

The background is a light blue gradient with several realistic water droplets of various sizes scattered across the surface. The droplets have highlights and shadows, giving them a three-dimensional appearance.

LOW IMPEDANCE RESISTANCE WELDING

TOM SALZER – HERMETRIC, INC.

HERMETRIC.INC@VERIZON.NET

LOW IMPEDANCE RESISTANCE WELDED SEALS

- **In early semiconductor history, resistance welded hermetic seals were the most ubiquitous sealing technology**
- **It was cost effective & reliable**
- **The technology lost market share as newer plastic non-hermetic packaging technologies were developed + welding of larger metal package sizes has always been problematic**
- **My objective is to explain the cause of these problems and demonstrate a cure that has worked reliably for our customers**

HERMETIC SEALING – WHY?

- **REQUIRED BY MANY PROGRAMS & SPECS.**
- **PROJECTION WELDING IS A ROOM TEMPERATURE PROCESS, LIKE LASER BUT FASTER & STRESS SYMMETRIC**
- **LIQUID & GAS BARRIER – H₂O (ENTERS SMALL LEAKS AS A GAS, THEN COOLS & CONDENSES TO LIQUID THAT CAN CAUSE CORROSION**
- **WELDED SEALS ARE STRONG & NO PREFORMS REQUIRED.**
- **HIGH SPEED & LOW COST**
- **EXAMPLES : 1. PRECISION THICK FILM CAPACITOR NETWORK- DIELECTRIC SHIFT CAUSED BY H₂O PARTIAL PRESSURE - 2. ARGON FILL FOR THERMIONIC DEVICES**

LOW IMPEDANCE RESISTANCE WELDED SEALS

- LITTLE HAS EVER BEEN DONE TO IDENTIFY AND REMEDY THE TRUE CAUSES OF WELD EXPULSION
- COMMONLY ASSUMED THAT IT IS UNAVOIDABLE- MANUFACTURERS OFTEN EMPLOY PARTICLE GETTERS TO MITIGATE ITS EFFECTS
- GETTERS ARE NO LONGER NECESSARY – OUR RESEARCH HAS DEMONSTRATED THAT REDUCING THE IMPEDANCE OF WELDING MACHINE MITIGATES THE EFFECTS OF EXPULSION
- IT'S AS THOUGH YOU HAD A CONSTANT VOLTAGE SOURCE AVAILABLE THAT COULD PRODUCE OVER 100,000 AMPERES OF WELD CURRENT QUICKLY AND EFFICIENTLY
- WE HAVE WELDED MILLIONS OF SEMICONDUCTOR PACKAGES OF ALL SIZES, AND HAVE NEVER EXPERIENCED AN EXPULSION ISSUE
- AS A RESULT, THE EXPULSION PROBLEM HAS BEEN TOTALLY RESOLVED

LOW IMPEDANCE RESISTANCE WELDED SEALS

- **Our studies showed that an impedance mismatch between conventional welding equipment and longer perimeter seals might account for most rejects. Actual seal impedance is on the order of a few μ -ohms & is easily calculated**
- **Based on this premise, we designed, built, compact low impedance welding equipment**
- **Results exceeded our expectations. We have now welded millions of large packages with 0 defects, & improved efficiency confirms the impedance reduction theory**

