NASA SP-5906 (03)

TECHNOLOGY UTILIZATION

FASTENERS AND FASTENING TECHNIQUES

A COMPILATION

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

Foreword

The National Aeronautics and Space Administration and the Atomic Energy Commission have 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 their research and development, NASA and AEC earn 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 document is organized into two sections. The first section includes a selected group of fasteners and concepts for fasteners such as locking devices, couplings, and connect and release mechanisms. The second section discusses a number of fastening techniques such as those for mounting panel lamps, clamping flange bolts, stretching fasteners, and transferring fuel from a tanker to another vehicle. Some of these items are new, some are modifications, and others are in the conceptual stage of development. These innovations should be attractive to a large segment of industry as well as to the general public.

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

Unless otherwise stated, NASA and AEC contemplate 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.

Technology Utilization Office
National Aeronautics and Space Administration

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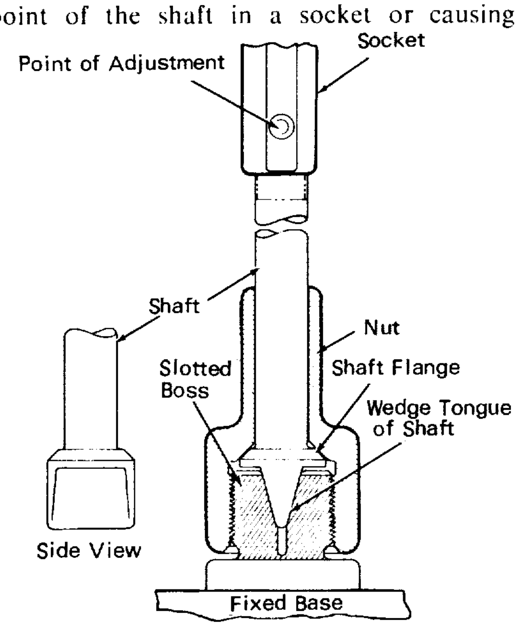
Contents

Section 1. Fasteners

CONNECT-DISCONNECT COUPLING FOR PREADJUSTED RIGID SHAFTS

A new coupling (see fig.) enables a rigid shaft to be connected to or disconnected from a fixed base without disturbing the adjustment point of the shaft in a socket or causing the shaft to rotate. The coupling consists of an externally threaded, internally slotted boss extending from the fixed base, and a nut that mates with the boss.

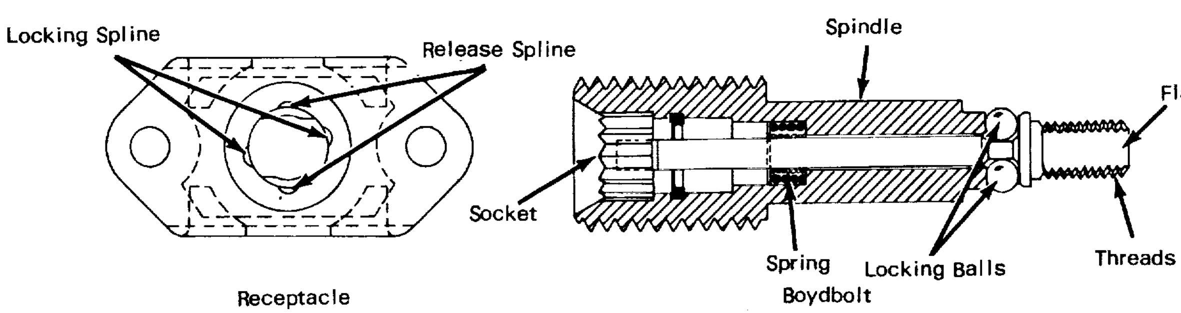


The slot in the boss is wedge-shaped to engage a wedge-shaped, flanged tongue at the end of the shaft. When the nut is tightened, the shaft is secured to the coupling in a rigid, nonrotating assembly. After the shaft is initially locked in the socket at the point of adjustment, the shaft can be disconnected from or reconnected to the boss in the fixed base. This is effected by loosening or tightening the nut as required, without causing the shaft to rotate or to change its initial adjustment point in the socket.

Source: A. Holmberg and F. W. Bajkowski of North American Rockwell Corp. under contract to Manned Spacecraft Center (MSC-15470)

No further documentation is available.

BOYDBOLT POSITIVE-LOCK, SIMPLE-RELEASE FASTENER



This fastener remains in a locked position under high dynamic preload but is easily removed by the application of only a small force. It has positive lock and release features to prevent accidental operation, and can be fabricated in a variety of sizes for a wide range of applications.

A floating receptacle, designed to receive the Boydbolt, is riveted or screwed to a support structure. This receptacle contains two locking and two release splines in its outer section. The inside of the receptacle is machined to form a four-lead thread that has opposing $\pi/2$ rad (90°) slots to provide a breach-type engagement for the bolt. The forward portion of the bolt is threaded in a mating pattern; i.e., flats are machined on approximately $\pi/2$ rad opposing slots so that the bolt may be freely inserted into the receptacle. Two locking balls whose action is controlled by the position of a central spindle are positioned as shown in the figure. In the raised position, the spindle prevents the balls from moving toward the center of the bolt, thus providing for positive engagement of the balls with either the locking or release splines. The spindle is maintained in its free position by a spring. The top of the bolt is machined to a double hexagonal socket in order to receive a lock or to release a hexagonal headed hand tool.

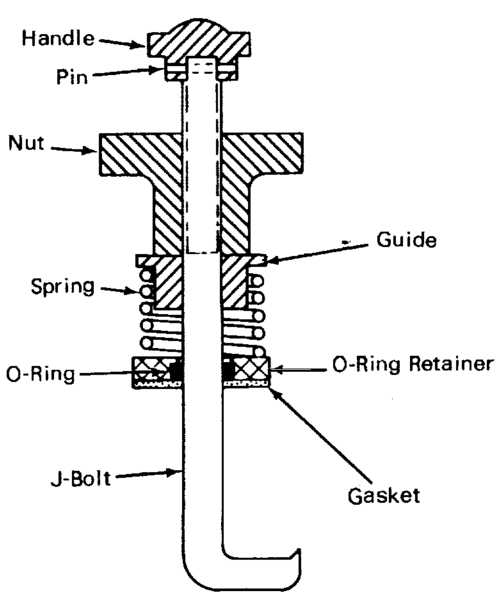
To assemble the Boydbolt fastener, the hand tool is inserted in the bolt socket, depressing the spindle and releasing the locking balls. The bolt assembly is then inserted in the receptacle with the locking balls oriented colinearly with the release spline. The bolt is rotated clockwise until the balls engage the locking spline and stop the bolt from turning further. The threads of the bolt and receptacle are now fully engaged. Upon withdrawal of the hand tool from the bolt, the spindle moves in to force the balls into the locking splines, thus preventing rotation of the bolt assembly under vibration.

Source: W. Hamill, J. Brueger,
M. Katz, and T. Fenske of
The Bendix Corp.
under contract to
Manned Spacecraft Center
(MSC-13061)

Circle 1 on Reader Service Card.

J-BOLT LOCKING DEVICE

A self-sealing, J-bolt locking device can be inserted in apertures where no threaded holes exist. Because of its hook-shaped end, the device can be anchored to an internal reinforcement to fasten a sealing plate or plug. This innovation can be used to seal openings in engine blocks and various castings.



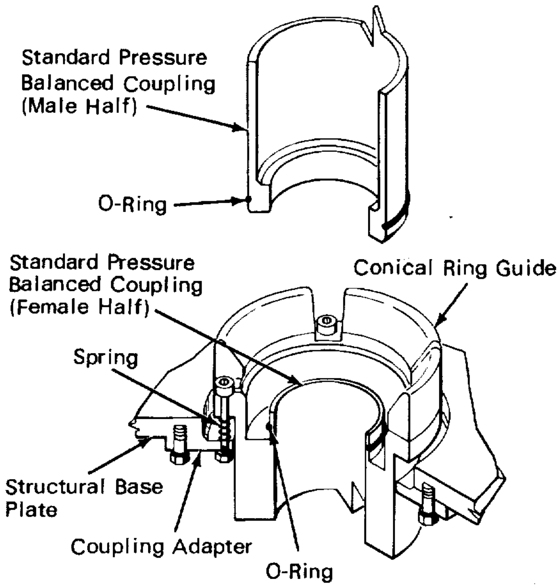
The device (see fig.) consists of a J-shaped bolt threaded only at the straight end, a gasket to seal the attaching surface, an O-ring with a retainer to seal around the bolt, a compression spring for providing adequate load on the gasket, and a guide bushing. A handle on the threaded end makes adjustments easier. To lock a plug or plate, the device is inserted into the aperture of the part being sealed, rotated to grip a reinforcement, and adjusted for adequate sealing.

Source: D. L. Dickinson
North American Rockwell Corp.
under contract to
Marshall Space Flight Center
(MFS-14275)

No further documentation is available.

