A close look at the Nason parking brake switch
And our solution for a replacement[i]

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June 2014

Update Dec 2019

It has come to our attention that the Cole-Parmer pressure switch is no longer available. A good substitute pressure switch is available here:

https://www.uatparts.com/freightliner-kick-off-low-air-switch-fsc-1749-1907/

https://www.anythingtruck.com/product/052-57746606.html

The pressure switch is fixed at 70 PSI and will not require an air compressor or the pressure adjustment.

As of Dec 2019 we have put over 54,000 miles on the substitute parking brake switch without any problems.

Experiencing the failure of two Nason parking brake pressure switches in the span of six years prompted some investigation. The part number on the parking brake switch used in our coach is SM-1C-66R/WP28. According to the Nason catalog[ii] that part number breaks down like this.

SM stands for low pressure switch
1C denotes 1/4" NPT Male SPDT (single pole, double throw switch)
66 means set for a fixed pressure set point of 66 PSI
R indicates a rising pressure switch
WP28 indicates a Weather Pack connector

The specification indicates this switch has a cycle life of 1,000,000 cycles. Making a conservative guess of 20 cycles of the parking brake in a driving day, one should be able to drive a motorhome every day for 137 years before cycling the switch one million times. Using the same estimated 20 cycles of the parking brake for a driving day of 300 miles, we estimated the cycles before failure on our coach. The coach has approximately 58,000 miles resulting in an estimated 194 days of travel. Rounding that to 200, or 100 days of use for each of the two failed Nason pressure switches, we arrive at an estimate of 2000 cycles of the parking brake before switch failure. Based on our actual real world experience it would seem that Nason missed the specified 1,000,000 cycles by a considerable margin.

Having the previous failed switch on hand we decided to do a test. A male air chuck fitting was attached to the old pressure switch as shown in Figure 1 and the air compressor in the garage set to 120 PSI. The Nason switch has three connections denoted as A, B, and C. Terminal “A” is connected to the black wire and is the common contact of the switch. Terminal “B” connects to the red wire and is the normally open contact. Terminal “C” is the normally closed contact and connects to the blue wire. A multimeter set to measure resistance on the 200 ohm range was connected between terminals A and C and revealed continuity of less than a half ohm. Plugging the switch into the air hose opened the contacts at A and C but no continuity occurred between contacts A and B. The switch was cycled several times and never achieved continuity between A and B but continuity between A and C always recovered after removing the air pressure. Lubricant was sprayed down into the diaphragm in the hopes that would cause the normally open contact to make. Still no continuity, even if the pressure was applied for an extended period. A substitute circuit fabricated to replace the Nason pressure switch is described later. After installing that substitute switch in our motorhome the second failed Nason pressure switch was tested and found to have the same failure mode as the first Nason switch.

Knowing that the failure mode of the Nason pressure switch is <u>both contacts open</u> when air pressure is applied, enlightened us to why the annoying bell goes off when the transmission is placed in gear with the parking brake released. Studying the schematic of our coach shows that when the parking brake is released the parking brake lamp goes out and both the transmission and leveling jack control modules receive a <u>parking brake off</u> signal as a result of contacts A and C opening. The closure of contacts A and B will disable the parking brake bell. That fails to happen and thus the bell sounds when the transmission is placed in gear.

The chassis schematic shows that the B contact connects to one side of the relay coil for Park Bell 1 and the other side of the coil is connected to 12 volts. The coil of a relay is an inductor and inductors react to changing current flow. When the contacts energizing the coil are opened, voltage increases across the contacts in an attempt to keep the current flowing. This can result in an arc that burns the contacts. The schematic does not show a diode across the coil to collapse the field of the parking bell relay coil and our suspicion was that the contacts between A and B were failing from prolonged arcing. This later proved not to be the case and inspection of the contacts with a magnifying glass did not show any burns or pits.

