Every time we suppress an arc we subject the contact to the benefits of the fritting process.

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THE EPCAS CYCLE

Contact Activity With Electronic Power Contact Arc Suppression

By Reinhold Henke and Robert P. Thorbus

The Electromechanical Life of Power Relays and Contactors

*A "**contact**" is a pair of electrodes (typically, one moving; one stationary) designed to control electricity. Power relays and contactors "turn power on" when the moving electrode (**M-electrode**) makes contact with the stationary electrode to carry current. Conversely, they "turn power off" when the **M-electrode** breaks contact and the resulting arc plasma stops burning as the dielectric gap widens sufficiently to prevent current flow (fig. I). Power relays and contactors have two primary life expectancy ratings: "**mechanical life**" is based on operating either without current or below the wetting current (i.e., "**Dry**") and "**electrical life**" is based on operating above the wetting current (i.e., "**Wet**"). These different ratings are due to contacts being designed to compensate for the destructive arcing that naturally occurs between the electrodes during normal **Wet** operation. Contact arcing is so destructive that the **electrical life** of power relays and contactors is a fraction of their **mechanical life**.*

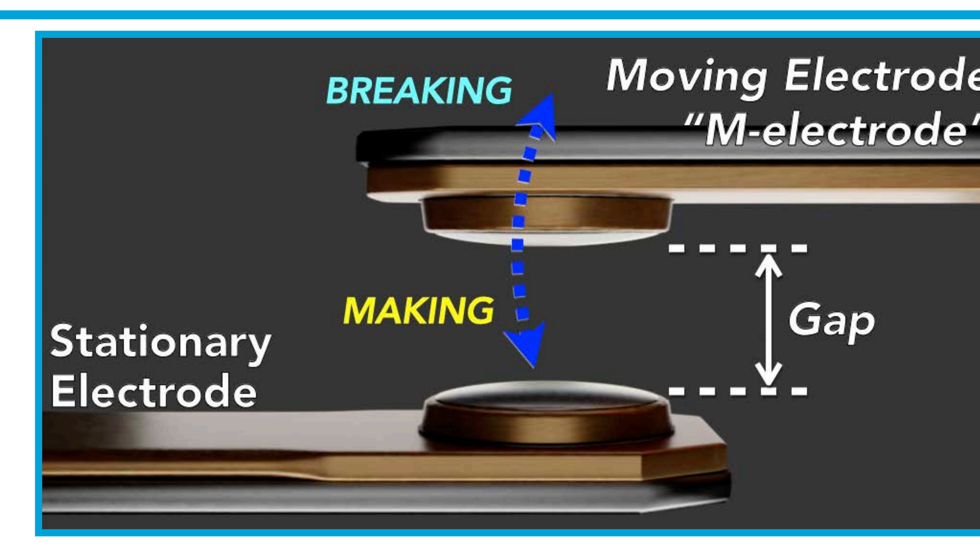

Figure I: Elements of a typical contact

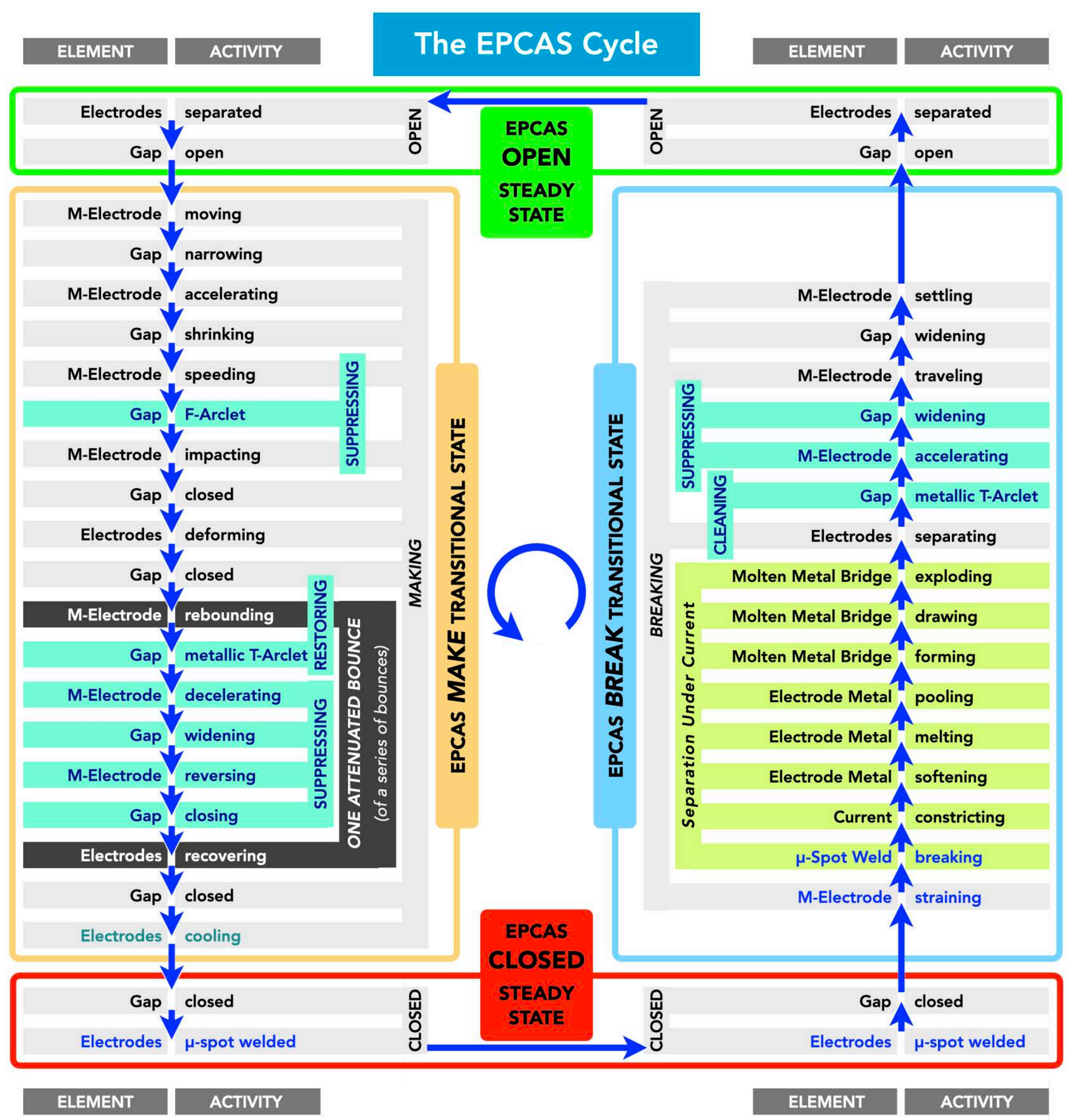

*Figure III: Abbreviated events that occur during "EPCAS" Cycle transitional states of MAKE and BREAK (**NOTE**: the "BOUNCE" activities represent a single bounce of many that may occur)*