MODIFIED PNEUMATIC UMBILICAL COUPLING PROVIDES MATING SELF-ALIGNMENT

The coupling and uncoupling of large pneumatic umbilical lines can be very difficult for remote manipulators, especially when the male and female connectors are out of alignment. To overcome this, the female half of the umbilical connector was modified to include a floating conical tapered guide that prealigns the male section, and four springs that restrain the axial and lateral movements of the female section.



The female flange (see fig.), normally bolted to a structural baseplate, is bolted to an adapter ring in the modified coupling. The ring arrangement provides the clearance necessary for free movement of the female section, which is restrained by four spring-loaded bolts. These bolts also hold a conical ring guide whose inside diameter is considerably greater than the outside diameter of the male section. The use of the ring guide eliminates the problem of center-line mismatch, and the spring loading of the entire female section compensates for angular mismatch.

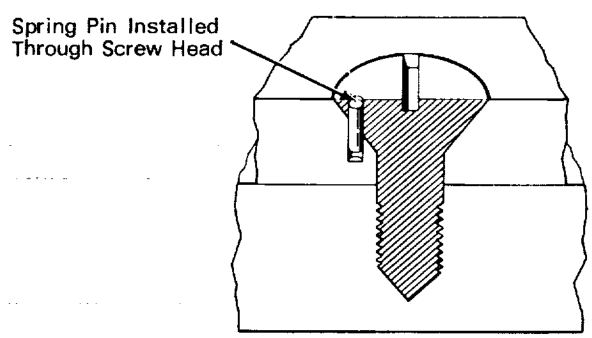
Source: P. A. Griffin of
Aerojet-General Corp.
under contract to
AEC-NASA Space Nuclear Systems Office
(NUC-0037)

No further documentation is available.

COUNTERSUNK HEADSCREW RETAINER

A technique has been proposed for retaining a countersunk screw (under dynamic conditions) when the use of a self-locking device is not feasible and a flat surface is desired. This innovation should interest the manufacturers of fasteners, as well as personnel working in the machinery, aircraft, automotive, and aerospace industries.

In an environment where countersunk head screws cannot be held by either self-locking inserts or lock wiring, a spring pin can be used (see fig.). A hole is drilled through one side of the screw head and into the component. The spring pin is then inserted to form a flat surface. A pin installed in this fashion performs adequately under dynamic conditions.

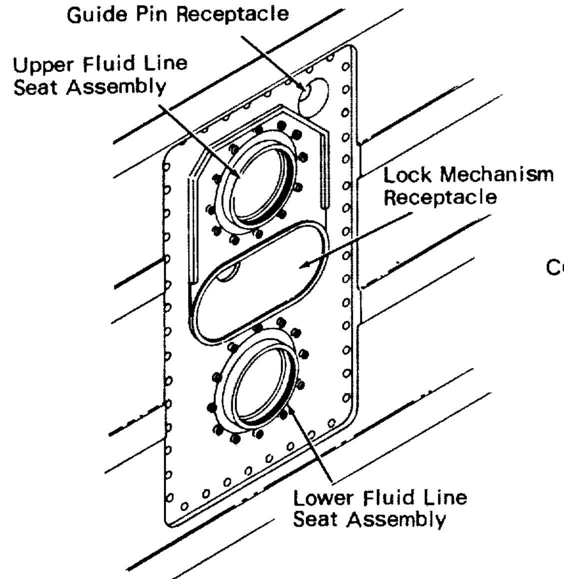


Source: R. S. Totah of
North American Rockwell Corp.
under contract to
Marshall Space Flight Center
(MFS-16481)

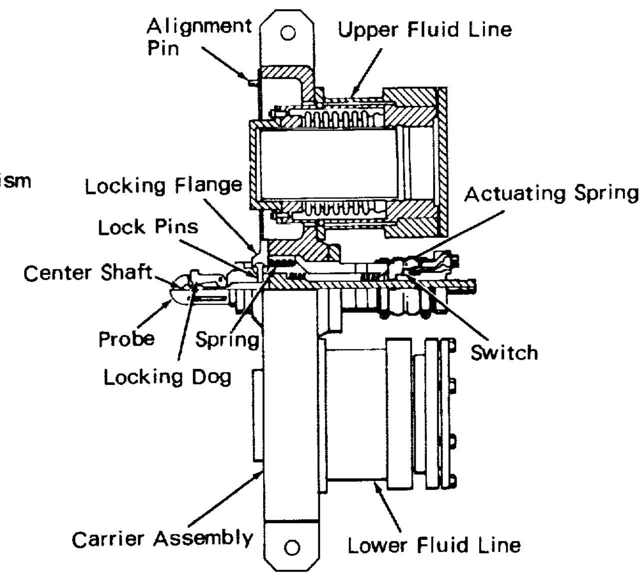
No further documentation is available.

RECONNECT MECHANISM

A mating and de-mating mechanism which is regulated from a central control system provides a means for locating, mating, and locking two bodies, and for remotely de-mating the bodies by unlocking and separating them. The mechanism (see fig.) is designed for use in the transfer of fluids from a dispensing body to a receiving body.



Receiving Body



Dispensing Body

The locking sequence begins when the dispensing body lock-mechanism probe contacts the lock-mechanism receptacle on the receiving body. The probe is guided, by the configuration of the receptacle, to a hole in the receptacle bottom and is aligned with the assistance of a guide pin receptacle in the receiving body plate. Three locking dogs on the probe are held in retracted position by a system of springs and lock pins. As the probe enters the hole in the receptacle, the locking flange is pushed back, compressing the actuating spring. When the probe reaches maximum depth in the receptacle, the locking flange releases the lock pins, permitting the center shaft to move forward, and forcing the locking dogs to pivot and lock on the inside surface of the receiving body plate.

To de-mate the two bodies, a pneumatic system (not shown) retracts the center shaft, withdrawing the locking dogs and releasing the two bodies. When the bodies are free of one another, a relatively high pneumatic pressure is applied to separate the two bodies at a controlled rate.

Source: D. L. Moore of
The Boeing Co.
under contract to
Marshall Space Flight Center
(MFS-12968)

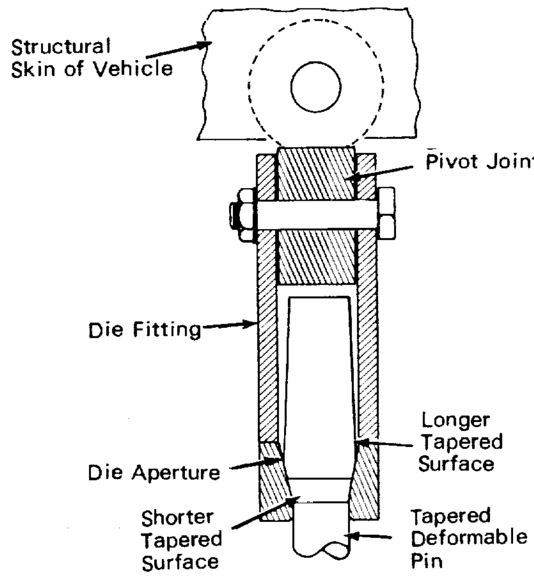
Circle 2 on Reader Service Card.

CONTROLLED RELEASE DEVICE PREVENTS DAMAGE FROM DYNAMIC STRESSES

A controlled release device can be used to retard motion by extruding or drawing a tapered ductile pin through a die. The device prevents damage from dynamic stresses imposed on a high-thrust vehicle which is instantaneously released at full thrust. This innovation could be used as a fail-safe system for tension loads, a deceleration mechanism for elevators, and other applications where loads must be limited to specific values or where given amounts of energy must be absorbed.

The device (see fig.) consists of a pivot joint, die fitting, and tapered deformable pin. The pivot joint is linked to the die fitting and is bolted to the structural skin at the base of the vehicle. The double tapered segment of the ductile pin fits within the die fitting, and the straight shanked segment passes through the die aperture and extends outside the fitting.

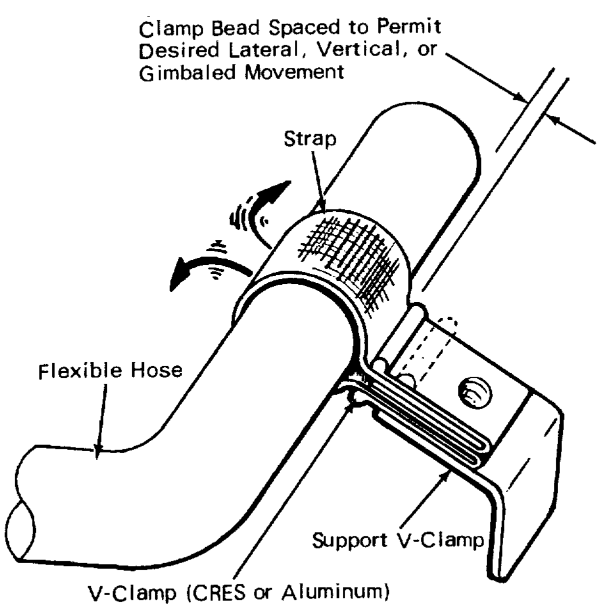
The aperture of the die is tapered with the small end facing outward, and the shorter tapered surface of the pin seats against this aperture. Since the minor diameter of the aperture is smaller than the major diameter of the pin, the ductile pin deforms as it is pulled through the aperture. Resistance to movement diminishes as the pin is pulled through the die because the longer tapered surface of the pin has a decreasing diameter.



