NASA SP-5928 (01)

TECHNOLOGY UTILIZATION

SAFETY AND MAINTENANCE ENGINEERING

A COMPILATION

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

NASA SP-5928 (01)

SAFETY AND MAINTENANCE ENGINEERING

A COMPILATION

TECHNOLOGY UTILIZATION OFFICE 1970
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
Washington, D.C.

For sale by the National Technical Information Service, Springfield, Virginia 22151 – Price $1.00

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 and nuclear communities. By encouraging multiple application of the results of research and development, NASA and AEC earn for the public an increased return on the investment in aerospace and nuclear research and development programs.

This compilation includes diverse items, united by a subject of universal interest: safety. Spanning a broad range of applications, from high-power illumination to high-rise construction, the items represent some of the safety-oriented innovations developed by NASA and AEC.

The concept of safety, taken in its broadest interpretation, includes hazard identification and elimination (accident prevention), as well as mitigation of the effects of accidents, for apparatus and personnel. Thus, the subjects of the items presented range from the obviously safety-related, such as life preservers and safety restraints, to those which may be classed as preventive maintenance.

The compilation has been roughly sorted into four sections, according to general subject and area of application. These are: General Personnel Safety, Electrical Safety, General Equipment Safety, and Fire Safety. Where noted, additional technical information on individual items can be requested by circling the appropriate number on the enclosed Reader's Service Card.

Unless otherwise stated, no patent action is contemplated on the technology described.

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

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

Contents

Section 1. General Personnel Safety

Section 2. Electrical Safety

Section 3. General Equipment Safety

Section 4. Fire Safety

Section 1. General Personnel Safety

SHATTER-RESISTANT FLOODLIGHT COVERS

Protective covers for floodlights are currently made from polycarbonate plastics or from glass. The polycarbonate covers have the disadvantage that they are flammable, and the glass covers can be shattered. Even when covers are made of tempered glass laminated with an inner plastic film layer, dangerous shards can spall off the outer layer of glass under impact or thermal shock. Further, the film layer often tends to discolor in time, thus reducing the transparency of the cover.

Nonflammable, shatter-resistant floodlight covers have been made by bonding a thin plastic film to the outer surface of the glass plate. The film, a transparent, fluorinated ethylene propylene (FEP) plastic, prevents glass shards from being scattered if the cover is broken. It is bonded to the glass surface by a transparent elastomeric silicone adhesive. The addition of the film and adhesive does not substantially reduce the transparency of the cover, even after extended use.

The superior qualities produced by this process suggest numerous commercial uses with other products. Protection of the faces of television picture tubes appears particularly promising.

Source: R. H. Oros of
North American Rockwell Corp.
under contract to
Manned Spacecraft Center
(MSC-15686)

Circle 1 on Reader's Service Card

PROTECTIVE CLOTHING FOR PERSONNEL WORKING ON HIGH-POWER COMPACT-ARC LAMPS

High-power (5 to 20 kW), xenon-filled compact-arc lamps are currently being applied in many areas. They are used by the military for battlefield illumination; by the police; by the motion-picture, television, and printing industries; and they are finding increasing use in sports for stadium illumination.

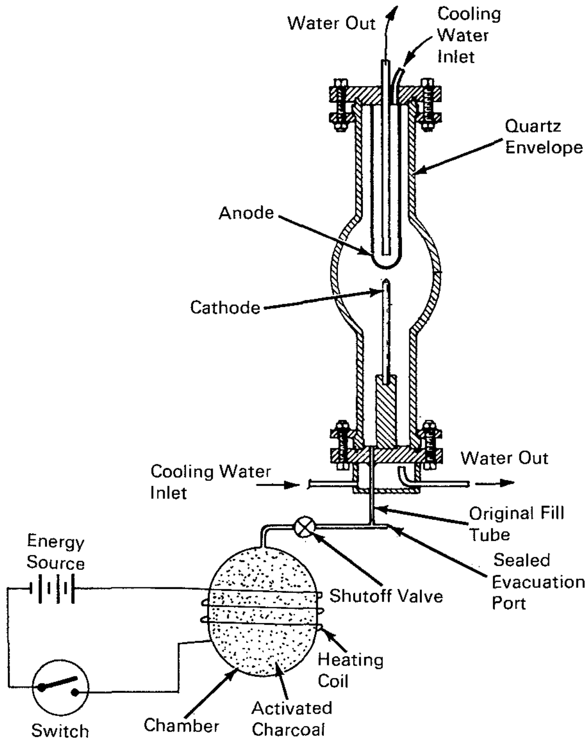
The lamps consist of two electrodes in an envelope of glass or fused quartz that also contains xenon gas at a pressure of 60 to 70 psi. During operation, the pressure may exceed 200 psi. Frequently, these lamps explode during handling or operation, and the flying fragments of glass or quartz can cause serious injury to personnel.

Two suits of protective clothing have been developed to be worn by personnel working near such lamps: one to be worn during assembly or servicing of inoperative 5- and 20-kW lamps; the other during adjustment or focusing or operating 5-kW lamps. The former suit comprises a riot helmet and modified face shield, with two-layer leather capes and a stainless-steel screen; leather jacket, pants, and toe-caps; apron and half-jacket; a pair of lightweight leather gloves; and a pair of heavy leather gloves. The latter suit consists of a heavy leather skullcap, with leather capes in front and rear; leather jacket; goggles; a pair of rubber gloves; and a pair of cloth gloves.

Source: M. J. Argoud of
Caltech/JPL
under contract to
NASA Pasadena Office
(NPO-11155)

Circle 2 on Reader's Service Card.

DEPRESSURIZATION OF XENON ARC LAMPS



Xenon compact-arc lamps, commonly operated at power levels of 20 kW with internal gas pressures of 200 psi, are less hazardous if they are depressurized during idle periods. The lamp structure is modified to permit depressurization by adding a tee to the existing gas fill tube, with a sealed evacuation port on one side and a depressurization mechanism, shut-off valve, and storage chamber on the other.

Two depressurization techniques are suggested. In one, the storage chamber is cooled by liquid nitrogen, causing the xenon to condense and producing a partial vacuum in the chamber. Upon opening the shut-off valve, gas is drawn from the lamp into the storage chamber and condenses, lowering the pressure within the lamp. After the valve is closed, the refrigerant may be removed, and the xenon is retained in the storage chamber. The lamp is repressurized automatically upon reopening the valve.

In the alternate technique shown in the illustration, the storage chamber is filled with activated charcoal. When the valve is opened, the xenon is adsorbed on the charcoal. No refrigeration is necessary. However, repressurization requires the use of heat to drive the xenon gas from the charcoal. This may be easily accomplished by the use of an electric heater, as shown.

Source: C. G. Miller of
Caltech/JPL
under contract to
NASA Pasadena Office
(NPO-10790)

Circle 3 on Reader's Service Card.

PROTECTIVE VISOR FOR USE IN HIGH-TEMPERATURE ENVIRONMENTS

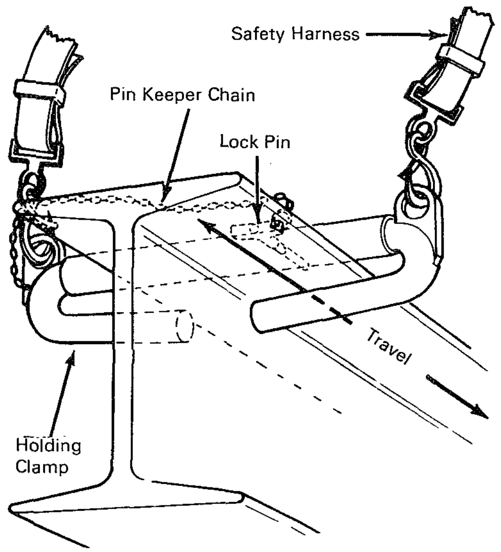
A visor has been developed for use in fires, to protect the faces and particularly the eyes of rescue workers. On test exposure to an external flame temperature of 1640°F for 10 minutes, the temperature at its inner surface rose only to about 210°F.

