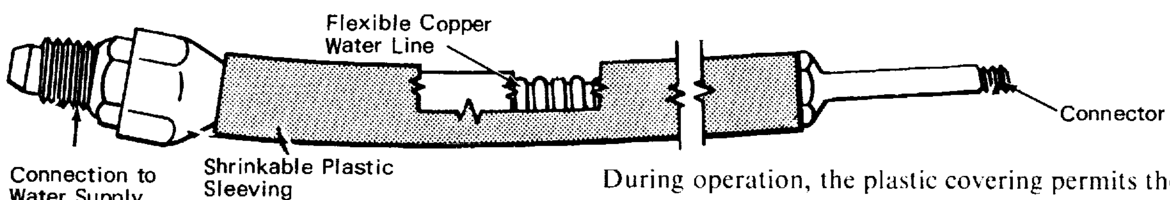
In this application, the joint is assembled dry to the proper seal compression and fusible metal is flowed into the threaded area, filling the void space between the threads. A bleed hole is used as an exit for any gas trapped during the filling process. The joint can be disassembled by heating it while expelling the fusible metal by applying pressurized gas to either end of the threaded joint. For joints where one part cannot be rotated relative to the other, or where a precise angular relationship is required, a left-hand/right-hand threaded turnbuckle-type double joint can be used.

Source: R. E. Meyer of
Pratt & Whitney Aircraft
under contract to
Marshall Space Flight Center
(MFS-21176)

No further documentation is available.

Section 2. Flexible Devices and Vibration Damping

PLASTIC TUBING PROTECTS FLEXIBLE COPPER HOSE



Reinforcing flexible copper purge and coolant hoses with a sleeve of high-temperature shrinkable plastic has proven to be an excellent protective measure in a severe vibration condition, such as testing a rocket engine. Similar flexible copper coolant lines can be used in automotive applications.

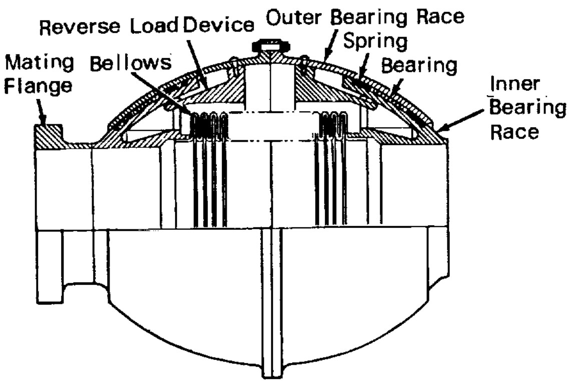
The flexible copper hose is inserted into a slightly larger plastic tube. Sufficient heat is then applied to shrink the plastic until it assumes the contour of the hose in intimate contact. During operation, the plastic covering permits the copper hose to take a radial bend without kinking, and prevents it from taking a permanent bend (setting). The plastic covering also serves as a reinforcement of the joint between the hose and fitting.

Source: B. E. Mellgren of
North American Rockwell Corp.
under contract to
Marshall Space Flight Center
(MFS-772)

No further documentation is available.

SPHERICAL PIPE JOINT LOADS MATING FLANGES EVENLY

A large-diameter ball joint pipe fitting transmits an evenly distributed load to the mating flanges of a large duct. The fitting incorporates



two spherical bearing races and balls in contact with centering cage springs that enable the races to center themselves when the joint is angulated.

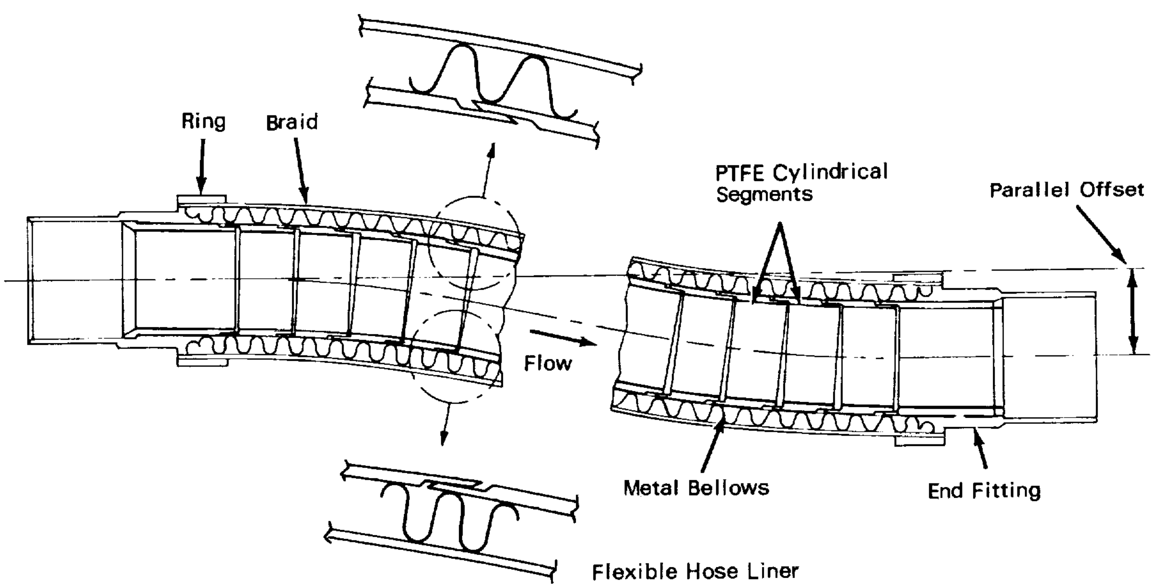
An inner bearing race is slotted to provide a channel in which a reverse load device with spherical, tipped fingers may move inward while under reverse loads and while traveling through the angular movement of the ball joint. Curved springs center the ball bearing, preventing it from free floating while the ball joint is under the reverse loading. The bearing contains 1,728 balls for high thrust loads through a $\pm\pi/18$ rad ($\pm 10°$) oscillation at 10 cpm.

This design should find application in piping systems where unequal load distributions exist.

Source: R. O. Pfleger of
North American Rockwell Corp.
under contract to
Marshall Space Flight Center
(MFS-807)

Circle 6 on Reader Service Card.

TFE-FLUOROCARBON LINERS FOR FLEXIBLE HOSES



Flexible Hose Liner

A flexible hose handles high flow rates under high pressure while permitting greater parallel offset than 0.10. Conventional hoses, commonly reinforced with one-piece or two-piece liners, allow the flow to impinge on the surrounding metallic bellows, causing failure of the hose.

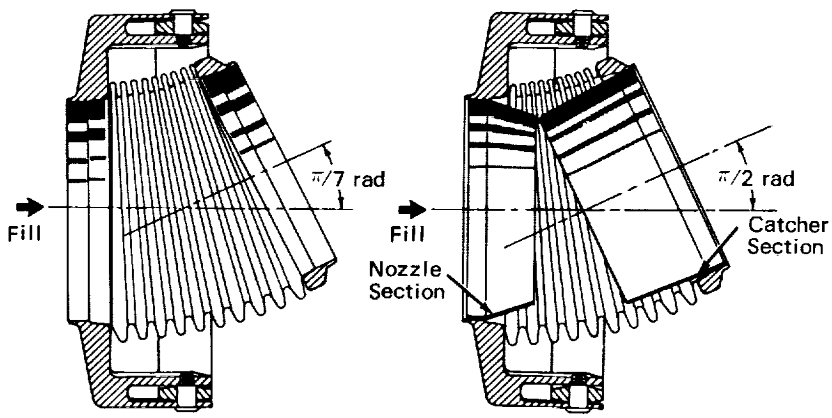
To prevent this type of failure, a superior flexible liner is made from short lengths of TFE-fluorocarbon tubing. The outside diameter of one end of each length is reduced so that it becomes a male end; the internal diameter of the other end is increased, making it female. The joints between the lengths are thus sliding overlaps that permit flexibility with much greater parallel offset. The liners are surrounded by the usual metallic bellows covered with braid.

