NASA TECH BRIEF
Lewis Research Center

Improved High-Temperature Gimbal Joint

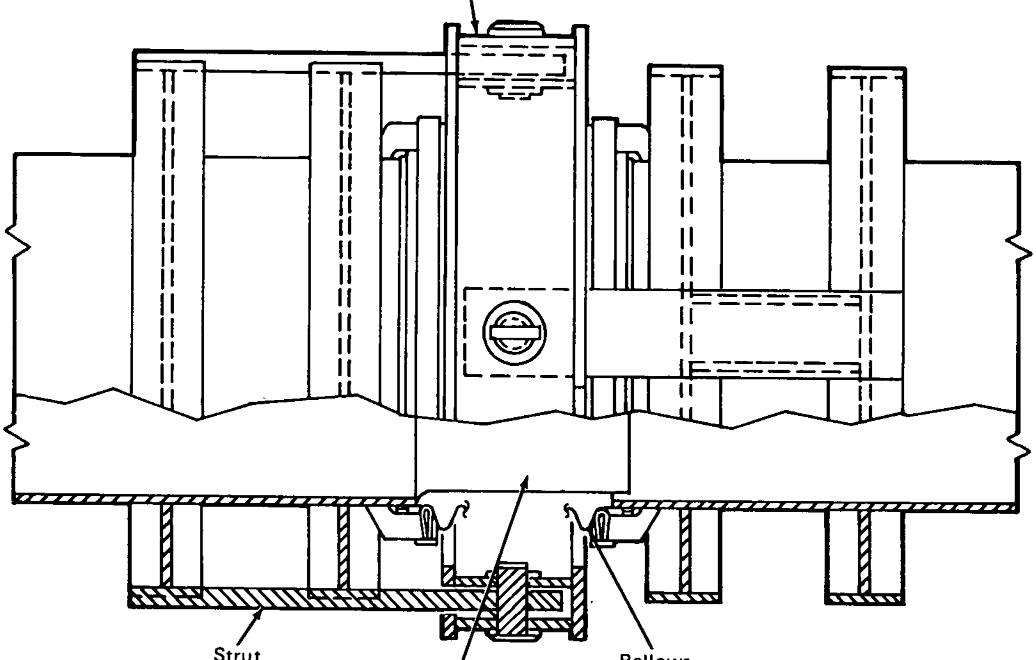

Figure 1. Conventional Design

A bellows gimbal joint for high-temperature use has been designed which reduces thermal stress problems encountered with joints of conventional design.

Conventional joint design is shown in Figure 1. Thrust rings welded to the pipe upstream and downstream of the bellows are connected to a central floating gimbal ring by struts alternately located 90 degrees apart. The upstream and downstream struts are connected to this floating ring with pins to form a double clevis gimbal joint. This arrangement permits thermal expansion of the piping system by angulation. In use, this joint must be brought up to operating temperature slowly and cooled down slowly, with supplemental heating of the thrust rings, to limit thermal stresses and prevent structural failure.

Joints of this type were required for use in large diameter lines conveying gases that undergo rapid and extreme temperature changes. The stress problems inherently caused by such conditions were minimized by an improved joint design.

The improved joint design is shown in Figure 2. The improvement consists essentially of attaching the thrust rings to the pipe with conical sections. This eliminates severe radial thermal gradients and mechanical restraints. The joint assembly is transformed to that of a varying diameter pipe subjected to a non-linear longitudinal

(continued overleaf)

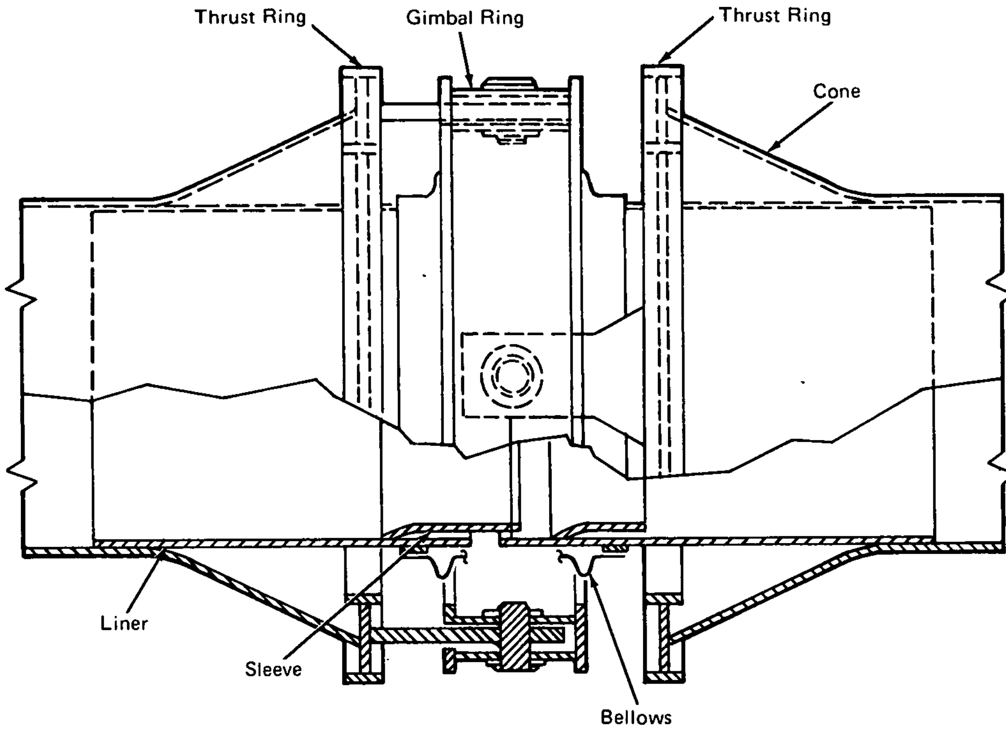

Figure 2. New Design

temperature variation. A minor structural discontinuity occurs at the high-temperature, high thermal gradient region where the cone is attached to the pipe, but the major structural discontinuity is displaced to a region of lower temperature and thermal gradient where the cone is attached to the thrust ring. Providing a smooth transition at the small end of the cone and joining the liner to the pipe remote from the cone-pipe juncture further reduces discontinuity effects. As a result, warmup times were greatly reduced and no supplemental heating was required. These joints have been operated at pressures from 1.04×10^5 to 11.4×10^5 N/m^2 (15 to 165 psia) and at temperatures from ambient to 650°C (1200°F) without failures.

Notes:

1. Joints of this improved design have been fabricated for NASA by a commercial joint manufacturer who is incorporating them into his product line.
2. The design principles used in the gimbal joints have also been applied to single hinged and universal joints ranging in diameter from 0.46 to 2.13 m (18 to 84 inches). Design pressures ranged from 0 to 12.4×10^5 N/m^2 (0 to 180 psia) at temperatures of –45 to 650°C (–50 to 1200°F).
3. No further documentation is available. Specific questions, however, may be directed to:
   Technology Utilization Officer
   Lewis Research Center
   21000 Brookpark Road
   Cleveland, Ohio 44135
   Reference: B72-10489

Patent status:

No patent action is contemplated by NASA.

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