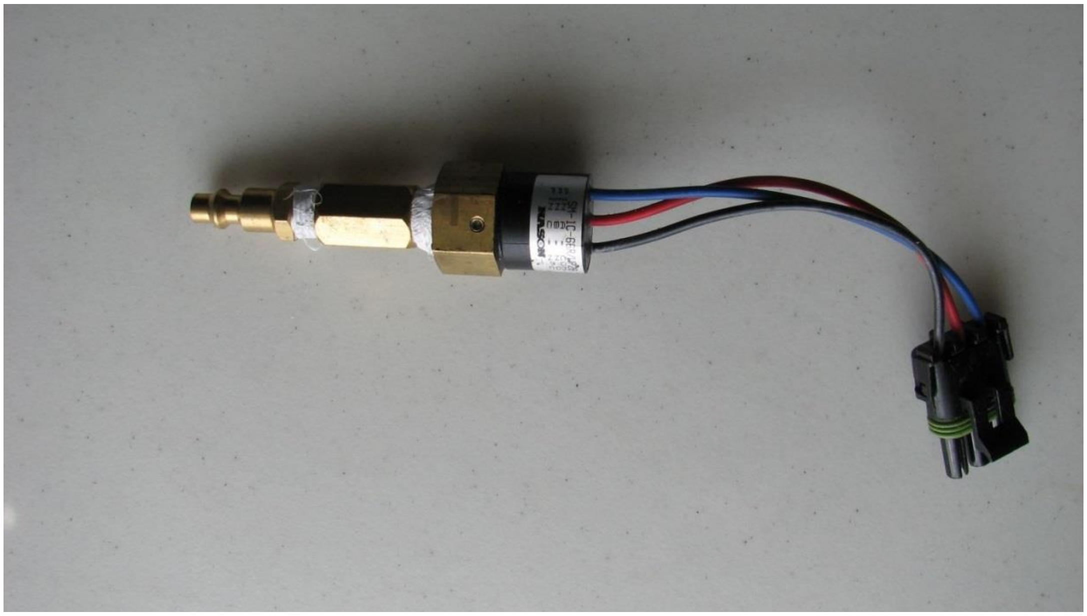

Figure 1 Failed Nason switch with male air chuck installed

Disassembling the Nason switch revealed a push actuator extended by a diaphragm.

Figure 2 Push actuator and brass housing

In Figure 2 the push actuator can be seen in the center of the black nut. The actuator is fully retracted in the photo and extends approximately 0.085 of an inch when 66 PSI or greater of air pressure is applied. The actuator pushes against the lever of a microswitch. After disassembly it became evident that Nason relies on the mechanical properties of the microswitch as part of the calibration. We connected the actuator housing back to the air compressor and turned the regulator down to about 5 PSI. Slowly bringing the pressure up the actuator started to extend at about 40 PSI and was fully extended at 70 PSI. The 66 PSI calibration claim is based on the size of the diaphragm and the tension of the spring. See

Figure 4. The actuator is fully extended at the calibration pressure and against a stop. Air pressure above 66 PSI does not increase the actuator travel against the microswitch lever. In Figure 2 note the threads inside the brass housing of the pressure actuator and the hole near my thumb where a set screw was removed. Note in Figure 5 that the housing containing the microswitch has mating threads that allow the housing to screw into the pressure actuator. It is assumed that Nason calibrates the pressure at which contacts A and B close by applying 66 PSI and screwing the housing into the pressure actuator until the contacts make. The set screw is then tightened and a sealant applied around the threads. When taking apart the second Nason switch we determined that the switch housing could be screwed further into the brass housing after removing the set screw. That supports our assumption that the calibration partially relies on the mechanical properties of the microswitch.

Over time the microswitch weakens mechanically until the travel distance of the push actuator is no longer adequate to close contacts A and B but sufficient to open contacts A and C. In Figure 3 note the microswitch actuator lever inside the switch housing. We pushed on the lever as far as the housing would allow and were able to make contacts A and B conduct. The connection was resistive at 51 ohms as shown in Figure 6. After disassembling the second failed Nason switch we repeated this test with improved continuity at about 5 ohms. Neither of the microswitches exhibited the snap action normally associated with a microswitch. We assume that the snap action was present when the switches were first placed in service but now absent after internal mechanical failure. If one were inclined, it might be possible to extend the service of a failing Nason switch by screwing the switch housing further into the pressure actuator. It is our opinion that the switch would inevitably cause problems later.