Oil companies and hose manufacturers may be interested in this new technique.

Source: D. F. Higley of
North American Rockwell Corp.
under contract to
Marshall Space Flight Center
(MFS-16480)

Circle 7 on Reader Service Card.

FLOW LINER EXTENDS OPERATING LIFE OF HIGH-ANGULATION BELLOWS



A flow liner appreciably extends the service life of externally gimballed high-angulation $\pi/6.92$ rad (26 degree) bellows at duct points handling high-velocity fluid flow in a liquid oxygen transport system. Unlined bellows have failed due to flow-induced vibration; and conventional, full-length conical liners, while protecting the interior of the bellows, result in an unacceptable reduction in flow area.

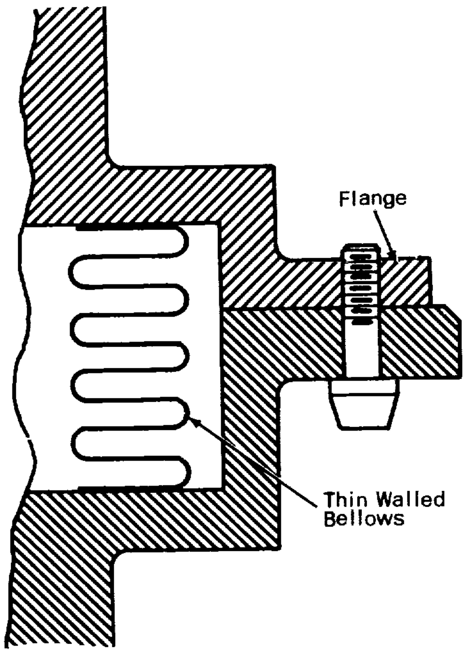
The solution (see fig.) is a bellows liner consisting of two sections: (1) a conical frustum or nozzle on the upstream side; and (2) a cylindrical section or catcher on the downstream side. The liner directs a jet from the nozzle across the open gap to the catcher on the other side of the bellows. The vibration-inducing flow is thus directed away from the bellows convolutions, while full gimbal motion and a relatively small reduction in flow area are allowed.

Source: D. G. Rumph of
The Boeing Company
under contract to
Marshall Space Flight Center
(MFS-12023)

Circle 8 on Reader Service Card.

BELLOWS JOINT ABSORBS TORSIONAL DEFLECTIONS IN DUCT SYSTEM

A long, thin-walled bellows, compressed into a much shorter length absorbs torsional deflections in duct systems where the usual dogleg, dual bellows arrangement, cannot accommodate a short, straight run. In the dogleg configuration, torsional loading in either half is absorbed by angular deflection of the bellows in the opposite half. Short space, and a requirement for



a straight-in approach, preclude the use of the dogleg approach.

A long, thin-walled bellows is compressed into a short length and then installed in a flanged linkage, which takes the separating pressure load and restricts the motion that the bellows absorbs due to torsional deflections. The bolts holding the two flanges of the torsional bellows are loosely torqued to take the separating pressure load and to allow relative torsional deflection between the two.

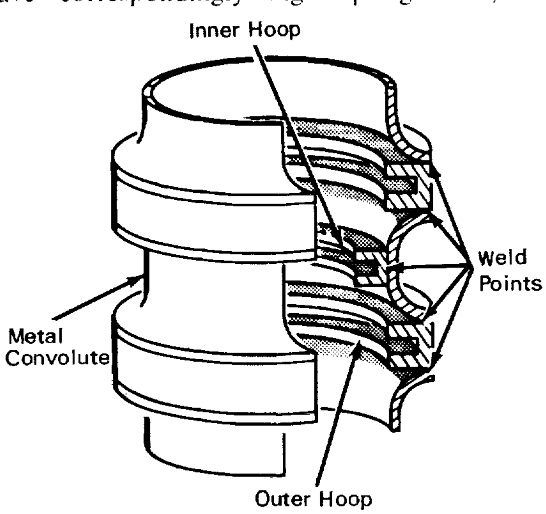
The torsional bellows has a lower torsional spring rate than any of the other bellows in the duct assembly. It thus absorbs the bulk of the duct's torsional deflections, leaving the other bellows of the duct assembly free to absorb the axial and angular deflections.

Source: C. M. Daniels of
North American Rockwell Corp.
under contract to
Marshall Space Flight Center
(MFS-882)

Circle 9 on Reader Service Card.

BELLOWS DESIGN FEATURES LOW SPRING RATE AND LONG LIFE

A high-pressure, economical bellows has a low spring rate and is sensitive to pressure and temperature variations. Present high-pressure bellows have correspondingly high spring rates, but are insensitive to small pressure changes, and exhibit unstable cross-sectional configurations.

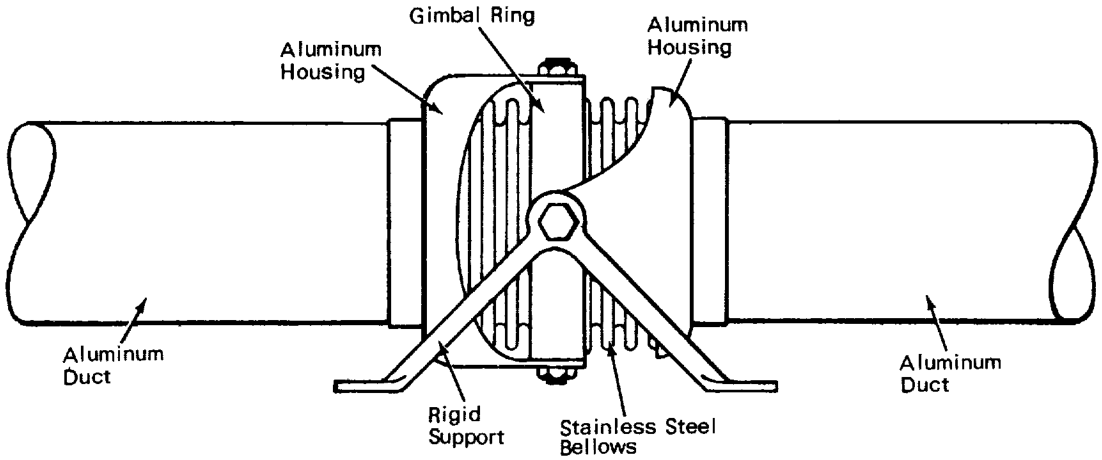


This concept combines high-strength rigid hoops, for strength and stability, with sheet stock, for low spring rate effects. Sheet metal convolutes are welded to alternate inner and outer hoops. The hoop skeleton structure withstands high pressures while supporting flexible sheet stock convolutes. The bellows diameter remains stable since the hoops do not deform under pressure. This bellows has long life because the flexible sheet stock is protected from stress fatigue at its bend radii.

