

Tribology Systems Incorporated

*** TSI ***

Patented **F**lywheel **E**nergy **S**torage **S**ystem - **FESS**

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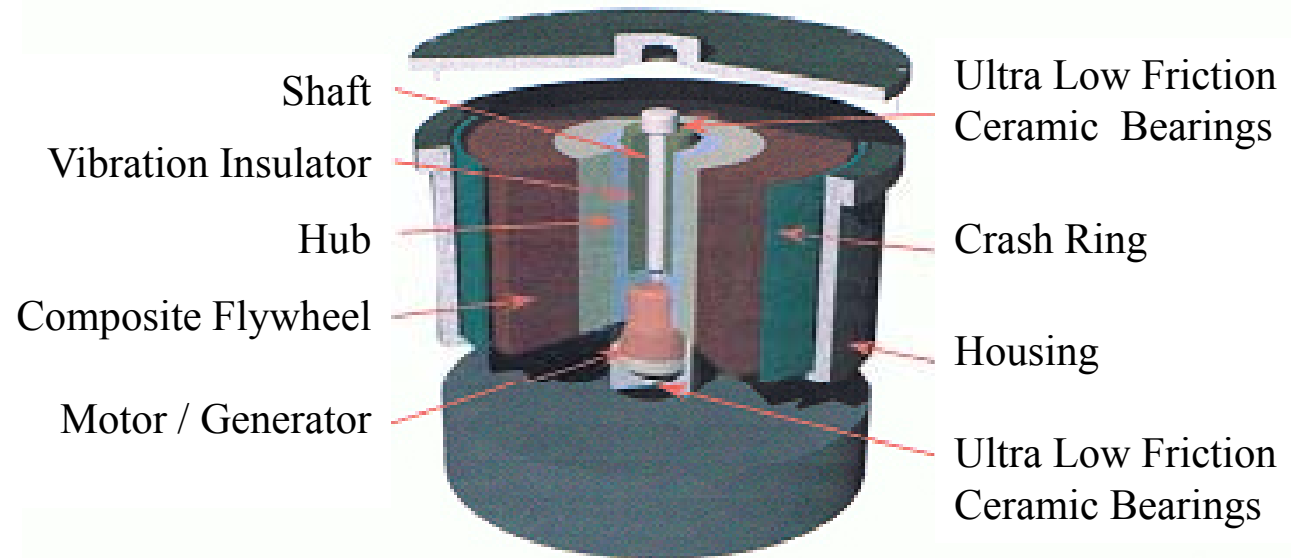
www.tribologysystems.com

TSI **FESS** benefits:

(does everything a chemical battery cannot and more)

- Over 10 Year Life Span
- **SCALABLE**
- 100% Environmentally Friendly
- Maintenance Free for +10 years
- Takes FULL advantage of regenerative systems
- ***completely eliminates***
Lead-acid, **Li Ion & NiCad Batteries**
- lighter weight than chemical batteries
- not effected by temperatures
- energy can be burst or trickled out
- energy can be burst or trickle charged back in
- can never be over charged

TSI FESS Diagram & Explanation



Both a composite flywheel and a motor/generator are mounted on the same shaft supported by TSI patented ceramic ball bearings inside a vacuum enclosure. Power supplied to the motor speeds up the shaft, storing energy as the kinetic energy of the flywheel, so that when power is required to a load, the motor acts as a generator, slowing down the shaft, thus regenerating the energy back to the load. The amount of energy stored is determined by the size, weight and maximum allowable speed of the flywheel within its centrifugal strength limits (the exact amount is a function of the square of flywheel speed) and the amount of power is determined by the rated power of the motor/generator. TSI patented bearings run continuously in a vacuum maintenance-free for ten to twenty years, proven by tests, and the rotor runs up to its critical speed smoothly, using our patented mechanical vibration isolator, also shown in tests to provide no more than a few tenths of a G vibration, running slowly over the entire design speed range.

