The Electromagnetic RF Shielded Door

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EVOLUTION OF A CONCEPT

Sometimes a good idea deserves a second look, and perhaps a third look to discover its true potential. A misfired attempt might cause a good concept to be shelved or forgotten; opportunities are lost because of a lack of creative perspective to find necessary, practical and novel solutions to bring a revolutionary product to an insistent market.

Such is the case of a "door assembly for an enclosure having a tight shielding for high frequency emissions," originally patented in 1972 by Hans-Peter Kaiserwerth. Kaiserwerth attempted several different configurations of both permanent magnets and electromagnets in order to "apply a clamping force to all edges of the door around the periphery of the opening in the casing member to pull the door against the sealing means, to insure a faultless and gapless electrical connection between the casing member and inner surface of the door member."

In fact, several related concepts chronicle a fascinating history of the use of magnetics for sealing or clamping devices. A cross-reference through a local patent office revealed the following evolution:

#2,659,115 11/17/50
Lloyd Anderson et al.
Magnetic Door Seal: An improvement of the previously marketed magnetic seal for refrigerator doors.

Conventional shielded door systems have presented myriad complications for facility operators.

#3,260,799 7/12/66
Russell Stetson
Magnetic Radio Frequency Seal for Shielded Enclosures: An RF shielded door utilizing permanent magnet structures.

#3,691,688 9/19/72
Hans-Peter Kaiserwerth
Door Assembly for an Enclosure Having a Tight Shielding for High Frequency Emissions: Offering three different configurations, including permanent magnets, permanent/electromagnets and permanent magnets with opposing structures.

#3,969,572 7/13/76
Paul Rostek
Electromagnetic Interference Shielded Gasket for Lightweight Equipment Enclosures: EMI gasket for equipment cabinets utilizing permanent magnet strips.

#4,110,552 8/29/78
Anthony Lombardi
Electro/Mechanical Enclosure with Magnetic Cover Means: A shielded equipment housing with a magnetically sealing cover.

#4,590,710 5/27/86
James Newland
Seal for a Shielded Enclosure with Opening: Another RF shielded door utilizing permanent magnet structures.

#5,039,829 11/6/89
James Newland
Seal for Shielding Enclosure: Adjustable hinge mechanisms for a permanent/electromagnet closure system.

A passive system door exclusively utilizing permanent magnets went on to production, but in present design implementation it exhibits confined SE characteristics, making it incompatible for many broad spectrum facility applications. It was a good first step in the right direction for magnetic sealing closure devices, and remains an appropriate option, especially for zonal shielding requirements.

A further attempt, this time utilizing the hybrid approach of both permanent magnets and electromagnets, has come to the shielding marketplace within the last five years. This active system door was originally intended to meet the NSA 65-6 specification, which provides extended SE values. Unfortunately, field installations were characterized by repeated compromises to required facility shielding and ineffective cyclic dependability.

Some of the specific system difficulties which were identified at

site installations included control electronics and power supply failures, as well as inadequate magnetic field strength due to magnetic coil configuration. Frame and contact structure variables suggested questionable in-process welding and metallic specifications, which created concerns about structural alignment and contact surface incongruities.

This attempt to utilize a magnetic sealing closure has apparently evolved in a field-versus-laboratory mentality, resulting in development at the expense of the client. Independently developed SE test data indicating the manufacturer's claimed product capabilities has yet to be released to the market. No wonder, then, that the original product brochure noted a policy of full payment before shipment of the unit to the buyer. The listed patent number for this product, taken directly from the same marketing brochure, is printed as US PN 4,490,710, which is listed as a "control stick assembly" designed by Joseph Kopsho, Jr. et.al. in December 1984, bringing further suspicion on a product that has brought dubious results to the EM shielding marketplace.

Over the course of 5 years this approach has earned the entire theory a less than reputable distinction. This is unfortunate, considering the potential benefits of the conceptual device.

MOVING ON

Conventional shielded door systems have presented myriad complications for facility operators, including continual requirements for maintenance, contact and pneumatic bladder replacements, and continual closure readjustments. The additional hinderances presented by cumbersome leaf weights, automation mechanics, and operational safety requirements all point towards a product that resembles standard architecture but still provides SE values to meet the demands of extended standards.

Certainly there has not been a shortage of good ideas for a new direction in RF shielded doors. What has been missing are innovative solutions and true applied engineering techniques to advance design solutions into the next century, instead of relying on methods that are based upon outmoded technology, or getting lost in myriad theories that never get past computer modeling.

Considering that a shielded door is the most active component in an enclosure system, it represents one of the most potentially susceptible points in a facility. It makes sense to devote the highest technology to securing the most vulnerable part of a critical system, and in this case, changes have been woefully overdue to meet the need.

It's interesting to note, then, that an operational prototype of a shielded door *exclusively utilizing electromagnetic force* has recently been constructed within a compressed time schedule. This same prototype, which initially exceeded NSA 65-6 SE requirements with absolutely no modification, has been cycled over 20,000 times and continues to exhibit consistent shielding characteristics. Fully independent evaluation by a government-assigned test agency has determined that the system exceeds MIL-STD-188-125 SE requirements with the contact surfaces in a normal unprepared state, and confirmed laboratory measurements for NSA 65-6 (Figure 1).

Parameters of the prototype include a 4' x 7' frame with a swinging leaf hung by two industry-standard adjustable hinges. The system utilizes the electromagnetic force of two wound coils recessed around the perimeter of the frame, which when energized, effect a magnetic field strength to adjoining contact rail surfaces that meet with the flat-sheet conductive surface of the door leaf. Full sealing strength is accomplished without the additional force of permanent magnetic structures. Contact between the frame and leaf is accomplished without the supplemental use of gaskets, fingerstock, absorbers, or other means of shielding enhancement.