Source: R. F. Lusic of
North American Rockwell Corp.
under contract to
Manned Spacecraft Center
(MSC-521)

Circle 10 on Reader Service Card.

UNIVERSAL GIMBAL FORMS FLEXIBLE TUBE SYSTEM

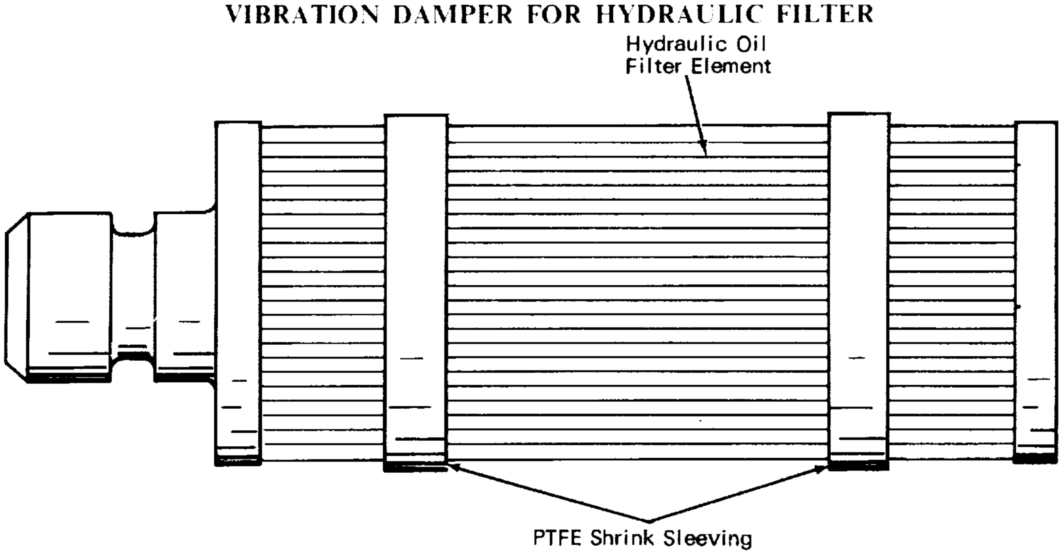


A universal gimbal (see fig.) is used in conjunction with swing links on either side to form a flexible tube system capable of absorbing thermal expansion and contraction forces. The swing links (not shown) provide only straight-line motion, but in a manner that is mechanically superior to a slip joint. The universal gimbal, however, comes into play when a change in plane is required. Combining the two joining devices provides a flexible tubing system that can respond to both linear and axial forces.

Source: O. P. Harwood, A. R. Cronk, and J. M. Schutt of McDonnell Douglas Corp. under contract to Marshall Space Flight Center (MFS-20965)

Circle 11 on Reader Service Card.

VIBRATION DAMPER FOR HYDRAULIC FILTER

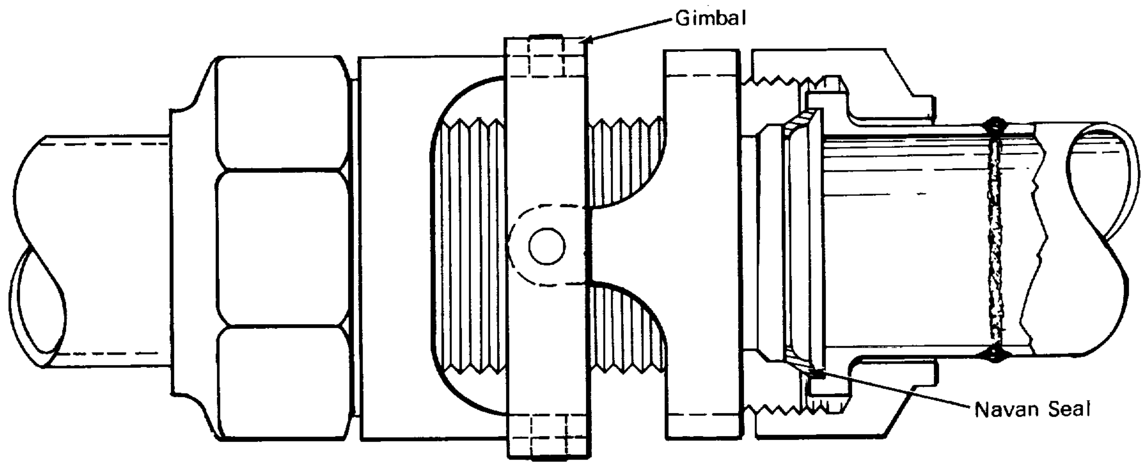


PTFE (polytetrafluoroethylene) heat-shrinkable sleeving rings slipped over the pleated portion of a hydraulic filter element absorb vibration forces that have proven destructive without such restraint. The rings essentially alter the natural frequency of the element and prevent failure in the pleated portion. The figure shows a typical application in which two PTFE rings of the shrink sleeving have been applied over the filter pleats. In practice, the required number of PTFE rings are slipped over the filter pleats and heat is applied to shrink the rings into intimate contact with the pleated section.

Source: R. E. Prout of
North American Rockwell Corp.
under contract to
Marshall Space Flight Center
(MFS-16173)

No further documentation is available.

THREADED UNION-TYPE GIMBAL

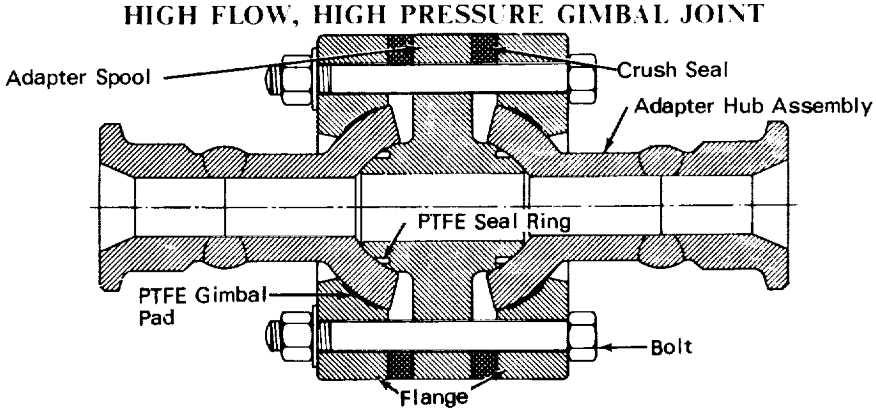


A threaded union-type gimbal functions without the use of bolted flanges and seals. Its simplicity permits easy replacement, and line assembly can be accomplished at less cost since the tubing can be fabricated to wire templates developed by normal mockup procedures. The innovation presents a good method for reworking existing line assemblies.

Source: M. C. Eyestone of
North American Rockwell Corp.
under contract to
Marshall Space Flight Corp.
(MFS-13870)

No further documentation is available.

HIGH FLOW, HIGH PRESSURE GIMBAL JOINT



A lightweight, high flow, high pressure gimbal joint gives leak-tight angulation through $\pi/30$ rad (6 degrees) about its centerline when operating at 41,364 kN/m^2 (6,000 psi). By using several such joints in fluid transfer systems, compensation can be achieved for relative motion between stationary and transporting storage devices. The joint is smaller and lighter, and can withstand higher pressures than the bellows type described in the preceding item. The design can be appreciably upgraded by proper material selection to handle operating pressures as high as 103,410 kN/m^2 (15,000 psi) at elevated temperatures.