Figure 3 Actuator lever for micro switch

Figure 4 Pressure actuator dissembled

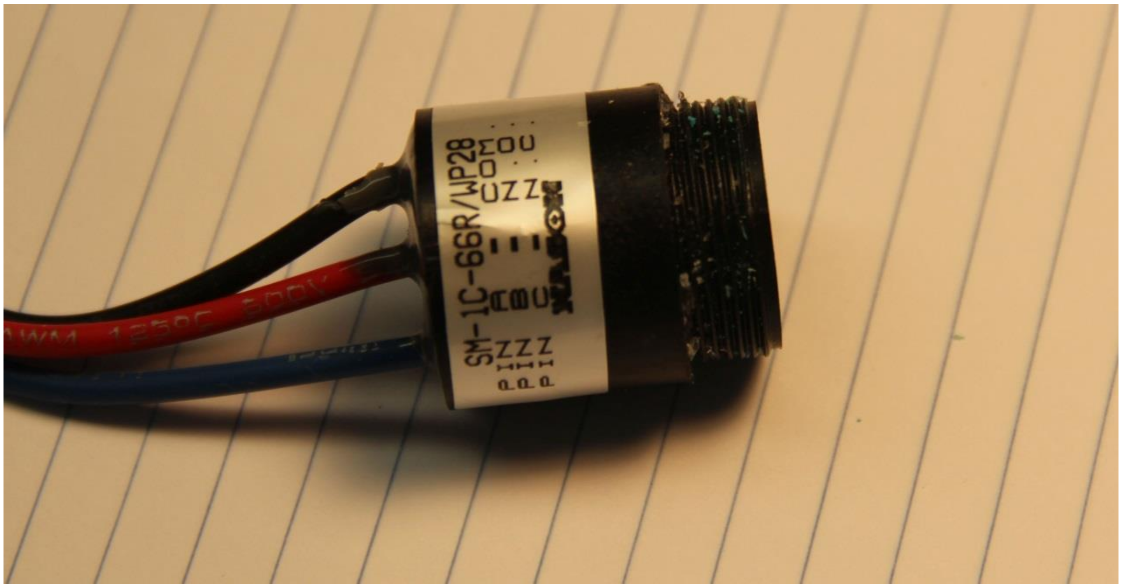

Figure 5 Switch housing

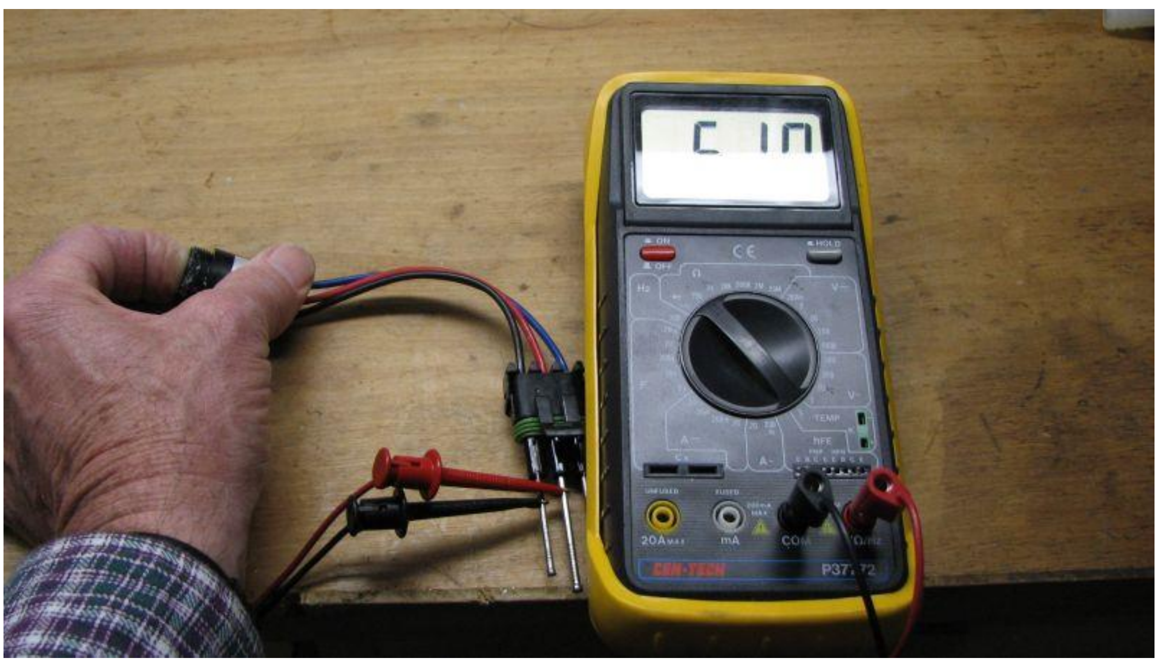

Figure 6 Contacts A and B make at 51 ohms when pushing actuator

After performing the electrical tests we split the switch housing of the Nason pressure switch to further disassemble it. That revealed the potted Cherry microswitch. See Figure 7. Once the housing around the microswitch was removed we were able to achieve maximum travel of the actuator. This reduced the resistance measurement between contacts A and B to 5 ohms on the original switch. Again the snap action feel expected when a microswitch is pushed was absent.

