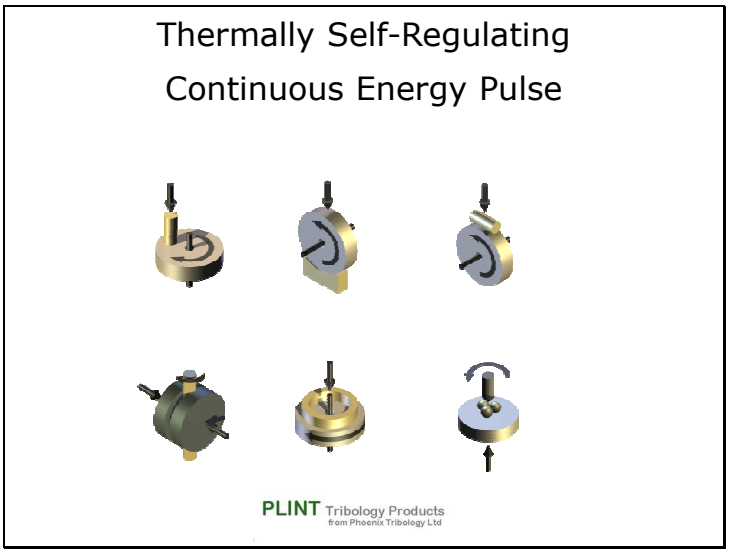
Guidance – Thermally Self-regulating Continuous Energy Pulse Machines

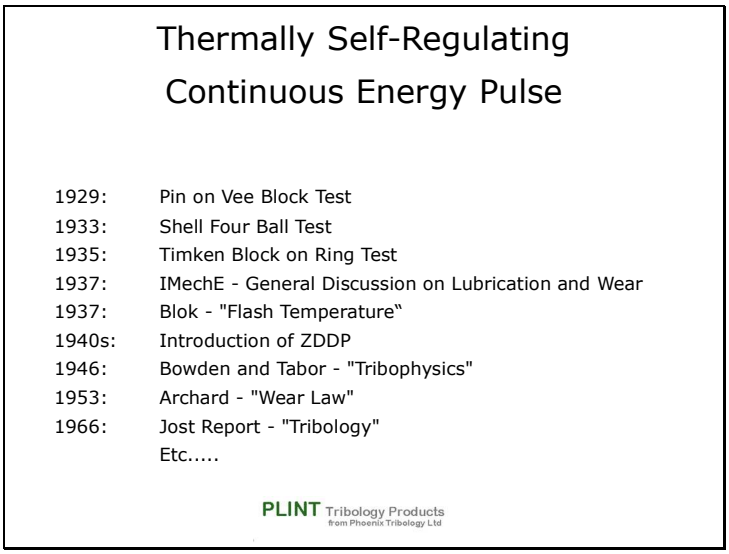
Extract from:

https://www.phoenix-tribology.com/wp-content/uploads/products/guidance/Tutorial-Tribology-Testing.pdf



Thermally self-regulating continuous energy pulse machines are those in which the point of contact is stationary with respect to one of the specimens and subject to constant speed uni-directional sliding. The test configuration defines the thermal conditions in the contact and the contact temperature is self-regulating and cannot be controlled as an independent variable.

There are few real life applications in which this type of motion occurs, especially with sliding hertzian contacts, and these machines thus do not normally provide adequate models of most real systems. Instead of brief rubbing episodes frequently repeated, the machines subject one specimen to continuous rubbing and the associated temperature field dominates. These machines are widely used because they are simple. Examples include pin on disc, block on ring, crossed cylinder and sliding 4-ball test machines. Not surprisingly, data generated by such machines rarely correlates with field data. However, the majority of existing standards in sliding wear use these uni-directional sliding machines.