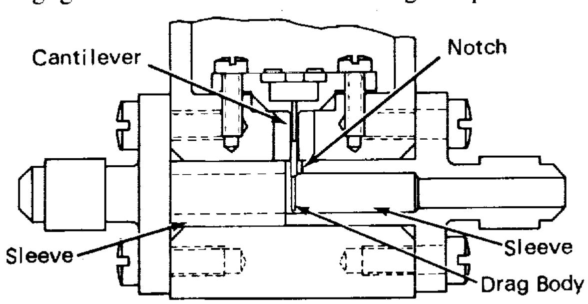
Source: J. S. Kunkle
Kennedy Space Center
(KSC-10205)

Circle 12 on Reader Service Card.

Section 3. Devices Used for Regulation and Control

IMPROVED DRAG-TYPE FLOWMETER: A CONCEPT

A flowmeter for low-range, high-response measurements will reduce unsymmetrical flow to a negligible level. Previous designs permitted unsymmetrical flow around the drag body and resulted in reduced output and/or poor response characteristics.

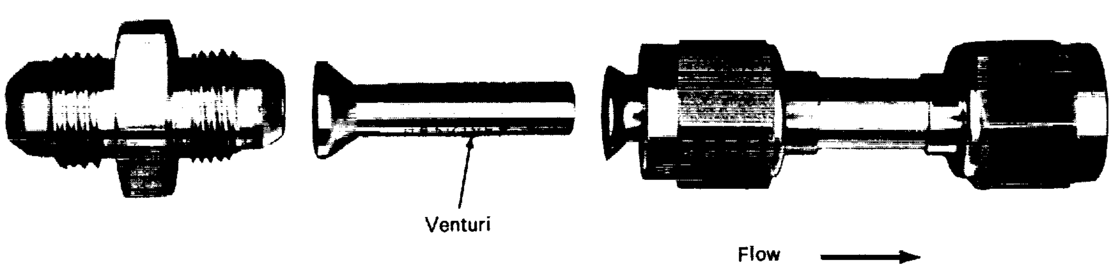


The new design introduces two abutting sleeves in the flow passage. These sleeves, one of which is notched to clear the cantilever support, are inserted axially into the flow passage after the drag body has been installed radially through a clearance hole. The sleeves act as over-range deflection stops that may be changed, without disturbing the drag body, by substituting sleeves having different bores.

Source: L. H. Groeper of
North American Rockwell Corp.
under contract to
Manned Spacecraft Center
(MSC-15908)

No further documentation is available.

FLOW RATE RANGE CONTROLLED BY CAVITATING VENTURI



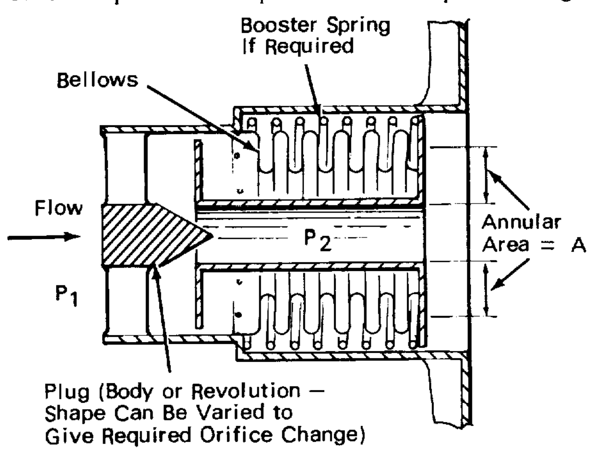
Installing a cavitating venturi in the flowline between supply tanks and fluid injectors eliminates appreciable testing by making test hardware pressure drop independent of supply tank pressure. By installing the cavitating venturi, flow rates become a function only of upstream temperature and pressure, and any preselected flow rate can be achieved by providing a tank pressure read from the venturi calibration curve, using the desired flow rate and temperature. Using this method, flow rates have been determined from venturi upstream pressure and temperature with the precision of 0.5% flowmeters.

Source: J. L. Kitchens and R. L. Ingram of
North American Rockwell Corp.
under contract to
Manned Spacecraft Center
(MSC-91102)

Circle 13 on Reader Service Card.

ORIFICE FOR AUTOMATICALLY REGULATING FLOW RATE: A CONCEPT

A variable-area, self-actuating orifice could control flow rate to maintain a preselected pressure drop at its output. The conceptual design



consists mainly of a bellows supporting a fixed-area annular piston. The port in the piston is centered on a plug with a contour matched to the spring rate of the bellows. This provides the proper area variation, under flow conditions, to maintain the required back pressure.

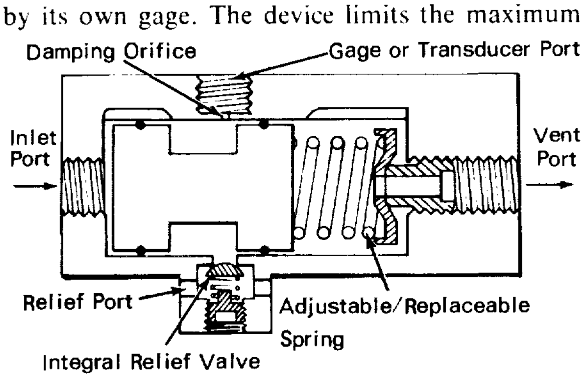
In operation, the bellows senses the pressure differential across the orifice, and responds to any change in this differential by changing in length, so that the orifice area is correspondingly changed to maintain a constant pressure drop.

Source: S. D. Butler and E. F. Shaeffer of
North American Rockwell Corp.
under contract to
Marshall Space Flight Center
(MFS-13915)

No further documentation is available.

PRESSURE BLOCK AND VENT WITH INTEGRAL RELIEF VALVE: A CONCEPT

This concept would automatically shut off system pressure to a given gage using an arrangement of increasing pressure stages, each monitored by its own gage. The device limits the maximum

