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MECHANICAL DEVICES

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.

Compilations are now published in nine broad subject groups:

SP-5971: Electronics - Components and Circuitry
SP-5972: Electronics Systems
SP-5973: Physical Sciences
SP-5974: Materials
SP-5975: Life Sciences
SP-5976: Mechanics
SP-5977: Machinery
SP-5978: Fabrication Technology
SP-5979: Mathematics and Information Sciences

When the subject matter of a particular Compilation is more narrowly defined, its title describes the subject matter more specifically. Successive Compilations in each broad category above are identified by an issue number in parentheses: e.g., the (03) in SP-5972 (03).

This Compilation describes a collection of new technology items that should be of interest to mechanical engineers, machinists, and others who design or work with mechanical devices. Section 1 contains articles on several new or modified tools, Section 2 describes a number of specialized mechanical systems, and the last section is devoted to valves, bearings, and other parts that might be used with larger systems.

Additional technical information on items in this Compilation can be requested by circling the appropriate number on the Reader Service Card included in this Compilation.

The latest patent information available at the final preparation of this Compilation is presented on page 36. For those innovations on which NASA has decided not to apply for a patent, a Patent Statement is not included. Potential users of items described herein should consult the cognizant organization for updated patent information.

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

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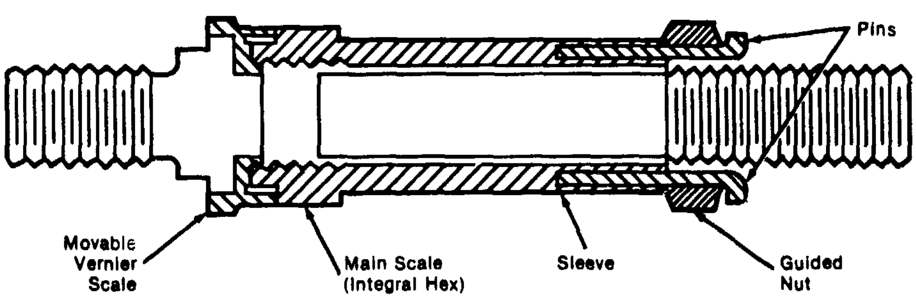
Contents

Section 1. Tools and Devices

VARIABLE LOAD INDICATOR



Variable Load Indicator

A new weighing device was developed for measuring loads as a function of its elongation. The device is compact, simple, and inexpensive. It does not require presetting and will measure any load from zero to its yield point. Because of its low cost relative to other load indicators such as strain gauges, the device can be used as a turnbuckle for tensioning straps, rods, or cables where accurate preloading is critical.

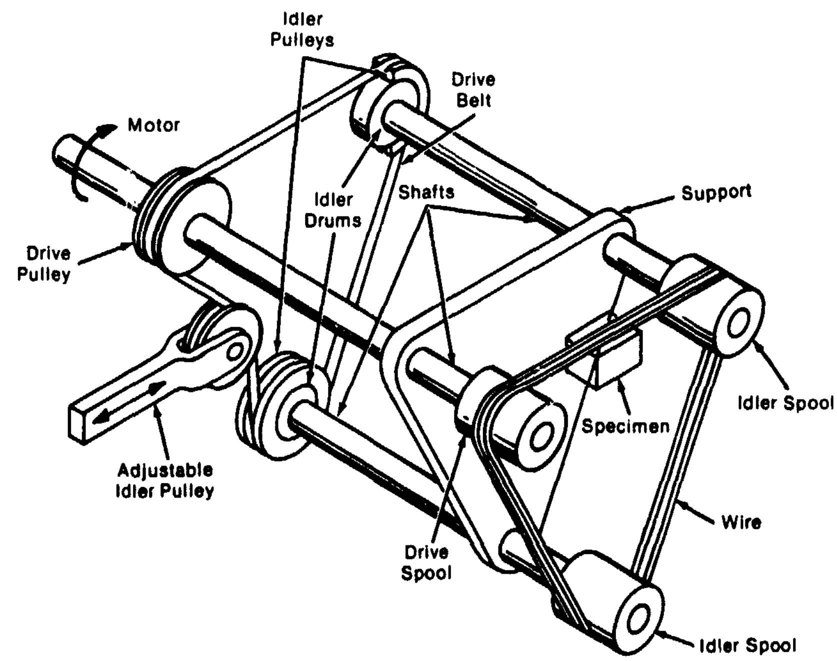
The stretching, due to load, is measured by the amount of rotation in a threaded sleeve (see figure). Since a single thread gives little rotation and large displacement for typically small loads, a differential thread mechanism is employed to give large sleeve rotation for little displacement (on the order of six or more times). This provides more accuracy in reading the scales. A scribed line on the sleeve indicates preload when alined with a line on the integral hex. The design allows a 500-pound (227-kg) load to be obtained at 60° rotation with ±10 percent maximum error.

During measurement, the load produces a gap between the sleeve and a guided nut which rotates with the sleeve but allows the gap to open or close. Since the sleeve and nut threads are of different pitch, they travel at slightly different speeds. The sleeve moves faster and will overtake the nut, thus closing the gap. Gap closure brings rotation to a halt. The direction and amount of subsequent load change are obtained by comparing new readings relative to previous readings.

Source: W. T. Appleberry of
McDonnell Douglas Corp.
under contract to
Marshall Space Flight Center
(MFS-21728)

Circle 1 on Reader Service Card.

ANTISLIPPING SYSTEM IMPROVES WIRE SAW PERFORMANCE



This system prevents slippage in a wire saw by providing sufficient friction to turn the idler spools, even when the turns of wire on the spools do not provide sufficient friction.

The system, which is readily incorporated on existing machines, entails the addition of a variable-position idler pulley to the drive-belt train. The position of this pulley controls the tension on the drive belt, which in turn, determines the frictional force between the drive-belt idler pulleys and their supporting drums. The rotational force, imparted by the pulleys to the drums, is transmitted to the wire idler spools. Thus, the position of the additional idler pulley controls the rotational force of the idler spools and permits simple adjustments to prevent wire slippage.

The improvement in performance offered by this system, combined with its low cost and applicability to existing equipment, should render it of interest to industries employing wire saws.

Source: E. A. Gallo of
Service Technology Corp.
under contract to
Johnson Space Center
(MSC-13508)

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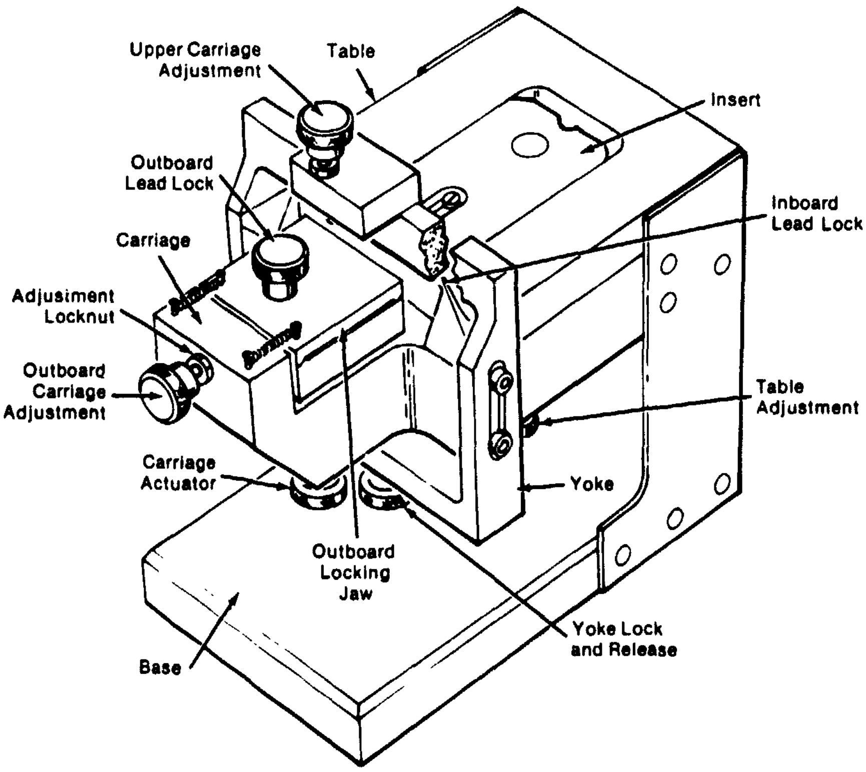
BEAM LEAD FORMING TOOL



Manufacturers of flat-pack electronic devices, such as integrated circuit packages, have a variety of tools for bending the beam leads. Most of these tools, however, are designed for bending the leads to a fixed angle.

A new tool, designed for table-top manual operation, can bend leads to any desired angle up to 90°. It can be readily adapted to electrical, hydraulic, or pneumatic systems.

The tool can handle lead lengths to 1/4 in. (0.6 cm). The desired angle of the lead is formed by positioning the flat pack on the tool table (see figure), and the table is adjusted vertically to aline the lower side of the lead with the inboard lead lock of the yoke. The lead is then inserted and locked between the jaws of the yoke. The carriage is then adjusted to a specified length required for the bend.

The adjusting screws and the insert are preset to the required position dictated by the bend of the leads, and the outboard locking jaw of the carriage is locked on the other end of the lead. The carriage is then moved upward by a carriage actuator, until it has reached the upper adjustment screw which stops the carriage at the preset bend angle. As the final step of the operation, the yoke lock is released and is adjusted vertically to clear the bent lead. The outboard locking jaw is released, and the flat pack removed from the device.

Source: P. W. Clemons of
Sperry Rand Corp.
under contract to
Marshall Space Flight Center
(MFS-22133)