TSI Bearings make the difference! Flywheel Comparisons

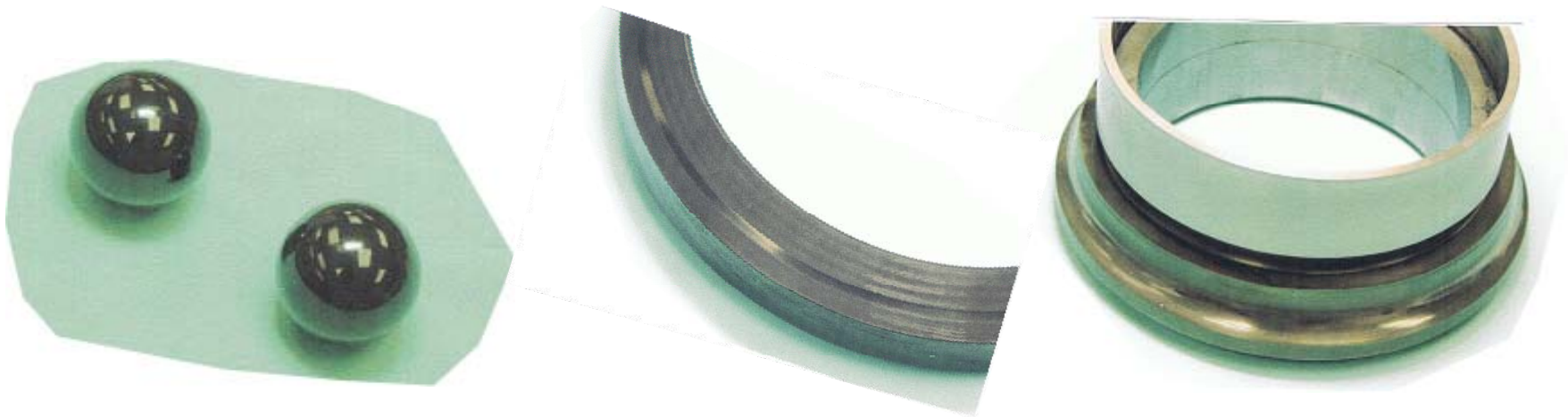
TSI **FESS** vs. others magnetic bearings

TSI: TSI's patented ceramic bearings and RINGLUBE® Technology allow the TSI FESS flywheel to coast unpowered for over 4 months *patented lubrication system yields a bearing coefficient of friction of 0.00008 which corresponds to a bearing friction **energy loss of less than 0.03% per hour**. Other tests have yielded a bearing coefficient of friction of 0.000017.*

Other flywheel manufacturers **MUST** rely on inferior high-loss & power consuming magnetic levitation bearings that rob the flywheel of efficient discharge of stored energy; thus rendering it *significantly* less efficient than TSI's FESS

TSI Bearings patented RINGLUBE® Technology allows the bearings to last over 10 years maintenance free!

After thousands of hours under load the RINGLUBE® bearings show no degradation



Benefits

- unlike chemical batteries, the TSI FESS can be completely (100%) discharged of its entire kWh energy without **any** degradation (over 100,000 times) to the energy storing capacity. The TSI-FESS can be sized to the exact design energy requirements; oversizing is NOT required with the TSI_FESS.
- The TSI FESS can be burst charged – example a 1kWh TSI FESS can be 100% recharged in under 10 minutes with a 220V 50 amp line and in 45 minutes with a 110V 30amp line
- TSI FESS' control module shows EXACTLY how many ah are left in the FESS
- The TSI FESS can be burst charged / complete drained of energy over 100,000 times before any reduction in holding capacity
- 10 ~ 20 year life span & 100 % maintenance free – all magnetic flywheel systems require maintenance every 2 – 3 depending on usage, the ***TSI FESS requires NO MAINTENANCE whatsoever for over 10 years.***
- ***The TSI FESS will out last most equipment it is installed in.....*** this is what makes the ***TSI FESS truly green, it's transferable and nearly renewable.*** There are no batteries on the market today (chemical, lithium ion, A123 or other) that can maintain the same capacity after 100,000 cycles of 100% drain / recharge over +10 years.

