Using new Magnetically Actuated Vacuum Interrupter technology for safe and reliable medium voltage circuit breaker switching in mines
Abstract:

The development of the magnetically actuated vacuum interrupter (VI) has allowed the design of Vacuum Circuit Breakers (VCBs) with very beneficial characteristics for the mining industry. In this presentation we will review the technology, the benefits that result from this technology and how the product actually looks and is applied in the mining industry. The simplicity of operation will be outlined. This simplicity will serve to illustrate why the device is very compact, very reliable, and is rated for so many cycles of operation. It will also serve to show how the vacuum interrupters and the operating mechanism can be so well protected. The discussion will then turn to how such a device can be fitted into smaller spaces than traditional VCBs, and how the desired features of visible open disconnects, and open into ground can be accomplished, along with the requirements of under voltage and shunt tripping, which are necessary in mining operations. The technology will be illustrated with an actual device and with PowerPoint slides.
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Note:
The Line Power Manufactured MAVRiC® will be used to illustrate the subject technology
Comparison of Technology

**Traditional VCB**

Open / Close: Stored Energy

**Magnetic Actuated VCB**

Open / Close: Magnetically actuated and held

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Comparison of Technology

Traditional VCB
Many Parts
(Many that move!)

Magnetic Actuated VCB
Few Parts
(Very few that move!)

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Comparison of Technology

Traditional VCB
Operation: Charge and Trip

Magnetic Actuated VCB
Operation: Pulsed Coil moves permanent magnet

Less than 3 cycle opening time!
Excellent for arc flash time limitation.

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Comparison of Technology

Traditional VCB
Vacuum Interrupter

Magnetic Actuated VCB
Vacuum Interrupter

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## Comparison of Technology

<table>
<thead>
<tr>
<th>Traditional VCB</th>
<th>Magnetic Actuated VCB</th>
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<tbody>
<tr>
<td>Solenoids for Shunt Trip and UV</td>
<td>VCB is closed with a charged module with control contact closure</td>
</tr>
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</table>

1. Internal capacitors for trip
2. Low power shunt tripping
3. Wide range of operating voltage, 85-265 VAC Typical
4. Relay controlled UV setting (Not based on solenoid drop out… BUT….)

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Comparison of Technology

Traditional UV option - Dual Tripping with loss of voltage

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## Comparison of Technology

### Traditional VCB
- Limited number of Auxiliary contacts!

### Magnetic Actuated VCB
- Large number of Auxiliary contacts*
  - Qty. of 6 “a” contacts
  - Qty. of 6 “b” contacts

* Supports plenty of indication, control and communications requirements.

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<td>Run and trip for remote operation</td>
<td>Control module pulses coil to move a permanent magnet</td>
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</table>

1. Rapid response  
2. Low control power  
3. Light weight  
4. Diagnostics:  
   1. Ready and Failure status - prior to trip requirement  
   2. Detection of cut wire to breaker!
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Comparison of Technology

Traditional VCB
Interlocked Visible Disconnect

Magnetic Actuated VCB
Interlocked Visible Disconnect

The mechanically interlocked disconnect in this model, allows for vacuum bottle opening without control power!
Comparison of Technology

**Traditional VCB**

- Load Side Grounding Option

**Magnetic Actuated VCB**

- Load Side Grounding Option

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<tr>
<td>Open Insulators</td>
<td>Enclosed Insulators</td>
</tr>
<tr>
<td>Subject to contamination</td>
<td>Live insulators under cover</td>
</tr>
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Using new Magnetically Actuated Vacuum Interrupter technology for safe and reliable medium voltage circuit breaker switching in mines.
Simplicity = Reliability

Magnetically actuated Vacuum Interrupters are rated for as many as 50,000 mechanical maintenance free operations.
Improved performance

Higher Ratings

Typical Mining VCB Interrupt Ratings
15kV, 600 amp, 12.5kA
25kV, 600 amp, 12.5kA

Magnetically Latching Mining VCB Interrupt Ratings
15kV, 600 amp, 20kA
25kV, 600 amp, 16kA
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Using new Magnetically Actuated Vacuum Interrupter technology for safe and reliable medium voltage circuit breaker switching in mines.
Case Study - Retrofit

Using new Magnetically Actuated Vacuum Interrupter technology for safe and reliable medium voltage circuit breaker switching in mines.
Case Study - Retrofit

Before

Compact design is very easy to retrofit!
This unit was converted to a dual circuit (with space to spare)

After

Using new Magnetically Actuated Vacuum Interrupter technology for safe and reliable medium voltage circuit breaker switching in mines
Case Study - Retrofit

Separate location for controls and push buttons.

Using new Magnetically Actuated Vacuum Interrupter technology for safe and reliable medium voltage circuit breaker switching in mines.
Case Study - Tight space

This Interrupter was fitted into a power center only 24” tall.
Case Study - Traditional Switchgear

This Interrupter was fitted into miniature traditional switchgear construction.

All the features of IEEE C37.20.3 metal enclosed switchgear in a smaller footprint.
Summary of Benefits

Reduced Down Time due to reliability and minimal service

Smaller..... ● Smaller VBC houses and Power Centers
            ● Simple retrofit

Low Power.... ● Reduced control power consumption

Reliable.... ● More service free operations
            ● Self diagnostics-
              Alert to disconnection prior to need!

Low Risk... ● Well establish technology in Utility and
             Industrial applications
             Reclosers and Vacuum Fault Interrupters
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