Figure 7 Housing removed reveals Cherry micro switch

The Cherry microswitch is a DB1 series. The Cherry specification[iii] for that switch claims an operating life of 10,000 cycles. That is 100 times less than what Nason claims. Cherry does state the mechanical life is 15 million cycles but our inspection indicates mechanical degradation of the Cherry microswitch is the cause of failure of both Nason pressure switches removed from our coach. Possibly Nason received a large order of the Cherry switches that were defective and manufactured the pressure switches without that knowledge. Maybe the potting process used by Nason affects the internal parts of the Cherry switch and shortens the life expectancy. The bottom line is that after having two parking brake switches fail in six years, we are not confident that Nason has improved the life of this product. Our real world experience with that switch resulted in an estimated life span of 2000 cycles motivating us to fabricate a substitute parking brake switch. We are confident that the weak point is the microswitch and wish Monaco had chosen a SPST pressure switch for the parking brake.

A life cycle as short as 10,000 would be satisfactory based on our estimate of 20 parking bake cycles per day of coach use. That would give the parking brake pressure switch a usable life of 500 days or 150,000 coach miles at 300 miles per travel day. We set out to fabricate a substitute parking brake sense switch that could be used in place of the Nason pressure switch. The two major components chosen to fabricate the substitute switch were a Cole-Parmer SPST pressure switch adjustable between 50 and 150 PSI[iv] and a common Bosch type 87a relay[v]. The Cole-Parmer and Autozone specification information available to us did not state a life cycle estimate. Bosch information[vi] shows life cycles of 50,000 or more for relays they manufacture. Cole-Parmer states the subject pressure switch does not use a microswitch but is made with metal blade contacts. Years of experience tell us that a 10,000 cycle life expectation from this combination is reasonable. We do acknowledge there is no cost advantage since the cost of the Cole-Parmer pressure switch and the 87a relay are about the same as a single Nason pressure switch. There is a cost advantage if the substitute switch last for 10,000 cycles or more and the Nason switches continue to fail at approximately 2000 cycles.

The sketch in Figure 8 shows the circuit fabricated using the Cole-Parmer pressure switch and the 87a relay. Figure 9 shows the completed assembly ready to install in the coach. We have completed two trips totaling over 2500 miles with the substitute parking brake switch with flawless performance. The advantage of the approach we took allows going back to the original Nason parking brake switch. It does require a faulty Nason switch be available to cut the connector from. A cleaner approach would be to move the 87a relay down into the front run bay but that would require modifying the coach wiring.

The first step of the fabrication process was acquiring the necessary components. The Cole-Parmer pressure switch and the 87a relay were purchased through the sources given in the references at the end of this document. The wire and push-on terminals were available from an auto parts supply stores. The connector used for the 12 VDC ignition hot power source is made by cutting in half the two pole trailer wiring extension shown in Figure 10. This item was also purchased at an auto parts store. The red wire with the female socket is used on the +12 VDC source circuit and the red wire with the male contact on the relay. This prevents accidental shorts should the ignition be turned on while the connector is unplugged.