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CHECKOUT AND ALINEMENT TOOL

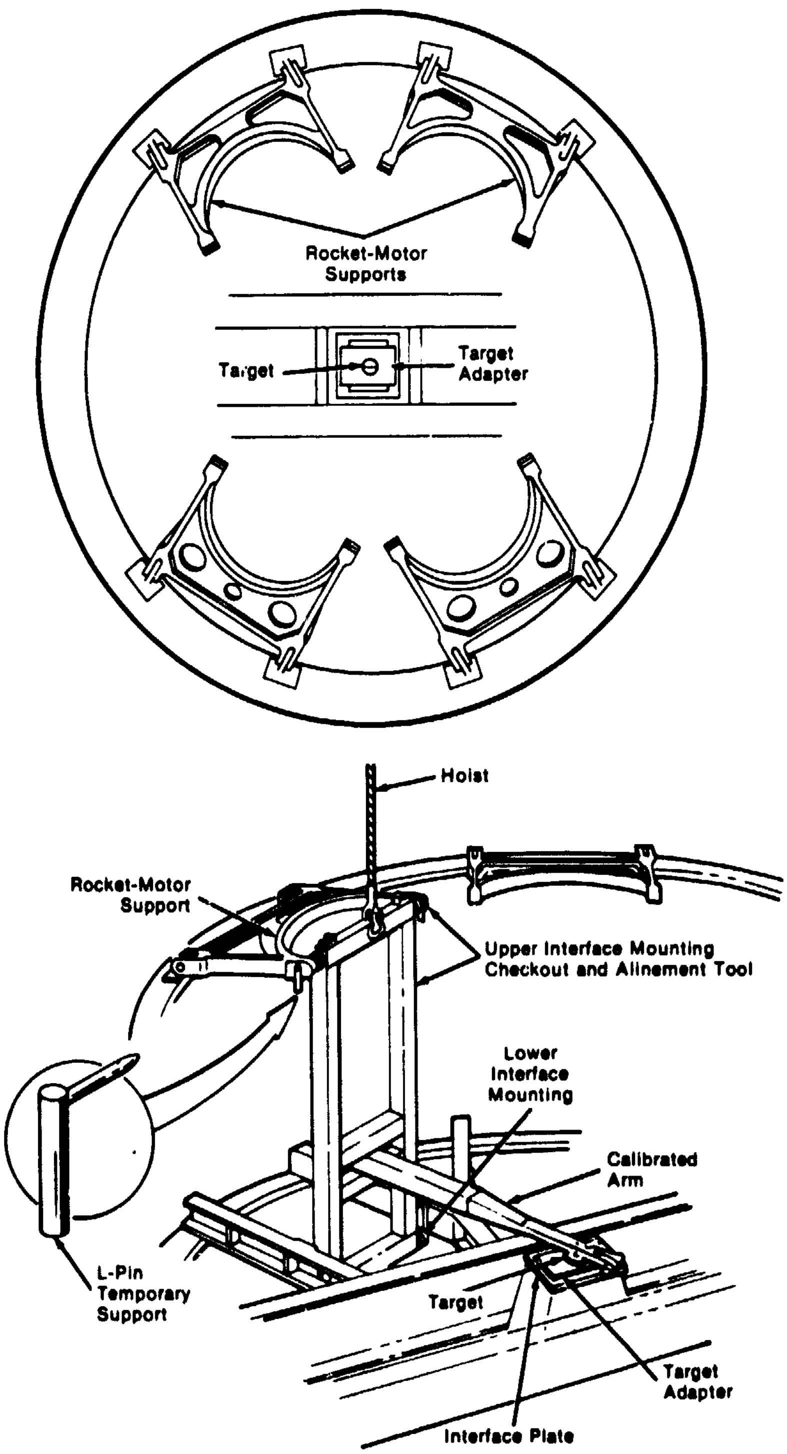


Figure 1. Support Structure With Alinement Tool

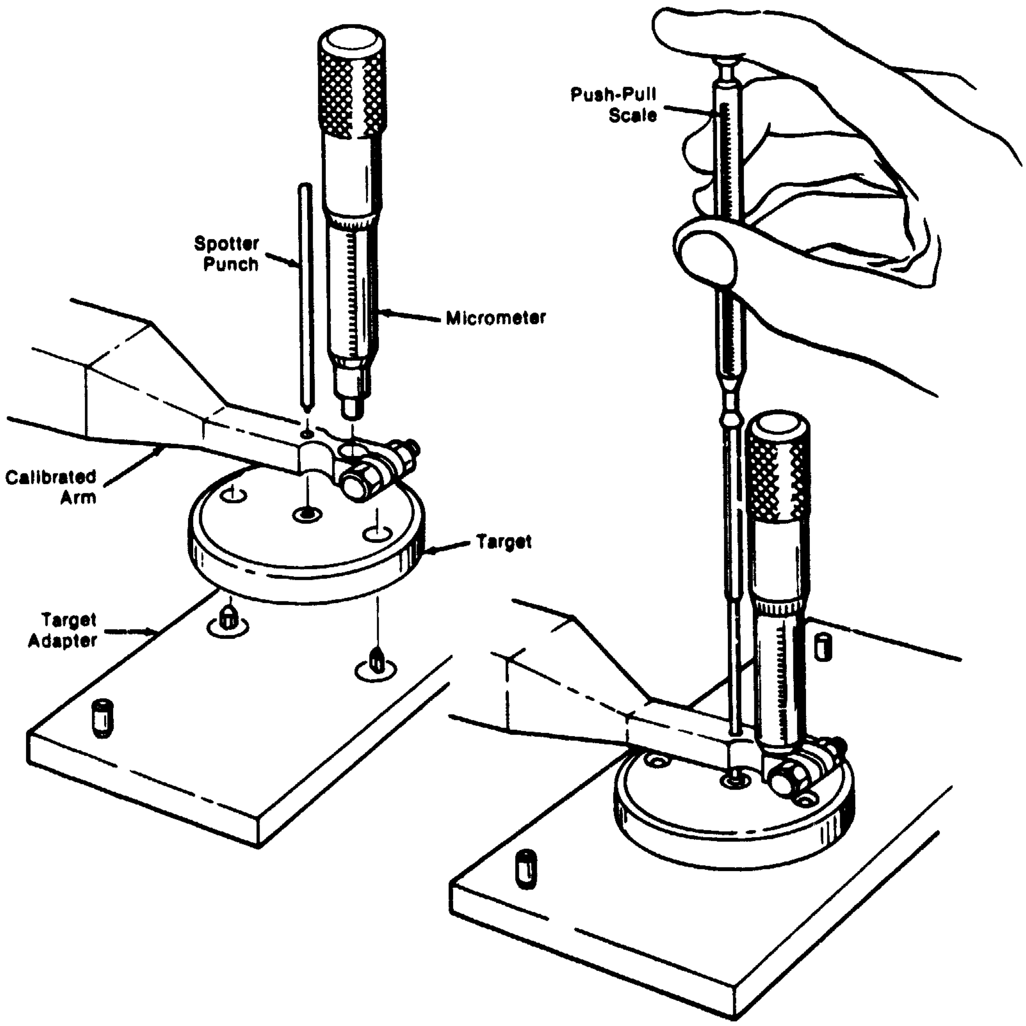


Figure 2. Thrust-Vector Simulation and Location

In multiengine rocket vehicles which do not have active stabilization systems, rocket-motor support alinement is critical. A combination tool checks the rocket-motor support-structure interface geometry (Figure 1) and ascertains the simulated location of the thrust vector of each motor (Figure 2).

The tool is positioned and attached securely to each individual rocket-motor support in turn (Figure 1), allowing mounting bolt alinement and span to be verified. While so positioned, the location of the motor thrust vector is simulated by means of a calibrated arm. The exact location of the simulated vector with respect to a target plate is determined by the use of a spotter punch and a micrometer (Figure 2).

Source: S. Hornyak and
W. Vobejda of
Martin Marietta Corp.
under contract to
Langley Resear :h Center
(LAR-11257)

Circle 4 on Reader Service Card.

FIELD CLOSE-TOLERANCE HOLE ENLARGEMENT

A new field technique makes it possible to enlarge holes with great precision without machine shop facilities. Of the three steps in the operation (i.e., positive location, reaming, and burnishing to size), the last is the specific improvement in bringing the hole to final size. Figure 1 illustrates the components and their use.

A drill fixture is attached loosely to a structure with a hole to be enlarged. The alinement pin is inserted to its stop depth, the loose drill fixture is tightened, and the alinement pin is removed. A reamer and a nose bushing then are affixed to the drill fixture, with the nose bushing being used for precise location and alinement. The reamer is 0.0025 cm (0.001 in.) smaller than the required minimum hole diameter. After reaming, the drill assembly is removed.

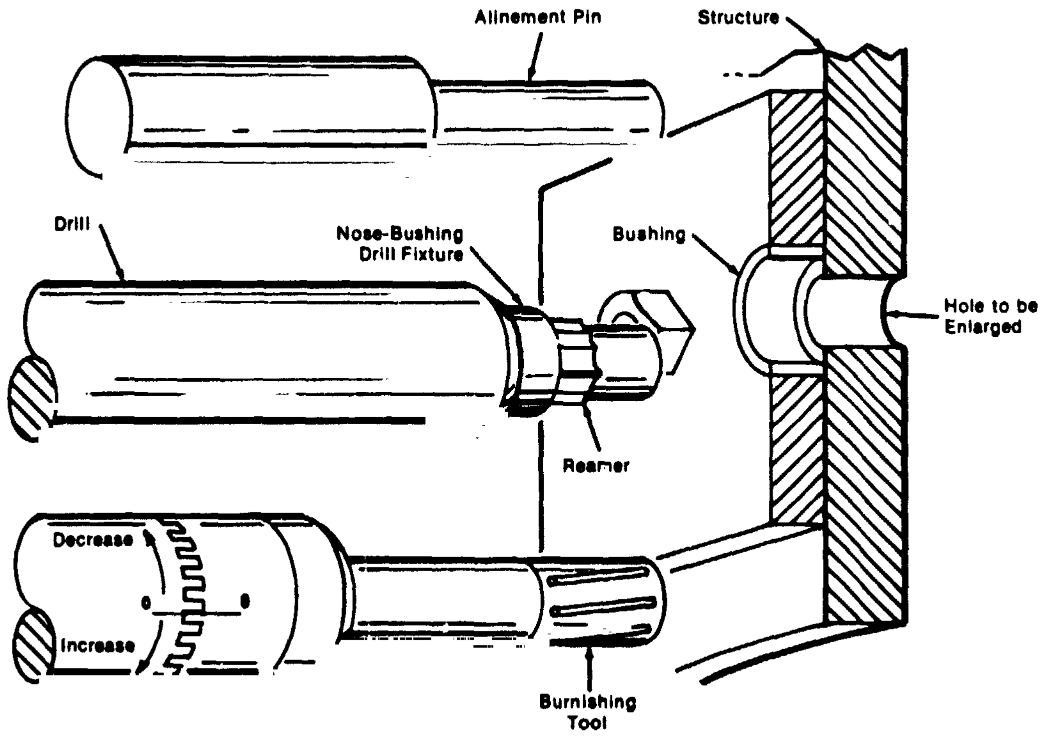


Figure 1. Close Tolerance Hole Enlargement

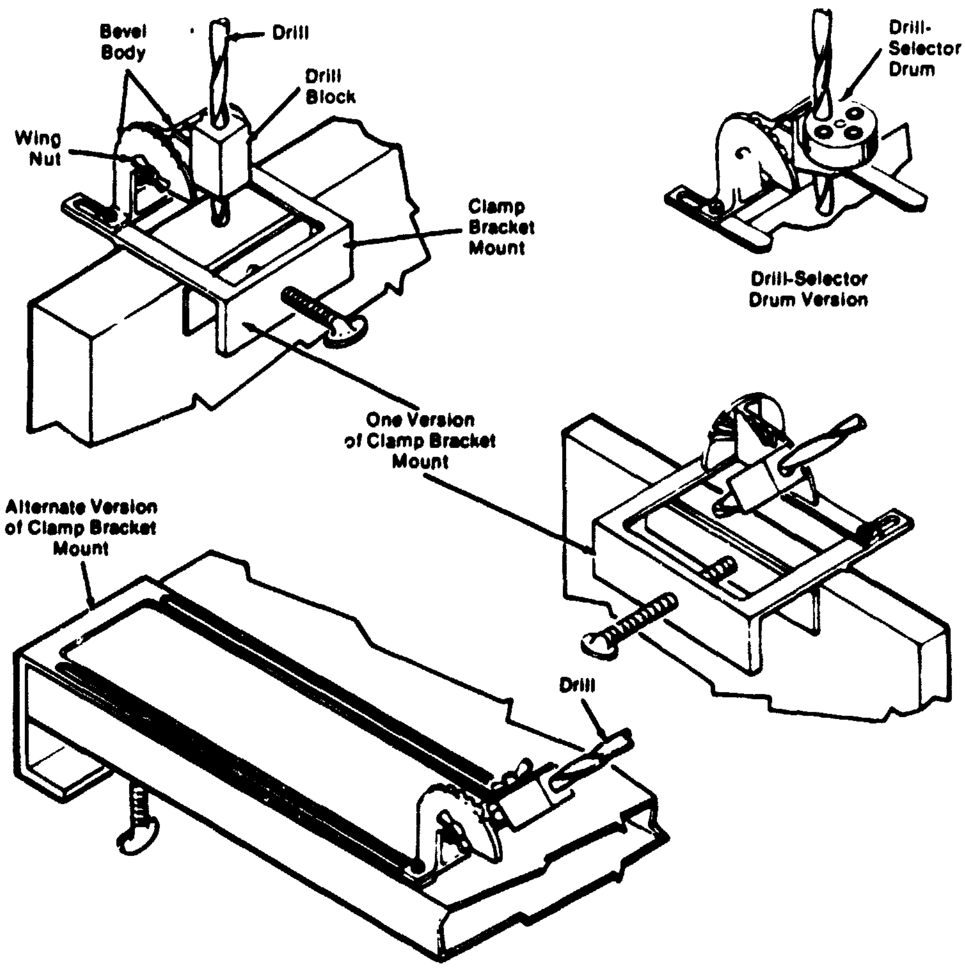
Figure 2. Air-Driven Drill Used to Enlarge Hole

Next a roller burnishing tool is hand-fed into the hole and is adjusted so that there is a slight resistance to rotation. At that setting, the hole is burnished by rotating the tool, removing it, and noting the hole size from the setting. The size noted is used to bring the hole to the exact specification. After readjustment to the specified size the burnishing tool is hand-rotated again in the hole at which time the diameter is formed to the required close tolerance. Figure 2 shows an air-driven automatic-advance drill being used to power the reaming operation.

Source: C. S. Schedler of
The Boeing Co.
under contract to
Kennedy Space Center
(KSC-10341)

Circle 5 on Reader Service Card.

UNIVERSAL DRILL JIG



Universal Drill Jig

Drilling of holes at different angles to the flat plane often requires expensive tools such as a radial arm drill press. Now, an inexpensive jig has been designed that can steadily guide the drill at selected angles to the flat plane from any direction.

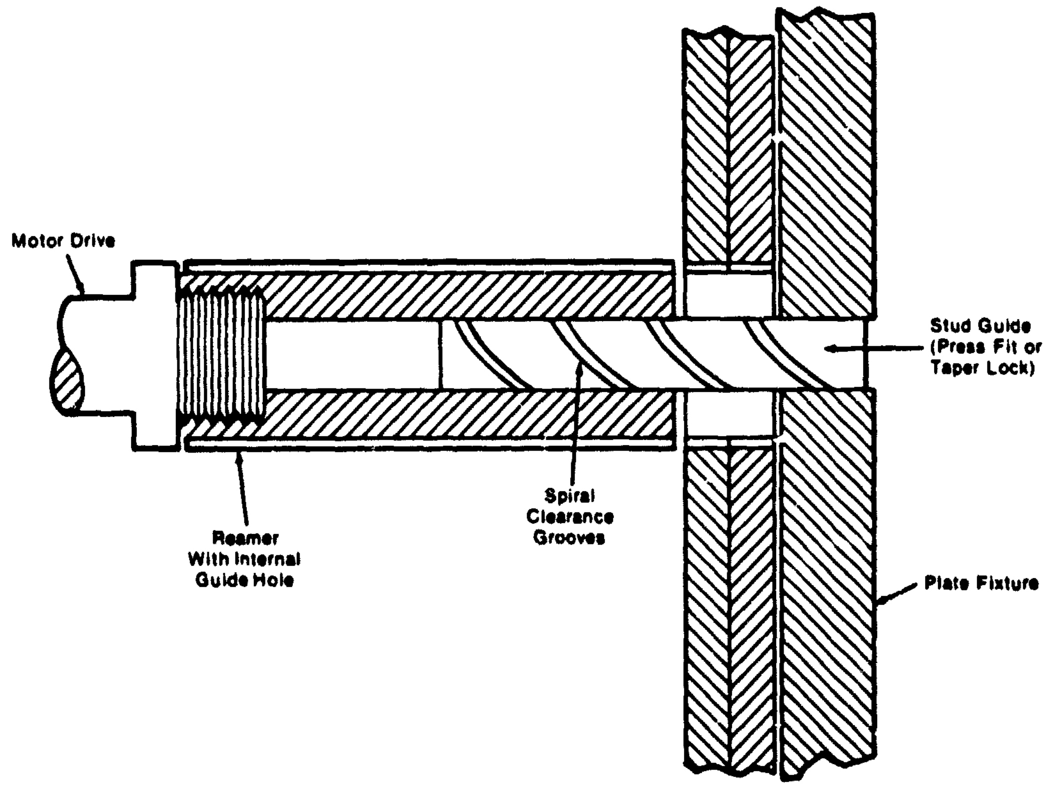
The jig shown in the figure uses two mutually perpendicular bevel bodies designed to set the drill bit at 15° intervals from 90° to 45° to the flat plane. Each bevel body has grooves to correspond to 15° interval settings. A drill block used for guiding the drill bit has a spline on one side to engage the groove on the bevel body at a selected angle. Angles are set by loosening wing nuts on either or both bodies, tilting the drill block to the desired angle until the spline engages the groove, and tightening the nuts. The drill bit is then inserted through the drill block and guided at the selected angle.

