Spectra Series™

Power Panelboards

Pressure-Locked Connections

Pressure-Locked Connections: How Do They Rate In Low-Voltage Power Distribution Equipment?

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Abstract

This investigation examines the pressure-locked connections employed in GE's new Spectra Series™ low-voltage power distribution equipment. The resulting data conclusively demonstrates the reliability of the new connection, favorably compares to bolt-on methods, and surpasses UL requirements.

Introduction

One prime prerequisite of a dependable power system is a highly reliable connection between the equipment's internal bus structure and the attached protective devices (e.g., fusible switches and circuit breakers). Although all the connections are important, many engineers consider the bus/protective device interface critical because it separates the line from load sides of the system. Two methods have been successfully used: bolt-on and pressure-locked connections.

Bolt-on connections are common in panelboards and switchboards. The protective device's contacts bolt to intermediate connecting straps which in turn bolt to the bus using a torque wrench. This method combines the electrical with a portion of the mechanical connection.

Pressure-locked connections are common in switchgear, bus plugs, drawout switchboard mechanisms and some panelboards. This method does not use intermediate connecting straps. Instead, a plug-in connection is employed, in which stabs, jaws or fingers are pushed onto the bus. In most instances, the mechanical and electrical connections are separate.

GE's new Spectra Series family of Low-Voltage power distribution equipment utilizes the pressure-locked connection. This patented design in these new panelboards and group-mounted switchboards has been tested for heat and corrosion performance. Like bolted connections, results show superior performance, and exceed UL standards in witnessed tests. The results of these tests are summarized herein. The physics principle of the connection method is detailed in Appendix A.

One Connection in Two Parts

The pressure-locked connection employs separate mechanical and electrical connections as shown in Figure 1. The circuit protective device bolts to an intermediate mounting module. The module in turn mechanically attaches to the equipment through a latching mechanism. This locks the jaws onto the bus structure, thereby providing the separate electrical connection.

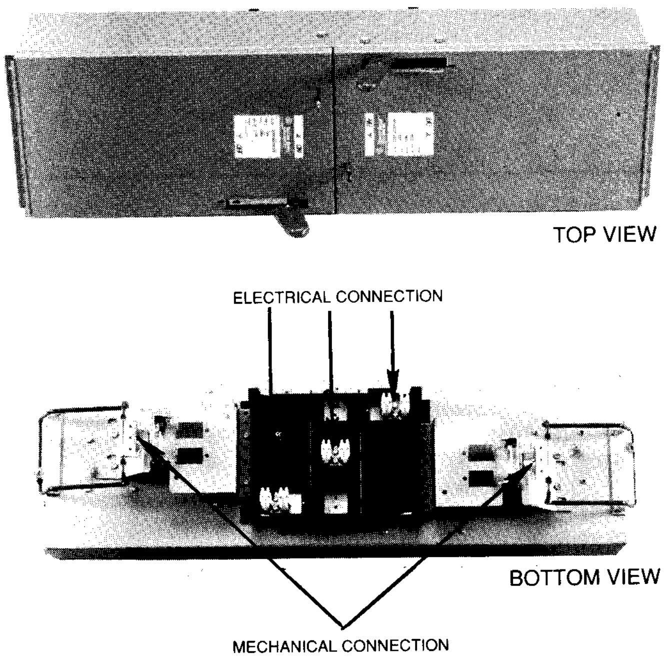
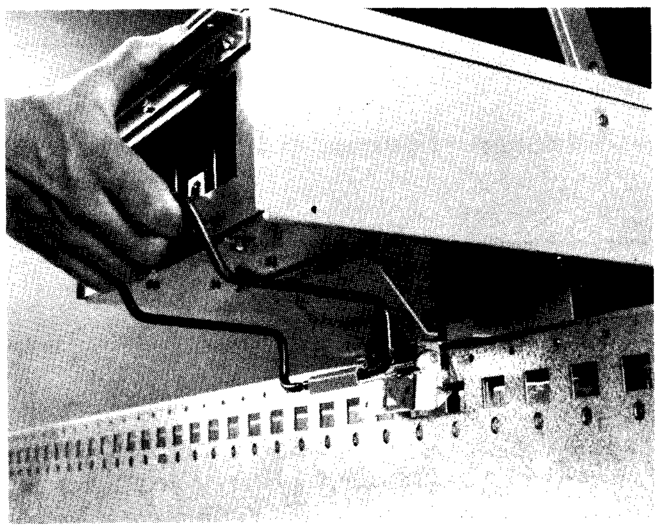


