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Research and technical note

Rotating feed-through for cryogenic fluid

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For many years we have been facing the problem of transferring cryogenic fluid to a rotating instrument. This article reports a first prototype of rotating feed-through built and successfully tested. This unit allows us to supply liquid nitrogen and liquid helium to an instrument animated by permanent rotation. © 1998 Elsevier Science Limited. All rights reserved

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Technical requirements

This application is dedicated to a very accurate optical measuring instrument. Therefore we had very tight specification on the operating torque which should in any case be kept as low as possible. In order both to avoid a cold surface which would spoil the measurements and to keep the consumption of coolant as low as possible, it was also necessary to reduce the thermal losses as far as possible. Moreover, this unit, which will be used in a remote site, was specified to operate failure free for at least ten million revolutions.

Design approach

A sketch of the feed through is shown in Figure 1. The feed-through is based on a thermally insulated connection usually known under the name of 'Johnston fitting'. A small spring-loaded valve seals the cold end of the transfer line. The warm side (external tube of the vacuum insulated line) is sealed using a custom-made ferrofluidic joint.

Figure 2 shows more detail about the cold sealing. The use of a well-designed shape and of the appropriate provides good sealing, low torque and reliable operation of the rotating function. The cold joint is ensured by a spherical surface, which turns in a conical seat. The conical seat is made from hard stainless steel, fine ground and coated with a molybdenum disulphide and lead compound. The spherical part is machined in Vespel SP3.

A small basket filled with live charcoal is attached on the coldest point of the transfer line to keep an insulating vacuum over a reasonable period.

Performance measured on the prototype

The overall thermal loss measured on the feed-through during testing never exceeds 1 W, which typically corresponds to the thermal load of the junction itself.

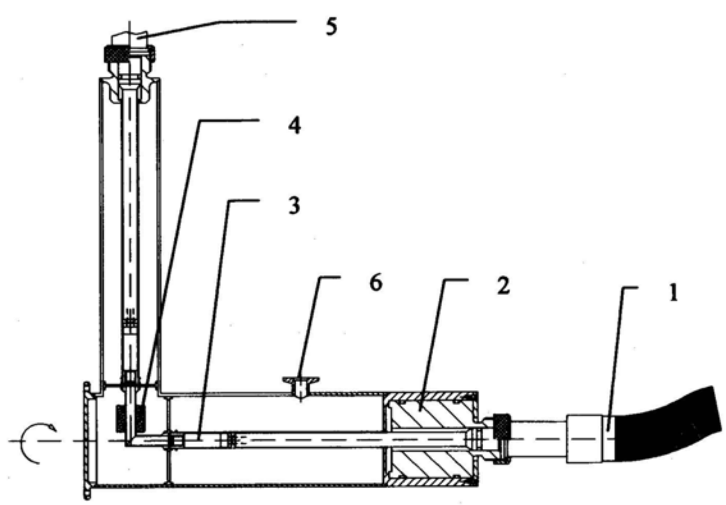

Figure 1 General view of the feed-through
1: Transfer line from the supply tank. 2: Warm seal (Ferrofluidic joint). 3: Cold sealing. 4: Charcoal basket. 5: Transfer line to the rotating instrument. 6: Vacuum port

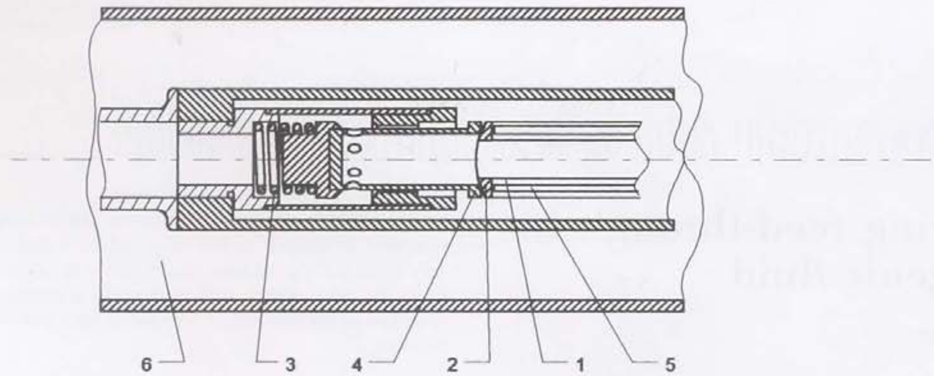

Figure 2 Detail of the cold sealing
1: Transfer line from the supply tank. 2: Spherical end. 3: Spring. 4: Conical seat. 5: static part (vacuum insulation). 6: Rotating part (vacuum insulation)

The unit has been tested over many thousand revolutions; the operating torque measured at various stages of the testing never showed any tendency to increase and always stayed below 0.2 Nm.

Compared with other possible designs using wrapped flexible tubes, this design has the advantage of a non-limited rotation range.

Conclusion

This prototype has proved the feasibility of a low cost, reliable and continuously rotating feed-through. This is a very important element for an application requiring permanent cooling in a rotating experiment.