To hold the entire assembly steady, several types of clamp bracket mounts are available for supporting the bevel bodies (see figure). In addition, another type of drill block may be used, to guide the different sizes of drill bits, by simply selecting a proper hole on the drill-selector drum.

Source: E. J. Stringer of
Rockwell International Corp.
under contract to
Marshall Space Flight Center
(MFS-24464)

Circle 6 on Reader Service Card.

STUD-GUIDED REAMERS



Stud Guide Reamer

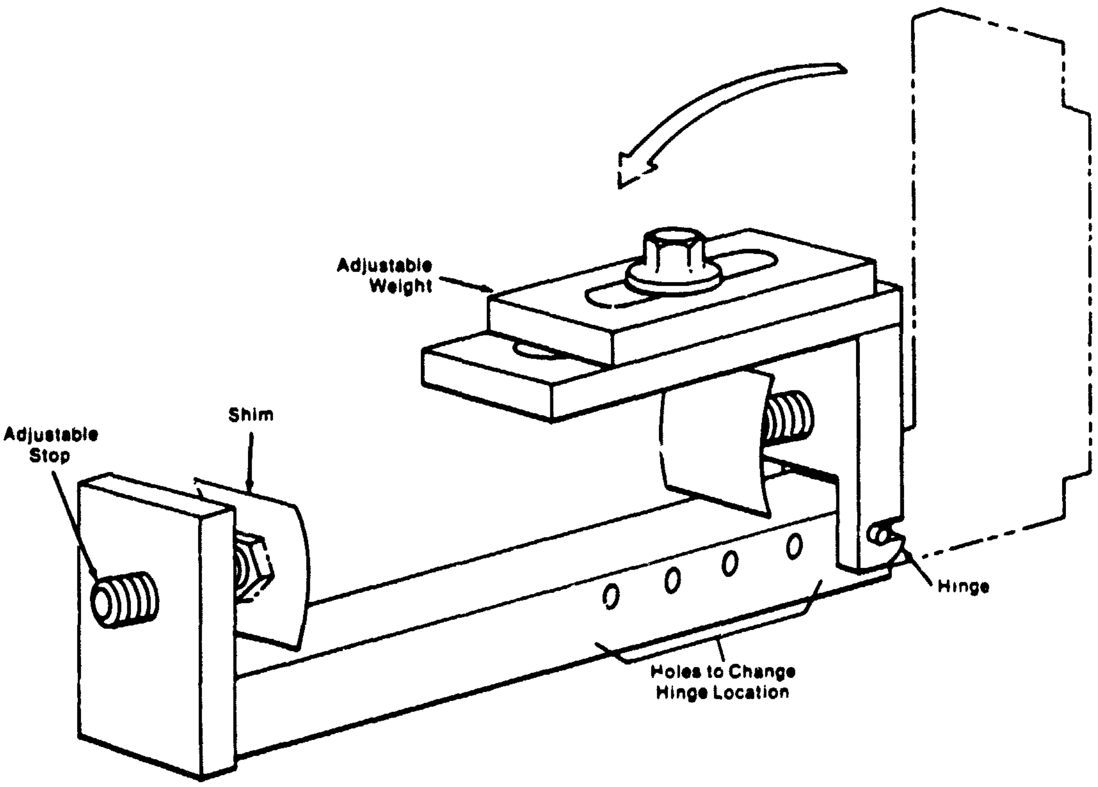
The internal reamer guide shown in the figure permits holes to be reamed in restricted-access locations, since the guide requires less tooling clearance than corresponding drill bushings or pilots. This guide has several other advantageous features. Spiral grooves on the internal stud guide allow excellent coolant flow and chip removal. The wearing action of reamer teeth on the guide is eliminated, so tool life is superior to that obtained with drill bushings. In addition, special undersize drill bushings are not required, and one stud guide can be used for several reamers.

The tool can be used for precise reaming of holes 1.27 cm (0.5 in.) and larger in diameter. The main advantage of the design stems from the alined support of the reamer by the stud guides.

Source: R. A. Marzullo of
Rockwell International Corp.
under contract to
Johnson Space Center
(MSC-19364)

No further documentation is available.

SELF-ADJUSTING ASSEMBLY JIG



Self-Adjusting Jig

Ordinary jigs and fixtures for holding parts in place while furnace brazing often do not accommodate thermal expansion and contraction, resulting in misalined, deformed, or incomplete joints. Conventional holding devices must often be tailored to each job, and their bulk frequently constitutes an undesirable heat sink that lengthens the time required for the brazing operation.

The lightweight jig shown in the figure self-adjusts for thermal expansion and contraction, to hold parts being joined under constant pressure and in correct alinement, during the entire joining operation. The jig consists of a flat bed with one fixed end and one adjustable hinged end. The hinged end is adjustable both at the hinge and at the weighted beam. The weighted beam and the beam arm are slotted to permit sliding adjustments. The hinge pin may be removed and relocated along the flat bed to compensate for the sizes of parts. Thus, the hinged end, together with the adjustable shims, provides an adjustable clamping force for holding together parts to be joined. The hinged end pivots to compensate automatically for thermal expansion and contraction while maintaining a constant force on parts.

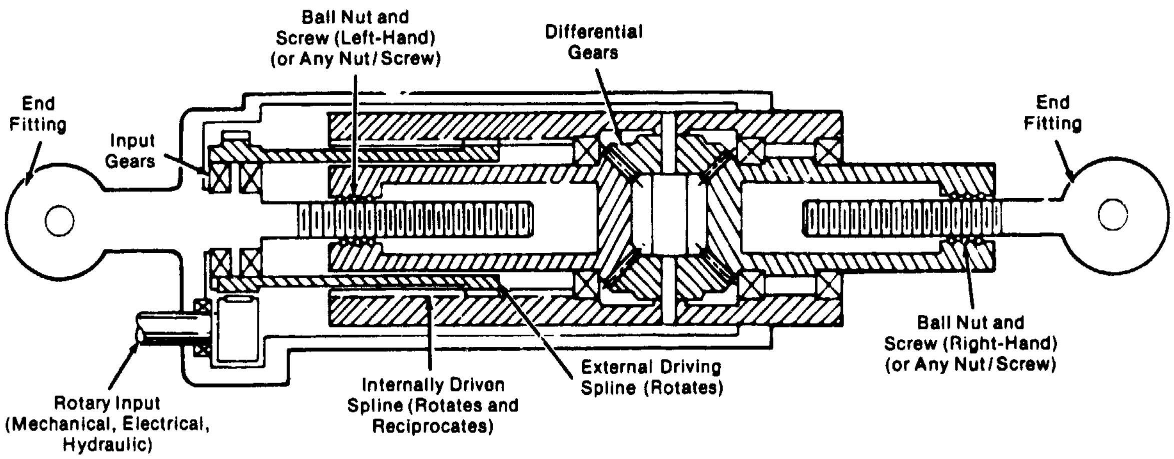
Parts and joints are readily visible and accessible. In furnace brazing, this accessibility allows the optimum placement of thermocouples that is important in experimental work where time and temperature parameters must be established. The jig, which is simple, easy to use, durable, and maintenance-free can be used with several joining methods to bond parts of many sizes and shapes.

Source: Michael J. Haaser
Lewis Research Center
(LEW-12034)

No further documentation is available.

Section 2. Systems

REDUNDANT SCREWJACK



Screwjacks used as actuators on aircraft flap systems, and in other critical applications, may be subject to failures. These failures occur in the existing double-nut and telescoping-type screwjacks when any of the nut/screw assemblies jam. These problems can be overcome with a redundant screwjack that uses differential gears to drive either one of the nut/screw assemblies, in the event that the other jams.

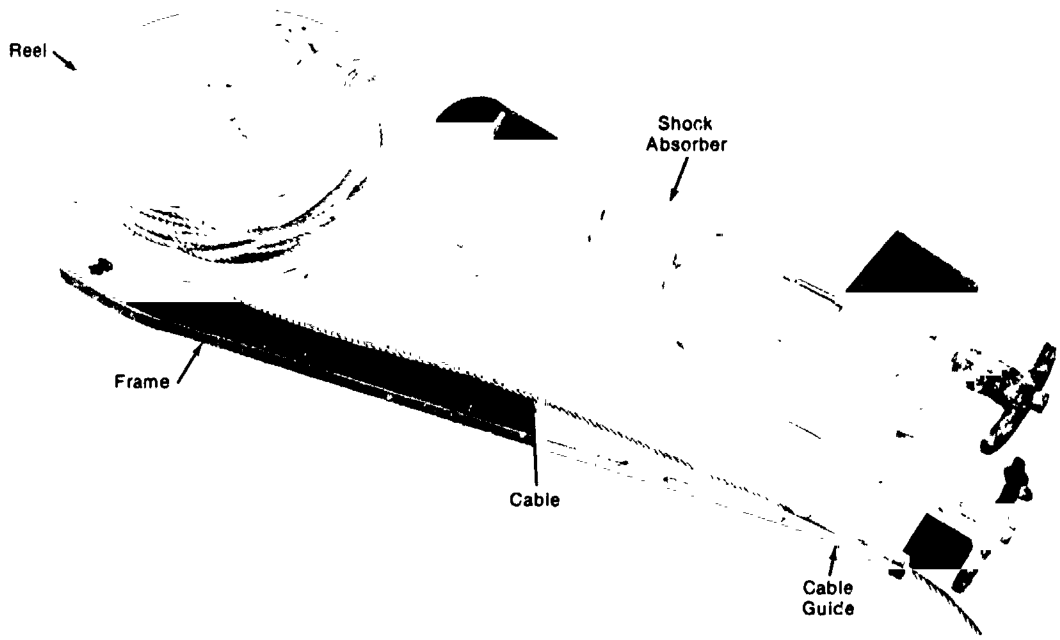
The redundant screwjack (see figure) utilizes input gears to drive a rotary external spline which, in turn, meshes with and drives an internal spline. The internal spline is designed to rotate and reciprocate with the external one. The internal spline also supports the spider input to the differential gears. These gears rotate the right-hand and left-hand ball nuts which move the left-hand and right-hand screws, extending or retracting them. The screws do not rotate but are firmly attached to the structure.

If either nut/screw combination jams, the differential gears will drive the other combination at twice its normal rate with no loss in overall performance.

Source: R. W. Benjamin of
Rockwell International Corp.
under contract to
Johnson Space Center
(MSC-19200)

No further documentation is available.

EMERGENCY-ESCAPE DEVICE



Emergency Exit Device

Burning buildings have been deathtraps ever since construction began. Even to this day, with all of our fire safety regulations, fires, particularly in high-rise buildings, continue to trap inhabitants in their rooms, because either the stairs are impassable, the elevators do not operate, or no fire escapes are installed. With all escapes blocked, the inhabitants either expire in their rooms or jump to their death from windows. To eliminate the risk of jumping from windows, several devices have been made to provide safe descent. Unfortunately, these devices are complicated to operate and require some degree of athletic ability.

A relatively-simple inexpensive escape device has been developed. Using a reeled steel cable, controlled by an automotive-type shock absorber, it allows safe descent from a burning building. The device is a metal frame containing a cable-wound reel and a shock absorber (see figure). The cable is made of steel wires, capable of supporting a 1000-lb (454-kg) load and is long enough to reach the ground from most any window. One end of the shock absorber is attached firmly to the frame; the other end is attached to a stud on the reel center.

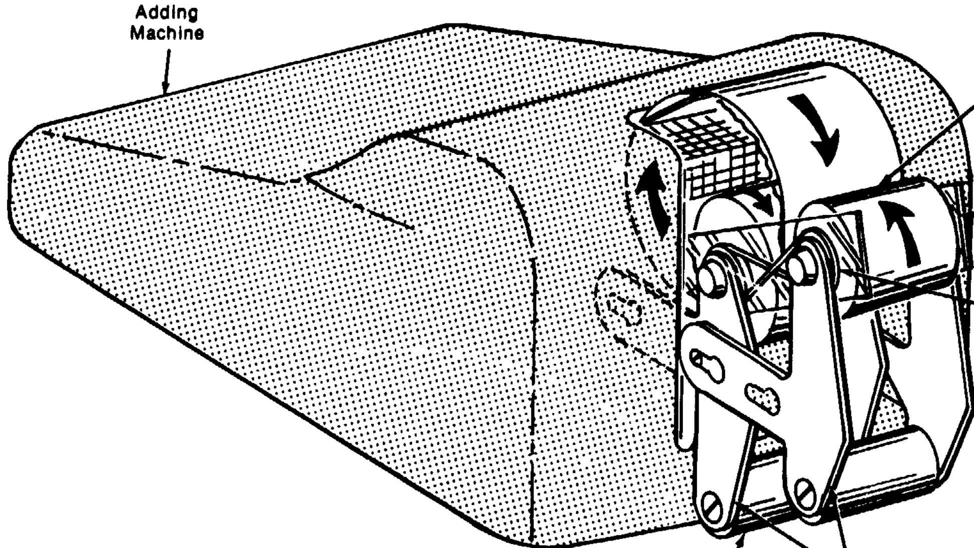
In an emergency, a man-carrying harness is attached to the free end of the cable. As an individual descends from a window, the cable unwinds and rotates the reel which, in turn, compresses and extends the shock absorber. The rotation of the reel is opposed by the absorber; the faster the reel rotates, the greater the opposing action of the absorber. Thus, for the given weight of an individual in the harness, an equilibrium is reached, resulting in a constant speed. As designed, the device can lower a 150-lb (68-kg) person at a rate of 2 ft/s (0.6 m/s). Heavier persons will descend at a slightly faster rate, lighter ones slightly slower. After the first person reaches ground, the cable is retracted manually, by detaching one end of the shock absorber from the frame and using it as a rewinding handle. Alternately, a spring-loaded ratchet, to retract the cable automatically after it reaches the ground, can be added to the device.

