CELTIC PIVOTS

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ABSTRACT

The Celtic pivot is a project initiated and financed by the **CNES**.

This new product is an improvement of the existing flexural pivots, today mainly the "Lucas Aerospace" type, whose defects are the following:

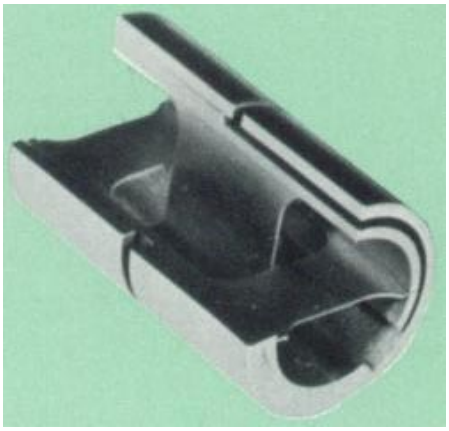
- Industrial manufacturing, without fine control, leading to a lack of homogeneity.
- Manufacturer's data (stiffness, behavior under vibration, fatigue) partial and not reliable.

These defects prevent any space application where an excellent reliability is needed.

The celtic pivots have been designed to guarantee an excellent reliability, and improve the "Lucas Aerospace" pivots performances, and are thus especially dedicated to space applications.

PRODUCT DESCRIPTION

The Celtic pivot is a flexural pivot. It consists in flat, crossed blades, supporting rotating sleeves, as shown on the figure hereunder:



(Picture from the Lucas Aerospace catalog)

Like the "Lucas Aerospace" type, this pivot is frictionless, stiction-free, with no internal clearance, and only suited for limited angular travel applications, of up to 60° rotation.

It is the only solution for application permitting no lubrication, demanding precise positioning and requiring infinite cycle life.

The Celtic pivot is compact, and can be easily mounted. It has predicable and repeatable performances.

PERFORMANCE CHARACTERISTICS

The main characteristics of the flexural pivots are:

- High radial stiffness
- High axial stiffness
- Friction less
- Stiction free
- No internal clearance
- Low center shift
- No lubrication
- Predicable performance
- Exceptional repeatability

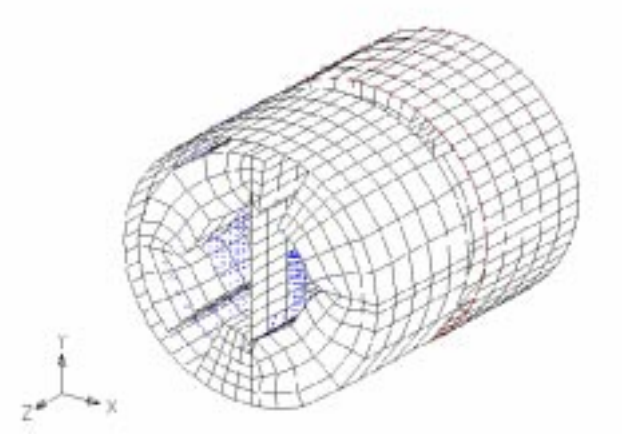
The Celtic pivot adds some more qualities:
The blades are simply clamped, instead of being welded or brazed like for the "Lucas" type:
This allows the use of more performing materials, with better Elastic limit / Young modulus ratio, and thus, lower angular stiffness and increased angular travel possibility.
Moreover, since the blade material characteristics are not deteriorated by the welding, the reliability and the performance predications are highly improved.

PERFORMANCE VERIFICATION

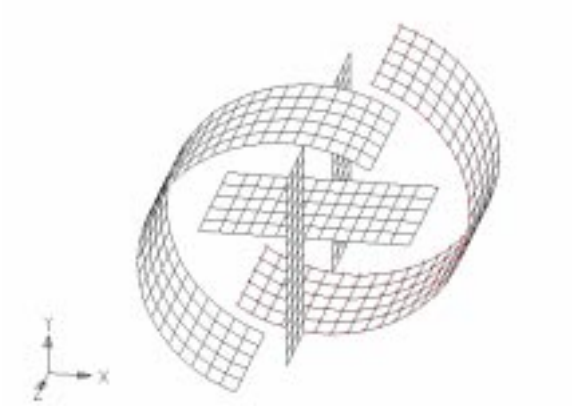
Moreover, FE Models can be used in order to predict new celtic pivots performances.

FE Models of existing pivots have been correlated to tests results (axial, radial and angular stiffness, maximum allowable forces, ...) and allow to know precisely the safety margins.

The figure hereafter shows the FEM



The figure hereafter shows only the blades, modelized with SHELL elements.



These FEM are fully parametric, allowing any combination of dimension and material.
The output is :

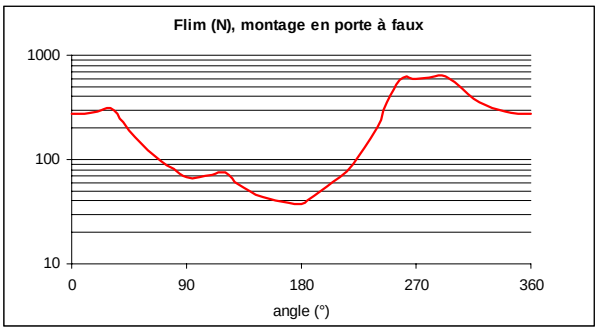
- angular travel, with safety margin
- radial and axial loads, with safety margin
- radial and axial stiffnesses
- center shift

For standard pivots, behavior laws are known and used through spread sheets

The table hereafter gives some results for celtics pivots in miscellaneous dimensions (A pivot with Diameter=20 mm, and blade thickness = 0.2mm is called D20e0.2)

Pivot	Max Faxial (in N)	Max Angle (degrees)	Center shift at max angle	Kteta (Nm/rad)
D10e0.1	823	30	0.2	0.035
D10e0.2	1490	18	0.07	0.28
D20e0.2	2040	30	0.4	0.21
D20e0.4	3780	18	0.15	1.7

The figure hereafter shows the admissible radial force evolution for a pivot D10e0.1.



CONCLUSION

4 kind of celtic pivots already exist and have been tested:

- Φ10mm, blades thickness: 0.1mm
- Φ10mm, blades thickness: 0.2mm
- Φ20mm, blades thickness: 0.2mm
- Φ20mm, blades thickness: 0.4mm

But the Celtic pivot allows many combinations of sleeves and blades:
Sleeves: Any external shapes and sizes (over 10mm diameter)
Blades: any thickness between 0.1mm to 0.5mm, and 2 possible materials (UBe2 or Inox)

Moreover, special pivots can be made on demand, with specified material, performance and interfaces.