The EPCAS Power Contact Cycle

The Electronic Power Contact Arc Suppression Cycle (**EPCAS Cycle**) operates above the arc-supporting current and includes **EPCAS** across the contact (fig. II). **EPCAS** suppresses the contact arcing that typically occurs during **Wet** operation, so that the contact is only subjected to a "fritting" arclet.

The **EPCAS** cycle is comprised of four (4) distinct states: OPEN, MAKE, CLOSED and BREAK (fig III). The transitional MAKE and BREAK states are generally of short duration, while the non-transitional OPEN and CLOSED states are generally longer in duration. During the OPEN state, voltage is present but load current is not flowing across the contact. The MAKE state starts with the **M-electrode** accelerating toward the stationary electrode, yielding a Field-emission-initiated-arc (**F-Arc**) which is terminated upon electrode impact. As the **M-electrode** rebounds, a series of Thermionic-emission-initiated-arclets (**T-Arclets**) restore the contact as arcing is suppressed. This results in **μ-spot welds** between the contact electrodes as the CLOSED state is achieved and current flows through the **μ-spot welded** contact-spots. As the contact cycle proceeds again through the BREAK state, contact metal is drawn into the molten metal bridge, while continuing to carry current. As the **M-electrode** continues to accelerate, the superheated molten metal bridge explodes, initiating a metallic **T-Arclet** that cleans the contact electrodes. Any other arcing is suppressed until the **M-electrode** settles back in the OPEN state.