Source: T. W. Burcham
Kennedy Space Center
(KSC-66-14)

Circle 3 on Reader Service Card.

CONCEPTUAL UNIVERSAL FLEXIBLE CLAMP



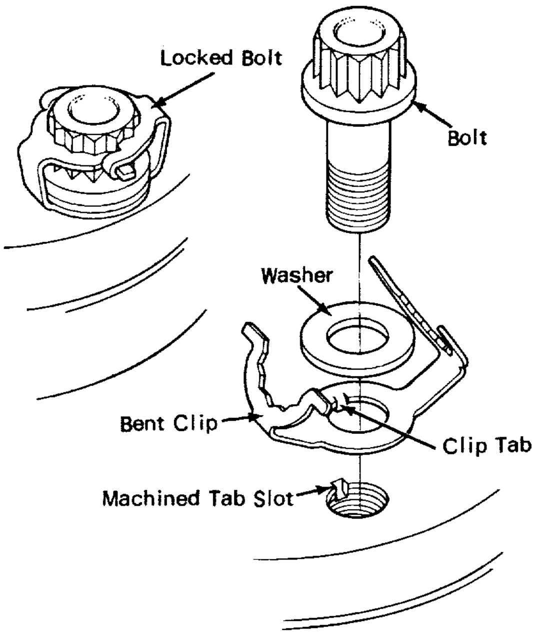
A concept has been advanced for a flexible support clamp that can be adapted to hold hoses (ducts) of various sizes. The clamp would firmly support the hose while allowing lateral, vertical, or gimbaled movement.

The clamp can be made of two metallic V-clamps (CRES or aluminum) and a metallic or nonmetallic flexible strap (see fig.), and can be quickly assembled at the time of installation. The use of a sizing table during assembly allows for a full range of sizes. This conceptual device provides adequate support without hampering the flexed or gimbaled movement of the hose, and without interferring with adjacent components.

Source: R. A. Kotler and W. L. Owens of
North American Rockwell Corp.
under contract to
Manned Spacecraft Center
(MSC-17204)

No further documentation is available.

CONCEPT FOR SINGLE-UNIT LOCKING DEVICE



A single-unit, "bent-clip" locking device concept provides a positive lock for wrench-type bolts. The device (see fig.) consists of a single stamped part with two open-end wrench arms and a washer. The device would eliminate safety wires, which present a significant disadvantage during maintenance and cannot be installed in confined areas because of the inaccessibility.

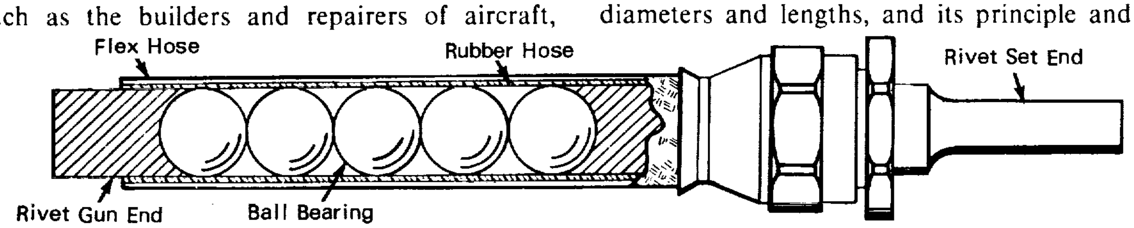
The stamped part and washer are installed and the bolt is torqued. The two locking arms are bent in such a way that they meet and interlock around the bolt-head points, providing a positive lock. The locking device is prevented from rotating by the clip tap, which is bent into a previously machined slot.

Source: J. P. Jenson of
North American Rockwell Corp.
under contract to
Marshall Space Flight Center
(MFS-13545)

No further documentation is available.

FLEXIBLE RIVET-SET DEVICE

A very simple device can be used to set rivets in confined places where the head of a conventional gun cannot be laid on the rivet. The rivet-set device may interest riveting gun users such as the builders and repairers of aircraft, ships, radios, and tanks. Previously, a special set had to be fabricated for each different situation, whereas this device suffices for all.



A typical device (see fig.) consists of a 10 cm (4 in.) length of rubber hose, with a 1.58 cm (5/8 in.) inner diameter, encased in a similar length of braided metal hose. An anvil for the riveting gun is set in the driven end of the rubber hose which is loaded with five steel ball bearings of 1.58 cm (5/8 in.) diameter; a rivet set is mounted in the other end of the device.

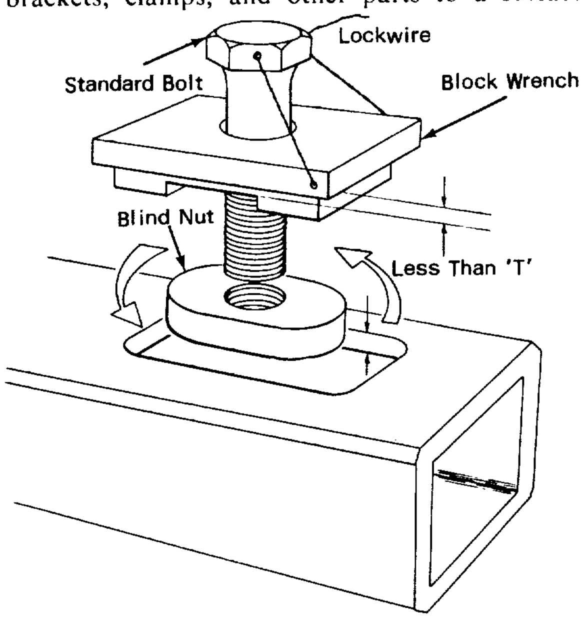
When the rivet-set tool is flexed to any degree between the head of a riveting gun (or any impact tool) and a rivet, the loss of impact is negligible. The tool may be made in any of many diameters and lengths, and its principle and use are not restricted to riveting. The ball-to-ball line of contact might be improved by the insertion of spacers.

Source: W. H. Hespenhide of
McDonnell Douglas Corp.
under contract to
Marshall Space Flight Center
(MFS-20317)

No further documentation is available.

SIMPLIFIED BLIND NUT PROVIDES POSITIVE LOCKING

A universal blind nut assembly provides a simple, inexpensive means for fastening plates, brackets, clamps, and other parts to a surface accessible only from one side. Neither riveting nor welding is necessary, and only minimum machining is required. The assembly consists of a standard bolt, an elongated nut, and a special cast or machined block designed for use in blind areas. This innovation can be used to fasten accessories and parts to tubing, box channels, ceilings, walls, floors, ducts, and any surface that cannot be tapped.

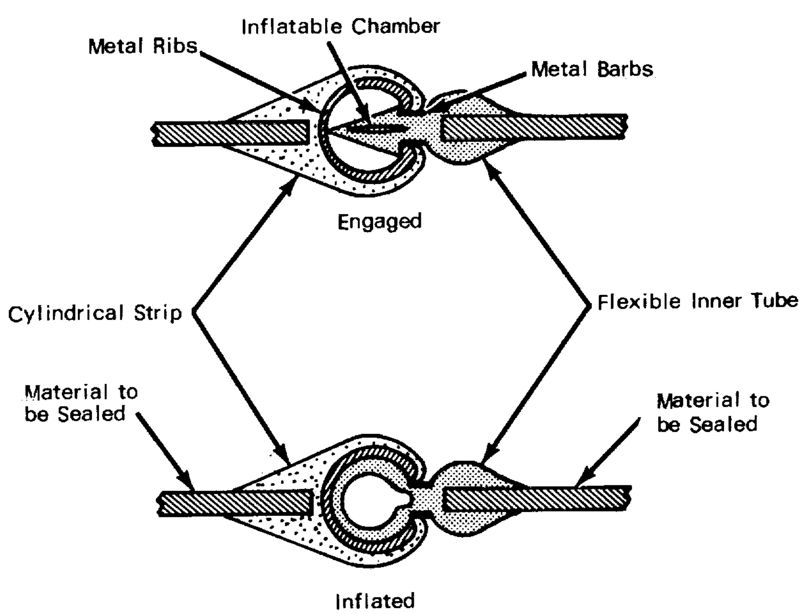


To obtain a positive lock, the bolt is inserted in the assembly, rotated $\pi/2$ rad (90°), pulled tight, and torqued as needed. A lockwire is then attached as shown in the figure. The assembly can be removed at any time without destroying its components.

Source: C. H. Held of
North American Rockwell Corp.
under contract to
Marshall Space Flight Center
(MFS-14319)

No further documentation is available.

FLEXIBLE FASTENER EFFECTS FLUID-TIGHT MATERIAL CLOSURE



A conceptual flexible fastener can be quickly joined or separated and will prevent the passage of fluids. A flexible, flat, preformed inflatable tube is inserted into a flexible, 3/4-round strip receptacle (see fig.). The tube is attached to one side of the material to be sealed and the receptacle is attached to the other side to form the closure. This innovation might be used with such equipment as underwater suits, contamination protection outfits, masks, tents, and doors.