The visor is constructed as a curved sandwich, with an aluminum frame which encloses two glass plates, a metallized plastic film, and a dead air space. In sequence starting from the inside, the layers are as follows: 1) a 1/4-inch thick, annealed glass plate that heats slowly due to its mass, provides impact protection, and resists shattering into small particles; 2) a film of gold-coated polyester, which is highly reflective to infrared wavelengths; 3) a dead air space, which prevents direct heat conduction from the outermost layer to the polyester; and 4) a thin sheet of highly tempered glass, which provides high impact resistance for the assembly and isolates the plastic film from direct contact with flame.

Source: F. A. Burgett
Manned Spacecraft Center
(MSC-12085)

Circle 4 on Reader's Service Card.

SAFETY YOKE PROTECTS CONSTRUCTION WORKERS



Construction workers handling tools and materials while high in the air astride steel girders are constantly in danger of falling. Currently, a harness is worn which completely encircles the beam on which they are working. This is a cumbersome and time consuming safety precaution, because it severely limits the worker's freedom of movement.

A new device permits the harness to slide freely along the girder. This is accomplished, as illustrated, by attaching the harness to a simple dismountable yoke that engages the upper flat of the "I" beam. A locking pin secures the inner and outer sections of the yoke and locks it securely to beams with flanges from 8 to 14 inches wide.

Source: O. H. Goforth of
Trans World Airlines, Inc.
under contract to
Kennedy Space Center
(KSC-10075)

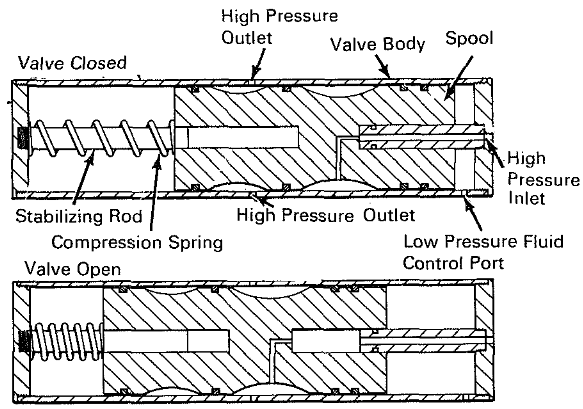
No further documentation is available.

REMOTELY OPERATED HIGH-PRESSURE VALVE

In testing or operating certain high-pressure systems, hydrostatic pressures greater than 20,000 psi may be used. Such conditions must always be regarded as hazardous, since a rupture in any high-pressure component can produce an explosion. Personnel should be isolated from the high-pressure system.

The remotely operated high pressure valve, cross sections of which are shown in the illustration, was developed to permit this isolation. As shown in the first diagram, the device is a spring-loaded spool valve. The high-pressure fluid is coupled through one end of the valve body. It exerts a force against the spool which is insufficient to overcome the opposing force exerted by the spring.

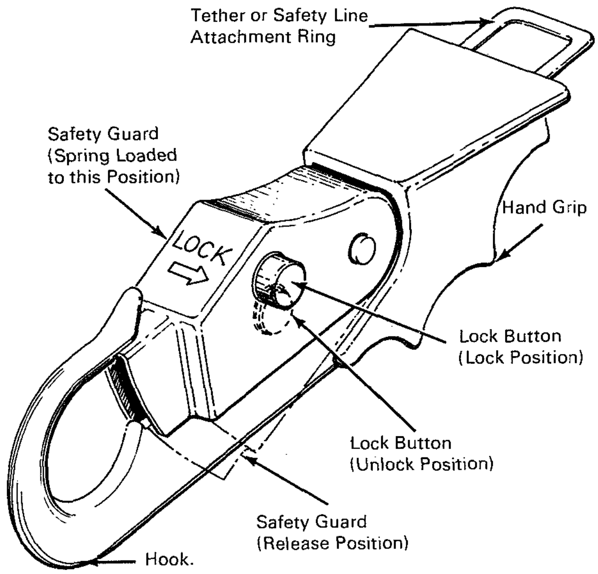
To open the valve, a low-pressure fluid is admitted through the control port. Its force supplements that of the high-pressure fluid, and moves the spool to the open position shown in the second diagram. The valve remains open as long as both pressures are applied. If either the control pressure is decreased or the high pressure drops below the desired level, the valve will automatically close.



Source: B. T. Howland of
North American Rockwell Corp.
under contract to
Manned Spacecraft Center
(MSC-11010)

Circle 5 on Reader's Service Card.

LOCKING HOOK FOR SAFETY HARNESSES

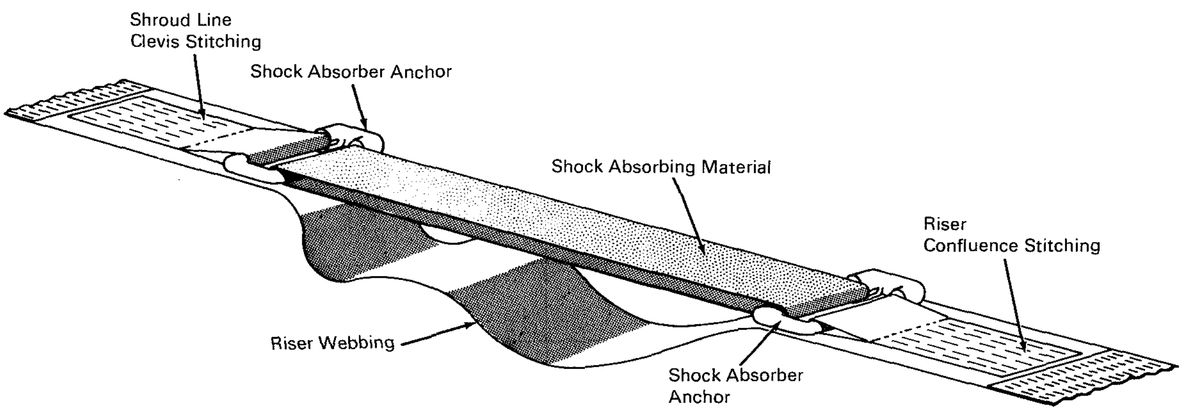


Another device for workers in dangerous occupations where safety belts or harnesses are commonly used. is a safety hook originally designed for the Apollo astronauts. As illustrated, the safety guard locking device prevents inadvertent release of the hook. When the lock button is in the unlock position, the hook may be snapped into a ring. In the lock position, the guard cannot be depressed because of a spring-loaded ball detent. To release the hook, the button must be pushed to the unlocked position and the guard depressed to the release position.

Source: R. J. Eggers of
North American Rockwell Corp.
under contract to
Manned Spacecraft Center
(MSC-11303)

No further documentation is available.

NYLON SHOCK ABSORBER FOR PARACHUTE HARNESSES



To reduce the canopy-opening shock of a parachute sufficiently to protect the wearer from injury, a nylon shock absorber has been devised. As illustrated, an 8-in length of nylon material is sewn into each riser between the shroud line clevis and the riser confluence. Sufficient slack is introduced into the riser to allow the nylon to stretch when the parachute opens, thus dissipating the opening shock.

Source: J. A. Mandel of
Goodyear Aerospace Corp.
under contract to
Manned Spacecraft Center
(MSC-90226)

Circle 6 on Reader's Service Card.

SELF-INFLATING LIFEVEST STORES IN SMALL PACKAGE

An emergency lifevest has been designed that can be stored as a compact, lightweight package and quickly inflated to support a person in the water.