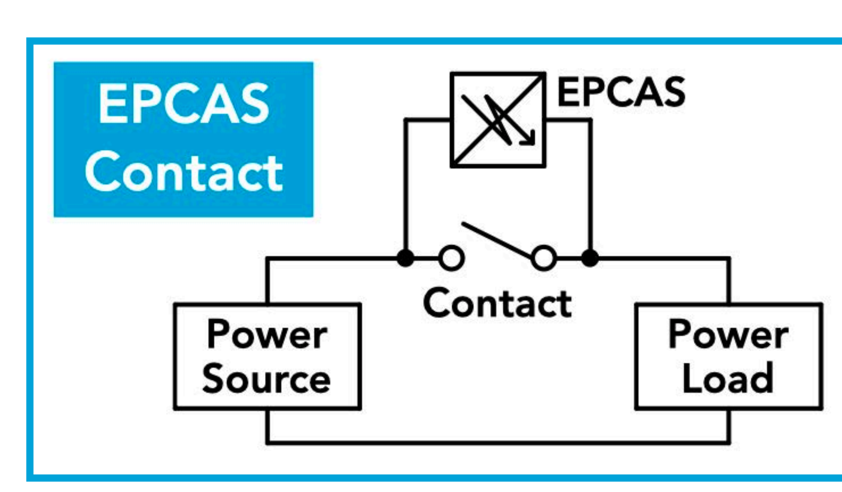

Figure II: Schematic diagram of an "EPCAS" protected contact

EPCAS Cycle as the "Best Case"

Electronic Power Contact Arc Suppression (**EPCAS**) protects, cleans, and restores contact electrode surfaces with each and every cycle, yielding a mechanical life expectancy from contacts operating with arc-supporting current. This is in contrast to the electrical (**wet**) life expectancy of a power relay or contactor, which is a fraction of the mechanical (**dry**) life expectancy. This is due to the **EPCAS Cycle** allowing a contact operating with arc-supporting current to look and perform "**like new**" until its mechanical end-of-life (fig. IV).

Therefore, the **EPCAS Cycle** defines the "best-case" scenario of electromechanical switch end-of-life expectancy, as it allows a power relay or contactor a mechanical lifespan while operating with current. Appreciating the difference between the destructiveness of the **Wet PCC** and the benefits of the **EPCAS Cycle** underscores why the **EPCAS Cycle** yields an operating life that equals the operating life of a **Dry PCC**.

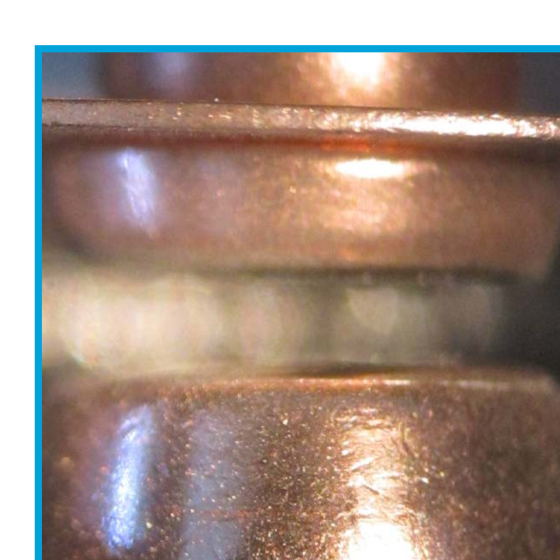

Figure IV: Controlled μ-spot welding in the EPCAS PCC yields a "like new" contact at 1 million cycles

References:
1. R. Henke and R.P. Thorbus, "Rethinking Contact Current Arcing," Arc Suppression Technologies publication, 2015
2. R. Henke and R.P. Thorbus, "The Dry Power Contact Cycle," Arc Suppression Technologies publication, January 2021
3. R. Henke and R.P. Thorbus, "The Wet Power Contact Cycle," Arc Suppression Technologies publication, February 2021