Figure 1

Mechanical Connection

The intermediate mounting module (for both fusible switches and circuit breakers) connects mechanically to mounting rails on each side of the bus structure. Spring-loaded latching mechanisms engage the rails, holding it in place. Tabs underneath the module slide into the mounting rail slots, thereby ensuring alignment.

As shown in Figure 2, the support plates (on each side of the module) consist of the alignment tabs, handles, torsion springs, pivotal hooks and pins. During removal, pulling each handle disengages the pivotal latches from the mounting rail.



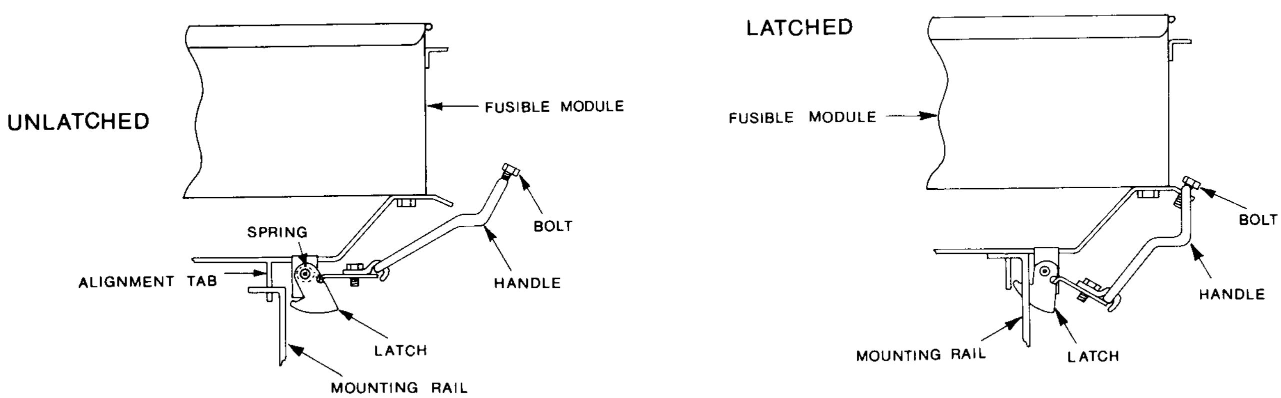
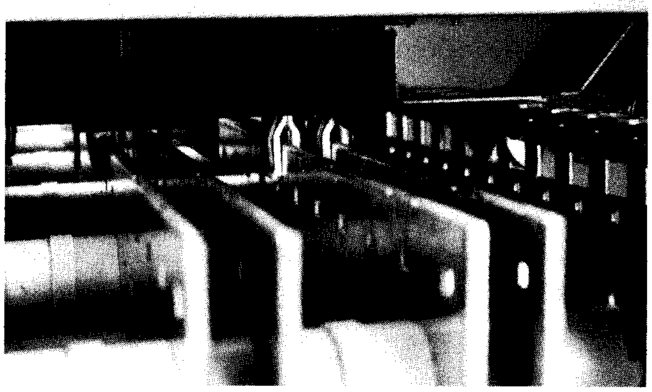


Figure 2 – Mounting Module

Electrical Connection

The jaws underneath the mounting module actually grip the bus structure. The design facilitates the griping action through a saddle-shaped spring wire nested in the slots of U-shaped, silver-plated copper clips. This assembly (shown in Figure 3) comprises the jaw. The spring wire assures excellent electrical connection with the bus structure over extended time periods by maintaining constant contact pressure.