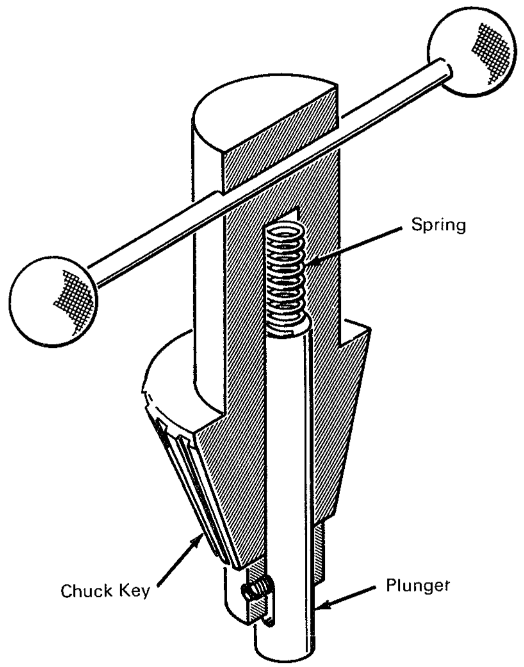
The vest can be inflated with carbon dioxide from a self-contained cartridge in 10 seconds. When deflated, it fits into a package that occupies less than 20 cubic inches and weighs less than 1 pound.

Prototype models of this lifevest were constructed from nylon with a neoprene coating. Its inflated configuration is maintained by internal V-shaped restraints. The carbon dioxide cartridge and triggering mechanism are built into the lifevest and provide an inflation pressure of over 2 psi. An oral inflator is also provided to maintain or increase the pressure.

Source: M. I. Radnofsky
Manned Spacecraft Center
(MSC-90005)

Circle 7 on Reader's Service Card.

SPRING-LOADED CHUCK KEY



The illustration shows a cross-sectional view of a safer chuck key of the type commonly used on drill presses, lathes, and other machine tools. Because of the spring-loaded plunger incorporated in this design, the key will remain in the chuck only so long as hand pressure is applied.

If a normal key is not removed from a chuck it can fly out when the machine is started, presenting a hazard to the operator and to other people nearby. To use the modified key, however, sufficient force must be exerted to overcome the spring pressure. Upon release of this force, the spring relaxes and automatically ejects the key from the chuck.

Source: G. L. Christman of
North American Rockwell Corp.
under contract to
Manned Spacecraft Center
(MSC-90506)

Circle 8 on Reader's Service Card.

MAGNETIC LATCHES PROVIDE POSITIVE OVERPRESSURE CONTROL

In rooms where explosion hazards exist, overpressure safety venting techniques are required. It is desirable to have the vents reseal automatically when overpressurization has been relieved.

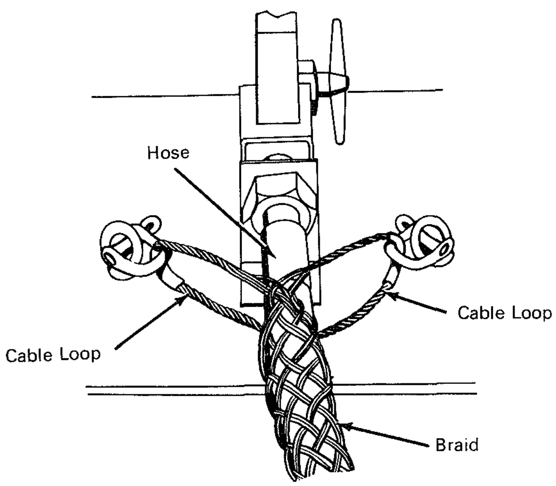
Louvers have been constructed with individually hinged closures that are held closed by commercially available magnets. When room pressure exceeds the holding power of the magnets, the hinged louvers swing open until the overpressure has been dissipated. Gravity then returns the louvers to the proximity of the magnets, which snap-lock them into the closed position.

In one application, 96-lb louvers have been successfully operated against an overpressure of 3.5 inches of water by using one magnet, with a 30-lb pull, per louver.

Source: J. L. Loy of
Westinghouse Astronuclear Laboratory
under contract to
Space Nuclear Propulsion Office
(NUC-90057)

Circle 9 on Reader's Service Card.

RESTRAINER PREVENTS WHIPPING OF RUPTURED HIGH-PRESSURE HOSE



The dangerous whipping action that may occur when a high-pressure fluid transfer line fails can be prevented by wrapping the line with a modified electric cable puller. As illustrated, the puller, made of braided wire, is installed around the hose, and its ends are spliced into twin cable loops. Each loop is tied to a structural member by a shackle and eye. This device provides a strong anchor that securely restrains a high-pressure hose even if it is completely severed.

Source: W. E. Thompson
Lewis Research Center
(LEW-90099)

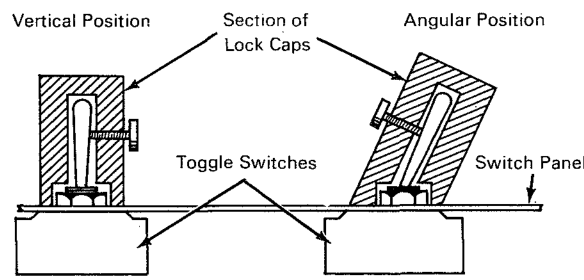
No further documentation is available.

Section 2. Electrical Safety

TOGGLE SWITCH LOCK

Locking caps have been designed to ensure that toggle switches remain in a preset position during various critical operations. They provide an enhanced safety factor to guard against accidental switching which might abort an operation involving human life or costly equipment.

The cap is made from a length of aluminum rod whose base is cut either square or inclined, depending on the position into which the switch is to be locked. As shown, the rod is bored to fit the switch lever's diameter and length, and relieved to fit over the switch base. A hole is tapped through the side of the rod and threaded with a lock screw. The cap is placed over the switch lever, pressed flush with the switch panel, and the lock screw



tightened. Until the cap is removed, the switch cannot be moved from the preset position.

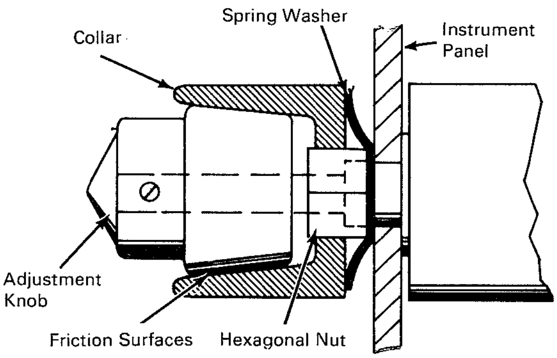
The safety device can be used in test consoles, aircraft, and various types of electronic equipment during testing, operation, checkout, or maintenance.

Source: P. R. Schaer of
The Boeing Company
under contract to
Kennedy Space Center
(KSC-10017)

Circle 10 on Reader's Service Card.

AUTOMATICALLY LOCKED CONTROL KNOB

A control knob that automatically locks after an adjustment is made has been designed for use on electronic instrument panels. The device incorporates a collar with a hexagonal opening in the bottom which fits snugly over the outside surface of the control retainer nut. A spring washer installed between the panel and the collar presses the inner surface of the collar against the outer surface of the knob; thus rotation of the knob is prevented by friction between the mating surfaces. To adjust, the collar is pressed toward the panel, disengaging the friction surfaces and freeing the knob. When the adjustment is completed and the collar is released, it automatically returns to the locked position.

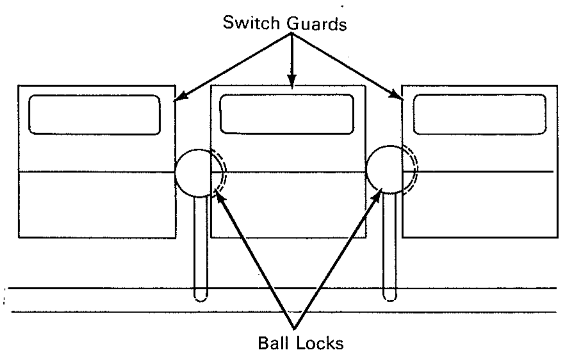


Source: Lear Siegler Corp.
under contract to
Marshall Space Flight Center
(MFS-90190)

Circle 11 on Reader's Service Card.

