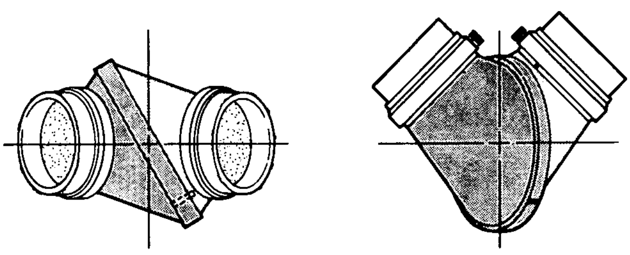
NASA TECH BRIEF

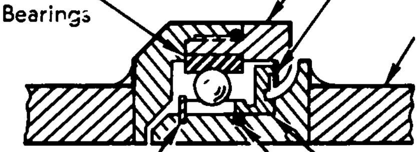
Ames Research Center

Space Suit May Have Orthotic Applications

The joints designed for use in a space suit must remain hermetically sealed and be neutrally stable. The principle of a rotating pseudoconic (stovepipe) joint and the fabrication techniques employed to construct the space suit could provide the basis for a variety of new orthotic and prosthetic devices.



Seal and bearing friction must be minimal in order for the stovepipe joint (figure above) to be acceptable and efficient. The deflection torques are directly proportional to friction and the angle at which the diagonal bearing is oriented with the longitudinal axis of the joint. Additionally, the angle of the diagonal bearing with respect to the longitudinal axis determines the range of motion of the joint. For example, a diagonal bearing oriented at 40° with the axis joint allows for ±100° or a total of 200° of motion. However, should the diagonal bearing be allowed to rotate into a position where it is at 90° with the plane of motion, the joint will become locked because frictional forces are at 90° to the bending forces. To prevent this locking, stops are placed on the bearing, essentially blanking out ±10° of relative joint segment rotation about the lock point. The problem of providing a minimum of 150° flexion in the knee and thigh joints, to permit normal leg mobility, was solved by incorporating a metal bellows in the lower segment of the joints to allow for 90° of motion (or an additional 60°). A cross-section of the seal and bearing configuration developed to meet the above requirements is shown in the figure below. Rotary torque of the seal and bearing was 45.4 mm-kg (4 in-lb).



The nonmovable portions of the suit are made of a segmented structure comprised primarily of a triangular-matrix honeycomb glass fiber. To form the segments, a triangular matrix defined by polyurethane mandrels was covered with a continuous-weave fiber cloth and placed over a mold. The cloth was saturated with an epoxy resin, and then the mold and matrix were placed in a vacuum bag attached to a pump to provide uniform pressure over the glass cloth during curing. After curing, the mandrels were withdrawn and the ends of the triangular cavities were filled to provide a uniform bonding surface. Aluminum bearing-and-seal housings and metal bellows were bonded to the nonmovable portions of the suit with an epoxy resin.

(continued overleaf)

Reference:

Vykukal, H.C.: Advanced Developments in Hard Space Suit Technology. Journal of Engineering for Industry, November 1968, page 577.

Notes:

1. Athetoid movements of neurologically handicapped patients could be minimized by placing the exoskeletal joint system on the patient and, with a damping system incorporated in the bearing housings, the large-amplitude motions of the wearer could be reduced or totally controlled, thus allowing the patient to become more self sufficient.
2. No additional documentation is available. Specific questions, however, may be directed to:

   Technology Utilization Officer
   Ames Research Center
   Moffett Field, California 94035
   Reference: B72-10297

Patent status:

This invention has been patented by NASA (U.S. Patent No. 3,636,564). Inquiries concerning nonexclusive or exclusive license for its commercial development should be addressed to:

NASA Patent Counsel
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