the COUPLING that went into SPACE

Most hardware can be improved in any of several ways and for any of several reasons and such improvements can be either of function or design. The Mechanical Design Project of the Typhon Weapon Control Division at the Applied Physics Laboratory, which was responsible for designing, fabricating, and testing mechanical hardware for the Typhon Weapon Control System, has attested to this fact in the form of a unique hose coupling, designed and fabricated by two of its members, A. B. Carver and K. C. Hickernell.*

Installation of the Typhon Weapon Control System aboard the USS *Norton Sound*, berthed at a Baltimore drydock, was being performed by the Westinghouse Electric Corporation, with several members of the APL Mechanical Design Project assigned to assist with the hardware aspects. During the installation process, certain units of the water-cooling system failed to meet required specifications. In their efforts to improve the effectiveness of the cooling system, Messrs. Carver and Hickernell found that hose fittings and hose connectors were the most vulnerable and least reliable parts of the cooling setup. Further investigation revealed that the flow of water through the system was being restricted by the existing couplings, because the bore diameter of these couplings was smaller than the inside diameter of the hoses they connected. It soon became apparent that improved fittings and connectors would correct this deficiency. With no satisfactory models commercially available, project personnel were assigned to pursue an effective design.

After a period of concerted effort, Carver and Hickernell designed a coupling that permitted unrestricted flow, while at the same time, promised high reliability. This was accomplished by a unique arrangement whereby the coupling and the hose sections it connected had openings of the same diameter, thus eliminating any flow restriction or cause of pressure drop.

The coupling constituting this design (Fig. 1) is illustrated as a connector for two separate sections of a hose for handling gas or liquid. More specifically, the coupling consists of a multipart insert and a cooperative multipart sleeve.

Referring to Fig. 2, it can be seen that the insert is composed of a nose element, having a spherical forward end and a removable extending ferrule, projecting in an opposite direction from the lead end. The sleeve is composed of a tubular sleeve body, a threaded tubular insert with a conical chamfer on the insert end, and an extending ferrule secured to the insert and projecting from the insert's opposite end.

To secure the component elements of the coupling to the free ends of two separate sections of hose, the following procedure was used.

A cylindrical metallic "bullet" secured to the end of a threaded rod or mandrel was inserted into the free end of one section of hose, the bullet having a sliding fit with the internal diameter of the hose and an interference fit with the reduced

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Fig. 1—Exterior view of coupling shown connecting two separate sections of flexible hose.

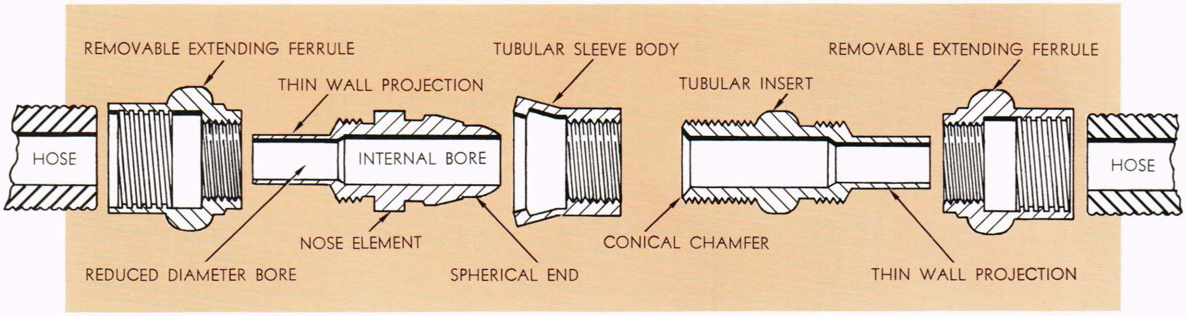

Fig. 2—Longitudinal section of the coupling components in an exploded condition.

diameter bore within the extended thin wall projection of the nose element. Next, the nose element, with screwed on ferrule and attached sleeve element, was telescoped over the opposite end of the threaded rod to place the thin wall section of the nose element in an insert position within the free end of the hose and simultaneously positioning the tubular section of the ferrule concentrically about the free end of the conduit external to the thin wall section of the nose element. An enlarged bushing, of plastic or the like, was then slipped over the extended end of the threaded rod and brought against the free end of the sleeve element. Then a crank nut was threaded onto the rod and screwed into engagement with the bushing. The crank nut was forcibly rotated against the bushing, causing withdrawal of the bullet from within the hose and assembled component elements. As the bullet element was withdrawn from within the hose it acted on the thin wall section of the nose element, which was of reduced diameter, deforming and expanding this same thin wall outwardly into tight engagement with the internal wall of the hose and compressing the hose wall between the thin wall section and the concentrically positioned ferrule sleeve of the nose element. This action caused the conduit wall to engage on and be firmly gripped by the buttress threads or annular grooves within the ferrule, binding the hose in a tight, secure fitting between the ferrule and the nose element wall section.

For securing the sleeve insert element to the free end of the second hose, the same procedure as described above was used.

To complete assembly of the coupling, the threaded end of the tubular insert was engaged within the threaded end of the sleeve component of the nose element to bring the conical chamfered seat of the insert member into tight positive sealing engagement with the spherical portion of the nose element. With the threads of the tubular sleeve body tightened against the threads of the tubular insert, the resultant force causes local yielding of the material at the line of contact between the spherical nose and its conical seat. This principle is important in obtaining a positive seal.

With the design problem resolved, it was then necessary to find a hose that would be compatible with the coupling in endurance and reliability. The R. E. Darling Company of Bethesda, Maryland, supplied a special silicone rubber tubing (trademarked Silastic), reinforced with nylon and stainless steel, which after thorough testing proved to be very dependable.

Because this coupling design permitted the use of a smaller hose, with resultant weight saving, and because this design provided a reliable fit between coupling and hose, it became attractive to the space industry. This recognition came with its adoption and successful use in NASA's Gemini-Titan program. The coupling made its debut in the Gemini-4 flight as an integral part of the umbilical cord that tethered Astronaut Edward H. White to his spacecraft during his historic walk in outer space. The oxygen line, a nylon tether, and electrical conductors were wrapped in goldplated nylon to form a single cable. Oxygen at 100 psi was supplied to the line, which fastened to the inlet port on Astronaut White's suit. His chest pack contained a suit pressure controller and an emergency supply of oxygen, which would have been supplied, if needed, through another length of reinforced silicone rubber hose fitted with the same coupling design as the main oxygen supply line.

Today, this same coupling is part of Colonel White's space suit as displayed at the Smithsonian Institution in Washington, D.C.

With the effectiveness of its design already proved, it is contemplated that the concepts of the coupling described in the preceding paragraphs will find many other uses.