INTERLOCKED GUARDS FOR SEQUENCED SWITCHES

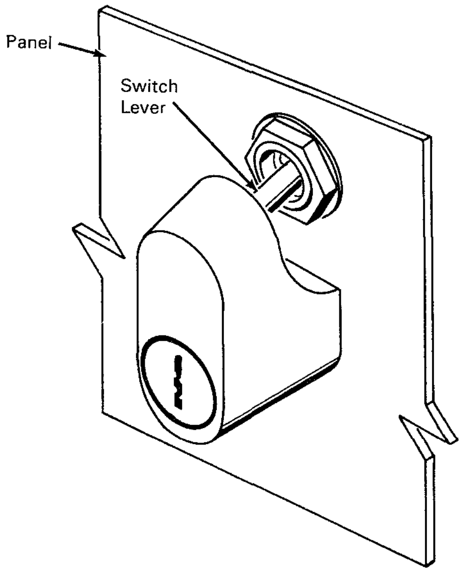
Another switch protection device ensures that sequenced switches are thrown in the proper order. As illustrated, a pivoted ball lock is installed between adjacent switch guards. The ball fits flush with the side of the first guard (covering the switch to be thrown earlier), and is positioned in a recess in the side of the second guard (covering the later-thrown switch). A mechanical interlock is thus established, since the second guard cannot be removed until the ball swings clear of the recess, and the ball cannot move while the first guard is in position.

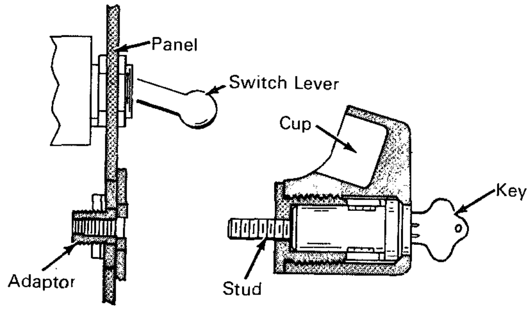


Source: P. J. Rossi of
North American Rockwell Corp.
under contract to
Manned Spacecraft Center
(MSC-15621)

No further documentation is available.

KEY-LOCKED SWITCH GUARD





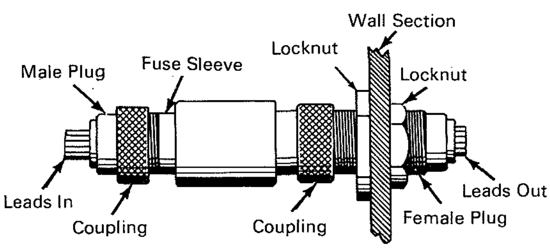
Another device, which will prevent either accidental or deliberate mispositioning of a switch, is shown in the illustraition. By installing an adaptor in the control panel near the switch, a key-operated guard assembly can be placed over the switch lever and locked into position. Then the switch cannot be thrown until the guard is unlocked and removed.

Source: K. C. Hawthorne of
North American Rockwell Corp.
under contract to
(MSC-90419)

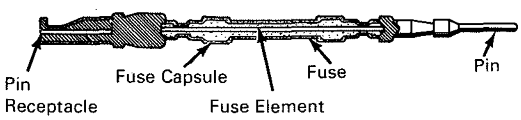
Circle 12 on Reader's Service Card.

CABLE CONNECTOR INCORPORATES MULTIPLE FUSES

A multi-conductor cable connector has been adaped to allow insertion of individual fuses for each line. As illustrated for a connector with threaded couplings, the adaptor consists of a male



Connector Assembly



Safety Fuse Assembly

coupling, a sleeve which houses the fuses, and a female coupling. Also shown is an individual fuse assembly. The sleeve contains an array of these assemblies which mates with the array of pins and receptacles in the connector pair.

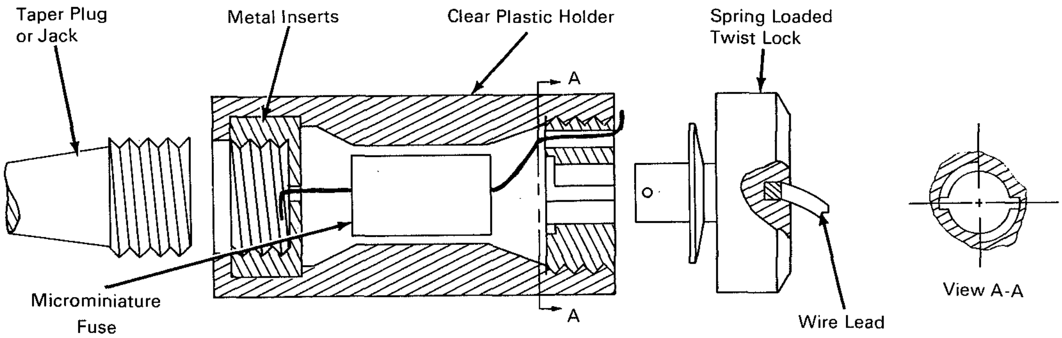
In use, the fuse sleeve first is pressed into the female plug so that all its fuse-assembly pins enter the mating receptacles, and is secured by tightening the coupling onto the threads of the female plug. The male plug then is pressed into the fuse sleeve so that its pins enter the pin receptacles of the proper fuse assemblies, and is secured by tightening the coupling onto the threads of the fuse sleeve.

To replace or exchange fuses, the male plug is disconnected from the fuse sleeve. Using a special tool (not shown), any fuse assembly may be quickly removed by pressing the tool against the shoulder of the pin and forcing the fuse assembly back out of its channel within the fuse sleeve. The replacement fuse assembly is installed by forcing it pin-first into its channel within the fuse sleeve. The fuse assembly is itself easily disassembled by pulling on each end of the fuse capsule; a new fuse element or one of a different value may then be installed in the capsule.

Source: C. J. Weber of
McDonnell Douglas Corp.
under contract to
Manned Spacecraft Center
(MSC-90199)

Title to this invention, covered by U.S. Patent No. 3281558, has been waived under the provisions of the National Aeronautics and Space Act [42 U.S.C. 2457 (f)] to McDonnell Douglas Corp., Box 516, St. Louis, Missouri 63166.

FUSED JUMPER WIRE



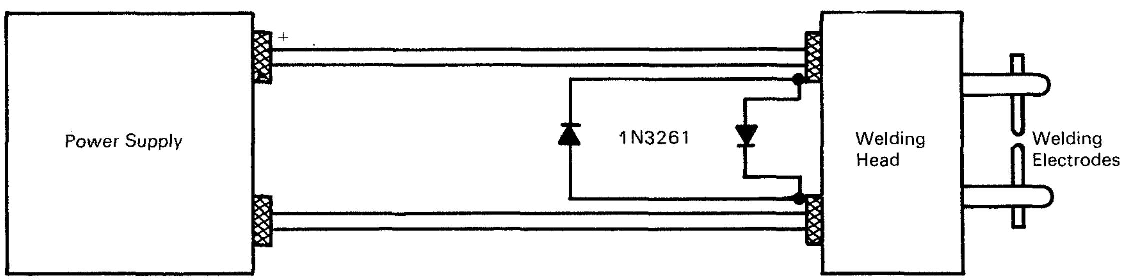
When jumper cables are used to connect or bypass certain parts of an electronic circuit, a safety hazard is created. If the cable insulation is cut in any way, for example if an access door is closed on the cable, an electrical short circuit may occur, causing possible damage to the equipment.