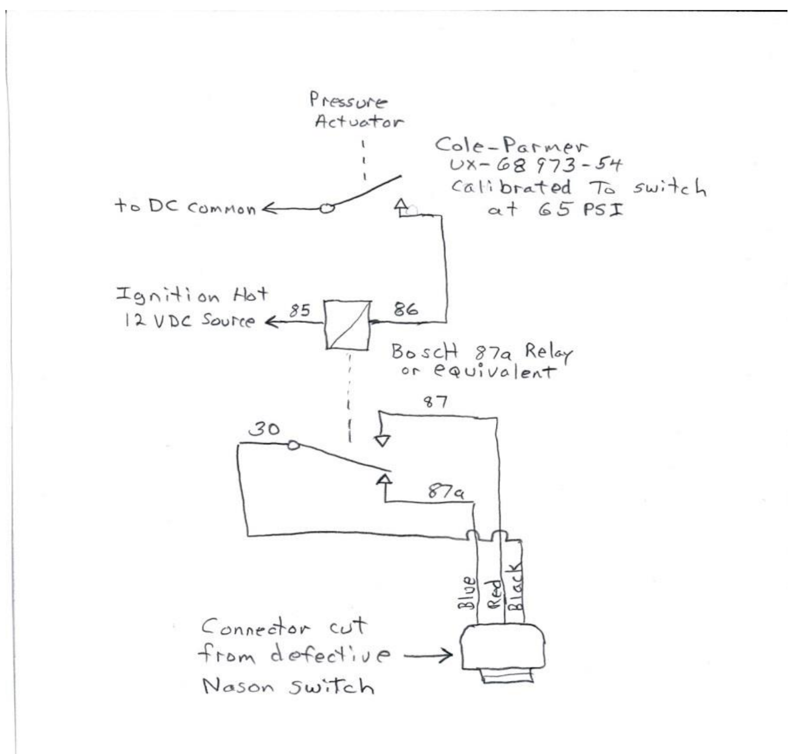

Figure 8 Sketch of circuit used to substitute the Nason parking brake switch

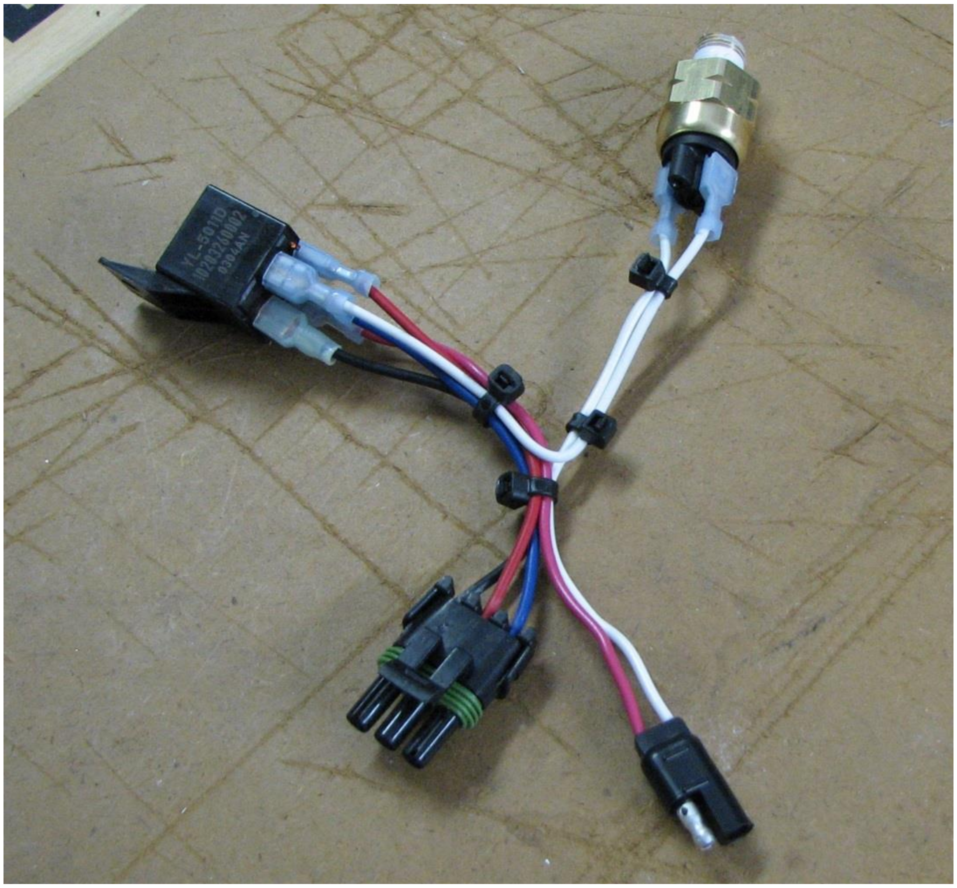

Figure 9 Assembled and ready to install in coach

Before use the Cole-Parmer pressure switch is calibrated to close the contacts at 65 PSI of air pressure. A temporary male air fitting is attached to the pressure switch as shown in Figure 11. The regulator on the air source is adjusted to 65 PSI as in Figure 12. The multimeter set on a low ohm range is connected between the terminals on the Cole-Parmer pressure switch and the air hose connected. The Cole-Parmer pressure switch comes out of the box set to a higher pressure than 65 PSI, thus the multimeter shows an open circuit. Using a small screwdriver, the adjustment screw is turned counter clockwise until the meter shows continuity. The adjustment location is shown in Figure 13 and the calibration setup in Figure 14. After the switch closes the air pressure applied is lowered until the switch opens. We wanted to insure that the dead band is smaller than 15 PSI and that the switch opens when the pressure drops below 50 PSI.

The connector with leads was cut off of one of the failed Nason pressure switches and push-on terminals are crimped to the wires. Refer to Figure 15. Two push-on terminals were crimped to the half of the trailer extension with the male terminal on the red wire. Push-on terminals are crimped to a short length of wire and used to make the connection between the pressure switch and the relay coil. All other connections are completed with the two pole connector and the plug from the old Nason switch. The connections of components follow the circuit in Figure 8 and fashion the substitute parking brake switch shown in Figure 9.