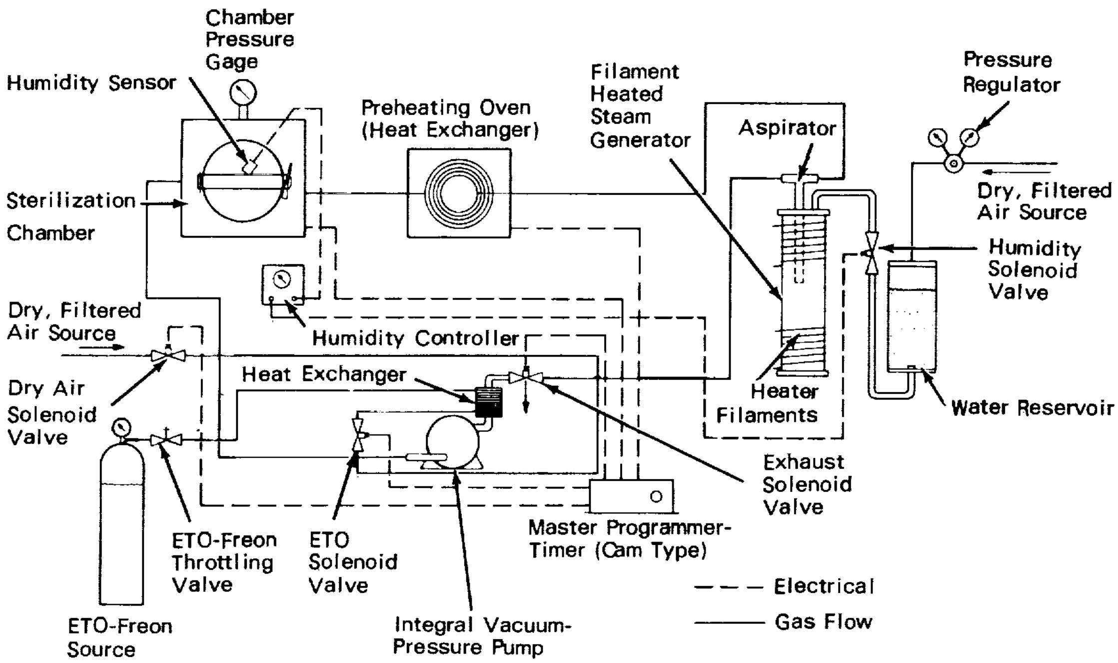


pressure to which each gage is subjected, and then vents the next lower range gage. This facilitates reading the next gage in line when the next higher pressure stage is attained. The device is essentially a spring-loaded spool valve with a spring tension calibrated to yield to the preselected pressure. A relief valve integral to the device protects against possible line surges.

Source: R. L. Gochowski of
North American Rockwell Corp.
under contract to
Marshall Space Flight Center
(MFS-16970)

No further documentation is available.

AUTOMATIC HUMIDITY REGULATION IN DECONTAMINATION SYSTEM



Incorporation of an aspirator and flash evaporation chamber in a specially designed and constructed automatic ethylene oxide/freon gas decontamination system has improved humidity regulation over the long term (300 to 500 hours) decontamination cycles involved. The new system minimizes contact between sterilant gas and steam or water and the heater elements, thus inhibiting long term decomposition of the decontaminating gases.

The flowing stream of gas passes continuously through the aspirator, but not in direct contact with the water or heaters. Passage of the gas creates a vacuum that pulls water vapor from the steam generator and into the gas stream, on an as-generated basis. A humidity-controlled solenoid valve meters water from the reservoir into the steam generator to achieve long term humidity control within the sterilization chamber.

Source: R. H. Silver and S. H. Kalfayan of Caltech/JPL
under contract to
NASA Pasadena Office
(NPO-10540)

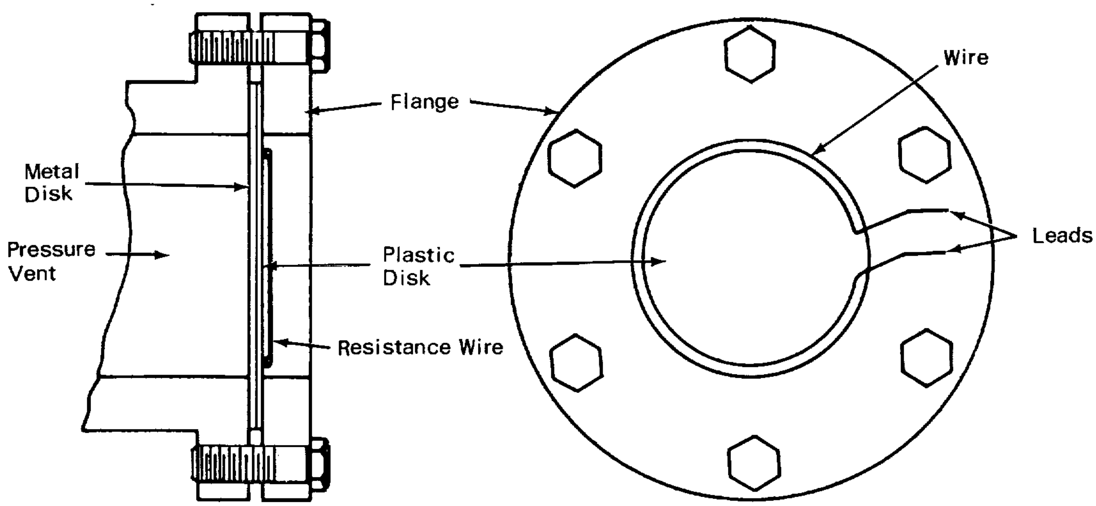
Circle 14 on Reader Service Card.

ELECTRICALLY ACTUATED BURST DISK ASSEMBLY

A composite burst disk, which gives way to pressure when an electric current is applied, should prove useful wherever programmed venting is desired.

The assembly consists of a plastic disk backed by a frangible metal disk which is placed on the high-pressure side of the unit. The two disks are held together and to the pressure pipe with a flange mounting. A resistance wire, mounted on the plastic disk around the inner perimeter of the flange, is connected to a voltage source.

Composite burst disks of brass shim stock and acetate (mylar) were used to vent a solid propellant motor with a 5.08 cm diameter vent. Mylar disks 0.036 cm thick were used with brass disks from 0.005 to 0.018 cm thick to provide



an operating pressure range of 689 to 8268 kN/m^2 (100 to 1200 psi). The 0.036 cm thick mylar disks permitted pressures of 1722 to 2067 kN/m^2 (250 to 300 psi) above the burst pressure of the brass disks.

Nichrome resistance wire of 0.02 Ω/cm was fastened to the surface of the mylar disks with ordinary masking tape. When the resistance wire was heated with a 24 V supply, the assembly was caused to fail and the motor vented within 20 to 100 msec, depending upon the motor pressure and the thickness of the brass disk.

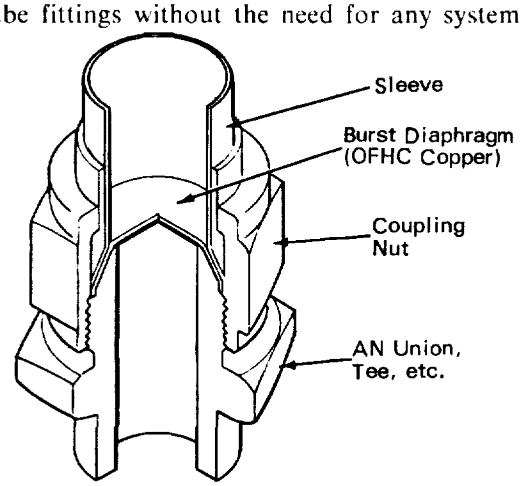
The metal and plastic disks can be fabricated inexpensively from sheet material, eliminating the need for costly close-tolerance burst disks or explosive bolt systems. The composite disk assembly does not require a momentary overpressure to achieve venting.

Source: G. E. Jensen of
United Aircraft Corp.
under contract to
Langley Research Center
(LAR-10479)

No further documentation is available.

SIMPLIFIED RUPTURE DIAPHRAGM FOR STANDARD FITTINGS: A CONCEPT

A pressure relief device in the conceptual stage is designed to operate in standard flared-tube fittings without the need for any system or component modification. The diaphragm, made of oxygen-free high conductivity (OFHC) copper, corresponds basically to the commercially available, conical metallic seal used for such fittings, with the exception that no hole is included. Material thickness is controlled, and the conical shape ensures correct positioning of the coined side for consistent burst value.