Such inadvertent shorting by damaged jumpers can be avoided by installing a fuse at each end of the jumper. A typical installation, adjacent to the jumper connector, is shown in the illustration. It contains: (1) a clear plastic holder with threaded or bayonet-type connectors on a metal insert at each end; 2) a microminiature fuse; 3) a spring-loaded cap; and 4) a taper plug, jack, or other type of connector.

Source: F. W. Baumann of
The Boeing Company
under contract to
Kennedy Space Center
(KSC-10241)

Circle 13 on Reader's Service Card.

DIODES PROTECT INTEGRATED CIRCUITS DURING LEAD WELDING



Two parallel, opposed silicon diodes may be placed across the electrodes of a module welder to protect integrated circuits from damage while their leads are being welded. The technique succeeds because the normal voltage drop across the welding electrodes during operation is less than the forward voltage drop of a silicon diode. However, in the event of intermittent interruption of the welding arc, the conduction of the diode is sufficient to prevent the potential from reaching a level high enough to damage the integrated circuit. To function properly, the diodes must be capable of carrying the full output current of the welding unit. Two diodes are needed to preclude operator error and to protect the integrated circuits from damage caused by both positive and negative transients.

Source: R. Cliff
Goddard Space Flight Center
(GSC-90326)

No further documentation is available.

Section 3. General Equipment Safety

HEALTH HAZARDS OF ULTRAFINE METAL AND METAL OXIDE POWDERS

Facilities that handle ultrafine metal and metal oxide powders will be interested in a comprehensive report appraising special health hazards associated with ultrafine metals and metal oxides. Materials studied included nickel, tungsten, niobium, molybdenum, cobalt, chromium, aluminum and aluminum oxide, magnesium oxide, and zirconium oxide.

The report was prepared specifically for use in powder metallurgy, but much of the material may be generally applicable to other operations which generate respirable, toxic dusts. Available data on toxicology are reviewed, and tentative limits for occupational exposure to ultrafine dusts are proposed. These suggested limits, based on the assumption that aı. particles in an air sample exert their physiological effects individually when inhaled, are lower than the current values recommended by the American Conference of Governmental Industrial Hygienists by factors ranging from 2 to 50. The lower levels reflect the increased toxicity of the ultrafine powders.

Results are presented of an industrial hygiene survey of laboratory work areas. They demonstrate that air monitoring is essential for the control of dust levels. Detailed analytical and air monitoring procedures are furnished, and control measures are recommended. Medical aspects of the control problem are also treated, including an outline for a continuing industrial hygiene and surveillance program.

Source: F. J. Viles, R. I. Chamberlin,
and G. W. Boylen, Jr. of
Viles, Chamberlin, and Boylen
under contract to
Lewis Research Center
(LEW-10878)

Circle 14 on Reader's Service Card.

HYDROGEN SAFETY MANUAL

A manual has been published which details the technical knowledge and long experience of the NASA Lewis Research Center in the handling and use of hydrogen. The Hydrogen Safety Manual covers the characteristics and nature of hydrogen, design principles for hydrogen systems, protection of personnel and equipment, and operating and emergency procedures. As an operating manual, it also sets forth acceptable standards and practices useful for establishing minimum safety requirements.

Source: Lewis Research Center
(LEW-10487)

Circle 15 on the Reader's Service Card.

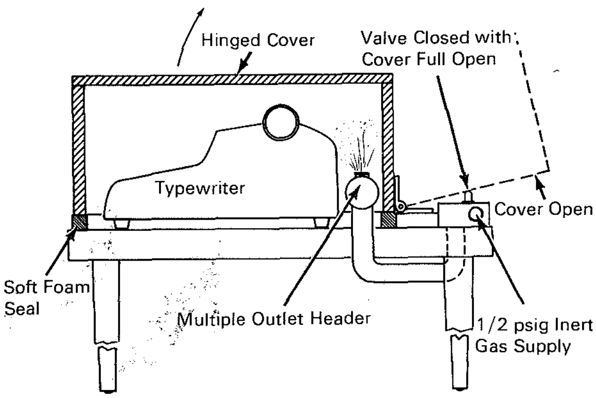
CHEMISTRY LABORATORY SAFETY MANUAL

A chemistry laboratory safety manual is available which outlines safe practices for handling hazardous chemicals and chemistry laboratory equipment. The information was gathered from a variety of reliable, up-to-date sources. Included in the manual are discussions of chemical hazards relating to fire, health, and explosion; good housekeeping conditions; safety equipment; and procedures for safely performing laboratory manipulations involving such things as glassware, vacuum equipment, acids, bases, and volatile solvents. The manual also contains a bibliography of books, leaflets, journal articles, and films on chemistry laboratory safety.

Source: R. G. Elsbrock
Sandia Office of Industrial Cooperation
(SAN-10030)

Circle 16 on Reader's Service Card.

INERT-GAS FILLED COVER PROTECTS EQUIPMENT FROM CORROSIVE ATMOSPHERES



Certain types of intermittently used equipment that may be easily damaged by corrosive atmospheres can be protected by an inert-gas filled cover. The illustration shows a typical installation, used to protect an electric typewriter. The size and shape of the cover may be easily adapted to protect other items.

As shown, a supply of inert gas (dry nitrogen) at 1/2 psig is connected through a normally open valve to a multi-outlet header within the enclosure. The cover is hinged so that, when fully open, it rests on a lever that closes the gas supply valve. As the cover is closed, the gas supply is reactivated to flush out the interior of the cover.

This device may be usefully applied in chemical laboratories, electroplating facilities, foundries, and many other industrial locations where corrosive materials are used.

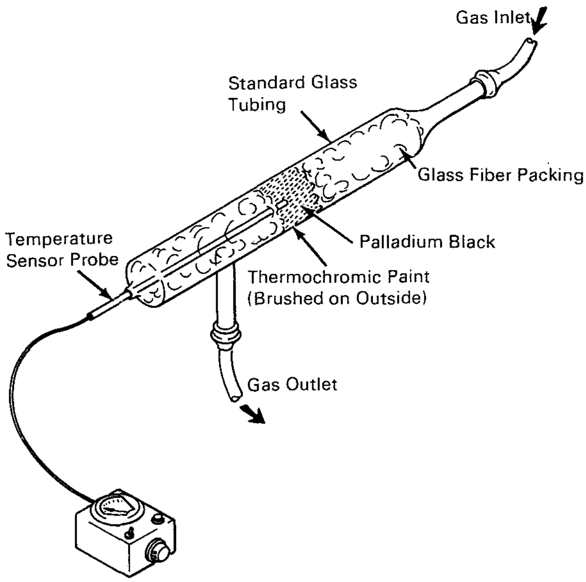
Source: P. L. Vienneau, of
North American Rockwell Corp.
under contract to
Manned Spacecraft Center
(MSC-15769)

No further documentation is available.

PORTABLE HYDROGEN DETECTOR

A portable, quick-acting device for the detection of hydrogen gas consists of a short, thin-walled glass or metal tube, packed with 0.5 g of powdered, activated palladium black held in place with compressed glass fibers. The outside of the tube adjacent the palladium black is coated with a thermochromic paint having two successive color change points, at 55° and 85°C. A temperature sensor is inserted and sealed into one end of the tube so that it penetrates the palladium black. The sensor is connected to appropriate instrumentation to give a continuous, direct indication of temperature changes.

In operation, the ambient gas is drawn through the inlet so that it passes through the palladium black. As hydrogen contacts the palladium black, heat is released in direct proportion to the density of the hydrogen. As the temperature



within the tube passes 55°C, the thermochromic paint changes color to give a visual indication of the presence of hydrogen. Simultaneously, the temperature gage registers the change quantitatively.