After the switch assembly we tested the operation using the air supply and the multimeter set to a low ohms range. The meter is connected between the common contact, black wire, and the normally closed contact, blue wire, as shown in Figure 18. The meter indicated continuity between the black and blue wires with the air hose disconnected. Moving the meter lead connected to the blue wire over to the red wire, Figure 19, the meter showed an open circuit. In Figure 20 the air hose is connected with the pressure above 65 PSI. Applying the air pressure resulted in continuity between the common, black wire, and the normally open contact, the red wire. Removing the air hose the circuit reverted back to continuity between black and blue and open circuit between black and red.

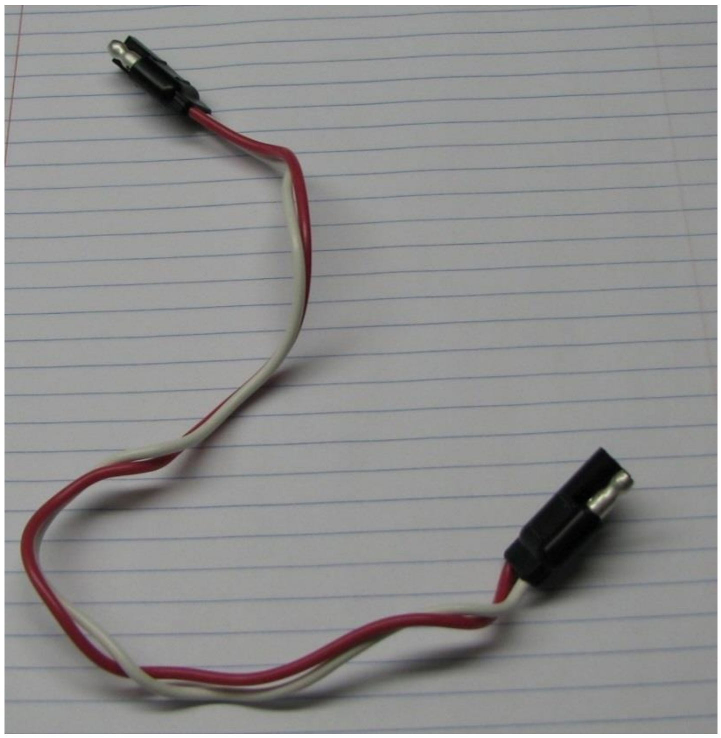

Figure 10 two pole trailer tow extension

Satisfied the substitute parking brake switch is functioning correctly it was installed in place of the Nason pressure switch in the coach. The other half of the two connector trailer extension with the female contact on the red wire was wired to a source of *ignition on* 12 VDC. Since the 87a relay is only energized when the parking brake is released and air pressure is present, one could use a source of full time 12 VDC. We prefer to energize the circuit only when the ignition is on. The new parking brake switch was installed in the coach near the end of April in preparation for a trip to Key West, Florida. We have since completed that trip and a second trip to Flat Rock, NC. We are very pleased with the performance of the substitute parking brake switch.