Source: E. M. Saxelby of
North American Rockwell Corp.
under contract to
Marshall Space Flight Center
(MFS-13662)

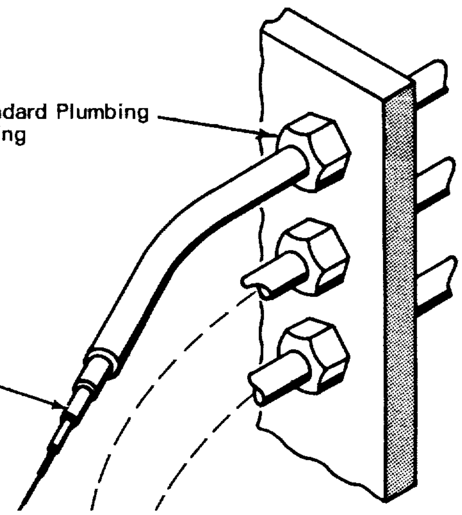
No further documentation is available.

Section 4. Shop Hints for Maintenance and Repair

TELESCOPING OF INSTRUMENTATION TUBING ELIMINATES SWAGING

A rapid, economical method for fabricating small-diameter tubing for instrumentation applications has been devised. Such tubing is conventionally fabricated by a swaging operation, which requires the use of relatively costly dies and frequently results in excessive material loss because of fractures produced when attempting maintenance of close tolerances.

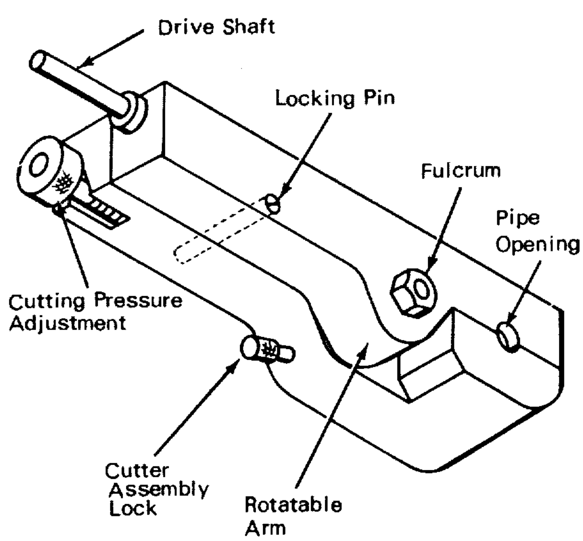
Short sections of commercially available stainless steel tubing of slide-fit sizes are fitted together and silver-soldered at the junctions. The large-diameter tubing section is connected to a standard plumbing fitting, and the stepped-down sections are successively fitted in place until the desired reduction in diameter is obtained. The tubing sections are secured together by silver soldering. Tubing fabricated by this method has been quickly and easily connected between 0.038 cm (0.015 inch) diameter pressure taps at various locations on wind-tunnel models and standard 0.318 cm (0.125 inch) diameter instrumentation plumbing.



Source: E. L. McClellan of North American Rockwell Corp. under contract to Marshall Space Flight Center (MFS-546)

Circle 15 on Reader Service Card.

PIPE CUTTING TOOL FOR USE IN LIMITED SPACE



A means has been found for cutting pipe or tubing in areas restricted by adjacent structural members. A portable tool clamps the pipe firmly and then rotates a cutter assembly that is internally connected to a drive shaft engaged in the chuck of an electric drill.

The rotatable arm is opened to allow insertion of the pipe. The pipe is clamped in place by closing the rotatable arm, tightening the cutter assembly lock knob, and inserting the locking pin. The blade cutting pressure is then adjusted, and a portable electric drill is connected to the cutter drive shaft.

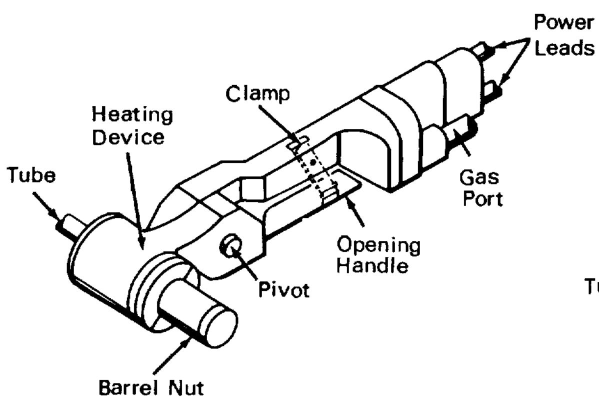
As the cutting progresses, it may be necessary to periodically tighten the cutting pressure adjustment knob until the pipe is severed. When cutting is completed, the clamping members are opened and the blades are backed off to prevent accidental overloading of the cutter assembly at the start of the next cutting operation.

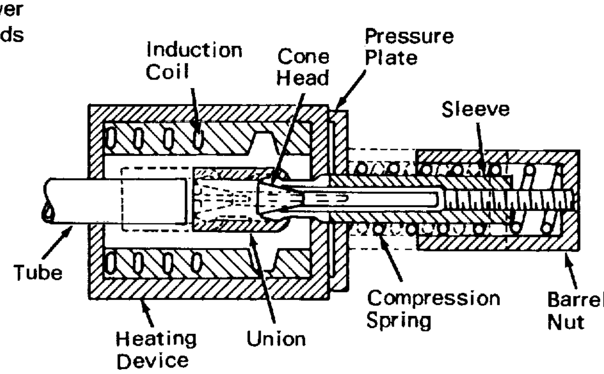
Title to this invention, covered by U.S. Patent No. 3,136,057, has been waived under the provisions of the National Aeronautics and Space Act (42 U.S.C. 2457 (f)) to the McDonnell Aircraft Corporation, Box 516, St. Louis, Missouri, 63166.

Source: D. D. Jones and C. A. Headley of
McDonnell Aircraft Corp.
under contract to
Manned Spacecraft Center
(MSC-36)

IMPROVED TOOL EASILY REMOVES BRAZED TUBE CONNECTORS

A portable, compact tool for removing brazed tube connections eliminates undesirable oxidation on the tube surfaces and lends itself to use in cramped areas. Conventional tools have short service lives because they use the heating unit to exert the necessary separating force.





Heating Device Details

The new tool uses an induction coil to melt the braze and a compression spring to automatically separate the connection. An inert gas such as argon is force-fed about the heated area to prevent tube oxidation.