The open side of the 3/4-round strip receptacle (made of plastic or rubber), which is reinforced with metal ribs, faces directly away from the material to which it is attached. The inflatable tube portion, opposite the material to which the receptacle is attached, is arrow shaped for easy insertion into the receptacle. The metal plates along the tube base adequately secure it in place.

The inflatable tube is inserted into the receptacle by pressing in either end and then gradually working the tube in lengthwise. After insertion, the tube is inflated through a releasable check valve. To break the closure, the check valve is opened to release the pressure, the metal plates at either end of the inflatable tube are gripped and compressed, and the tube is easily stripped from the receptacle.

Source: D. L. Nay
Jet Propulsion Laboratory
(JPL-684)

No further documentation is available.

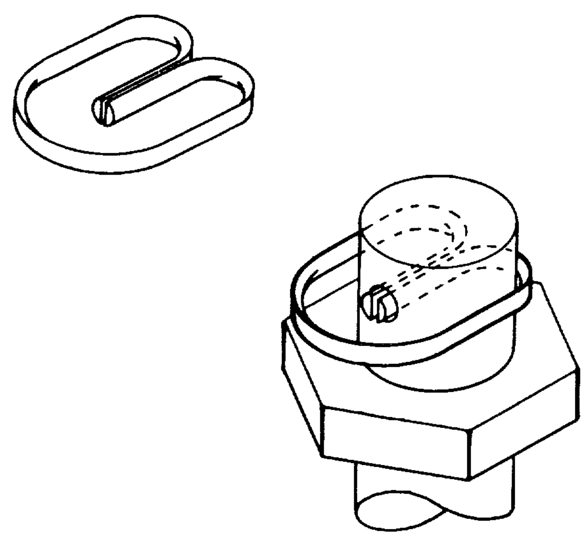
IMPROVED COTTER PIN

An improved cotter pin can be easily installed or removed without the use of hand tools. The pin, made of high-strength materials, does not easily shear and provides a stronger joint than those with malleable standard pins.

In the installation or removal of conventional cotter pins, considerable time is spent forming the ends with a hand tool. When cotter pins must be installed or removed in confined areas where the free use of hand tools is restricted, the operation is even more time consuming. The improved cotter pin (see fig.) can be easily installed or removed by hand.

The pin is installed by placing the loop edge on the stud, with the two cotter legs lined up with the drilled hole. The legs are inserted into the hole by pushing the pin downward, and the entire pin is then pushed toward the stud. The loop of the pin springs down over the stud to retain the pin in place.

To remove the pin, the looped end is raised to clear the end of the stud. The pin is then pushed away until the legs clear the hole.

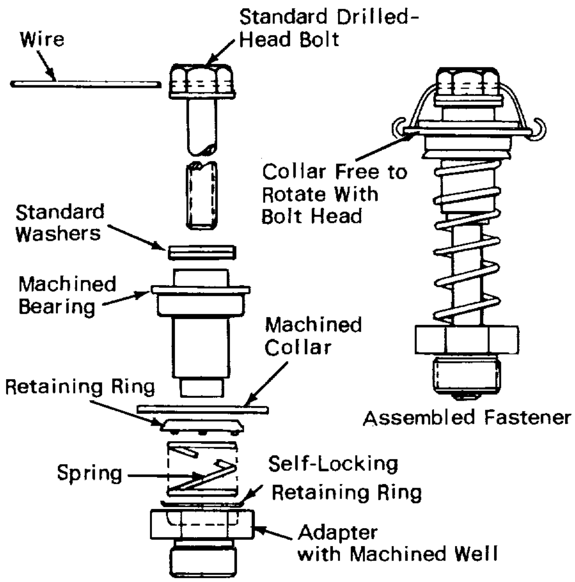


Source: R. M. Cobiella of
The Boeing Co.
under contract to
Kennedy Space Center
(KSC-10170)

No further documentation is available.

RETRACTABLE CAPTIVE FASTENER

A retractable captive fastener, consisting of a standard drilled-head bolt and a spring to retract the bolt, held together as shown in the figure, provides a positive means for attaching bolts without modifying test plates or panels. The



fastener could be used in steam engine caps, hydraulic lines, oil well caps, and various system test plates. It is particularly adaptable to heavy-duty test plates used for system pressurization in either through- or blind-hold installations. This means of fastening is better than conventional ones because it allows the use of bolts of various lengths and diameters, eliminates the hazard of loose or worn hardware on the far side of a hole in a test plate, and allows work to be performed on test plates without structural damage to the plate.

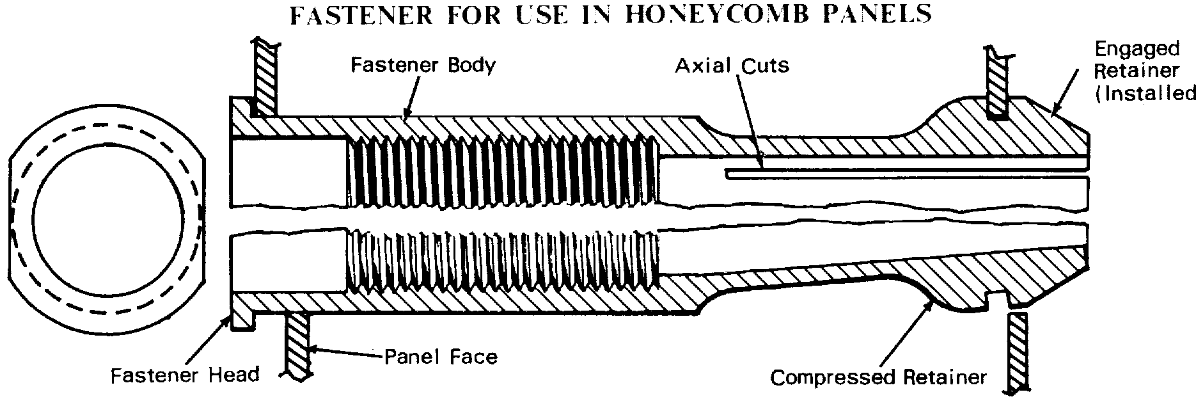
The linear movement of the spring must be coordinated with the rotational-linear movement of the bolt. To accomplish this, the hole through the bolt head is used to attach the bolt to a free-moving machined collar that carries part of the load exerted on the bolt.

To retract the bolt, a spring is attached. One end of the spring is connected to the bearing shank and the other end is retained in a machined well. The well may be in an adapter, making the assembly a self-contained unit, or it may be machined directly into a plate. As the spring is compressed, the bearing comes in contact with the test plate, transmitting the load to the plate.

Source: D. L. Dickinson of
North American Rockwell Corp.
under contract to
Marshall Space Flight Center
(MFS-14261)

Circle 4 on Reader Service Card.

FASTENER FOR USE IN HONEYCOMB PANELS



A conceptual fastener may be used in mounting lightweight electronic components on fiberglass or aluminum honeycomb panels (see fig.). The one-piece fastener is retained by the spring action of tangs formed by four axial cuts through the fastener's blind end. Presently, panels must be removed prior to mounting electronic equipment. This procedure results in costly electric wiring and check-out.

The new fastener, easily inserted without removing the panel, would support one-half of a 0.9 kg (2 lb) component. The blind end of the fastener is forced through a prepared hole in the panel until the fastener snaps in place. This innovation should be of interest to the manufacturers of air frames and general-purpose hardware.

Source: R. M. Johnson and R. K. Shogren of
McDonnell Douglas Corp.
under contract to
Marshall Space Flight Center
(MFS-20570)

No further documentation is available.