An alternate, more passive method uses a finely woven but porous glass fiber tape or pillow impregnated with palladium black and coated with a pattern of thermochromic paint. Hydrogen entering the porous packet reacts with the palladium black to liberate heat and cause the thermochromic paint to change color.

Source: M. A. Rommel and V. H. Dayan of North American Rockwell Corp. under contract to Marshall Space Flight Center (MFS-90806, 90846)

Circle 17 on Reader's Service Card.

PREVENTION OF MOISTURE ACCUMULATION IN IDLE MOTOR WINDINGS

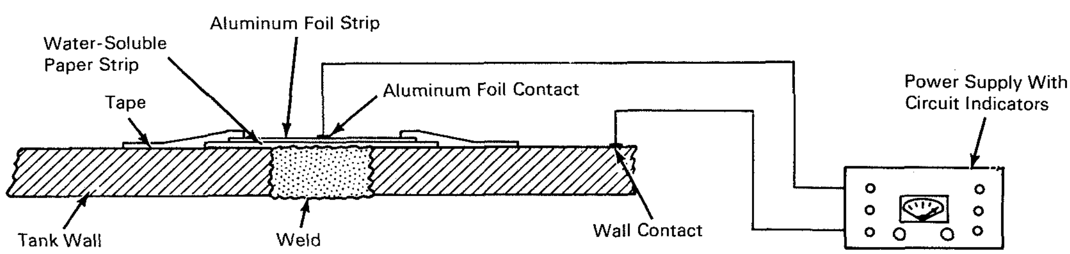
Normal accumulation of moisture in the winding insulation of electric motors that stand idle in damp climates may be prevented by connecting a low-voltage source to the motor windings. Since current flow in the conductors generates heat, the motor temperature remains above the dew point, preventing condensation of moisture.

In an actual installation, a trio of delta-connected 24-volt transformers was installed behind the motor starter and connected to the high-voltage motor windings. Adjustable resistors were used to limit current flow such that temperature of the windings did not rise above 40°C. An auxiliary contact in the starter switch can deactivate the system while the motor is in use.

Source: T. Woodley of Trans World Airlines, Inc. under contract to Kennedy Space Center (KSC-10248)

Circle 18 on Reader's Service Card.

ADHESIVE TAPE LEAK DETECTOR: WATER



Various techniques have been developed using specially prepared adhesive tapes for the detection of fluid leaks, particularly at welded seams and joints. They provide continuous, automatic monitoring from a remote location; are considerably less costly than currently used electronic sensors or closed circuit TV monitors; and provide a positive indication of the site of a leak.

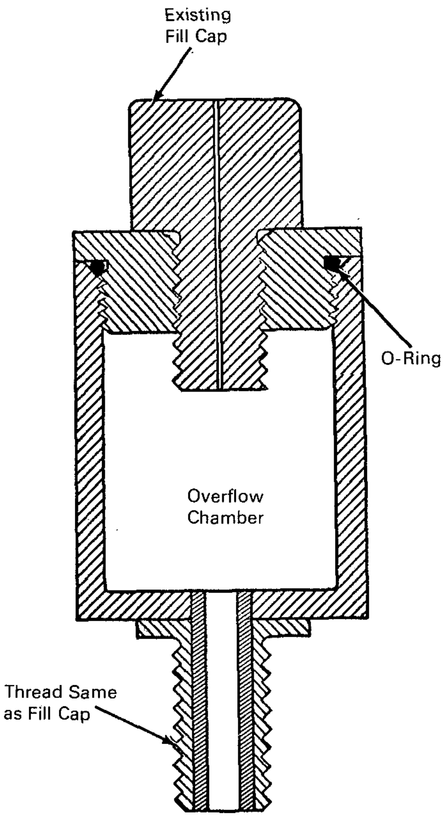
One, developed for water-filled metal containers, uses a strip of aluminum foil, electrically insulated from the container by a strip of water-soluble paper and bonded to the metal surface by a standard adhesive tape. A low-voltage source is connected between the surface and the foil.

If a leak occurs, the paper immediately over the source of the leak dissolves, the aluminum foil contacts the metal surface, and a current sensor is used to detect the increased conduction and trigger an alarm.

Source: The Boeing Company
under contract to
Marshall Space Flight Center
(MFS-90362)

Circle 19 on Reader's Service Card.

BATTERY CAP STORES RESERVE ELECTROLYTE



An inexpensive device has been developed to maintain adequate electrolyte within each cell of a nickel-cadmium battery, and to minimize spillage when charging. Normally, when such a battery stands idle, the electrolyte level decreases because of absorption by the porous battery plates. If water is added to restore the electrolyte level before the battery is returned to service, an injurious overflow may occur when the plates release the absorbed electrolyte during the charging process.

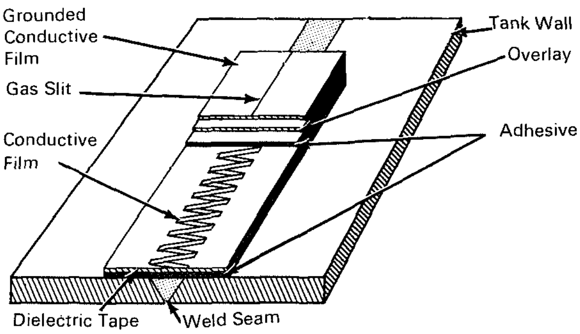
As illustrated, the reserve electrolyte cap provides an overflow chamber to contain the surplus fluid and maintain a reserve of electrolyte. The transparent plastic reservoir is molded to fit the original battery cap and thus provide proper cell venting. Electrolyte fill marks may also be indicated on the side of the cap in accordance with the battery type and function.

Source: R. E. Carpenter, Jr. of
The Boeing Company
under contract to
Kennedy Space Center
(KSC-10235)

Circle 20 on Reader's Service Card.

ADHESIVE TAPE LEAK DETECTOR: LIQUIDS OR GASES

Another detector, capable of use with either liquid- or gas-filled containers, is constructed as a parallel plate capacitor. An electrically conductive film is sandwiched between two layers of a plastic, dielectric adhesive tape. The stretch and tear strengths of the conductive film and tape are made considerably less than the peel strength of the adhesive. Thus, the adhesive effectively seals the joint over which it is applied. Any leakage will form a bubble which will stretch the plastic film

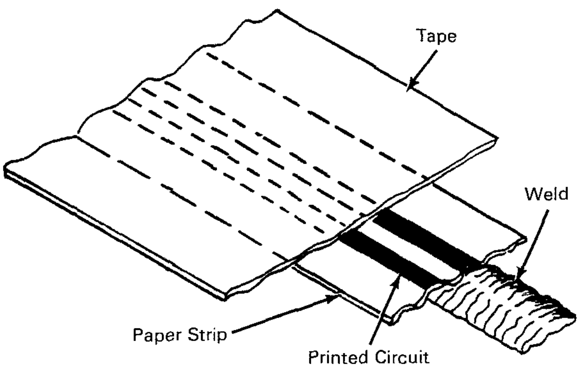


and break the conductive film, thereby reducing the effective capacitance between the film and the container. A standard capacitance bridge is used to detect the breakage and trigger the alarm.

Source: North American Rockwell Corp.
under contract to
Marshall Space Flight Center
(MFS-90478)

Circle 21 on Reader's Service Card.

ADHESIVE TAPE LEAK DETECTOR: ORGANIC LIQUIDS



A third detector, designed for use on containers filled with organic liquids, uses a length of 1-in. wide, porous, noncoated paper, on which are painted two parallel electrical conductors, 1/8-in. wide and 1/8-in. apart, of powdered graphite in an asphalt matrix. The paper is centered, conductor-side up, against a 2-in. wide strip of masking tape and applied to the surface to be monitored. In the event of a leak, liquid is absorbed by the paper, dissolves the asphalt bonder, and interrupts the conductor. A current sensor again detects the change in conduction and activates the alarm.