The jaw design minimizes heat rise by the shape of the clips and the bus bar itself. The clips' flat surface and the bus bar's rounded top edge maximizes the electrical contact surface. This reduces heat rise within the equipment.



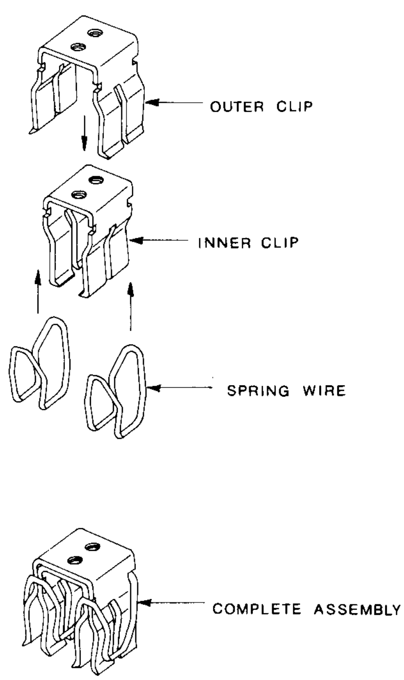


Figure 3

Test Results

GE completed numerous tests in addition to those necessary for UL listing. Three of these tests demonstrated the superiority of the patented pressure lock connection: heat rise, heat cycling and corrosion.

Heat Rise

Silver-plated jaws and bolt-on connections were attached to tin-plated aluminum bus bars in a standard panelboard. (GE tested tin plating instead of the standard silver plating, providing a worst-case scenario.) Three thermocouple locations were chosen: the bus connection point; the line strap; and the load strap. Temperature readings were obtained at 600A and 1200A.

The pressure-locked connection on an average ran slightly warmer (0.5–2.5°C) than the properly torqued bolted connection. However, the range of temperature readings was more narrow, thereby indicating a more consistent temperature rise. In both connections, the temperature range is consistent with a superior electrical connection. Results are summarized in Figure 4.

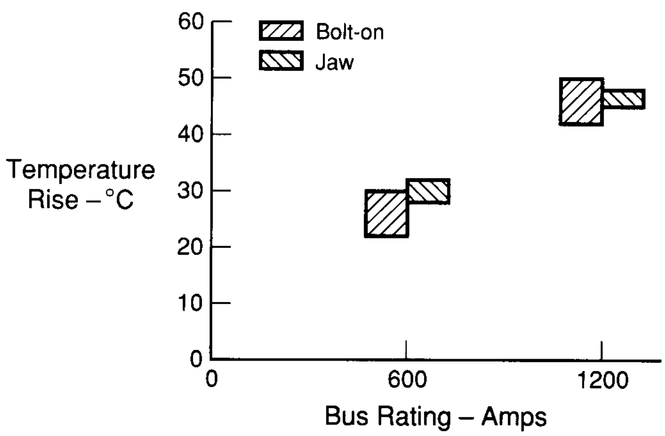


Figure 4 – Heat Rise Results

Heat Cycling

While no available standard test predicts the "aging" process of the pressure lock connection in equipment, GE patterned one after UL's Clamp Joint Heat Cycling Test for Bolted Joints. This test requires that the temperature rise after 500 heating cycles not exceed the rise after 25 cycles by more than 15°C. To add conservation, GE "overheated" the connection to 75°C (requiring 1830A). In addition, the connection was "conditioned" with 25 module insertions prior to commencing the test. Table 1 summarizes the test procedures.

Cycle	Test Procedure Action
1	Power adjusted, T-rise = 75°C
2-24	3 hours ON, 1 hour OFF, per cycle
25	Measurement of Heat Rise after cycle
25-499	3 hours ON, 1 hour OFF, per cycle
500	Measurement of Heat Rise after cycle

Table 1

Corrosion

Both the bolted strap and pressure lock connections were tested in a harsh, saturated hydrogen sulfide environment. Readings were taken every four hours for nearly a week. Figure 5 illustrates the results. Resistance values (in milliohms) increasing with time would have indicated deteriorating connection performance.