LOW IMPEDANCE RESISTANCE WELDED SEALS

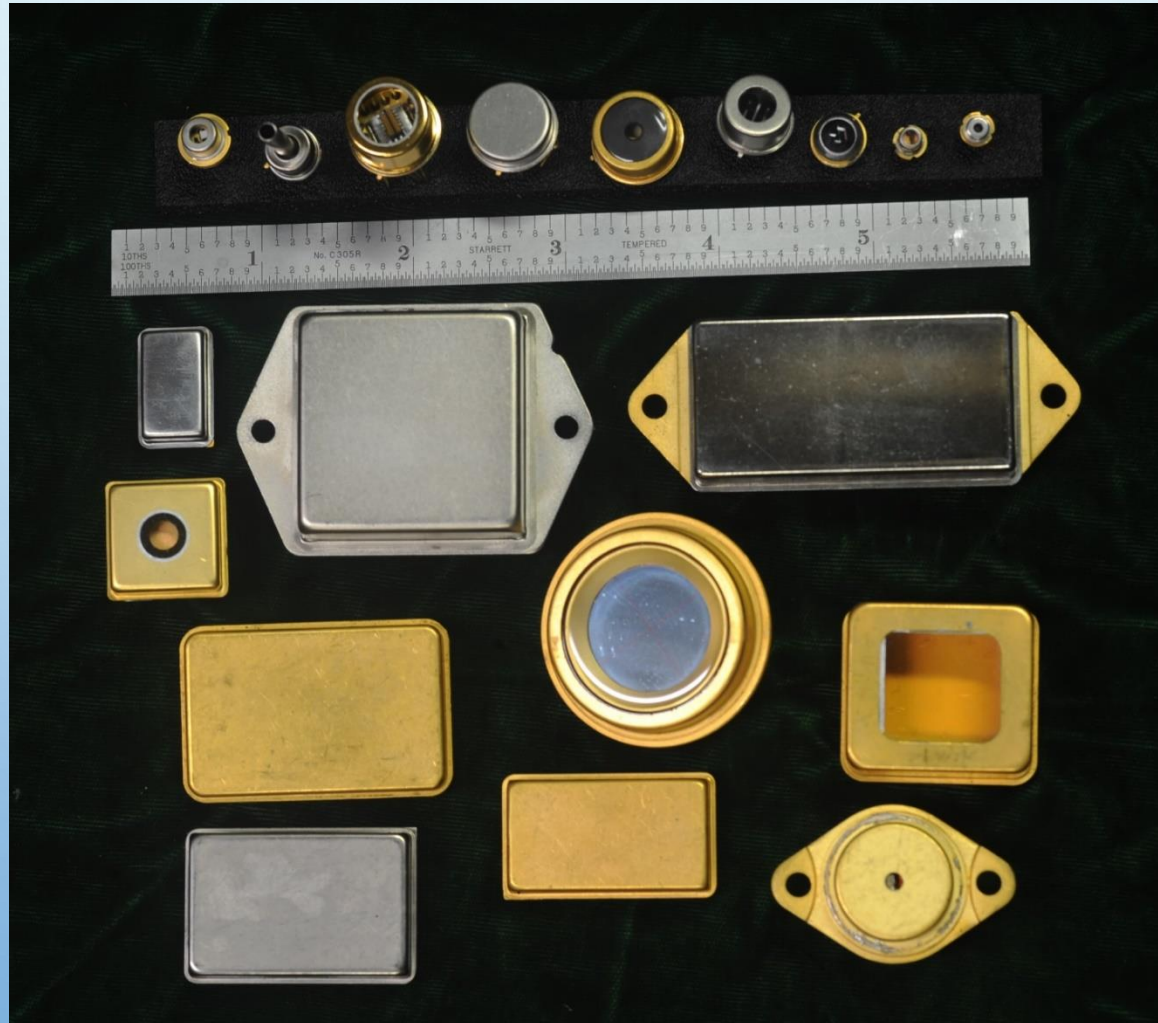
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LOW IMPEDANCE RESISTANCE WELDED SEALS

- **UNCLEAR WHY INDUSTRY HASN'T ACCEPTED THESE RECOMMENDATIONS, BUT THE SCIENCE IS CLEAR – IF YOU WANT TO WELD LARGER PACKAGES RELIABLY, YOU MUST REDUCE THE IMPEDANCE OF THE WELDING EQUIPMENT**
- **THE IMPEDANCE OF MOST COMMERCIAL EQUIPMENT IS ON THE ORDER OF 1000 MICRO-OHMS**
- **THE IMPEDANCE OF OUR MACHINE IS 35 MICRO-OHMS**
- **LOWERING THE MACHINE IMPEDANCE INCREASES EFFICIENCY AND ELIMINATES BOTH INTERNAL AND EXTERNAL EXPULSION**
 - **INTERNAL EXPULSION IS THE REASON PARTICLE GETTERS ARE REQUIRED - ELIMINATE EXPULSION & NO GETTERS ARE REQUIRED**
 - **AT LEAST ONE OTHER MFGR. NOW RECOMMENDING INVERTER EQUIPMENT FOR THESE APPLICATIONS**

LOW IMPEDANCE RESISTANCE WELDED SEALS

Above the ruler are welded packages that can be sealed using conventional resistance welding equipment



Below the ruler are larger packages that benefit from welding using low impedance welding technology

LOW IMPEDANCE RESISTANCE WELDER IN DRY BOX



LOW IMPEDANCE RESISTANCE WELDED SEALS

In a 1965 text, F. Früngel (from work done in the 1940's) discusses particle ejection (which he refers to as "electrodynamic ejection cooling" – we call it expulsion

Früngel further states that a method to reduce this effect is to reduce the impedance of the welding machine

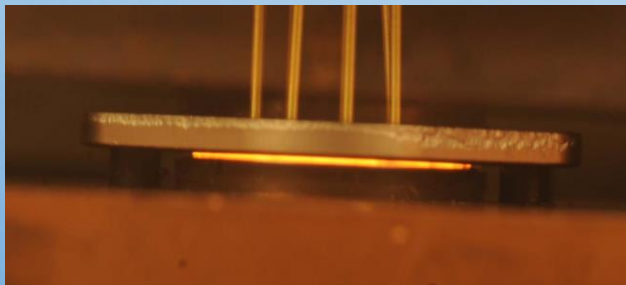
Based (in part) on this recommendation we developed the first low impedance welders