SELF-RETAINING SUPPORT

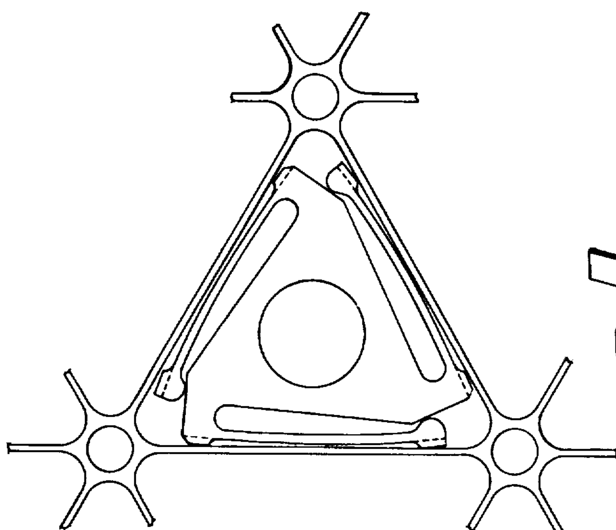


Figure 1

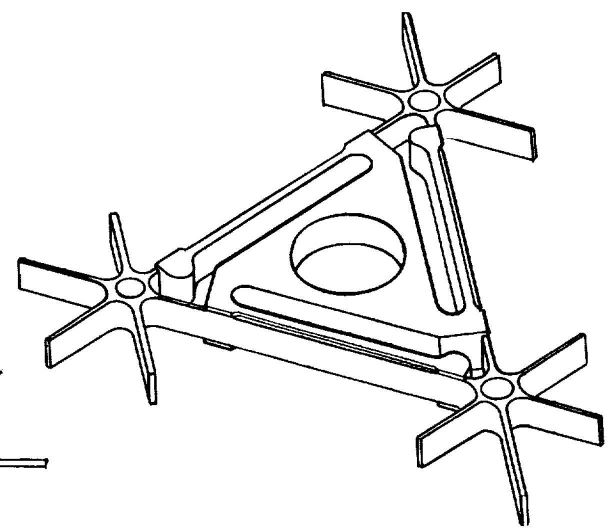


Figure 2

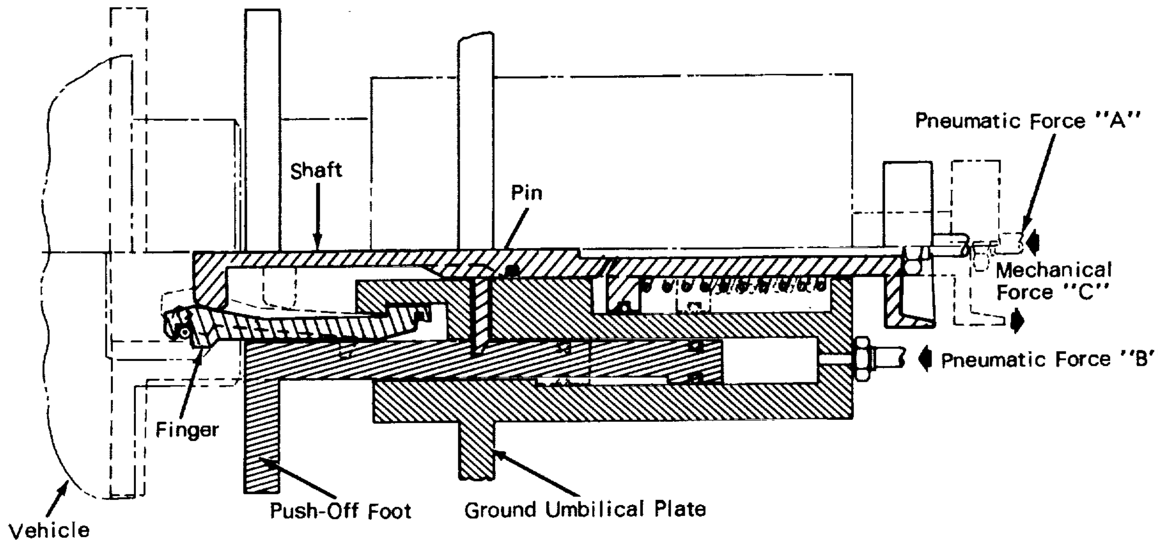
A unique grommet can support a covered wire bundle or other hardware in a triangular grid structure. The support does not require attaching hardware and can be quickly installed in and removed from a structure. Since no holes or hardware are required to install the support, no damage occurs when it is removed. The grommet could be particularly useful to the aircraft industry.

The support design uses the elasticity of the material of which it is made in order to retain the support in the structure to which it is fitted. Integral cantilever arms keep the body in place. The grommet is installed by deflecting the arms to reduce the overall size (see Fig. 1) and, as the arms return, the support is locked in place (see Fig. 2).

Source: J. J. Bissot of
McDonnell Douglas Corp.
under contract to
Marshall Space Flight Center
(MFS-20563)

No further documentation is available.

LOCK-DISCONNECT MECHANISM PROVIDES POSITIVE RELEASE FOR JOINED BODIES



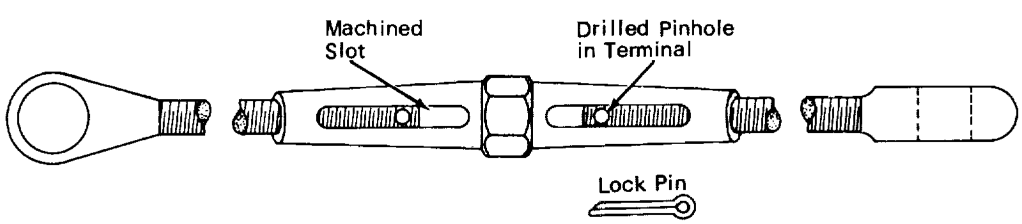
A unique mechanism locks and unlocks through an internal collet device that is locked and released by the action of a single reciprocating shaft. The appreciable reduction in the number of parts needed to operate the mechanism, compared to conventional umbilical systems, results in a high reliability.

The mechanism, in the locked position, joins the vehicle and the ground umbilical plate (see fig.). Prior to disconnect, a pneumatic force "B" is applied to preload the push-off foot; the preload is withheld from the vehicle by a series of pins that engage the foot shaft. To unlock the mechanism, either a pneumatic force "A" or a mechanical force "C" is applied to the actuator shaft. As the shaft is forced to the right, the fingers collapse toward the centerline of the mechanism, allowing the ground umbilical plate to be unlocked from the vehicle. Once the device is unlocked, the pins ride down the ramp of the actuator shaft until they reach a predetermined point. The push-off foot is then released and the preload forces it against the vehicle, separating the vehicle and the ground umbilical plate.

Source: C. E. Beaver of
The Boeing Co.
under contract to
Marshall Space Flight Center
(MFS-2147)

Circle 5 on Reader Service Card.

SAFETY-LOCKING TURNBUCKLE



A new safety-locking turnbuckle which does not need a lockwire provides a safer, more effective locking capability at reduced cost. The turnbuckle can be installed more easily and in less time than the lockwire type. The device should be particularly useful in the marine and construction industries.

The lock pin is inserted through drilled holes or slots in the barrel and then through a hole drilled in the end of the threaded terminal, locking the terminal and barrel together (see fig.).

Source: F. Broadwick of
Chrysler Corp.
under contract to
Marshall Space Flight Center
(MFS-14645)

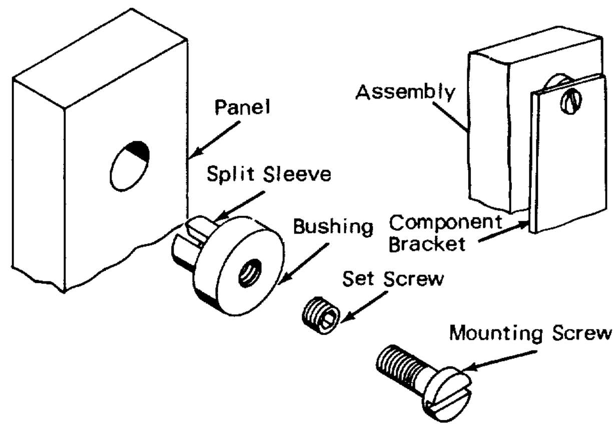
No further documentation is available.

EXPANDABLE INSERT SERVES AS SCREW ANCHOR

An expandable self-locking adapter with a female thread that mates with a mounting screw provides a means for securing components to panels where only one side is accessible. The device (see fig.) could be used in electronic and mechanical assembly work, as well as for attaching various household appliances to solid panels.

The adapter, made of metallic or nonmetallic material, has a bushing and a split sleeve which fits inside a mounting hole in the panel. The sleeve is internally threaded to receive a short Allen-head set screw, and the bushing is threaded to receive a mounting screw.

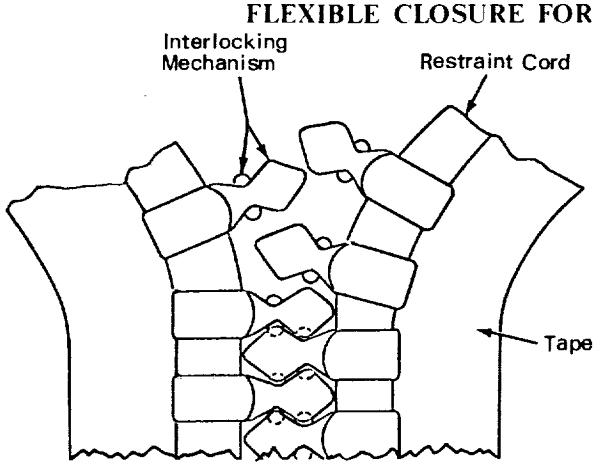
The adapter is securely fastened to the panel by inserting the sleeve into a mounting hole and tightening the set screw with an Allen key to expand the split end of the sleeve against the surface of the mounting hole. A mounting screw may then be inserted in the threaded bushing and tightened with a screwdriver.



Source: North American Rockwell Corp.
under contract to
Manned Spacecraft Center
(MSC-301)

Circle 6 on Reader Service Card.

FLEXIBLE CLOSURE FOR PRESSURIZED ENCLOSURES



A flexible sealing device made of brass alloy provides an adequate closure for protective suits, storage bags, and similar pressurized enclosures. The configuration of the scoops for the chain is shown in the figure. Each scoop has an interlocking feature that significantly aids in achieving high crosswise break strength and positive engagement during linear loading under pneumatic pressure. A tape made of Nomex or similar material is used to support the scoops. Two sets of neoprene-base sealing lips, one on either side of the chain, provide adequate sealing against both air and water.