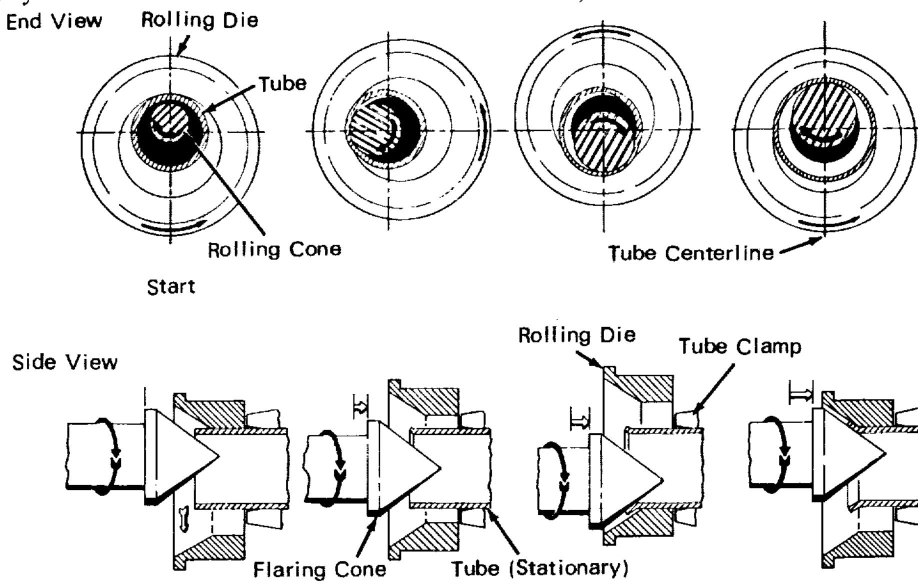
First, the connection is cut, preferably with a tool that will crimp its walls inwardly to form a rough ridge or burr. The pulling device is then inserted into the connector until the cone head on the sleeve is past the burr. The barrel nut is rotated counterclockwise as the sleeve is held, causing the cone head to expand outwardly and grip the connector ridge from within. The pressure plate is forced over the sleeve and pressed against the barrel nut, thus compressing the spring, and the heating device is placed over the connector and clamped shut. High-frequency current is applied to the induction coil in the heating device through the leads in the end of the handle, and argon gas is applied to the induction coil area through the gas port in the handle. As the braze melts, the force of the compression spring backs the connector off of the tube. Current is removed, and the argon gas is allowed to flow until the danger of oxidation is past.

Title to this invention has been waived under the provisions of the National Aeronautics and Space Act (42 U.S.C. 2457 (f)) to McDonnell Aircraft Corporation, Box 516, St. Louis, Missouri, 63166.

Source: R. A. Schoppman of
McDonnell Aircraft Corp.
under contract to
Manned Spacecraft Center
(MSC-263)

ORBITAL TUBE FLARING SYSTEM PRODUCES CONNECTORS WITH ZERO LEAKAGE

An orbital tube flaring system, which is a modified version of the split die and cone, incorporates a rolling cone and rolling die to closely control flare formation, achieving zero leakage in high-pressure systems.



The zero-leakage can be obtained from welded and brazed joints or from precision mechanical connectors which may be assembled and disassembled. Although there are many tube flaring methods, including impact forming, ballistic forming, hydraulic forming, pneumatic forming, and the conventional split die and cone procedure, it is extremely difficult to produce a flared tube configuration with zero leakage.

The orbital system produces a flare on the tube end by rolling the material between an externally orbiting rolling die and an eccentrically rolling internal cone. The rolling die is the essential difference between the oribtal flaring method and the conventional flaring system which uses a split die as the flare receptacle. The rolling die and the rolling cone are held in rotational registry at all times, permitting the tube material being flared to be formed between the two rolling surfaces.

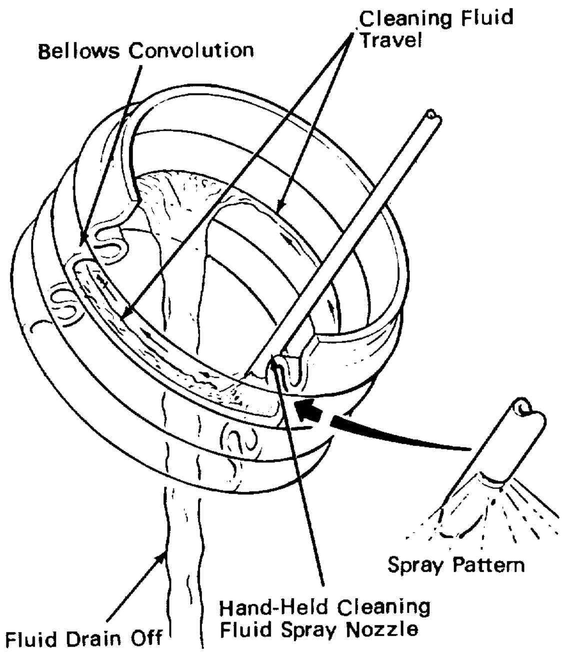
The three primary parts of the system are: the tube clamp, the I.D. flaring cone, and the O.D. rolling die. The tube clamp is designed to hold the O.D. of the tube concentric with the centerline of rotation of the main spindle which drives the orbital adaptor flaring head. The tube holder design incorporates an iris type collet which compensates for slight variations of the tube diameter; the O.D. of the tube is therefore always positioned concentrically. The split jaw die holder on the commercial machine is replaced by a one-piece bracket which concentrically positions the iris type tube collet.

The I.D. flaring cone of the orbital system functions in a manner similar to the I.D. flaring cone on the conventional flaring machine. The cone is completely bearing mounted and is free to roll about its own centerline. The centerline of the cone shaft is slightly eccentric to the centerline or rotation of the main drive spindle. Therefore, during operation, the centerline of the cone orbits around the centerline of the main drive spindle. The flaring action takes place as the O.D. surface of the flare cone is forced axially against and rolls around the I.D. of the tube. The cone is driven only by frictional contact as the material being flared bottoms against the rolling die.

Source: J. R. Williams
Marshall Space Flight Center
(MFS-2016)

Circle 16 on Reader Service Card.

CLEANING METHOD FOR BELLOWS CONVOLUTIONS: A CONCEPT



A proposed method for cleaning the convolutions of a bellows removes foreign materials such as dust and other matter that could damage high speed pump impellers. This previously presented a real problem due to the small access area and relatively large entrapment volume.

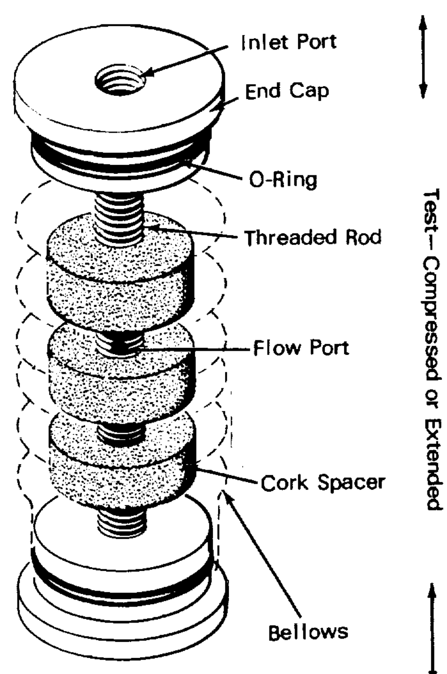
A small metal tube, attached to a system for pumping the cleaning fluid, has two thin slots machined in its cleaning end at opposite sides (π rad (180°) apart). Starting at the uppermost convolution, the two opposite jets enter the cavity and are progressively moved down, flushing each succeeding convolution and permitting the spent fluid to drain freely through the bellows outlet.

Source: J. M. Lynn of
North American Rockwell Corp.
under contract to
Marshall Space Flight Center
(MFS-13935)

No further documentation is available.

GUIDES PROTECT BELLOWS DURING PRESSURE TESTING

A protective device, consisting of internal guides, assists in pressure testing bellows used in fluid flow systems. Two end caps (see fig.) with O-ring seals are arranged to close the end flanges of the bellows under test. One end cap has a blind thread and the other has a through thread, so that they may be assembled and adjusted lengthwise on a threaded through rod. The threads are of sufficient length to adjust the bellows from fully restricted to fully extended. The through-threaded end cap contains the inlet port, through which pressurized air is introduced into the test bellows via a blind center hole and intersecting radial hole in the threaded rod.