To understand their historical context, consider the following:

1929: Pin on Vee Block Test

1933: Shell Four Ball Test

1935: Timken Block on Ring Test

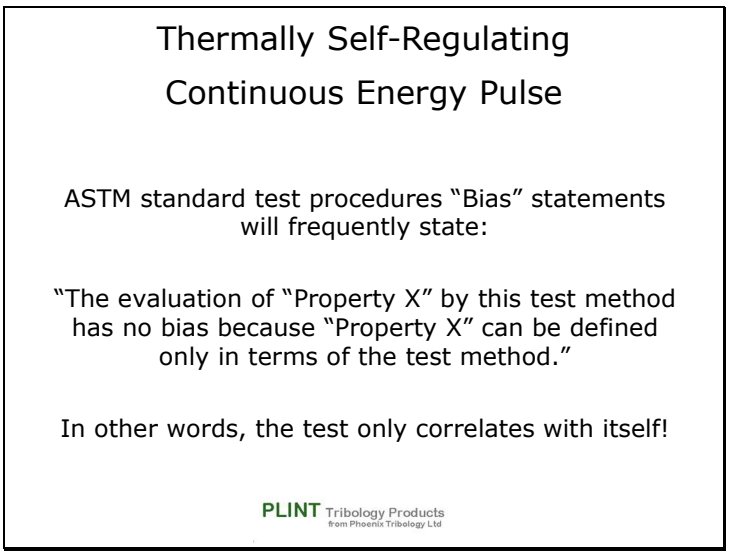
1937: IMechE - General Discussion on Lubrication and Wear

1937: Blok - "Flash Temperature"

1946: Bowden and Tabor - "Tribophysics"

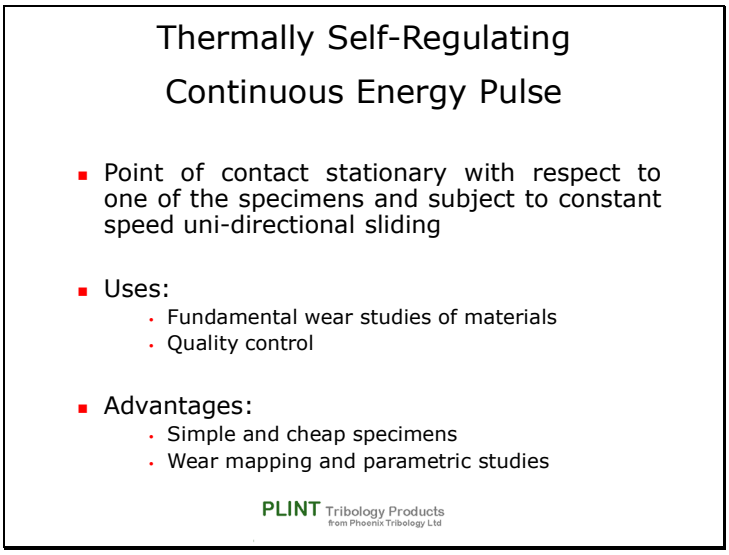
1953: Archard - "Wear Law"

1966: Jost Report - "Tribology"

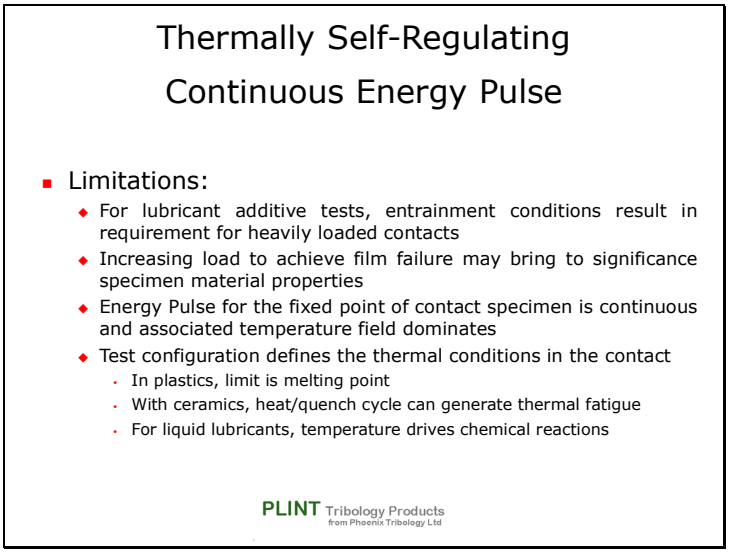


If you were to choose to follow ASTM standard test procedures you should note that the "Bias" statements will frequently state the following:

> "The evaluation of "Property X" by this test method has no bias because "Property X" can be defined only in terms of the test method."