The parent test structure was a welded enclosure measuring ap-

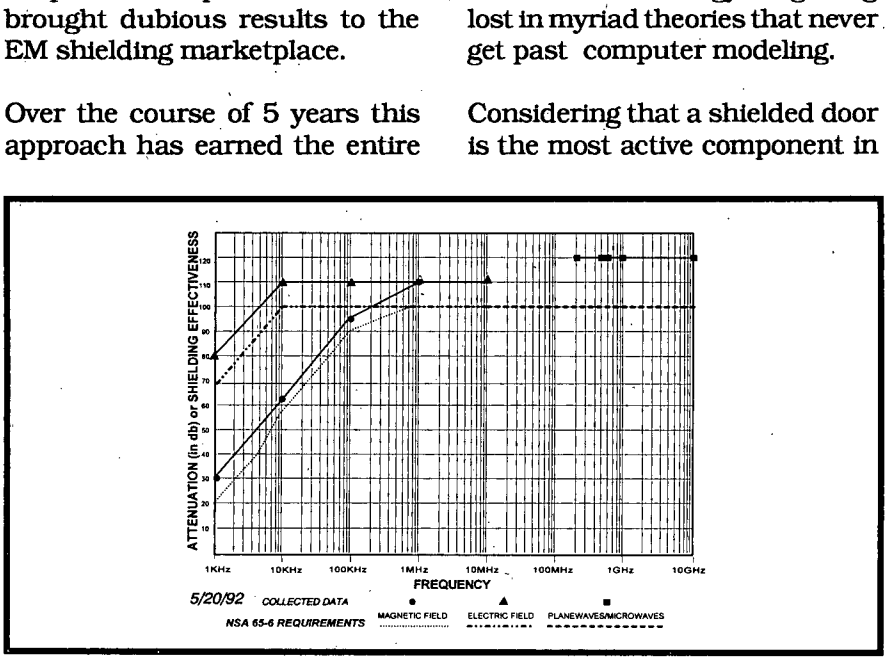

FIGURE 1. *Shielded Door Shielding Effectiveness Data vs. NSA 65-6 Requirement.*

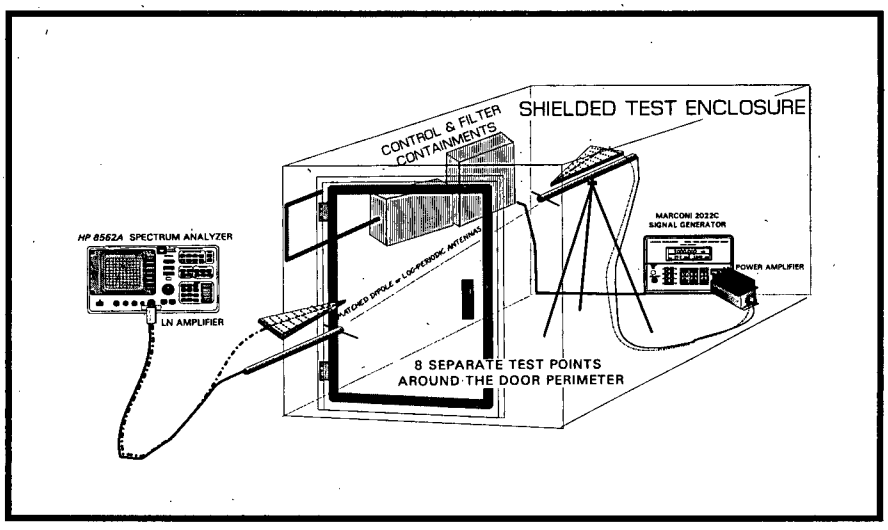

FIGURE 2. *Planewave Test Configuration.*

proximately 10' x 12' x 8' with the door frame weld-mounted on one of the 10 foot walls. The electronic control unit was located inside the cell with isolated power and control filters. The entire test structure was verified for shielding integrity prior to the commencement of testing the closure device (Figure 2).

A shielded door represents one of the most potentially susceptible points in a facility.

The design and fabrication of this approach was accomplished by evaluating the pitfalls unique to the concept and re-examining the characteristics that have proven unsatisfactory. These include thermal build-up, structural rigidity, material efficiency, contact surface treatments, electronic reliability, etc. The success of this type of design relies on the sum of the parts. Components which are balanced to interact as a unit rather than relying heavily on any one element deliver results. Balancing the equation means encompassing various disciplines and giving any possible solution a fair chance to prove itself. Most of all, common sense can prevail over many theories that look good on paper, but cannot stand up to practical applications.

What has resulted from this refinement strategy is a technology that provides a sophisticated but easily utilized component for advanced RF shielded enclosures and buildings. This system affords the lightweight advantages of an architectural door—low leaf weight, user-friendliness, high safety margin, and an aesthetic appearance. It lends itself easily to integration of present systems, making it ideal for shielded facility replacement doors. It connects readily to existing security systems, operates in a dual-door interlock mode, and withstands high-cycle use providing SE consistency on a reliable basis.

LOOKING AHEAD

After demonstrating this prototype construction to provide both the SE and cyclic reliability required for practical use, the next step will be to test the versatility of this ultimately adaptable system. With a wide-tolerance alignment of contact surfaces that are subjected to minimal stress, fatigue and wear, the design configurations are exceptionally diverse. Construction of a track-sliding unit, now in progress, will move this concept even further in providing application flexibility.

Configurations are potentially unlimited, allowing the initial design to be adapted to many styles, including double-leaf swinging, large-scale sliders, flush-sill, and double-pocket. A design program to further simplify and modularize components will create standardized, interchangeable elements that promise to introduce a new level of efficiency to production and field installation.

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