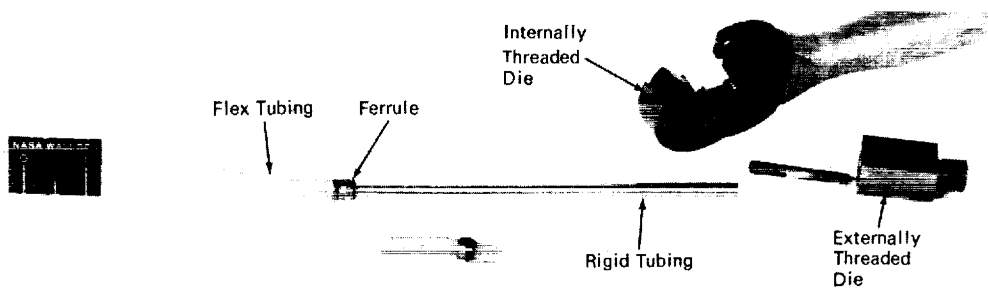


Prior to attachment of the end caps, rings of cork or a suitable elastomer are arranged on the center rod in a manner which will support the inside of the bellows convolutions. These rings have no effect on the burst pressure of the bellows, but they prevent the bellows from buckling and whipping when internal air pressure is applied.

Source: B. T. Howland of
North American Rockwell Corp.
under contract to
Manned Spacecraft Center
(MSC-15264)

No further documentation is available.

IMPROVED TECHNIQUE FOR COUPLING FLEXIBLE TUBING ONTO RIGID TUBING



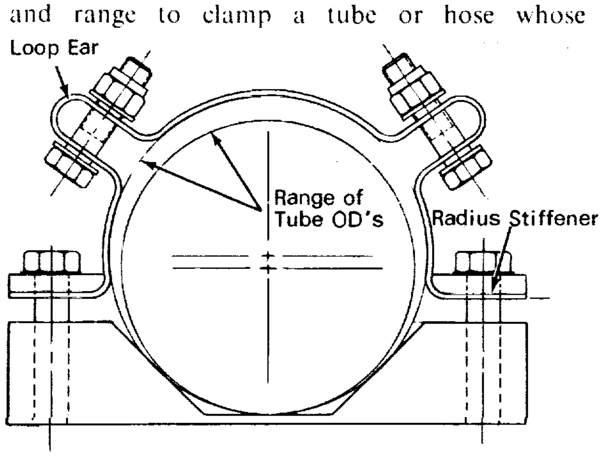
A simple, improved technique uses a ferrule and a hand tool with internal and external dies to couple flexible tubing onto rigid metal tubing. The flexible tube end is slipped over the metal tube end, the ferrule is slipped over this junction, and the tool with dies installed is rotated around the ferrule, crimping it firmly in place. This roll-crimped ferrule exerts appreciable, constant, and equal pressure around the joint.

Source: J. C. McConnell
Wallops Station
(WLP-10006)

No further documentation is available.

ADJUSTABLE SADDLE CLAMP FOR TUBING

An adjustable saddle clamp has the flexibility and range to clamp a tube or hose whose outside diameter may vary as much as 0.635 cm (0.25 in.) during system operation. This is an appreciable improvement over conventional fixed-dimension clamps that can only be used for items that are manufactured to and retain close tolerances. The clamp should be useful in the automotive industry and in the installation of insulated tubing for the plumbing, heating, and air conditioning industries.

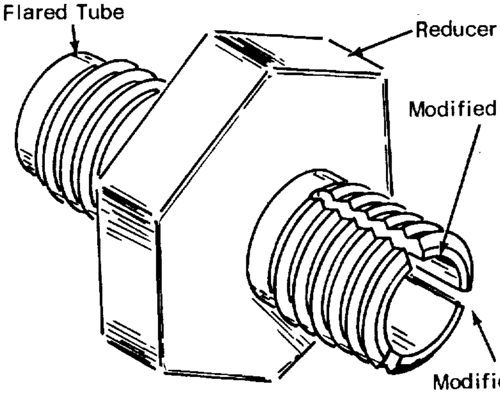


Source: J. Flihan of
North American Rockwell Corp.
under contract to
Marshall Space Flight Center
(MFS-14031)

Circle 17 on Reader Service Card.

ADAPTER SIMPLIFIES FLUSH CLEANING OF FEMALE HALF COUPLERS

An inexpensive adapter made from a standard reducer provides a cheaper and more efficient means of flush cleaning fluid system couplers.



Previously, the more expensive test point connector was used as the flush cleaning connector.

In some fluid systems, the female half couplers are repeatedly used to engage the male stems of the system. In one fluid system, for instance, 73 male stems are used at test points, and up to 150 connections are made to each during weld purging, flushing, testing, etc. With the simplified flushing adapter (see fig.), considerable savings are realized compared to the use of class I stems, which cost several hundred dollars each.

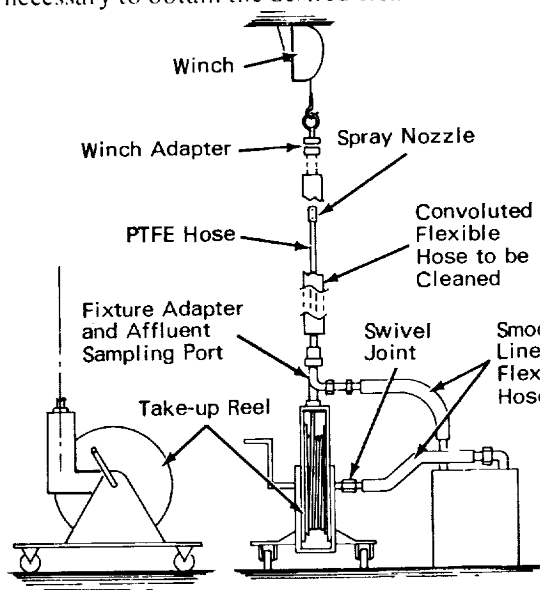
Source: J. A. Klein and H. H. Maltby of
North American Rockwell Corp.
under contract to
Manned Spacecraft Center
(MSC-17096)

Circle 18 on Reader Service Card.

CLEANER FOR CONVOLUTED HOSE

A new cleaner does an excellent job of cleaning convoluted flexible hoses, and has a built-in method for determining the degree of cleanliness achieved. Previous methods have proven unsatisfactory because the cleaning was done with the hose lying in a horizontal plane, either coiled or extended. With the hose horizontal, dirt tended to remain in the bottom of the convolutions, even though cleaning solvent was forced through vigorously.

In the method devised, the convoluted hose is suspended from a winch, and the lower end of the hose is attached to a fixture adapter. A hose of PTFE (polytetrafluoroethylene) is inserted into the full length of the convoluted hose and is topped by a spray nozzle. The lower end of the PTFE hose is attached to a reel hollow shaft which is connected to a cleaning fluid source. As cleaning fluid is forced through the PTFE hose to its spray nozzle, the reel is turned to slowly lower the spray nozzle. This action cleans the convolutions one-by-one, and allows the cleaning solvent and dislodged dirt to be carried off by gravity. An affluent port provides a means of sampling the descending fluid to determine the degree of cleanliness being achieved in the flexible hose convolutions. Several cleaning passes can be easily accomplished as necessary to obtain the desired cleanliness.



Source: T. L. Moen of
McDonnell Douglas Corp.
under contract to
Marshall Space Flight Center
(MFS-20590)

Circle 19 on Reader Service Card.

NASA-Langley, 1971