The device, with an aluminum slider pull, was installed in a torso mockup of a space suit for a structural test; at 188.9 kN/m^2 (12 psig) for 15 minutes, it was found satisfactory.

Two different closures were tested for leaks. One had a leak rate of 1.8 mm/min at 126.8 kN/m^2 (3.7 psig) and another had a leak rate of 0.5 mm/min at 126.8 kN/m^2 (3.7 psig), demonstrating a high degree of performance compared to other state-of-the-art closures.

Source: David Clark Co.
under contract to
Manned Spacecraft Center
(MSC-13772)

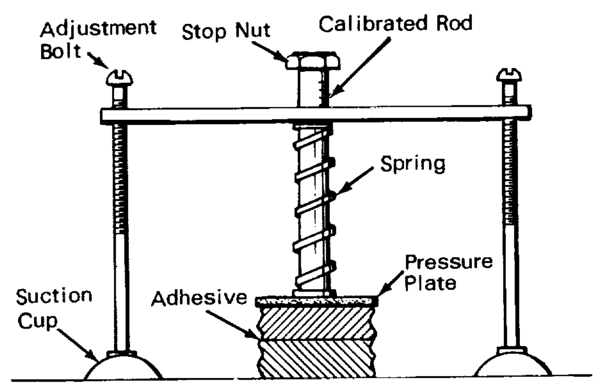
Circle 7 on Reader Service Card.

CALIBRATED CLAMP FACILITATES PRESSURE APPLICATIONS

A spring-loaded clamp, with two adjustable legs that terminate in suction cups, can be used to hold materials together or to attach a workpiece to a surface during bonding, machining, welding, and other similar operations.

The two threaded bolts connected to the crossbar (see fig.) are fitted with suction cups in a swivel connection, facilitating attachment to a curved surface. The pressure plate is attached to the spring-loaded rod passing through a hole in the center of the crossbar.

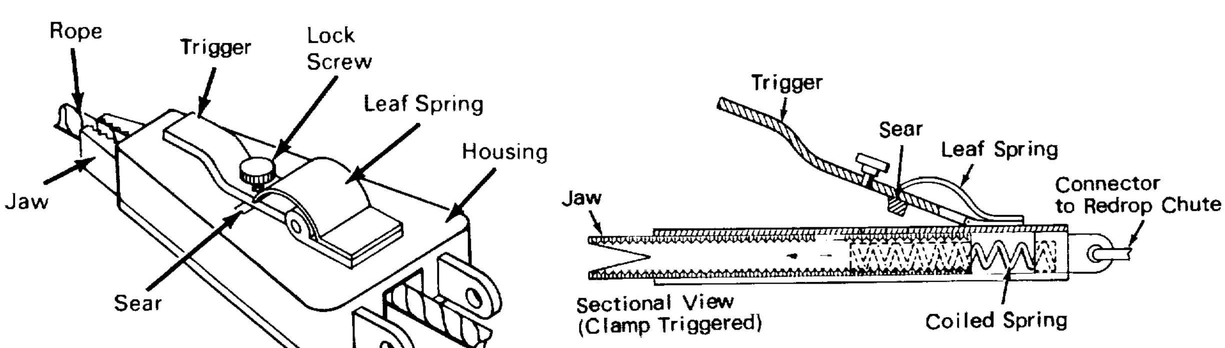
When the device is used to clamp materials together, the suction cups are placed on a supporting surface and fastened, if necessary, with a nonhardening adhesive. The screw bolts are then adjusted to apply the desired pressure to the plate. The spring-loaded rod may be provided with calibrated markings to indicate the applied pressure.



Source: North American Rockwell Corp.
under contract to
Manned Spacecraft Center
(MSC-298)

Circle 8 on Reader Service Card.

QUICK-ATTACH CLAMP



An improved slidable-jaw clamp can be easily and quickly attached to moving lines such as cables and ropes. The improved clamp would be particularly useful in attaching a redrop parachute to an aerial recovery package.

Although prior clamps are quite efficient, there are many situations where the jaws get in the way when the clamps are being attached. The jaws of such clamps must generally be held apart manually so that the line can be placed between them.

The new clamp (see fig.) has trigger-operated jaws that can be easily actuated to attach a redrop parachute to a moving tow cable. The trigger mechanism maintains the jaws in a retracted position in the housing until they are released for clamping. A sear on the trigger engages a groove in each jaw to hold the jaws retracted. A leaf spring keeps the sear in the grooves before the device is triggered. Two coiled springs force each jaw into clamping engagement when the sear is raised by trigger action. (A removable lock screw is provided to prevent accidental tripping of the trigger.)

With the jaws retracted, the clamp is placed in close proximity to a moving cable. When the clamp is correctly positioned, the trigger is raised to release the sear. The coil springs then immediately snap the jaws into engagement with the moving (or stationary) cable.

Source: A. E. Vano
Flight Research Center
(XFR-05421)

Circle 9 on Reader Service Card.

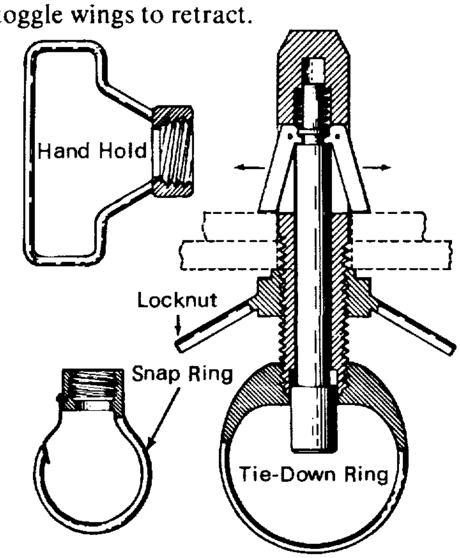
EASY INSERT, EASY RELEASE TOGGLE-BOLT FASTENER

A new fastener (see fig.) has a cylindrical body with a tapered head for easy insertion into a hole, and a threaded back end for receiving the locknut and desired attachments (such as tie-down ring, hand hold, plain retainer nut, and snap ring). Slots in the cylindrical body act as receptacles for two or more toggle wings (or detents) which are held in place by pins. The toggle wings are extended, except when the spring-loaded central actuator pin is depressed.

Possible uses of the device include fastening items to a wall or deck where simultaneous access to both sides of the wall or deck is not possible, or fastening two surfaces of opposite curvature; i.e., a concave surface to a convex surface. The device would also be useful in the construction of underwater or space structures that require the use of nuts and bolts.

To insert the fastener into a hole, the fastener is merely pushed into the hole, causing the toggle wings to retract. When the fastener is in place, the actuator pin is released and the toggle wings expand, thereby preventing the fastener from being removed. The fastener is secured by screwing the locknut down firmly, thus exerting a compressive force between the locknut and the toggle wings. With the threaded portion of the cylindrical body functioning as a stud, a suitable attachment may be screwed on.

To remove the fastener from the hole, the locknut is loosened and the exposed portion of the central actuator pin is depressed, causing the toggle wings to retract.



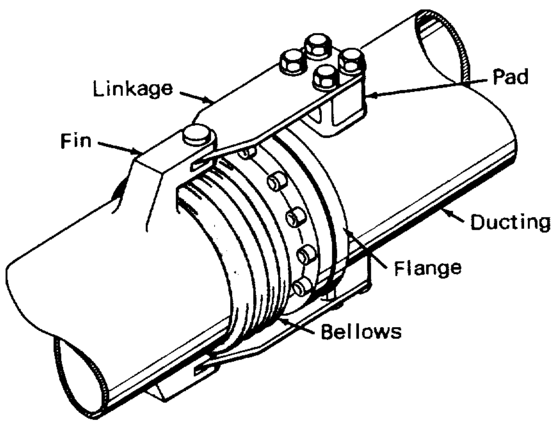
Source: C. C. Kubokawa
Ames Research Center
(ARC-10140)

Circle 10 on Reader Service Card.

Section 2. Fastening Techniques and Systems

EXTERNAL LINKAGE TIE ALLOWS REDUCTION IN FLANGE THICKNESS OF DUCTING SYSTEMS

A proposed concept provides for an external linkage tie to reduce flange thickness and increase seal efficiency in high-pressure ducting



and piping systems. Presently, the pressure-separating load is transmitted directly to the flange, which has to be made extra thick to carry the load. The linkage tie (see fig.) would transmit the pressure-separating load to the tube wall behind the flange.

This design may be implemented by extending the linkage tie across the flange and bolting it to a pad directly behind the flanged joint. Since the pressure-separating load would be transmitted to the tube wall behind the flange, the flange could be designed to support only the seal.

A linkage tie based on this concept would also allow the pressure load, caused by the bellows, to put the flanged joint in compression, thereby increasing the efficiency of the seal.