Figure 11 Temporary air chuck fitted to Cole-Parmer pressure switch

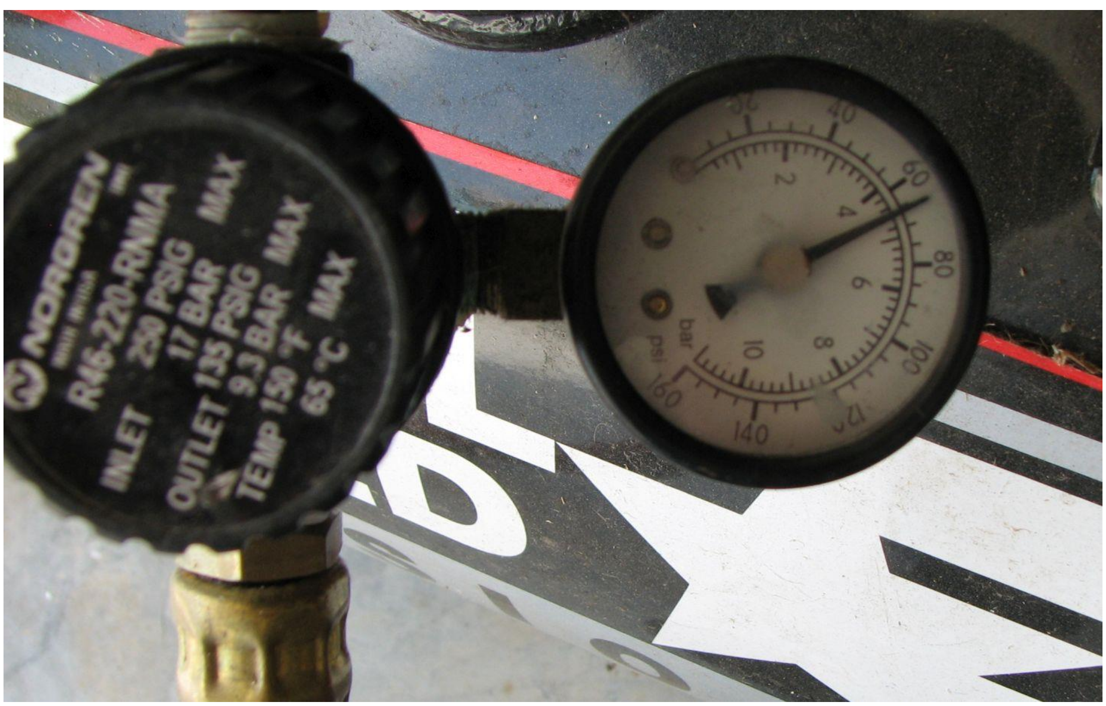

Figure 12 65 PSI used to calibrate the pressure switch

Figure 13 Adjustment shown between terminals

Figure 14 calibrating the pressure sensor to close at 65 PSI