The connections showed no increased resistance. In fact, the relative resistance values of 0.005 and 0.006 milliohms for the two connections is negligible compared to values for a typical switch (0.6 milliohms) or fuses (as high as 4.0 milliohms). The performance of both connections in the unusually harsh environment was excellent.

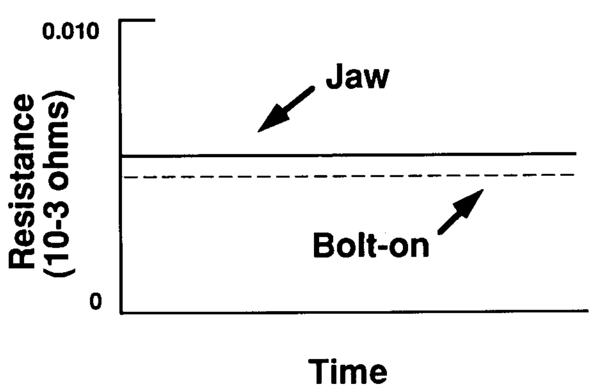


Figure 5 – Corrosion Results

Conclusions

Bolted connections have provided years of superior performance in panelboards and switchboards. GE's tests conclusively demonstrate that pressure lock connections, which use the same principles as those in heavy duty switchgear and busway, are also a superior connection for panelboards and switchboards. Testing included heat rise, heat cycling and corrosion.

Appendix A – Physics Principles

Under short circuit conditions, the pressure lock jaw assembly actually clamps onto the bus bar more tightly than under normal conditions. Stated mathematically, the basic physics formula is:

$$F = I\,(l \times B)$$

where F is the clamping force, I is the current, l is the length of conductor and B is the magnetic flux density (or strength of the magnetic field).

The pressure lock connection was designed with this principle in mind. Figure 6 illustrates the electromagnetic field lines around the jaw/bus bar connection and shows the current paths. The magnetic flux density (B) is a function of the electric current (I) passing through the conductor. When current increases to short circuit levels, flux also increases, and hence the clamping force also increases.

Spring Reinforced Jaw Connection

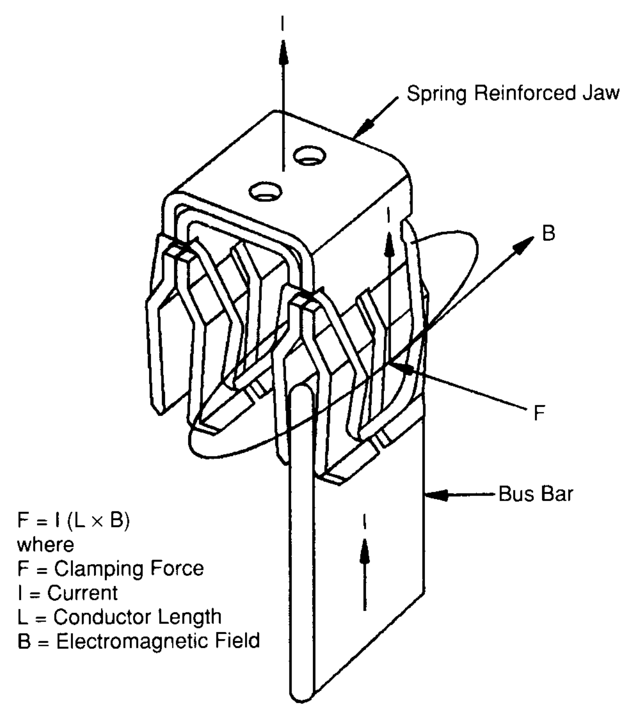


Figure 6 – Pressure-Locked Jaw Connection

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