The device is inexpensive to manufacture and assemble. It weighs 8 lb (3.6 kg) and requires neither skill, special knowledge, or athletic ability to operate. It is reliable and fireproof and can be deployed instantly. In practice, it may be anchored to a permanent installation outside of a window or to a wall inside.

Source: P. M. Broussard
Marshall Space Flight Center
(MFS-22720)

Circle 7 on Reader Service Card.

REVERSE PAPER-TAPE ADAPTER FOR ADDING MACHINES AND CALCULATORS



Adapter to Utilize Both Sides of Paper Tape

The adapter shown in the figure automatically rewinds paper tape to facilitate use of its reverse side in an adding machine or similar device. By using both sides of the paper tape, the cost per roll is essentially cut in half.

The adapter consists of two metal brackets, two spring-loaded rollers, two rubber bands, and two paper guides. The reverse paper-tape adapter is fitted onto an adding machine or a calculator. A rubber band in the shape of a figure 8 is placed on the two rollers, to make the rollers rotate in opposite directions. The paper tape is run through the machine and proceeds onto the adapter roller, where it is accumulated in a counter-clockwise manner.

Source: P. J. Cavanna
Kennedy Space Center
(KSC-10310)

No further documentation is available.

EASY MANUAL OPERATION OF OVERHEAD GARAGE DOORS: A CONCEPT

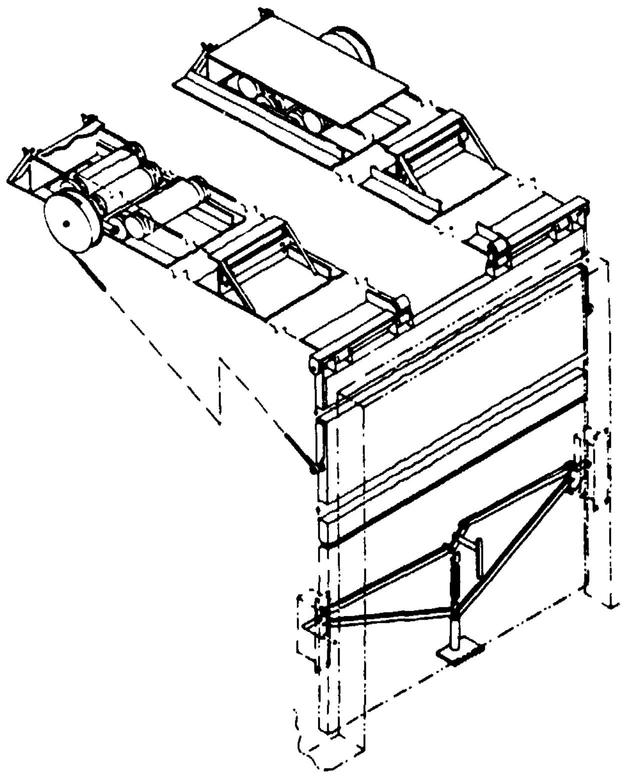
A novel manually-actuated mechanism (see figure) could easily raise or lower a two-section overhead garage door; the Rolamite principle (see AEC-NASA Tech Brief 67-10611) is used to provide a controlled but varying rate of ascent or descent.

Rolamites traversing an overhead channel generate forces that rotate a drum that maintains a controlled tension on a cable attached to the door. The geometry of the apparatus permits the door to translate and rotate when opening or closing, and requires no vertical guides in the doorway. Once manually actuated by turning or pulling a handle, the Rolamite apparatus opens or closes the door without further manual effort.

The rate of raising or lowering can be controlled by design characteristics based on the Rolamite principle. The mechanism is extremely quiet since rolling friction is minimized and no vertical guides or rollers are required for vertical movement of the lower section of the door.

The life of the mechanism should be long because the only stressed components are the cables and the contoured bands of the Rolamites, all of which can survive the average life of a residence. Installation is simplified by hanging the overhead channel from the ceiling so that all necessary support is provided for the door and mechanism. Apart from the latch, no coil springs take part in movement of the door. Maintenance is minimal, because Rolamites require no lubrication.

Although the device is intended primarily for operation of home or industrial doors, it may be applied where any type of vertical shielding or baffling needs to be raised or lowered. It may be inverted for raising a barrier from floor level without vertical guides or supports.

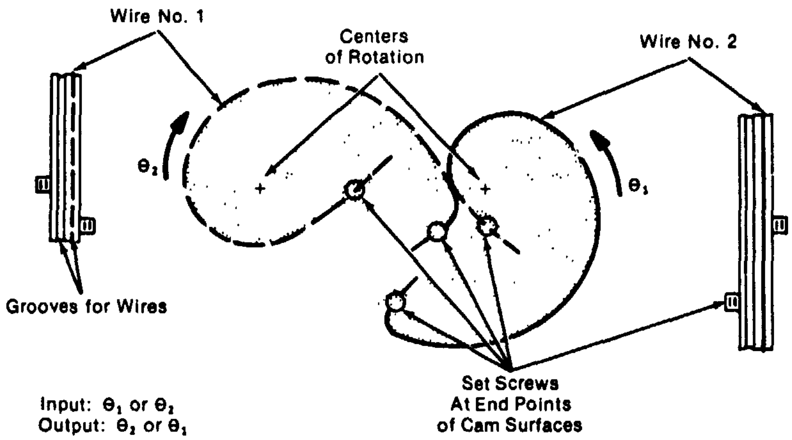


Garage-Door System

Source: C. J. Fuller of
The Boeing Co.
under contract to
Kennedy Space Center
(KSC-10555)

Circle 8 on Reader Service Card.

MECHANICAL NONLINEAR FUNCTION GENERATOR



Mechanical Nonlinear Function Generator

Photographic cameras and many other instruments often require a mechanism to convert a linear mechanical input, such as a shaft rotation, into a mechanical output which is a nonlinear function of the input. An example is the logarithmic relation between the exposure control setting and the shutter opening. Noncircular gears and cam-and-follower systems have been used to solve this problem. However, noncircular gears have inherent backlash, need lubrication, and are costly to manufacture. A cam-and-follower system requires either spring loading to maintain contact or grooves that add friction and backlash. The cam-and-follower arrangement is also less versatile if the output is to be a shaft rotation.

A nonlinear mechanical function generator avoids these disadvantages. It has no backlash, minimum friction, and the correct input/output relationship. It is similar in operation to a pair of noncircular gears. Although gear teeth are absent, the two gears (cams) are in contact, or close to contact, at their pitch lines. The assembly of the two cams and wires is shown in the figure.

As one cam is rotated it rolls along the surface of the other. The ratio of the radii of the two cams at the point of contact determines the rotational ratio for that point. As the cams rotate, the ratio varies as the two radii vary. The two cams are kept in positive angular relationship to one another by two small wires, which are secured at the end points of the cam contour surfaces and run in parallel shallow grooves in the cam surfaces. One wire holds or moves the output cam in one rotational direction, and the other band or wire acts in the opposite direction. As the cams rotate, each wire rolls off one cam and onto the other.

Ideally the two cams are always in contact at one point, but in actuality a moderate gap is possible without hurting the accuracy or smoothness of operation. The cams are prevented from slipping by the action of the two wires. Each wire joins the end point of one cam to the corresponding end point of the other cam. The wires can be fastened to the cam end points in any suitable manner (the figure shows setscrews, which are convenient for assembly and adjustment purposes). Only moderate tension in the wires is required for smooth, zero backlash operation.

This device can be used wherever a nonlinear relationship is needed between a mechanical input and an output. The device is not limited to logarithmic functions and can be designed to generate almost any mathematical function that does not reverse its slope or have discontinuities or excessive ratios.

Source: J. T. Sharpsteen of
Perkin-Elmer Corp.
under contract to
Johnson Space Center
(MSC-14629)

Circle 9 on Reader Service Card.

POSITIVE-LOCKING LEVER-ADJUSTMENT MECHANISM

A predetermined relationship between the interfacing surfaces of a valve-latching mechanism can be set up and maintained, even under limited accessibility, with a positive-tension lock. The lock may be used with housings, adjustable cams, levers, or linkages, in deep recesses where machines are required.

Valve-latching mechanisms often have failed from interference between interfacing surfaces (X and Y in Figure 1). This results from dimensional-tolerance variations reflected in the relative positions of the surfaces. With the addition of adjustment provisions to the lever, a definite clearance between surfaces X and Y can be established and maintained, to ensure consistent latching.

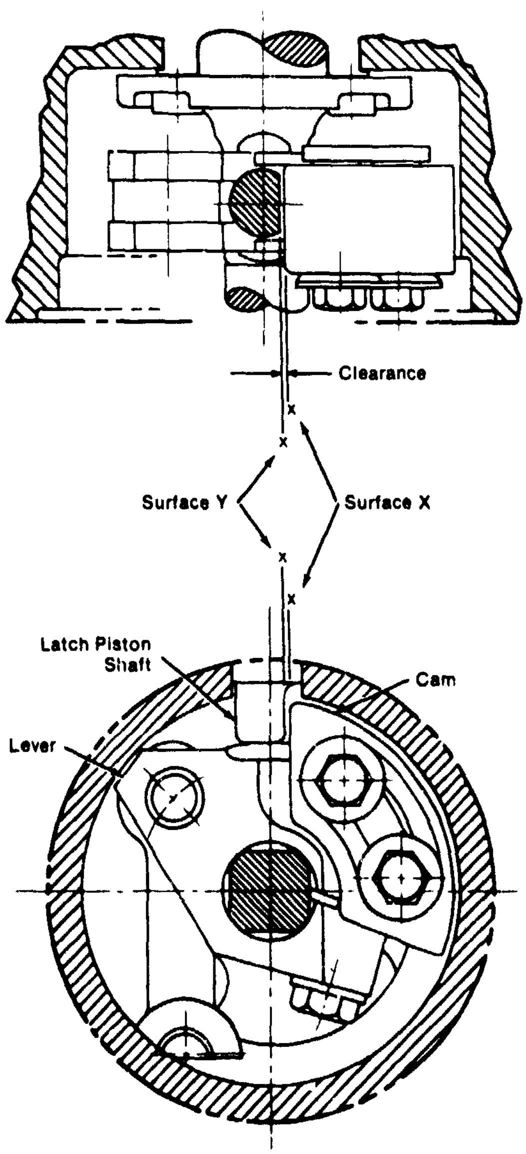


Figure 1. Standard Valve-Latching Mechanism

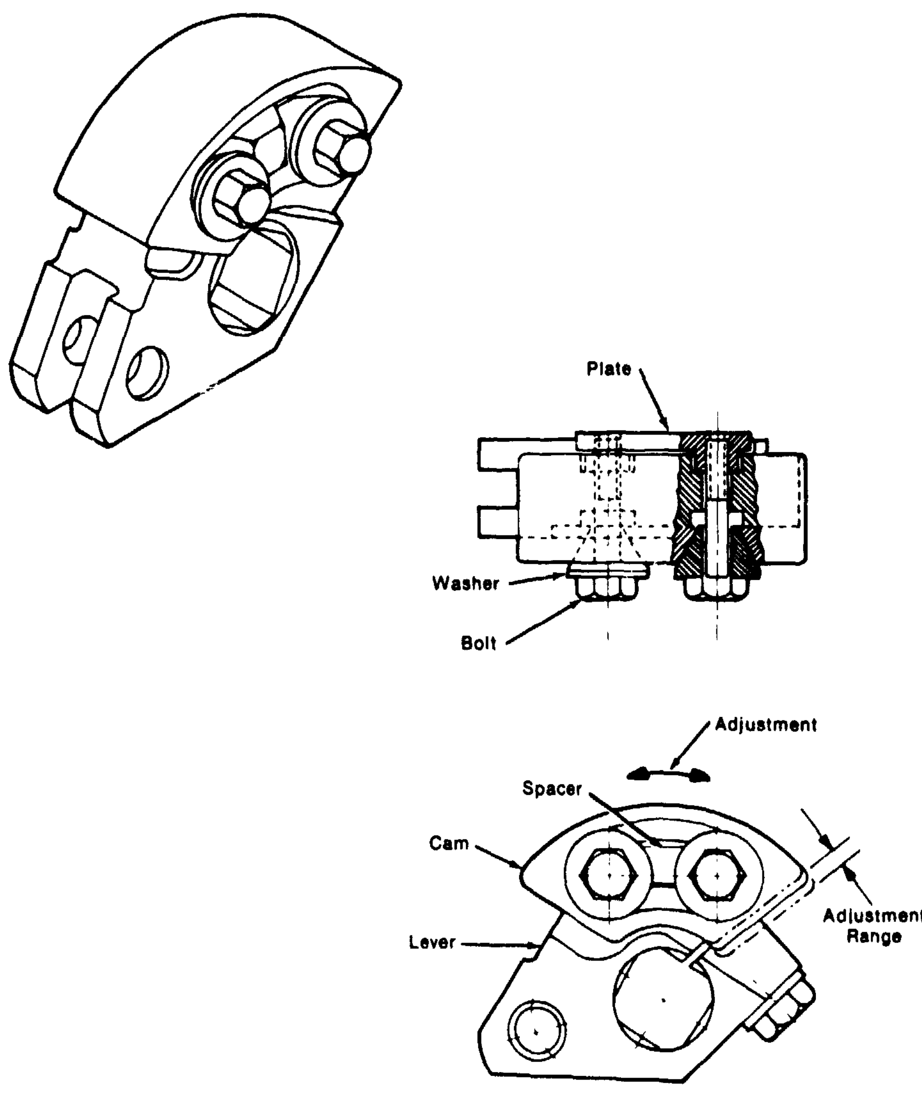


Figure 2. Locking-Lever-Adjustment Mechanism

The procedure is illustrated in Figure 2. Rotating the two bolts in opposing directions imparts a correspondingly-opposed rectilinear motion to the two conical washers. In turn, the motion of the conical washers is transmitted through the conical mating surfaces of the cam, with a resultant clockwise or counterclockwise displacement of cam surface X. By the proper opposing rotation of the bolts, lever surface X can be adjusted to a position that will provide the prescribed clearance with interfacing surface Y. When the adjustment is complete, surface X is locked in position by torquing the bolts. The spacer prevents inward bolt deflection under locking loads.