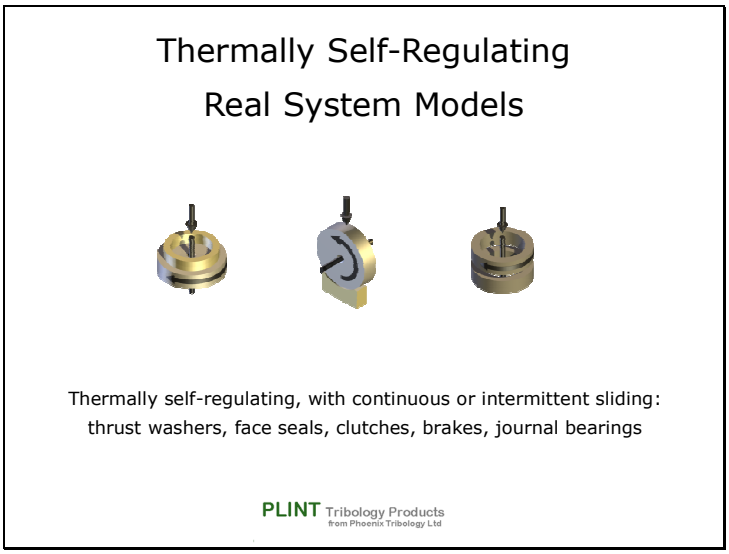
Historically, these machines have been used for fundamental wear studies of materials and coatings in dry conditions. Because they can usually be run over a wide range of loads and speeds, wear mapping and parametric studies may readily be performed.



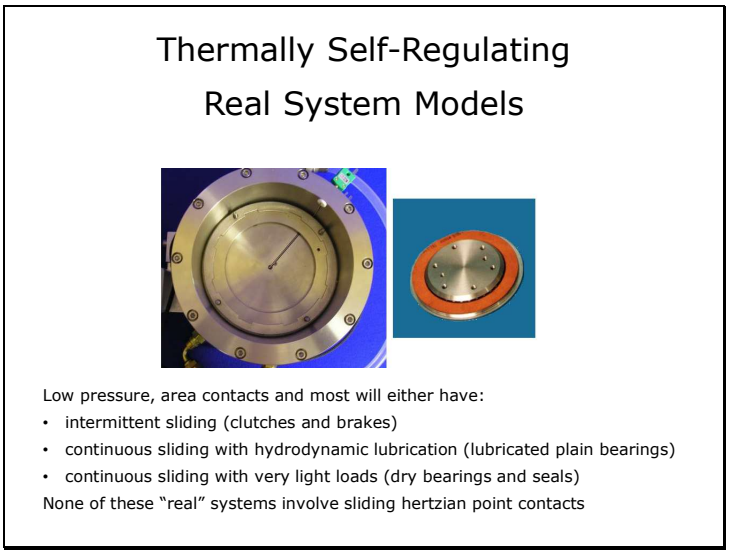
They are less successful for liquid lubricated tests where the entrainment conditions associated with constant speed sliding usually results in a requirement for heavy loads to overcome hydrodynamic lubrication and to promote mixed or boundary lubrication or film failure.

Increasing the load to achieve film failure usually results in thermally induced scuffing failure; that is fine if scuffing is your interest, but not good if you are interested in wear.

Further to this, for fully formulated lubricants, temperature drives the chemical reactions of additives with specimen surfaces, changing the friction and wear conditions in the contact. In these machines we have no control of, or satisfactory means of measuring, the contact temperature.



There are, of course, real systems that are thermally self-regulating, with continuous or intermittent sliding, including thrust washers, face seals, clutches, brakes and journal bearings.



These are all low pressure, area contacts and most will have either have:

- intermittent sliding (clutches and brakes)
- continuous sliding with hydrodynamic lubrication (lubricated plain bearings)
- continuous sliding with very light loads (dry bearings and seals)

None of these “real” systems involve sliding hertzian point contacts.