Source: R. O. Pfleger of
North American Rockwell Corp.
under contract to
Marshall Space Flight Center
(MFS-823)

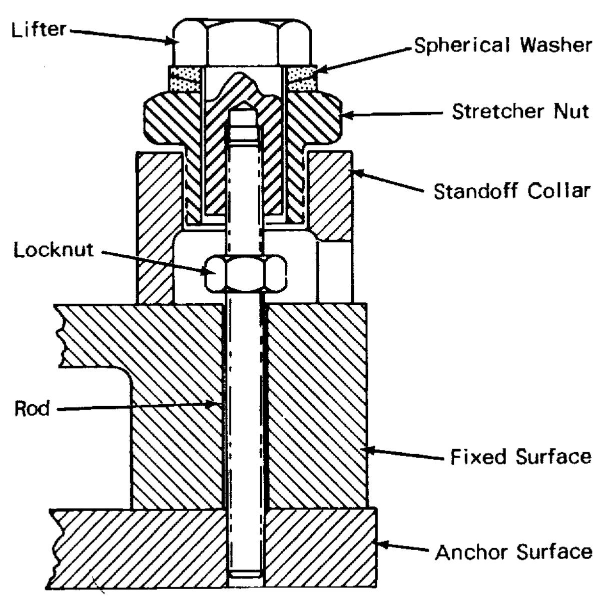
No further documentation is available.

TECHNIQUE FOR STRETCHING FASTENERS

A simple, easy-to-use technique provides a means of increasing the load-carrying capacity of threaded tension members such as bolts and rods. It maximizes the safe working strength of the materials from which the tension members are made, and may be particularly useful where exact tension on fastening rods is required.

High-torque loads are normally applied directly to the nut that threads on a bolt or similar fastener, preventing the fastener from reaching its theoretical tensile strength. The innovation alleviates this shortcoming by stretching the rod or similar fastener, one end of which is secured to an anchor surface by threads or other means and the other end of which is secured to a tension member called the lifter. When force is applied to the lifter, the fastener is stretched and a nut is finger-tightened to hold the rod in tension.

A fastener stretcher can be operated either



mechanically, pneumatically, or thermally. The principle of the mechanical operation is schematically illustrated in the figure. In this case, the fastener to be stretched is a threaded rod attached at one end to an anchor surface. The stretching device consists of a lifter threaded to the other end of the rod and a stretcher nut threaded into a standoff collar. The collar bears on the fixed surface, creating a bearing structure during the stretching operation.

The assembly (lifter, stretcher nut, and standoff collar) is attached to the threaded rod. As the stretcher nut is turned, the load on the lifter stretches the rod. When the rod is stretched to the desired amount, the locknut is turned by hand or with a small wrench until it mates with the fixed surface. Backing off the stretcher nut transfers the load to the locknut that maintains the rod in the stretched condition. The fastener stretcher is then removed by backing off the lifter.

Source: J. W. O'Connor and V. C. Orem
Goddard Space Flight Center
(GSC-11149)

Circle 11 on Reader Service Card.

CLAMPING FLANGE BOLTS IN CRYOGENIC TURBOPUMPS

Locks for clamping bolts that are used to secure flanges inside cryogenic turbopumps tend to fail under severe thermal cycling. As a result, materials such as metallic particles, or loose washers or bolts, may become entrained in the fluid stream and cause catastrophic malfunction. To overcome this shortcoming, flanges were redesigned to include a retaining lip for securing the bolts, thus eliminating the need for locks. This innovation is applicable wherever clamping bolts are used inside machinery or fluid-transport equipment.

The bolt holes in the flange being secured are elongated into short, annular slots so that the flange may be rotated approximately four bolt-diameters with the bolts in place. The bolt head is secured by a lip on the flange, and a notch is machined at one end of each slot in the lip to facilitate bolt installation. After all the bolts are in place, the flange is rotated so that the bolts are in the opposite ends of the slots. The bolts are then torqued down into shallow counterbores to prevent further rotation of the flange.

Although this is a more expensive method of locking bolts than conventional ones, the improved reliability more than compensates for the additional cost where failure could initiate severe danger to personnel or equipment.

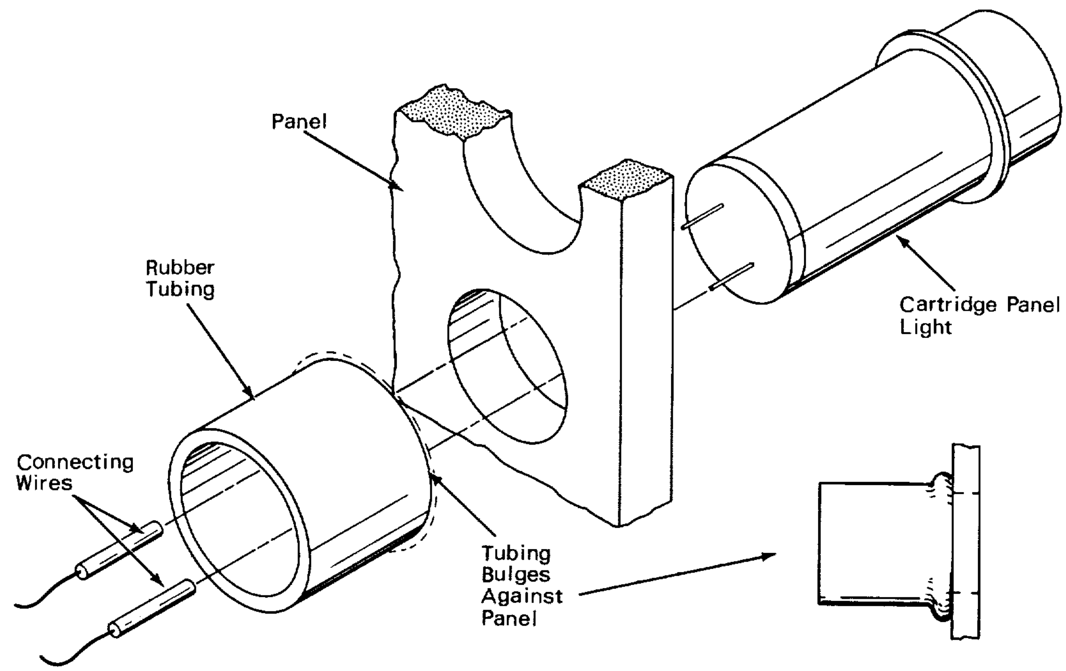
Source: F. L. Catterfeld of
North American Rockwell Corp.
under contract to
Marshall Space Flight Center
(MFS-12770)

Circle 12 on Reader Service Card.

MOUNTING PANEL LAMPS

The use of rubber surgical tubing allows cartridge-type lamps to be mounted in close proximity to other lamps and to be easily removed without damage. Such lamps can be mounted on digital displays, test control boards, and other display panels using this technique.

A hole large enough to receive the cartridge lamp is drilled in the panel. The lamp is then inserted into the hole (see fig.). While pressure is applied to the outer portion of the lamp, a short piece of surgical tubing is slid over the part that extends through the hole. A slight bulging of the tubing at the panel secures the lamp during vibration.



The use of an insertion tool, a piece of metal tubing with an inside diameter slightly larger than the outside diameter of the lamp, is helpful in seating the rubber tubing. The lamp can be easily removed by withdrawing the rubber tubing and sliding the lamp from the panel.

Source: R. D. Banta of
The Boeing Co.
under contract to
Kennedy Space Center
(KSC-10401)

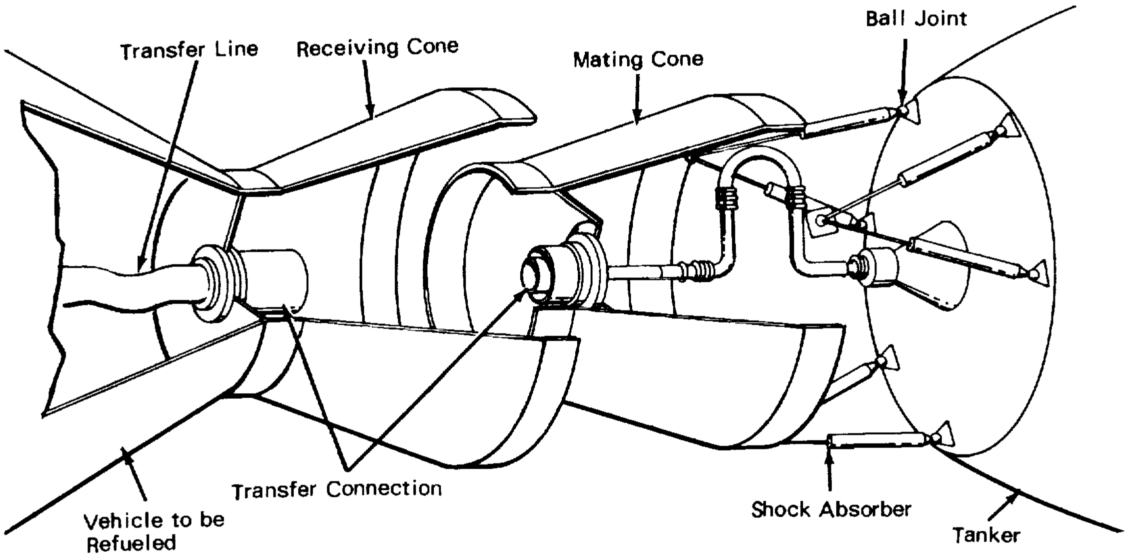
No further documentation is available.