Source: E. D. Storms of
Rockwell International Corp.
under contract to
Marshall Space Flight Center
(MFS-24014)

Circle 10 on Reader Service Card.

FLANGE DESIGN FOR LARGE-SCALE MODULAR ASSEMBLY JIGS

Figure 1. Flanges Installed on Modular Assembly Jig

A new technique has been developed for attaching flanges to three-dimensional frameworks called large-scale modular assembly jigs. These jigs are designed so that two or more of them may be assembled to make a complete tooling-and-assembly jig. The overall assembly of such modules then provides working platforms and reference points and planes for the assembly-and-tool operation upon such large structures as spacecraft, aircraft, seagoing vessels, and railcars.

The large-scale modular assembly jig (Figure 1) is a rectangular parallelepiped in form and is made of

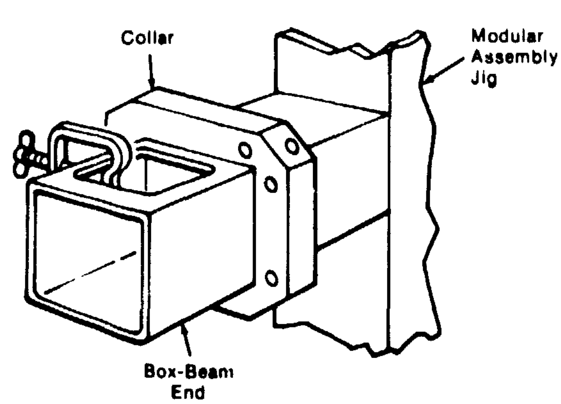


Figure 2a. Collar on Box-Beam End

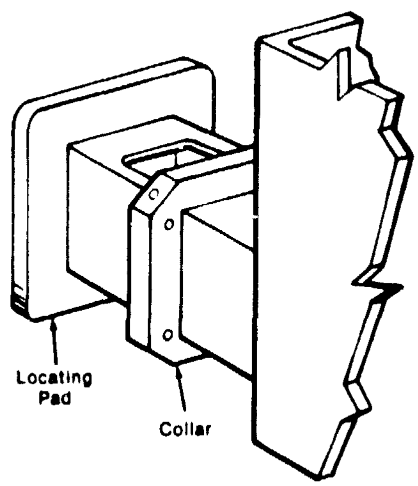


Figure 2b Locating Pad on Box-Beam End

three intersecting sets of unmachined box beams welded together. From each surface of the welded structure, a number of beam ends project outwardly. Such members, owing to the weld method of construction, are approximately parallel, are spaced from each other approximately to conform to a predetermined pattern, and terminate approximately in a common plane.

Using the new technique, locating pads are installed on the beam ends so as to provide tooling planes (tops, bottoms, and sides) oriented at 90° with respect to each other (Figures 2a and 2b). These planes are thus provided with tooling holes 3/4 in. (1.9 cm) in diameter, set on 77.00-in. (177.80-cm) grid centers, which are accurately located with respect to each other within 0.005 in. (±0.013 cm). Combined planar deviation is held to 0.015 in. (±0.038 cm). Because the tooling is held to close tolerance while being fabricated, special alinement during the buildup of several modules is not necessary.

The technique consists of alining and doweling sets of precision-machined pads and collars to the unmachined square tubing ends of the modular assembly jig, to provide distortion-free load-bearing flanges. The floating pad-and-collar design permits the lateral alinement of pad centers relative to master grid-plate centers. The collar is connected to the pad by a set of machine screws, passing through slightly oversize holes in the collar and into tapped holes in the pad, by a pair of dowel pins driven through registering holes in both members. The attachment collars then permit movement for exact length and perpendicularity alinement, prior to being attached by dowels to the box-beam ends (Figure 2c). Thus the outer surfaces of the flanges are accurately coplanar and are accurately spaced from one another according to the predetermined pattern.

In the previous three-dimensional modules, the flanges are attached by welding. These all-welded structures have the usual disadvantages associated with welding, e.g., lack of accurate dimensioning,

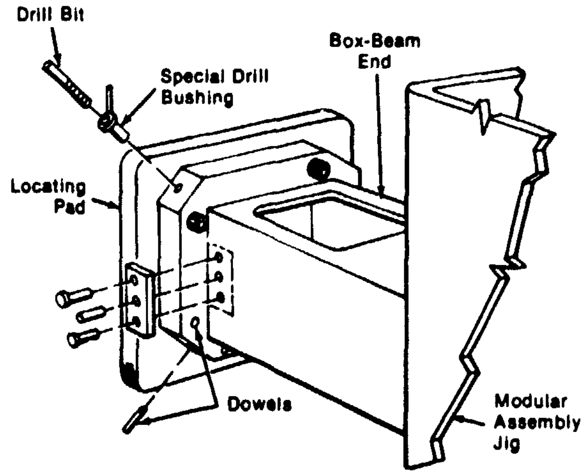


Figure 2c. Installation and Alinement of Locating Pad and Collar

lack of coplanarity, and lack of parallelism. The new technique provides a weldless method for securing flanges to the projecting ends of an unmachined box-beam framework in such a manner that the flanged structure may be reused without modification. One such framework may be readily assembled to another by simply matching the flanges together and passing connecting members between preformed holes in the structures. So far as is known, this is the first large modular tooling that does not require special alinement of the flanged joints during assembly.

Source: M. M. Gilman of
Rockwell International Corp.
under contract to
Johnson Space Center
(MSC-19372)

Circle 11 on Reader Service Card.

DETACHABLE SPRING-LOADED INDEXING ACCESSORY FOR MODULAR TOOLING SYSTEMS

A new detachable spring-loaded indexing accessory improves the large-scale modular assembly jig reported on in the preceding Compilation article (MSC-19372). The accessory is used only when rigging and alining (indexing) a modular tooling component to a floor mount or to another component, and it facilitates the alinement of grid holes during the assembly of the modules (Figure 1). When alinement is complete, the accessory is removed and replaced by bolts and nuts.

The accessory latches into the tooling module by rotating two latching fingers into grooves (Figure 2) in the main structural posts of the modular assembly jig. The grooves in the module are provided by adjusting the spacing between the box-beam ends and the flanges before the flanges are pinned into place. This quick attach/detach feature permits the rapid removal of the indexing accessory for the installation of the assembly bolts after the module is alined.

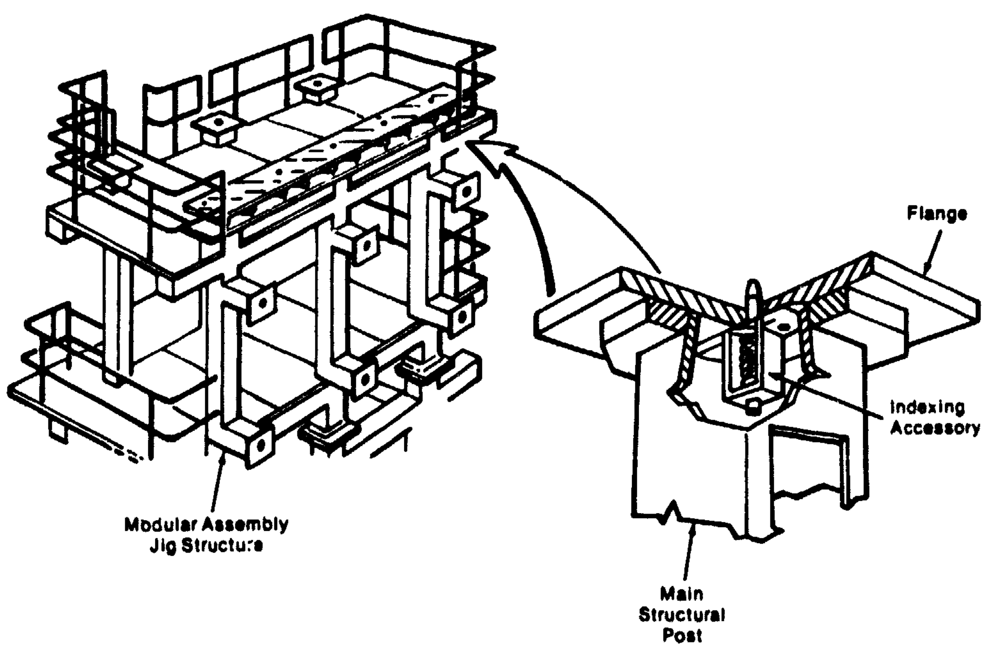


Figure 1. Indexing Accessory in Modular Tooling System

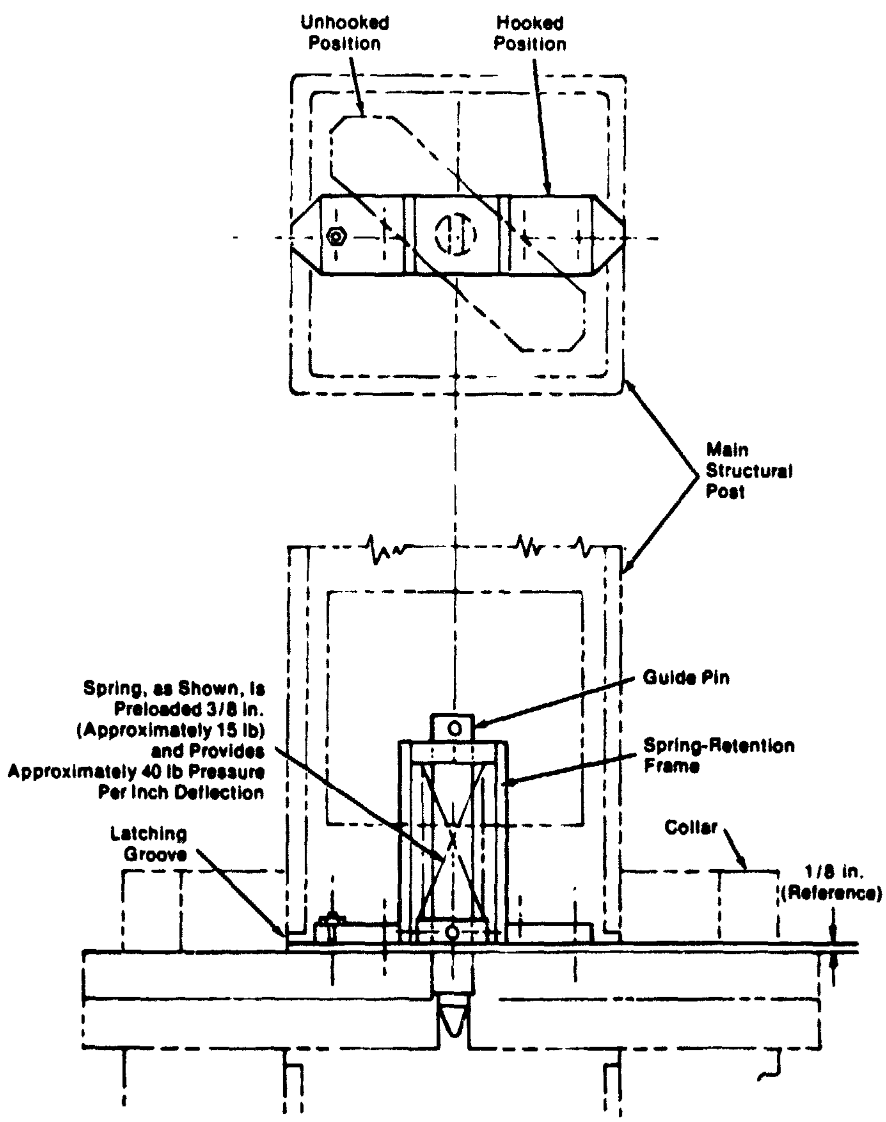


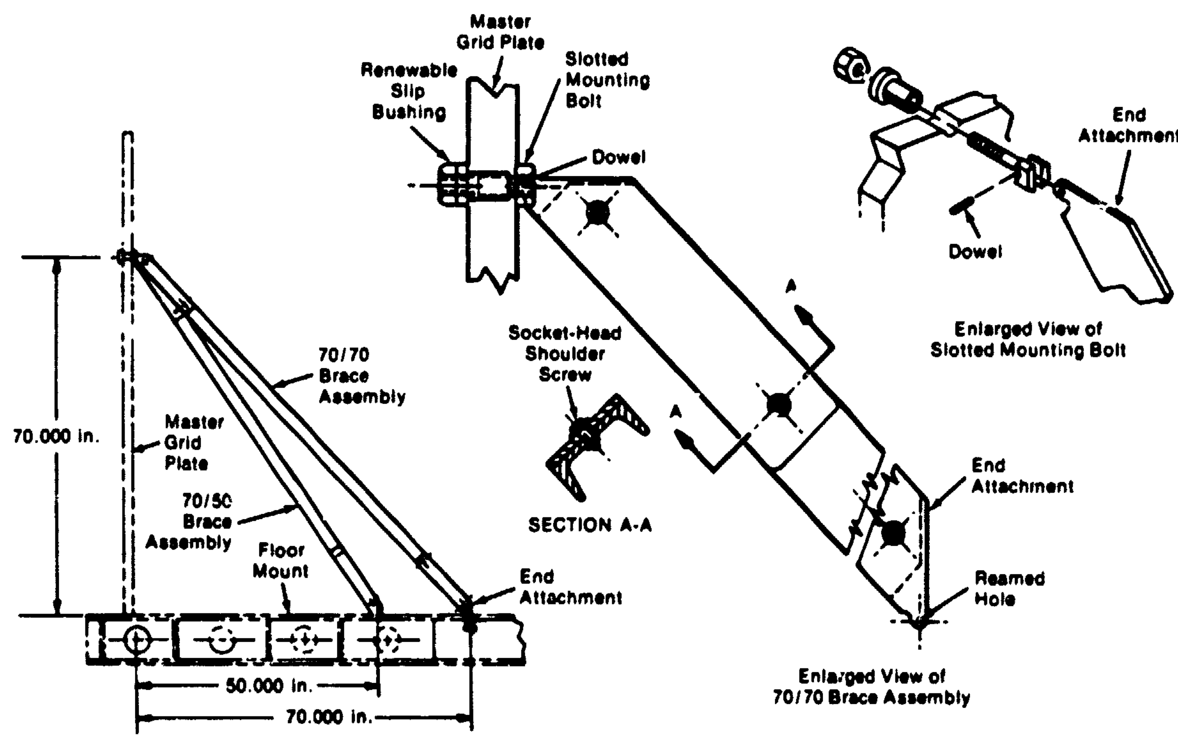
Figure 2. Installation and Detail of Indexing Accessory

The spring-loaded, bullet-nosed guide pin will not jam or scratch the boltholes, since it retracts to avoid damaging the fixture yet snaps into place when assembly alinement is achieved. The accessory reduces fixture assembly time and maintenance costs, and it could readily be incorporated into many large tooling structures for damage-free rigging and alinement.