Source: D. K. Mitchell of
The Boeing Company
under contract to
Marshall Space Flight Center
(MFS-14058)

Circle 22 on Reader's Service Card.

Section 4. Fire Safety

TECHNIQUE FOR ASSESSING POTENTIAL FIRE HAZARDS

A combustion-hazard modeling technique has been developed which may prove valuable in the assessment of potential fire hazards. The analytical techniques and procedures can be used to predict ignition and fire-propagation hazards in various commercial and industrial situations. The predictions may then be used to institute appropriate fire protection measures. Application of this technique supplements engineering judgement with analytical results, and may ultimately permit a reduction in costly fire testing.

The technique evaluates the thermal energy exchanges involved in the burning process, and also calculates the resulting temperatures, temperature changes, and weight losses, as functions of time. The combustion model assumes heat transfer by conduction, convection, or radiation into the flammable material. At a given temperature a phase transition occurs; the evolved gases ignite and burn.

The problem is basically one of thermal energy accounting. Computer programs are now capable of performing transient thermal analyses, and can handle large thermal node networks with sufficient flexibility to control the simulated burning process.

Additional capabilities of this technique include determining the heat flux needed to produce ignition at a given location (this can be related to current overloads); evaluating the propagation potential of a given ignition site; determining the effectiveness of proposed fire prevention techniques; calculating the effect of adjacent heat sinks on ignition and propagation; examining multiple ignition sites within each component; and assessing the effects of other parameters, such as system acceleration or variable atmospheric composition.

Source: H. M. Lampert, B. Karhan, G. Heiser, M. I. Green, L. V. Dudley, and R. Schell of General Electric Co. under contract to NASA Headquarters (HQN-10279)

Circle 23 on Reader's Service Card.

CATALYTIC CELL REDUCES HYDROGEN CONCENTRATION

A relatively inexpensive catalytic cell has been developed to reduce the risk of fire or explosion caused by accumulation of hydrogen gas. The cell, in which hydrogen reacts with atmospheric oxygen, is intended for use near sources of hydrogen evolution, such as electroplating cathodes, battery plates, fermentation vats, and certain distillation columns.

The catalyst is ferric oxide containing a formulation of platinum and rhodium impregnated in small cylinders of silicon carbide. Pellets of the catalyst are loosely packed, in random orientation, between screen barriers in a duct. As a mixture of hydrogen and air passes through this bed, the iron oxide platinum, rhodium catalyst stimulates reaction in the combustible gas, increasing the temperature to the autoignition point and harmlessly burning the hazardous mixture. Reliable performance has been achieved at ambient temperatures for oxygen/hydrogen mixtures with ratios ranging from 0.5 to 170:1.

Source: R. W. Roberts of North American Rockwell Corp. under contract to Lewis Research Center (LEW-10551)

Circle 24 on Reader's Service Card.

TOROIDAL RING PREVENTS ELECTROSTATIC DISCHARGE AT VENT STACK

Combustible gases such as hydrogen can be ignited by electrostatic sparks or coronas. Such discharges are likely in the vicinity of a vent stack outlet, because of the static charge built up both in the piping and in the gas itself by the flow process.

To prevent these unwanted discharges, a toroidal ring is welded onto the vent stack outlet. The ring inhibits current flow at the stack lip by reducing the turbulence characteristic of gas flow through a sharply defined orifice. Additional protection is gained by grounding the ring and the piping system leading to the vent stack, and by designing the diameter of the stack large enough to assure low velocity flow.

Source: T. R. Spring of North American Rockwell Corp. under contract to Marshall Space Flight Center (MFS-92042)

Circle 25 or Reader's Service Card.

FIBERGLASS FIRE BARRIER FOR SILICONE RUBBER PARTS

Silicone rubber compounds are used to form a variety of components (spacers, fillers, padding, wiring harness sheaths, etc.) with many commercial applications. They are preferred over other elastomers which are malodorous, and tend to outgas when subjected to low pressures. However, silicones are flammable, and may present an extreme fire hazard, particularly when used in an atmosphere with a high oxygen content.

Knitted fiberglass covers have been found to be a very effective fire barrier for parts made of silicone rubber. The covers are placed about the silicone parts to isolate them completely from any nearby flame. They permit retention of the desirable resilience of the silicone rubber while forming a very effective fire barrier.

Source: K. L. Blackmer of
North American Rockwell Corp.
under contract to
Manned Spacecraft Center
(MSC-15555)

No further documentation is available.

SARAN FILM IS FIRE-RETARDANT IN OXYGEN ATMOSPHERE

Saran, a commercially available polyvinylidene chloride copolymer, which forms heat shrinkable films that do not support combustion in air (2.9 psia oxygen partial pressure), was tested for flammability as a wrapping on electrical wire bundles in oxygen gas at pressures of 7.5 psia and 14.7 psia (1 atmosphere).

Several tests in the oxygen atmospheres were made on specimens of Saran heat shrinkable sleeving on TFE-insulated electric wire. At 14.7 psia oxygen, the Saran on test specimens in a horizontal position extinguished fires started in the TFE coating; the Saran on specimens in a vertical position was consumed. In runs in which TFE-coated wire was overheated by electric current, Saran sleeving reduced the rate at which the TFE insulation was consumed. The Saran wrapping was self-extinguishing in fires in 7.5 psia oxygen except when polyethylene heat shrinkable sleeving was also used.

Source: J. T. Goodwin and W. R. Herrera of
Southwest Research Institute
under contract to
Manned Spacecraft Center
(MSC-11604)

Circle 26 on Reader's Service Card.

BORAX DISPERSION IN PLASTIC MAKES EXCELLENT FIRE-RETARDANT THERMAL INSULATOR

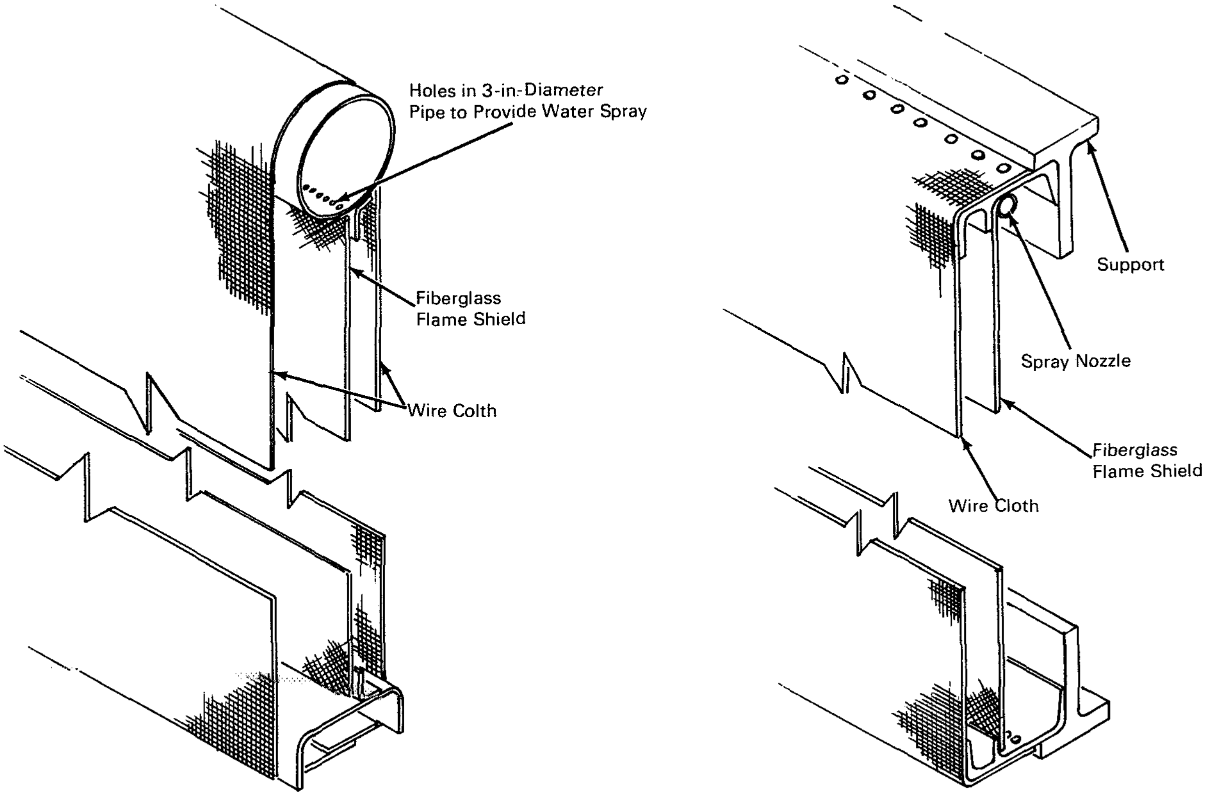
A mixture of borax powder, sodium bicarbonate, and an anhydrous chlorinated organic resin has been shown to possess desirable properties as a fire-retardant thermal insulator. The compound resists decomposition, exhibits low thermal conductivity, releases only small quantities of toxic vapors and a white smoke which will not clog an air filtration system, and is self-extinguishing when exposed to an oxyacetylene flame.