FUEL TRANSFER SYSTEM ALLOWS RAPID COUPLING

A new fuel transfer system provides a simple, efficient means for transferring fuel from a tanker to another vehicle. The docking or connecting mechanism, shown in the figure, consists of a receiver cone mounted on the vehicle to be fueled, and a mating cone mounted on the tanker vehicle by shock absorbers. One part of the fuel transfer connector is mounted on the receiver cone, the other section on the mating cone. A flexible line allows transfer of the fuel from one vehicle to the other. The system could be adapted to industrial operations where large amounts of fuel must be transferred quickly.

The initial engagement of the mating cone with the receiving cone is brought about by the low spring portion of the shock absorber stroke and the multiplane freedom of motion allowed by the ball joints. The short cylindrical ends on the two cones align the parts of the fuel line connector just prior to their engagement.

During docking, as the mating cone enters the receiving cone, the probe enters the body. The springs keep the probe centered and facilitate self-alignment of the probe with the body. As the probe enters, it depresses the plunger and releases the balls. This permits the collar to move to the right, thus trapping the balls and locking the two parts of the connector together. A motor then operates a screw jack, which joins the mating and receiving cones more firmly together, with the forces being transmitted through the balls.



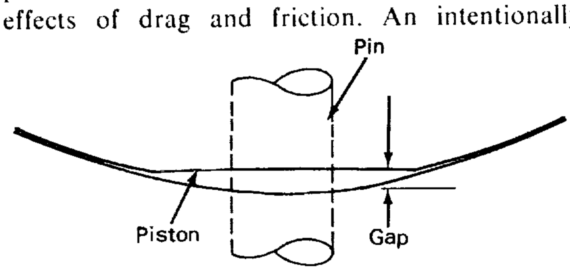
To release the two sections, the motor first releases the jacking forces. Pressure is then supplied to a bellows which moves the collar to the left, permitting the balls to disengage the probe. The cones, together with the connector, are now free to separate.

Source: A. M. West of
Lockheed Missiles and Space Co.
under contract to
Marshall Space Flight Center
(MFS-91326)

Circle 13 on Reader Service Card.

CONTROLLED SHEAR PIN GAP ASSURES MORE CONSISTENT SHEAR VALUES

A simple method provides a means for better prediction of shear values by eliminating the side effects of drag and friction. An intentionally controlled gap is made at the shear surface by milling a flat on the piston where the shear pin is installed.



As shown in the figure, a flat is machined on the piston to establish a gap at the point of shear pin installation. Such pins will shear at more consistent values when there is a small controlled gap between the shearing surfaces. This method should interest industries whose operations require close control of shear forces.

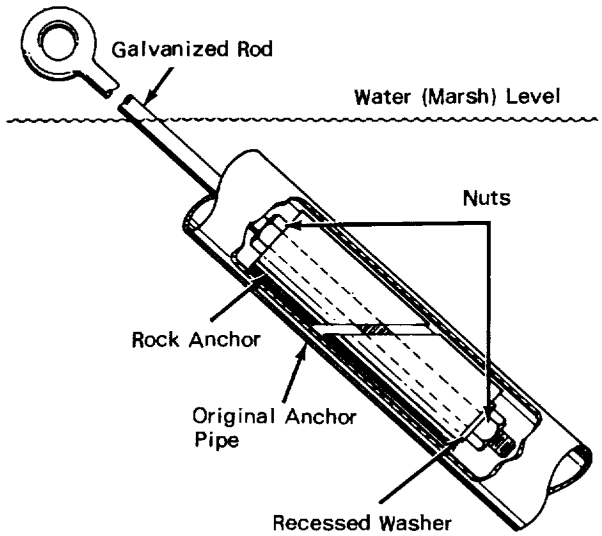
Source: H. Schmidt of
North American Rockwell Corp.
under contract to
Manned Spacecraft Center
(MSC-15014)

No further documentation is available.

TECHNIQUE FOR RESTORING SWAMP ANCHORS

Swamp anchors, consisting of steel plates secured at the ends of 5 cm (2 in.) diameter pipes, are screwed into marsh land at depths of 7.5 to 27 m (25 to 90 ft) to hold guys. In time, the exposed portion of pipe at the surface becomes corroded and fails. Previously, a failed swamp anchor was replaced. To eliminate complete replacement, a crushed rock anchor is installed within the upper portion of the pipe that remains attached to the original swamp anchor.

The rock anchor (see fig.) is fastened to the threaded end of a 1.8 m (6 ft) long galvanized rod, and is inserted into the exposed open end of the pipe secured to the original swamp anchor. The galvanized rod is then rotated to force a recessed washer against the crushed rock, causing it to expand against the inner walls of the pipe. When sufficient compression is achieved, the guy is attached to the eye at the free end of the galvanized rod. Tests indicate that the restored swamp anchor can withstand 1360 kg (3000 lb) of tension without failure.

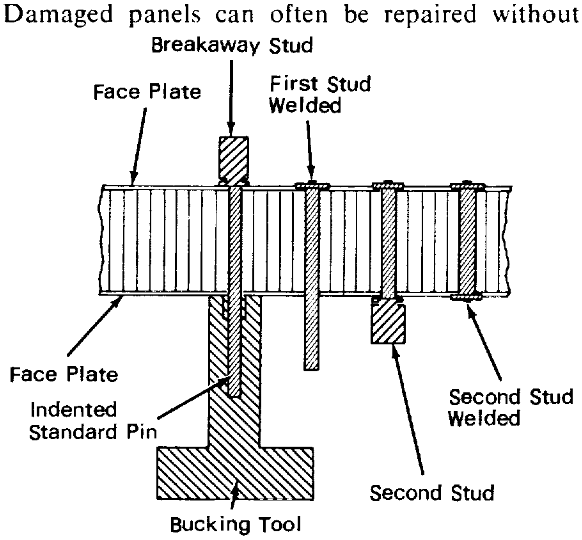


Source: J. W. McAllister
Wallops Station
(WLP-10004)

No further documentation is available.

REPAIR OF HONEYCOMB PANELS WITH WELDED BREAKAWAY STUDS

An easy-to-use technique provides a way to repair honeycomb panels by drilling holes and welding breakaway studs to both facing plates. Damaged panels can often be repaired without the use of doublers and with greater strength than doublers can provide. Since this technique requires minimal welding heat, it greatly reduces the distortion of highly-stressed panels and makes possible the repair of panels that otherwise could not be repaired.



With a number-30 drill, holes are drilled at a $\pi/2$ rad (90°) angle through both facing plates of a 2.54 cm (1 in.) thick panel (see fig.) and the burrs are then removed. A 0.32 cm (1/8 in.) diameter pin with an indented end is held in a bucking tool and placed through the holes. The pin is adjusted so that its exposed end is flush with the outer surface of the far plate when the bucking tool is held hard against the opposite plate. With a contact gun, the projection of a breakaway stud is driven into the dent in the end of the pin; the stud is welded to both the face plate and the pin while the bucking tool is held hard against the opposite plate. The body of the stud is then twisted off, using a circular motion, before the bucking tool is removed, and the pin is torque-tested to 1.13 N-m (10 in.-lb).

The other end of the pin, cut flush with the face sheet, is indented with a Starrett No. 18-A automatic center punch, and another breakaway stud is inserted in the dent. Again, the stud is welded to the pin and face sheet before its body is twisted off.

Source: D. F. Bruce of
North American Rockwell Corp.
under contract to
Manned Spacecraft Center
(MSC-15046)

No further documentation is available.

SPRAY-ON ELECTRODES ENABLE EKG MONITORING OF PHYSICALLY ACTIVE SUBJECTS

A new technique provides an easy way to apply electrocardiogram (EKG) electrodes to the skin of human subjects. These electrodes allow the heart signals to be monitored while the subjects are engaged in physical exercise. After use, the electrodes can be easily removed with acetone.

The conductive cement from which the electrodes are formed consists of a mixture of a commercially available household cement, silver powder, and acetone. The spray gun is a modified atomizer assembly with two valves and a small glass container for the liquid cement mixture. A special barrel with a slit tab on the end holds an electrode lead which is disengaged by a spring loaded release rod. The barrel confines application of the conductive cement mixture to a circular area of half-dollar size. A T-connector is incorporated to enable the use of one air hose instead of two. Two valves permit the sequential use of liquid spray for electrode application and then air for drying.

Before the electrodes are applied, the selected skin areas are cleaned with an electric toothbrush and electrode jelly. Residual jelly is removed with a clean, dry sponge, and a thin film of fresh jelly is wiped onto the prepared skin area. The conductive cement mixture is sprayed over the jelly film to capture one end of the lead wire and to form a half-dollar-size electrode on the skin. The electrode is then air dried and coated with a commercially available insulation cement released from an aerosol can.

Source: Flight Research Center
(FRC-36)

Circle 14 on Reader Service Card.

NASA-Langley, 1971