Source: M. M. Gilman of Rockwell International Corp. under contract to Johnson Space Center (MSC-19373)

Circle 12 on Reader Service Card.

STANDARDIZED BRACES FOR MODULAR TOOLING SYSTEM



Standardized Brace

A new standardized brace has been developed to be used in conjunction with the large-scale modular assembly jig described in a preceding Compilation article (MSC-19372). Specifically, the new brace simplifies the precision assembly of the load-bearing flanges incorporated into these modules by supporting the modular tooling master grids in a perpendicular position, when assembled at the appropriate grid points, with slip bushings and special bolts (see figure). The design incorporates slotted mounting bolts to center the end pins in the tooling plate surface planes. Because the brace can be made to precise lengths by using the master tooling grid plates, the new design permits the onsite assembly of precision braces with a minimum of large tooling.

The brace assemblies are made in kit form in two different sizes for fabrication onsite. The assembly consits of a central channel with two bolted and dowelled end attachments as shown in the figure. One size brace squares a 50-in. by 70-in. (1.3-m by 1.8-m) triangle, and the second squares a 70-in. by 70-in. (1.8-m by 1.8-m) triangle.

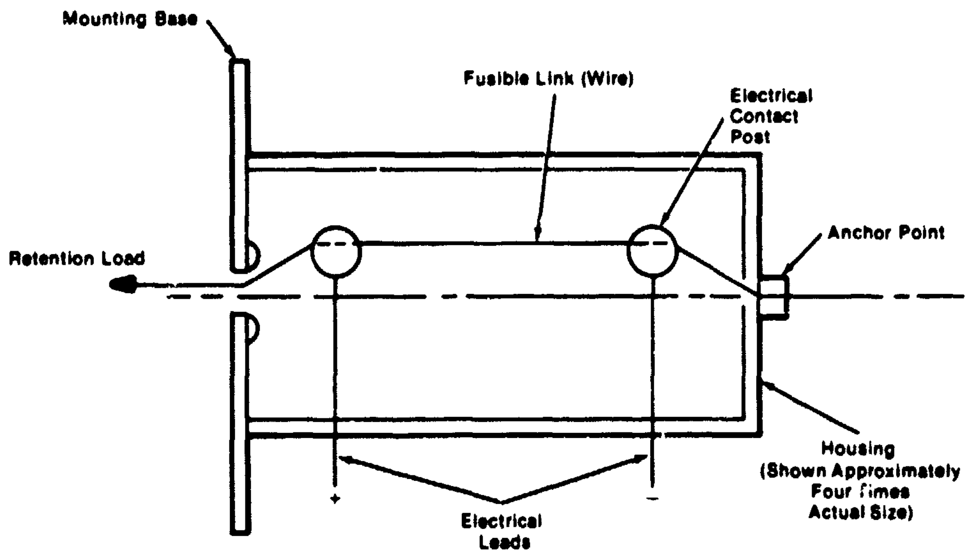
The first step in the onsite assembly of the brace consists of pinning the reamed holes of the two end plates to the appropriate holes on the master grid plate using step pins. The end plates are then turned and alined under the center channel. The three pieces then are clamped, and the assembly is drilled and reamed at the channel pilot holes. The pieces are then removed and assembled with shoulder screws.

Source: M. M. Gilman of
Rockwell International Corp.
under contract to
Johnson Space Center
(MSC-19374)

Circle 13 on Reader Service Card.

Section 3. Components

ELECTROFUSIBLE QUICK-RELEASE DEVICE



Electrofusible Quick-Release Device

The device shown in the figure can be used to secure mechanisms in a locked condition until such time as they must be released remotely for action. Although existing devices may be used for certain medium-sized and small mechanisms, this device is simpler, lighter, and more reliable.

Small-diameter wire, 0.025 to 0.051 cm (0.010 to 0.020 in.), is used to apply a tension force to the mechanism being restrained. High-strength steel-alloy wire can be used to provide a locking force in excess of 222 N (50 lb). The holding wire bears on two eccentric electrical contact posts that are grooved to help secure this fusible link, even when exposed to severe vibrational environments. When quick release is required, a small electric pulse of about 10 to 20 W for 1 or 2 seconds brings the temperature of the wire between the two posts to a sufficiently elevated point to produce failure of the wire, thus releasing the mechanism being held.

Although a wide range of electrically-conductive tension links might be used, tests have shown that high-strength ferrous alloys work very well. In automobiles and trucks the device could be used to release fire extinguishers in engine compartments or cargo areas by pushing switches on dashboards. The applications of the device could be widespread due to its low cost and basic simplicity.

Source: Merton L. Clevett of
Martin Marietta Corp.
under contract to
Langley Research Center
(LAR-11179)

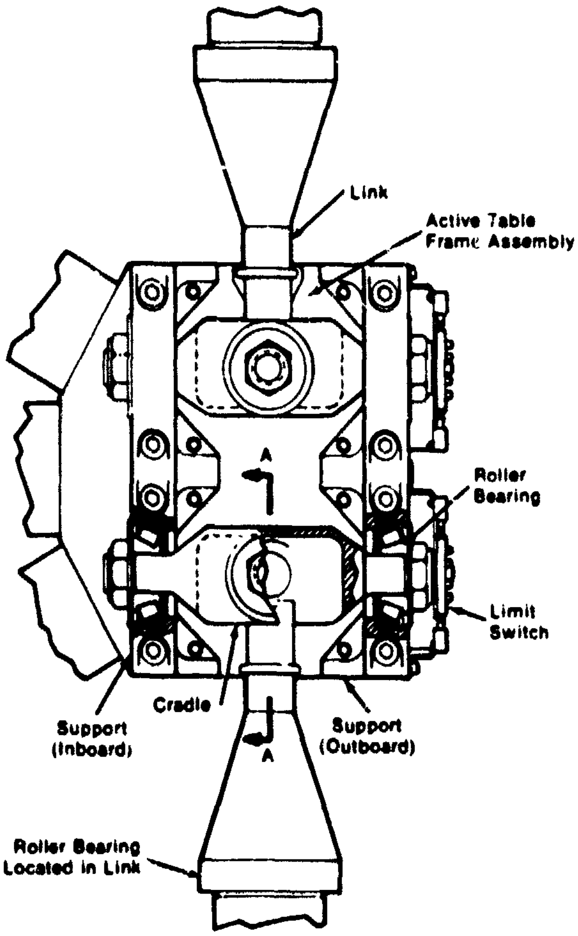
No further documentation is available.

TRIROTATIONAL WIDE-ANGLE THRUST JOINT

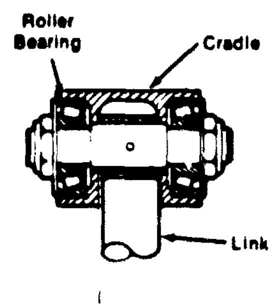
A trirotational wide-angle thrust joint shown in the figure is basically a swiveled rod end pinned in a trunnion-mounted cradle with antifriction roller bearings located at each point of relative motion. It provides three degrees of angular freedom for use in a six-degrees-of-freedom (three angular and three translational) motion simulator. The joint has zero backlash under shock load, is relatively light, and is characterized by low friction and a minimal number of deflections. In addition, it has a capacity for large angular motions exceeding those usually found in spherical rod ends.

The joint has several desirable features. No special hardware is required as all its components are off-the-shelf items. Any desired bearing preload can be established, and the design can be modified readily to suit larger or smaller angles. Limit switches can be provided to limit angular motion.

The housing, machined from high-strength steel, is as small as design requirements allow, to reduce weight to an absolute minimum. Maintenance is minimal since bearings are packed during assembly and have covers that protect them from contamination.



Active Table Assembly

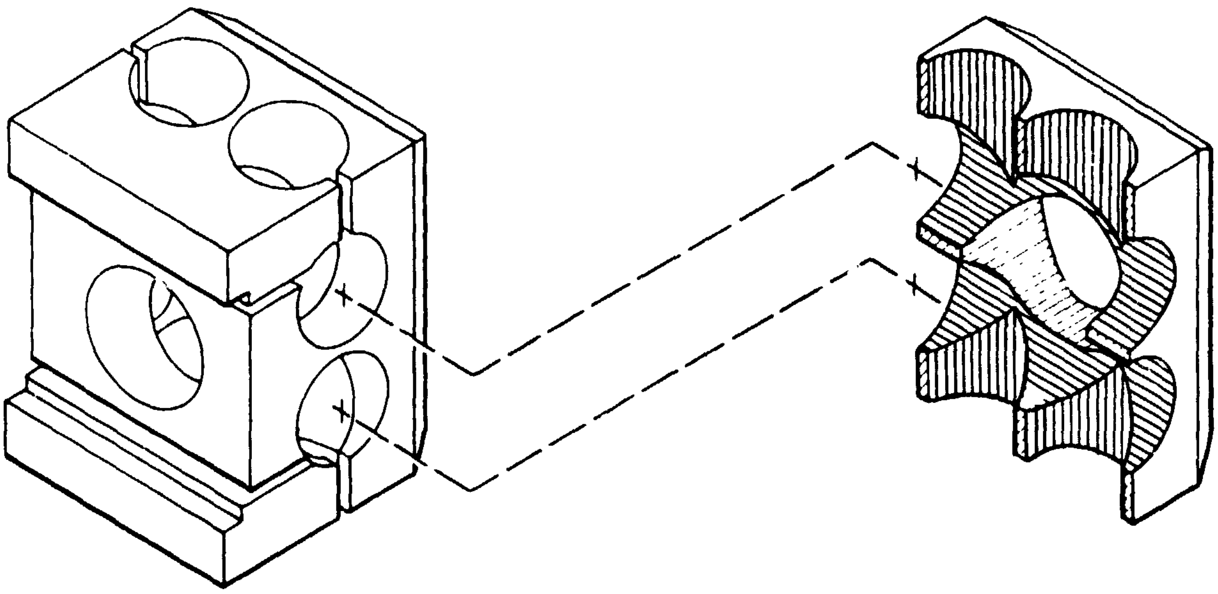


Section A-A

Source: T. F. Ryan and H. L. Adair of
Kentrol Hawaii, Ltd.
under contract to
Johnson Space Center
(MSC-14451)

No further documentation is available.

UNIVERSAL INVERTED FLEXURE



Assembled Block

Section Detail

A frictionless, inverted, universal pivot (two angular degrees of freedom about a common point) minimizes the effect of temperature changes and prevents overstressing of the flexing elements. The pivot is a flexure block which can be readily fabricated from a single piece of material. It is first machined with external surfaces as shown in the diagram. Then the single side hole and the vertical holes are bored through the block, and the four side holes are bored just deep enough to intersect the centerline of the through holes. The device maintains stiffness during boring operations so that accuracy is easily achieved without special restraining fixtures.

Finally, six saw cuts are made to free the flexing elements; because of their width, they also provide the limits of motion, that is, they are inherent limit stops.

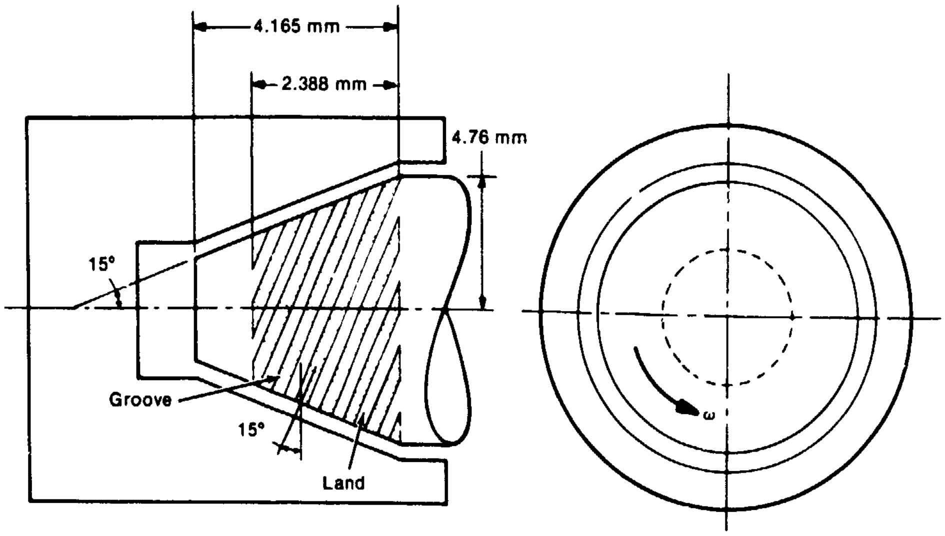
The device is symmetrical about the third (nonflexing) axis. Thermal expansion and contraction will not displace the flexural center from this axis. For this reason, temperature changes will not cause any significant angular movement in a body suspended from the block, regardless of the material from which the block is made.