Resins which are suitable for making this compound include polyvinyl chloride, and vinyl chloride copolymers; chlorosulfonated polyethylenes; and chlorinated polyolefins, epoxies, rubbers, and polyesters. When made with the polyester resin, the optimal composition by weight is 60 parts of borax ($Na_2B_4O_7 \cdot 10H_2O$) and 20 parts of sodium bicarbonate ($NaHCO_3$) per 100 parts of resin. Areas of this composition exposed to high heat form a hard, crusty, nonspalling carbonaceous layer containing fireproof $Na_2B_4O_7$ and fused NaCl.

Source: J. Hughes, F. Schmitz, and
H. Evans
Argonne National Laboratory
(ARG-90005)

Circle 27 on Reader's Service Card.

FRAGMENT- AND FLAME-ARRESTING BARRICADE



This safety barricade, like the preceeding item, provides protection from high-velocity fragments. It also reduces the hazard of fire caused by an explosion. Capable of either permanent or temporary installation, the barricade consists of a fiberglass flame shield and either one or two wire-cloth screens.

The fiberglass is kept wet by a water spray: the 4-mesh wire cloth is woven from 7-strand, 20-gage, galvanized mild steel cable. This fabric is loose enough to permit rapid dissipation of shock waves, yet sufficiently dense to resist passage of fragments.

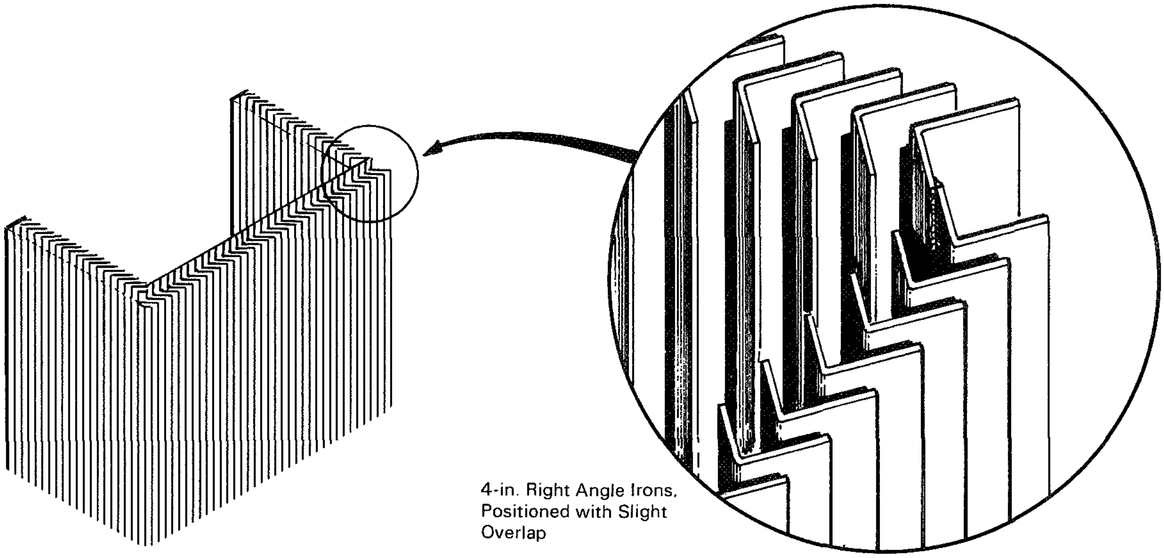
As shown in the illustration, the temporary installation is constructed using lengths of 3-inch diameter piping, which serve both as upper structural members and as plumbing for the water spray. The fiberglass screen is attached to the pipe adjacent to a row of water-spray holes. The steel cloth is draped symmetically over the pipe, and its lower ends are joined under a free-hanging 3-inch channel iron.

The permanent installation requires fastening a single length of wire cloth to a heavy, rigid structural member at top and bottom. The fiberglass screen and water spray apparatus are located on the side away from the potential explosion in order to shield them from damage by fragments.

Source: T. R. Spring and E. S. Hutmacher of
North American Rockwell Corp.
under contract to
Marshall Space Flight Center
(MFS-18070)

Circle 28 on Reader's Service Card.

LOUVERED BLAST SHIELD



A safety barrier constructed from readily available materials provides protection from flying debris generated by an explosion. As shown in the illustration, a set of vertically oriented, 4-inch angle irons are nested in a slightly overlapped, louvered pattern which permits a blast wave to be rapidly dissipated, while greatly reducing the transmission of fragments. The technique offers an alternative to currently used concrete and steel structures that are both costly and cumbersome.

Source: J. H. Barton of
North American Rockwell Corp.
under contract to
Marshall Space Flight Center
(MFS-91120)

Circle 29 on Reader's Service Card.

NASA-Langley, 1971

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
WASHINGTON, D.C. 20546

OFFICIAL BUSINESS
PENALTY FOR PRIVATE USE $300

FIRST CLASS MAIL

POSTAGE AND FEES PAID
NATIONAL AERONAUTICS AND
SPACE ADMINISTRATION

POSTMASTER: If Undeliverable (Section 158 Postal Manual) Do Not Return

---

"The aeronautical and space activities of the United States shall be conducted so as to contribute . . . to the expansion of human knowledge of phenomena in the atmosphere and space. The Administration shall provide for the widest practicable and appropriate dissemination of information concerning its activities and the results thereof."

— NATIONAL AERONAUTICS AND SPACE ACT OF 1958

NASA TECHNOLOGY UTILIZATION PUBLICATIONS

These describe science or technology derived from NASA's activities that may be of particular interest in commercial and other non-aerospace applications. Publications include:

TECH BRIEFS: Single-page descriptions of individual innovations, devices, methods, or concepts.

TECHNOLOGY SURVEYS: Selected surveys of NASA contributions to entire areas of technology.

OTHER TU PUBLICATIONS: These include handbooks, reports, conference proceedings, special studies, and selected bibliographies.

Details on the availability of these publications may be obtained from:

National Aeronautics and
Space Administration
Code KT
Washington, D.C. 20546

Technology Utilization publications are part of NASA's formal series of scientific and technical publications. Others include Technical Reports, Technical Notes, Technical Memorandums, Contractor Reports, Technical Translations, and Special Publications.

Details on their availability may be obtained from:

National Aeronautics and
Space Administration
Code KS
Washington, D.C. 20546

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
Washington, D.C. 20546