Pictures

TSI FESS



Latest Innovative Controller



TSI Patented Bearings



TSI FESS with safety cap removed



Carbon Nanotubes hold the future for Flywheel Energy Storage. The table to the left illustrates the densities of many different materials.

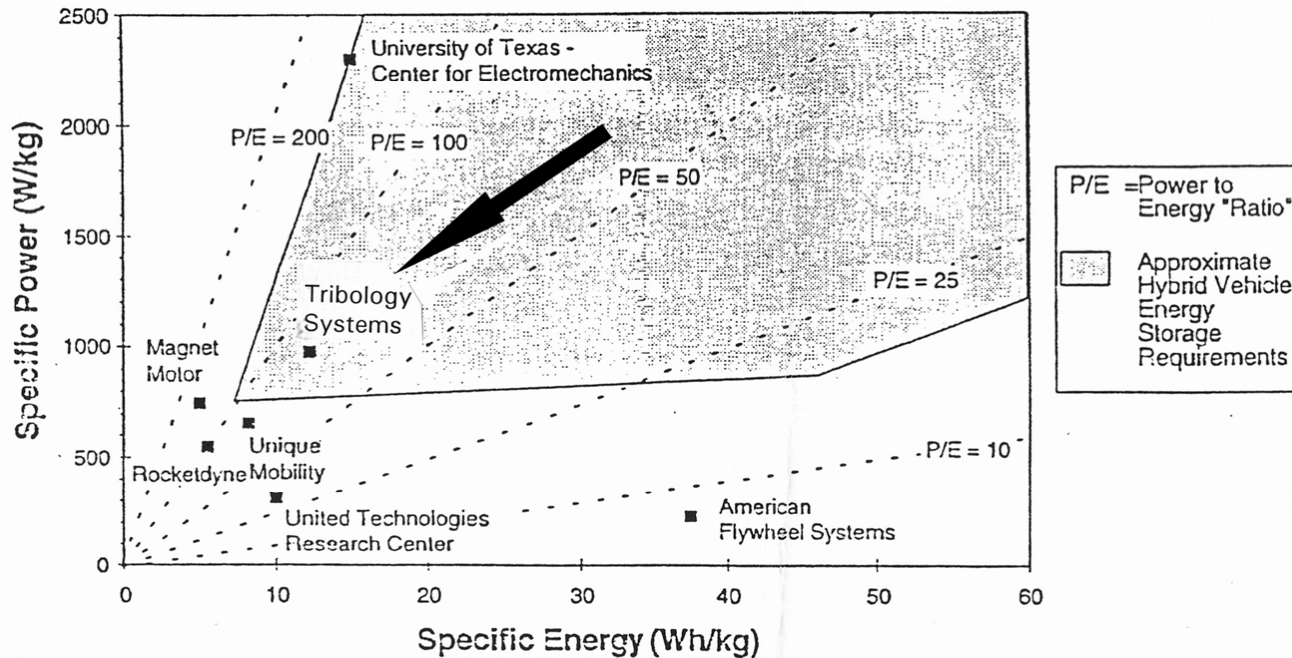
Carbon Nanotubes will allow nearly 10x the energy to be stored over continuous strand carbon fiber windings presently used.

	Composite Strength* (Gpa)	Composite Density (kg/m ³)	Theoretical Max Specific Energy (Wh/kg)	Relative Max Specific Energy (Steel=1.0)
Graphite fiber (1995)	4.8	1609	414	11.2
Graphite fiber (1989)	3.4	1609	293	7.9
S-glass (fiber)	2.1	2190	133	3.6
E-glass (fiber)	1.8	2205	113	3.1
Maraging steel	2.1	7860	37	1.0

Characteristics of Flywheel Rotor Materials

* Ultimate strength for fibers, yield strength for steel

Specific Power vs. Specific Energy of Selected Flywheel Systems



Graph to the left is based on a steel forged housing and NOT the use of Kevlar® or other light weight composite housing