The device is intended for inverted use: input and output on the same side. However, it can easily be used in a normal, noninverted configuration by attachment to the innermost block through the counter-bored portion of the single side hole.

Source: Wayne O. Hadland
Ames Research Center
(ARC-10345)

Circle 14 on Reader Service Card.

GREASE-LUBRICATED SPIRAL-GROOVE GYRO BEARINGS



Bearing Specifications:
Number of Grooves = 7
Land-to-Groove-Width Ratio = 1
Groove Depth = 0.025 mm

Geometric Parameters of Conical Bearing

A theoretical study is available which examines, by analysis and testing, the suitability of lubricated spiral-groove bearings for the spin axis of a gyro, such as might be used for an auto pilot or a platform-stabilizing momentum wheel. Results indicate that bearings fitted with spiral grooves and lubricated with grease will develop a full fluid film, provide high load capacity, exhibit excellent tolerance to overload and start-stop rubbing, and have a long operating life under certain conditions. The bearings must be designed so that the net lubricant flow out of the clearance space is zero. The physical and chemical properties of the lubricant must remain relatively constant over the operating life.

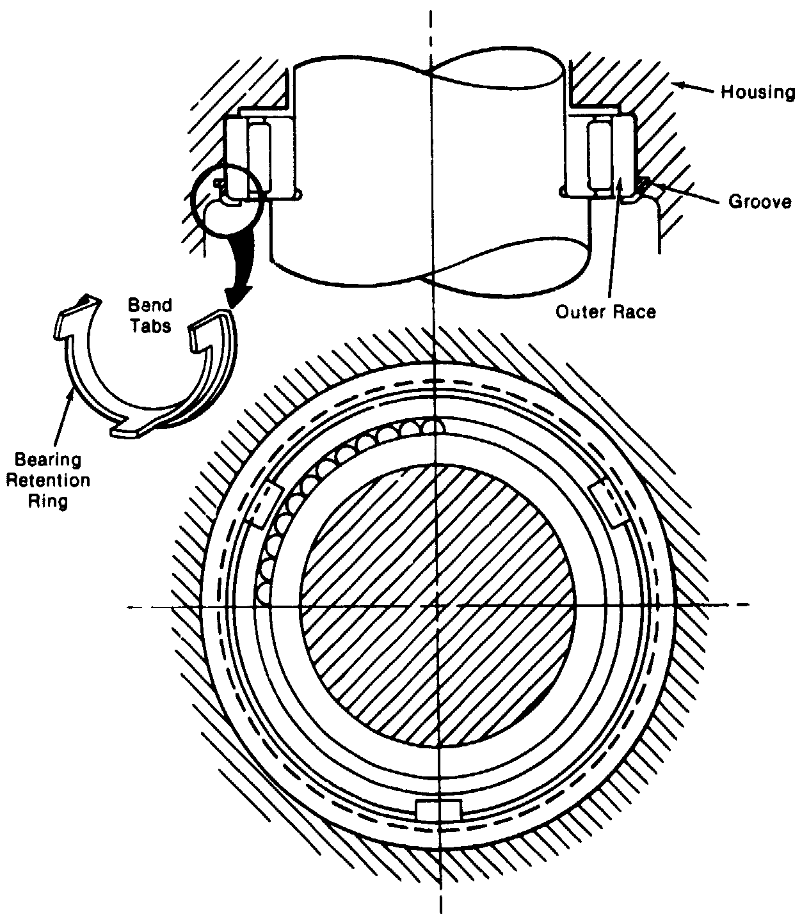
A numerically implemented analysis, based on the finite element method, is presented for the general class of spiral-groove bearings lubricated with an isoviscous Newtonian fluid. A test facility constructed for validating the analysis, has shown it to be accurate. Tests performed with an instrumented 10 cm (3.9 in.) diameter journal provide data on film pressure and flow pattern history. A dead-ended bearing with a spiral-groove conical journal is analyzed, and general parametric data generated. In addition optimization and manufacturing tolerance data such as the influence of cone axis misalinement are included.

Experiments conducted with air-turbine and motor-driven rotors, supported by conical bearings with a base diameter of 3 mm (0.12 in.) [angular momentum about 3×10^{6} g-cm^{2}/sec (1.02×10^{3} lb-in.^{2}/sec)], indicate the feasibility of using spiral-groove bearings in small gyros or large momentum wheels, provided the bearings meet the two requirements previously mentioned. Greases demonstrating shear stability and having predictable and reproducible properties have been developed and tested. Also, the properties of the base fluid, the thickener, and the grease formulation are given, along with the viscosity and vapor pressure measurements.

Source: J. T. McCabe and T. Y. Chu of
Franklin Institute Research Labs
under contract to
Marshall Space Flight Center
(MFS-21662)

Circle 15 on Reader Service Card.

BEARING RETENTION DEVICE



Bearing Retention Device on Roller Bearing

A novel method of retaining the outer races of roller bearings allows smaller and lighter housings where a more rugged housing might normally be required. The method utilizes a thin metal bearing retention ring with integral tabs and a narrow rim fitted into a groove machined in the housing wall. The outer bearing race then is slipped into the housing bore, thus trapping the retaining ring in place. The tabs are then bent over the outer race to retain the bearing (see figure).

This method is relatively inexpensive in that no drilling, tapping or threading operations, or threaded fasteners needing a locking device are required. The number of tabs can be varied to suit various conditions such as loads and diameters. The ring material is a ductile alloy in order to prevent cracking of the tabs during clamping.

The method is only suitable for light loads and is not intended to take any direct thrust loads. However, for light loads, it is adaptable to other types of bearings or cylindrical components that require retention in a housing.

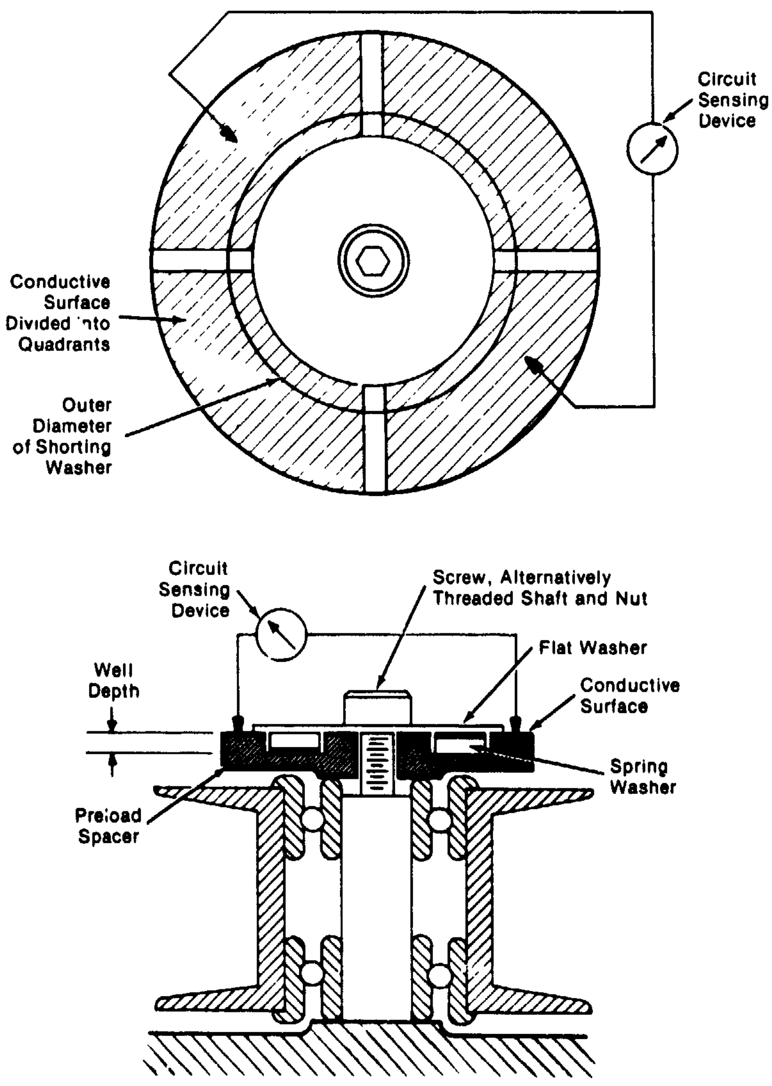
Source: A. P. Swift of
Rockwell International Corp.
under contract to
Marshall Space Flight Center
(MFS-19189)

Circle 16 on Reader Service Card.

BEARING PRELOAD SPACER

A preload spacer (fixed preload) has a well to accept a spring washer. The controlled well depth provides the desired preload when the spring washer is compressed to the well-depth height. When the flat washer (see figure) makes contact with the conductive surface on opposing sides of the spacer, the design preload is established on the bearings. This condition is identified by electrically sensing the initial contact between spacer and washer.

A second type of preload spacer (spring preload) has a depth-controlled well to provide the desired preload when the spring washer is compressed to the well depth, less the thickness of a preselected feeler gauge. When the spring washer is compressed to the desired amount, the spacing is determined by the feeler gauge and the desired preload is established.



Bearing Preload Spacer

The preload spacer is dependent only on the axial force applied to the bearing race to determine the amount of axial load. The electrical sensing device will sense less than 1° of angular movement. The corresponding axial movement for an 8-32 screw is less than 0.000218 cm (0.000086 in.). A portion of this axial movement is used to bring the axial load up to the design load, so that the established load is very close to the design goal. A more accurate control of the preload may be obtained by using a finer thread on the hardware used to apply the load. Normal machining tolerances only are required for the fabrication of an assembly using a preload spacer. The well depth of the preload spacer should be controlled to ±0.0025 cm (0.001 in.).

Conventional bearing preloads are controlled by very tight dimensional tolerances or shimming. It should be noted that 0.0003 cm (0.0001 in.) axial movement of one race relative to the other in a bearing pair will change the preload by 1.4 kg (3 lb). Torque measurement is commonly used in bearing assembly to measure the preload. However, false measurement may result if a grease is used to lubricate the assembly. The torque caused by the grease may be sufficient to indicate a nonexistent preload.

Establishing a bearing preload using shims or lapping to obtain the final dimensions is a costly, time consuming process, and the final preload established may not be the desired amount by at least a factor of two. Preloads can be established using a preload spacer in less than 5 minutes within a tolerance of ±10 percent. Preloads established on bearings by shimming or lapping cannot be checked on the completed assembly except by torque measurements. Preloads can be checked easily on an assembly having a preload spacer, even when the unit is in operation. Definite fixed preloads of fractions of a pound can be established on bearing assemblies using a preload spacer.

Previously, preloads of this type could be established using matched bearing pairs with a tolerance on the applied preload of ±50 percent. These preload spacers permit the establishment of bearing preloads, fully independent of tolerance on the rest of the bearing assembly. Bearings can be preloaded to desired levels with accuracy limited only by the spring washer tolerance. Additionally the spring preload permits the assembly of unlike materials in a unit which operates under a varying thermal environment and maintains approximately uniform loading over a wide thermal range.

Source: E. Holloway of
RCA Corp.
under contract to
Goddard Space Flight Center
(GSC-10678)

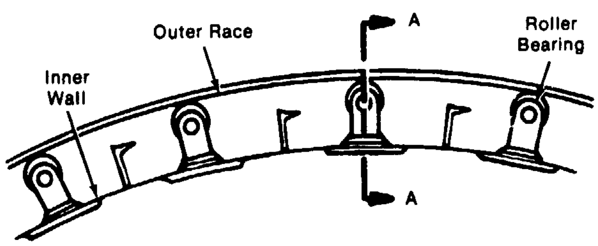
No further documentation is available.

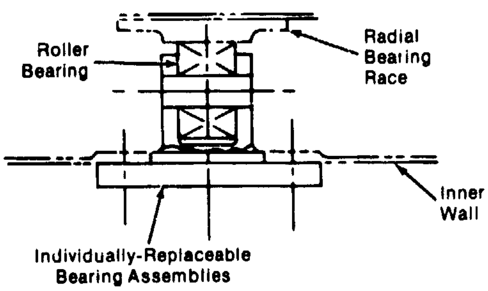
NEW BEARING IS REPAIRABLE WHILE IN SERVICE: A CONCEPT

A newly developed bearing has a structural race on which many individual ball or roller bearings run as wheels. This design makes it possible to replace the individual bearings while the unit is operating.

Figure 1 illustrates the assembly for a radial load, and Figure 2, for a thrust load. The race is attached to the outer wall of the structure and the individual bearings are mounted on an inner assembly. The removal of one of these individual bearings for replacement or repair does not affect the others.

This bearing should be attractive for applications requiring continuous or lengthy periods of operation, although some positioning accuracy may be sacrificed. The innovation may be of interest to manufacturers of large, rotatable communications antennas and rotating platforms for construction equipment.