**Others appear to favor the more complex approach of developing inverter power supplies
In either case, both approaches achieve similar results by reducing welder impedance**

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**PARTICLE EXPULSION CAUSES SERIOUS RELIABILITY
CONCERNS IN PROJECTION WELDED PACKAGING**



**HIGHER IMPEDANCE WELD TECHNOLOGIES ”
FREQUENTLY CAUSE EXPULSION & LEAKS**



**IMPEDANCE REDUCTION BY $\cong 1/10$
ELIMINATES EXPULSION & LEAKS**



LOW IMPEDANCE RESISTANCE WELDED SEALS

- **YOU CAN OBTAIN A CLEARER VIEW OF HOW LOW IMPEDANCE WELDING WORKS BY VIEWING THIS SHORT YOUTUBE PRESENTATION ON YOUR COMPUTER.**
- [HTTPS://WWW.YOUTUBE.COM/WATCH?V=UYGF-ZHAXWK](https://www.youtube.com/watch?v=UYGF-ZHAXWK)

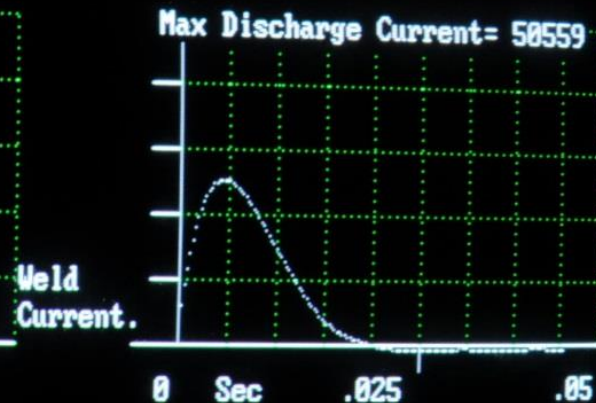
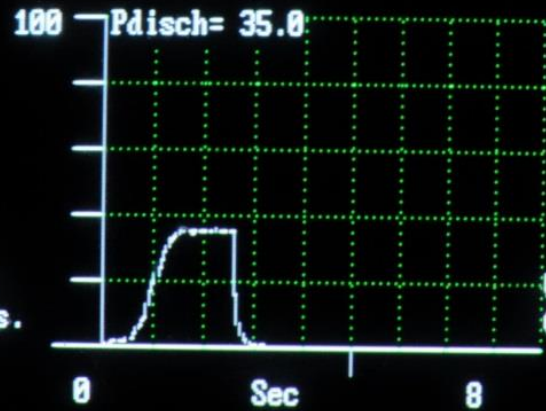
AFFECT OF IMPEDANCE REDUCTION

- **ON THE FOLLOWING SLIDE YOU WILL OBSERVE THE RESULT OF IMPEDANCE REDUCTION**
- **ON THE LEFT IS THE SHORT CIRCUIT WELD CURRENT (THE DISCHARGE CURRENT WITHOUT A WELD BEING MADE). ON THE RIGHT IS THE ACTUAL WELD CURRENT DURING A WELD AT IDENTICAL MACHINE SETTINGS**
- **THE REDUCTION OF PEAK WELD CURRENT INDICATES THAT THE WELD IS BEING MADE FROM A LOW IMPEDANCE (VOLTAGE) SOURCE. WHEN A CONVENTIONAL (HIGHER IMPEDANCE) WELDER IS USED, THE PEAK WELD CURRENTS ARE MUCH CLOSER TO THE SAME VALUES. THIS IS NOT THE WAY WE WANT OUR MACHINES TO OPERATE**
- **THIS INVESTIGATIVE METHOD PROVIDES A POWERFUL TOOL FOR ILLUSTRATING PROPER WELDING MACHINE OPERATION**