SECTION A-A

Figure 1. Bearing Installation for Radial Load

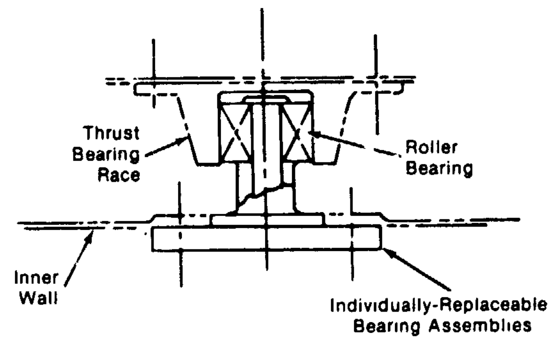
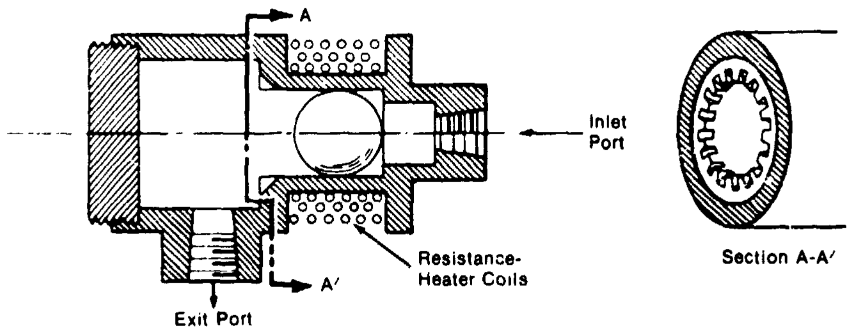


Figure 2. Bearing Installation for Thrust Load

Source: R. W. Benjamin of
Rockwell International Corp.
under contract to
Johnson Space Center
(MSC-17467)

No further documentation is available.

THERMALLY ACTUATED VALVE



A small, reliable, lightweight valve is designed to release a pressurized fluid in a single operation. An effective seal in a one-shot valve is made by shrink-fitting a ball within a cylinder; thermal expansion of the cylinder, caused by a contiguous source of heat, will release the ball and open the valve.

The valve (shown in the diagram) consists essentially of a cylindrical body which is shrink-fitted around the ball. When activated, a resistance heater fitted into the recess warms the cylinder and releases the ball. The ends of the cylindrical body have a threaded inlet and exit ports so that the valve can be connected to a fluid dispensing line.

To set up the valve for the first time, the cylindrical body is oriented into a vertical position with the inlet port resting on a flat surface. The cylinder is heated in this position by placing it in a hot oven, by energizing the heater, or by some other means. When the cylinder is cold, it is too small in diameter to permit entry of the ball; however, when the cylinder is hot, thermal expansion has increased its diameter, and the ball drops into place. The ball normally would fall and be seated on the circular edge near the inlet port; however, the ball in the diagram is purposely set away from the edge to emphasize the fact that hermetic closure occurs at the contact zone between the ball and the cylinder wall. Assembly of the valve is completed when the closure disk is screwed into place.

The sealed valve can be installed in a line and will hold back a pressurized fluid in the inlet cavity. To open the valve, the heater is energized; the cylindrical body expands until it becomes large enough to release the ball. The pressurized fluid ejects the ball into the body cavity, and flows around the sphere and through the exit port. Radial flutes are cut into the circular edge (show in detail in Section A-A′) so that once the valve has been opened the ball cannot effect a seal at the upper edge of the cylinder under any conditions of valve orientation or acceleration.

The fact that high stresses can be generated when one member is shrink-fitted around a second member is well known. With proper design and fabrication, the seal produced between the seat and plug is leakproof; in fact, the valve can be tested easily (while sealed) any number of times with degradation because of the absence of moving parts.

The valve can also be adapted for repeated operation and can be made capable of being opened without a pressurized fluid. For this configuration, a call or other suitably configured plug is released from the seat (after heating) by a compression spring interposed between the ball and the bottom of the cylinder. A bellows brazed into a hole in the assembly closure disk, with a nominal capability of spring-like action, holds the ball against the circular edge while fluid passes through the radial flutes cut into the circular edge. When it is desired to close the valve, the heater is again energized and a sufficiently great force (provided by a mechanical linkage, pressurized hydraulic fluid, or some other means) is applied through the center of the bellows to overcome the force of the spring and the force (if any) applied to the plug by fluid flowing around it. When it has been determined that the plug is properly located at the seat, the heater is deactivated and, when the seat has cooled, the passageway through the valve will again be sealed.

Source: Robert H. Silver of
Caltech/JPL
under contract to
NASA Pasadena Office
(NPO-11846)

Circle 17 on Reader Service Card.

SHOCK ABSORBING CONNECTOR/CLAMP

The connector/clamp incorporates a double overcenter mechanism, utilizing two springs, one of which can be made to operate the mechanism and the other providing redundancy. The mechanism consists of a receptacle fitting and housing, floating strut, spherical bearings, piston, tension springs and overcenter linkages. The connector/clamp may be used to connect two structures; one being attached to the floating strut, the other to the receptacle fitting. In the open position, before release of the mechanism, a shock absorbing capability is provided by the tension spring which supports the floating strut (Figure 1). In

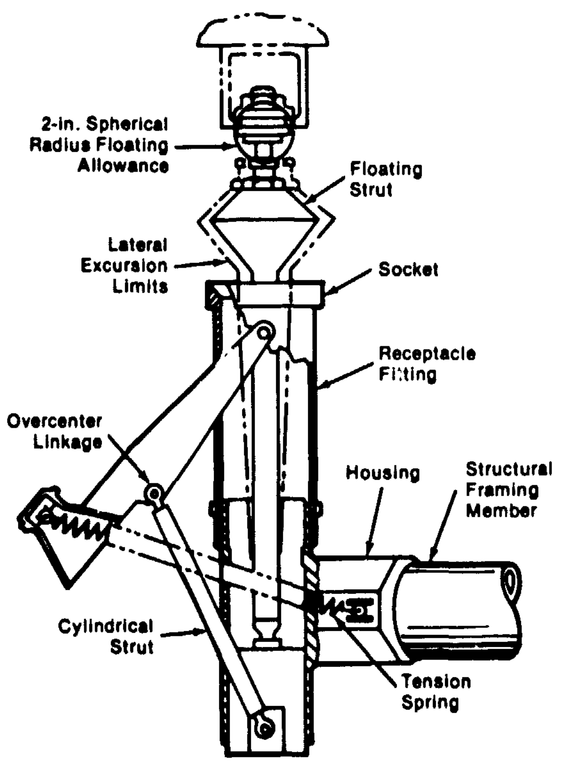


Figure 1. Connector/Clamp Shock-Absorber Mode

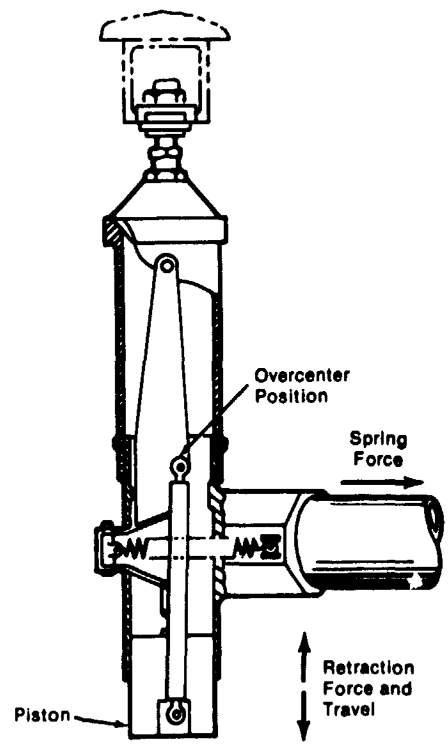


Figure 2. Connector/Clamp Rigid-Clamp Mode

this operating mode only mechanical spring loads and system friction loads are transferred between structures. Upon release of the mechanism, the tension springs drive the overcenter linkage into the overcenter position causing the conical surface on the floating strut to be pre-loaded into the receptacle fitting, thereby ensuring a rigid, load-bearing connection (Figure 2). The cylindrical struts of the overcenter linkage are adjustable, providing a capability for overcenter and clamp-up force control.

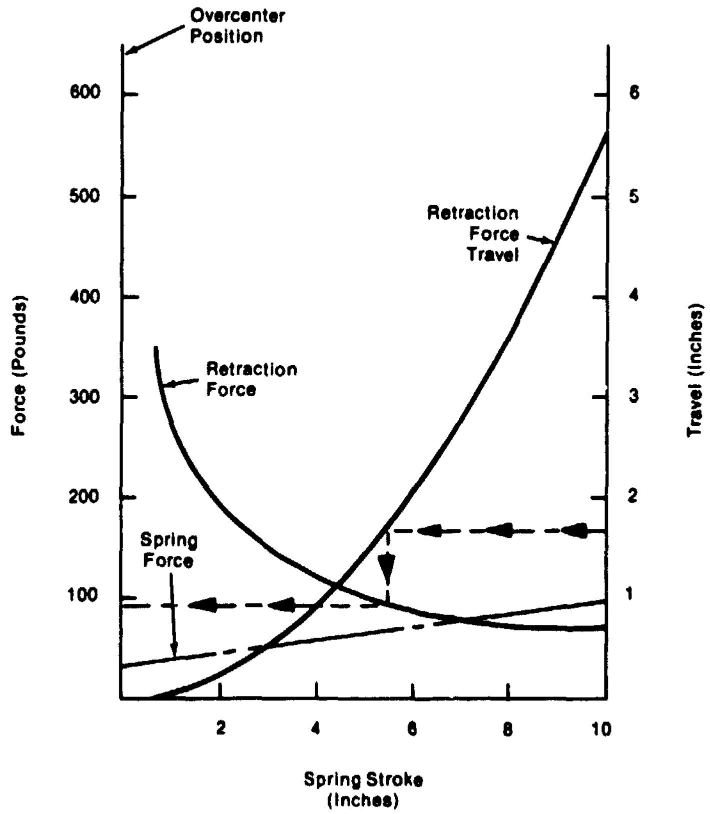


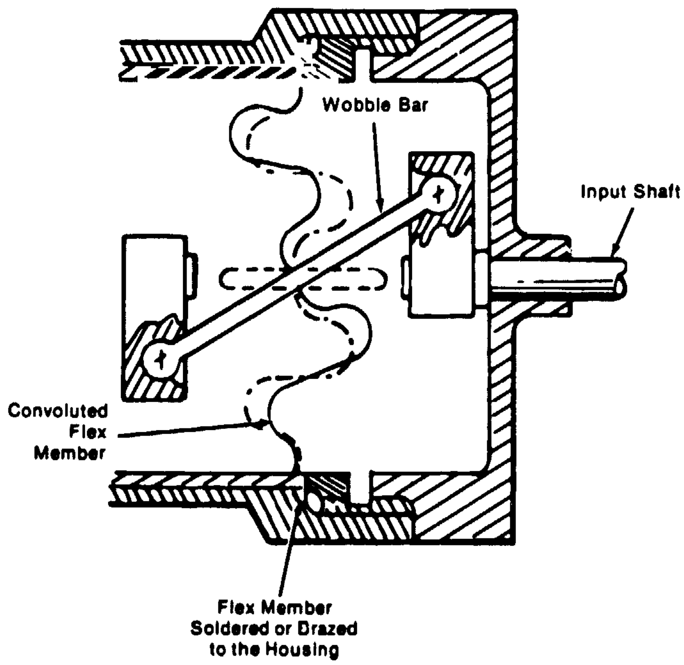
Figure 3. Operating Loads

Three or more connector/clamps may be combined, by means of structural framing members, to form a stabilizing system. Axial alinements are obtained by adjusting the studs in the floating strut. The graph of Figure 3 describes the operating loads of the mechanism.

Source: D. G. Wetzler of
McDonnell Douglas Corp.
under contract to
Marshall Space Flight Center
(MFS-21680)

Circle 18 on Reader Service Card.

HERMETICALLY-SEALED MOTION TRANSMITTER



An hermetically-sealed motion transmitter has been developed which allows transmission of rotational or single-planar arc motion through an hermetically sealed chamber without the use of dynamic seal or complex mechanisms.

Motion is transmitted between two shafts on the same axis using a wobble bar that has its end points captive in crank arms. A convoluted member of a highly-flexible fatigue-resistant metal (e.g., berrylium copper) is soldered or brazed to the shaft at the wobble axis and to the housing, thus forming a seal without the use of dynamic seals.

Each design application is limited to a maximum pressure differential. Excellent operating life can be expected with the proper design ratio of the radius of the crank arm, the length of the bar, and the diameter of the convoluted member.

This device may be of interest to pressure vessel designers and those who need to isolate equipment from a hostile environment.

Source: Robert L. Eckert of
Rockwell International Corp.
under contract to
Johnson Space Center
(MSC-17348)

No further documentation is available.

SHOCK MITIGATOR

Low-cost aluminum foil can be used as a shock mitigator where space limits the use of other energy-absorbing methods. The concept was developed in order to absorb the energy acquired in extending a telescoping boom from a spinning rocket. In tests simulating the extension of the boom, there was reduction in peak shock from 300 g's without the foil to 9 g's with four wraps of foil 0.015 in. (0.0038 cm) thick, initially 1-1/2 in. (3.81 cm) wide, on each of two elements of the boom. The foil was crushed to approximately 1/4 in. (0.63 cm).

The crushed foil filled the clearance volume between the telescoping elements, thus taking out all initial looseness and providing sufficient friction to prevent rebounding of the boom elements. The concept might be of use in the auto industry as a low-cost shock-absorber for bumpers.

Source: Robert H. Carro
Goddard Space Flight Center
(GSC-11097)

No further documentation is available.

Patent Information

The following innovations, described in this Compilation, have been patented or are being considered for patent action as indicated below:

Variable Load Indicator (Page 1) MFS-21728
and
Beam Lead Forming Tool (Page 3) MFS-22133
and
Universal Drill Jig (Page 8) MFS-24464

Inquiries concerning rights for the commercial use of these inventions should be addressed to:

Patent Counsel
Marshall Space Flight Center
Code CC01
Marshall Space Flight Center, Alabama 35812

Easy Manaul Operation of Overhead Garage Doors: A Concept (Page 14) KSC-10555

Inquiries concerning rights for the commercial use of this invention should be addressed to:

Patent Counsel
Kennedy Space Center
Code AD-PAT
Kennedy Space Center, Florida 32899

Universal Inverted Flexure (Page 25) ARC-10345

Inquiries concerning rights for the commercial use of this invention should be addressed to:

Patent Counsel
Ames Research Center
Code 200-11A
Moffett Field, California 94035

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