PRINCIPLES OF IMPEDANCE REDUCTION

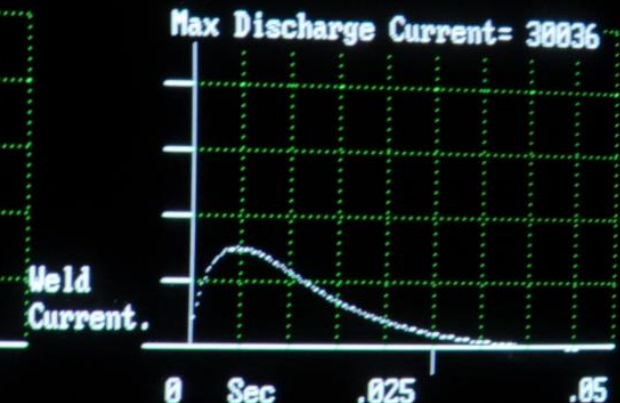
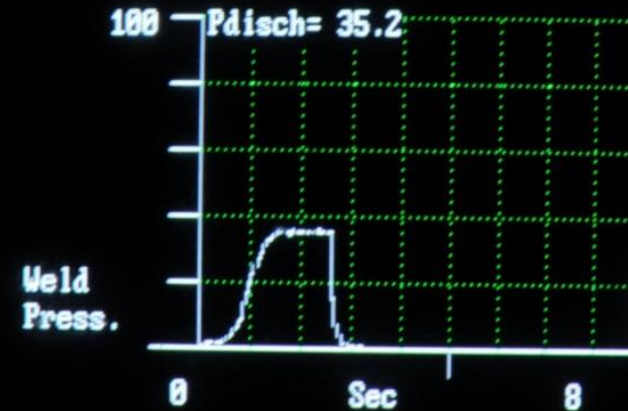
P Increases, p Lowers Pressure Pressure= 35.0
F Increases, f Lowers ForgeTime Forge=0.50
S Increases, s Lowers SqueezeTime Squeeze=0.50

Begin weld sequence
SEQUENCE TIME=3.600
Electrodes Closed
TPRESS>.9*SETPOINT
TPRESS >= SETPOINT



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(Is) **Peak Short Circuit Current** = 50,559A

(Iw) **Peak weld current** = 30,036A

$$I_s - I_w / I_s \times 100 = 40.6\%$$

IMPEDANCE REDUCTION EXPLAINED

- **Commercial welders can be used to seal packages, however, as one attempts to weld longer perimeters, defects such as leaks and, or expulsion will increase, even if you have sufficient weld current. The result is thermal run-away. Our solution is to reduce the impedance of the welder**
- **Another solution is to switch to an inverter power supply and use constant power or constant voltage option settings**
- **This may work if the inverter you choose can supply adequate weld current to make the weld in about .015 to .030 seconds. At longer weld times, thermal shock to adjacent seals can be a problem**
- **The welder you have just seen is capable of delivering short, low impedance pulses at currents $>120,000$ amperes**

WHAT IS THE RECOMMENDED IMPEDANCE VALUE?

- WHAT IS AN APPROPRIATE IMPEDANCE VALUE FOR A WELDING MACHINE ?
- DEPENDING ON DESIGN & CONDITION, WE HAVE FOUND THAT TYPICAL COMMERCIAL WELDING MACHINES HAVE AN IMPEDANCE VALUE OF ABOUT **300-1200** MICRO-OHMS
- THE IMPEDANCE OF OUR MACHINE IS **35** MICRO-OHMS
- YOU MAY HAVE BEEN TOLD THAT THE WAY TO ELIMINATE EXPULSION IS TO INCREASE BOTH WELD CURRENT AND FORCE – THIS IS A SLIPPERY SLOPE THAT LEADS TO INCREASED ELECTRODE WEAR AND RELATED PROBLEMS – WE DON'T RECOMMEND IT

THE REST OF THE STORY

- AN ADDITIONAL ASPECT OF THIS STORY IS THAT THAT AS THE SOURCE IMPEDANCE OF THE WELDER IS REDUCED, THE HEATING RATE (dT/dt) IS ALSO REDUCED
- THE EFFECT AUTOMATICALLY REDUCES THE PEAK TEMPERATURE OF THE WELD METAL WHEN THE MACHINE IS OPERATED AS A LOW IMPEDANCE SOURCE DUE TO THE POSITIVE TCR OF THE WELD METAL (MIMICKING THE OPERATION OF A CONSTANT VOLTAGE WELDER)
- THIS REDUCTION OF HEATING RATE ELIMINATES WELD SPLASH AND MECHANICAL SHOCK THAT CAN DAMAGE ADJACENT G/M SEALS
- IT'S POSSIBLE TO REDUCE WELDER IMPEDANCE BY USING INVERTER WELDING TECHNOLOGY, BUT WHY COMPLICATE MATTERS IF YOUR OBJECTIVE IS IMPEDANCE REDUCTION?

CLOSING REMARKS

- **LARGE WELD CURRENT IS STILL REQUIRED TO MAKE LARGE WELDS, BUT THE IMPEDANCE OF THE WELDER IS ALSO CRITICALLY IMPORTANT**
- **INVERTER WELDERS CAN PROVIDE LOW IMPEDANCE, BUT EXHIBIT OTHER LIMITATIONS**
- **IF YOU EXPERIENCE CURRENT LIMITATIONS WHEN USING CONVENTIONAL WELDING EQUIPMENT YOUR ONLY OPTION MAY BE TO EXTEND WELD TIME – WHICH COMES WITH ITS OWN TRADEOFFS**

**IF YOU HAVE AN INTEREST IN THE RELIABILITY OF WELDED HERMETIC SEALS,
PLEASE FEEL FREE TO CONTACT US**