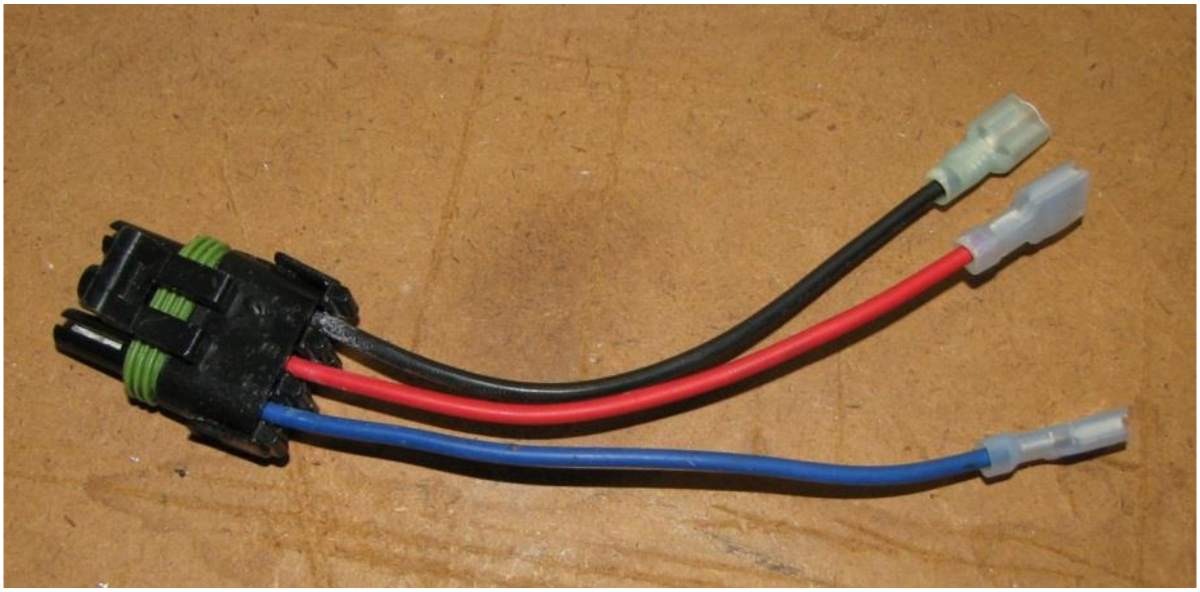

Figure 15 Connector from failed Nason pressure switch

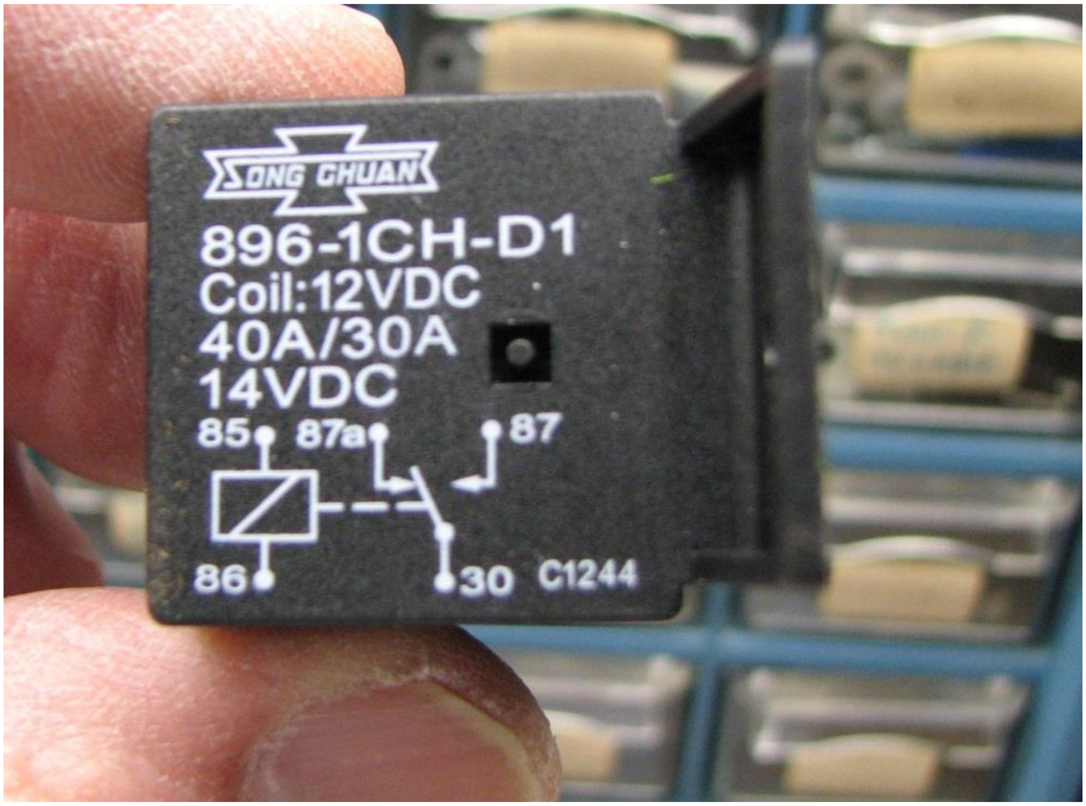

Figure 16 Diagram on top of relay

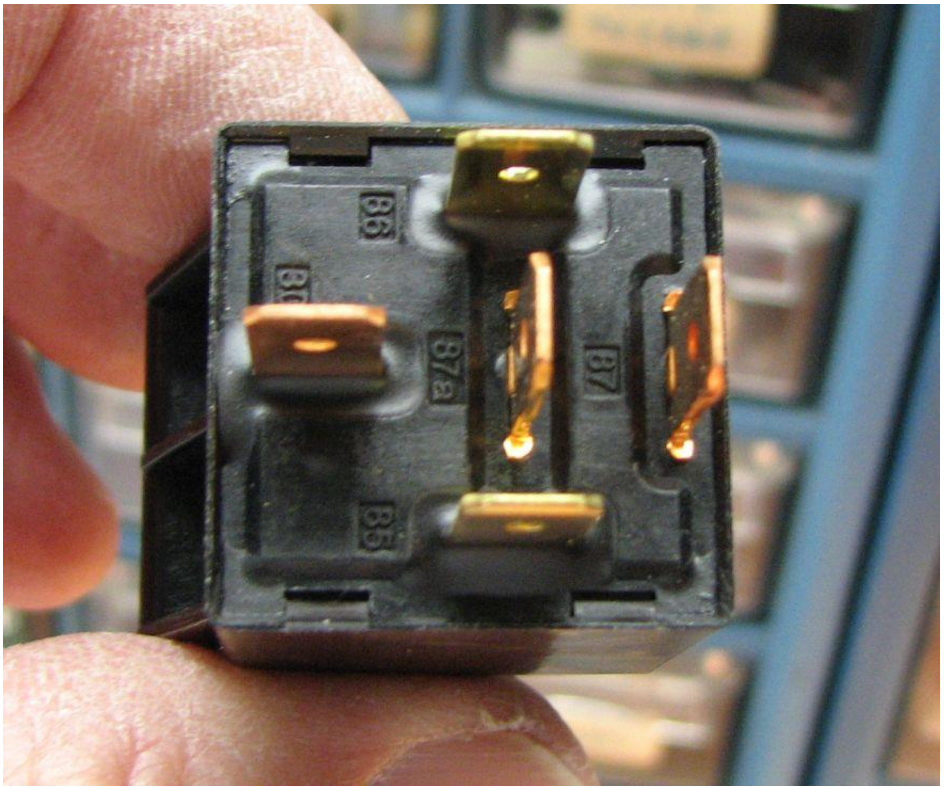

Figure 17 Location of terminals on bottom of relay

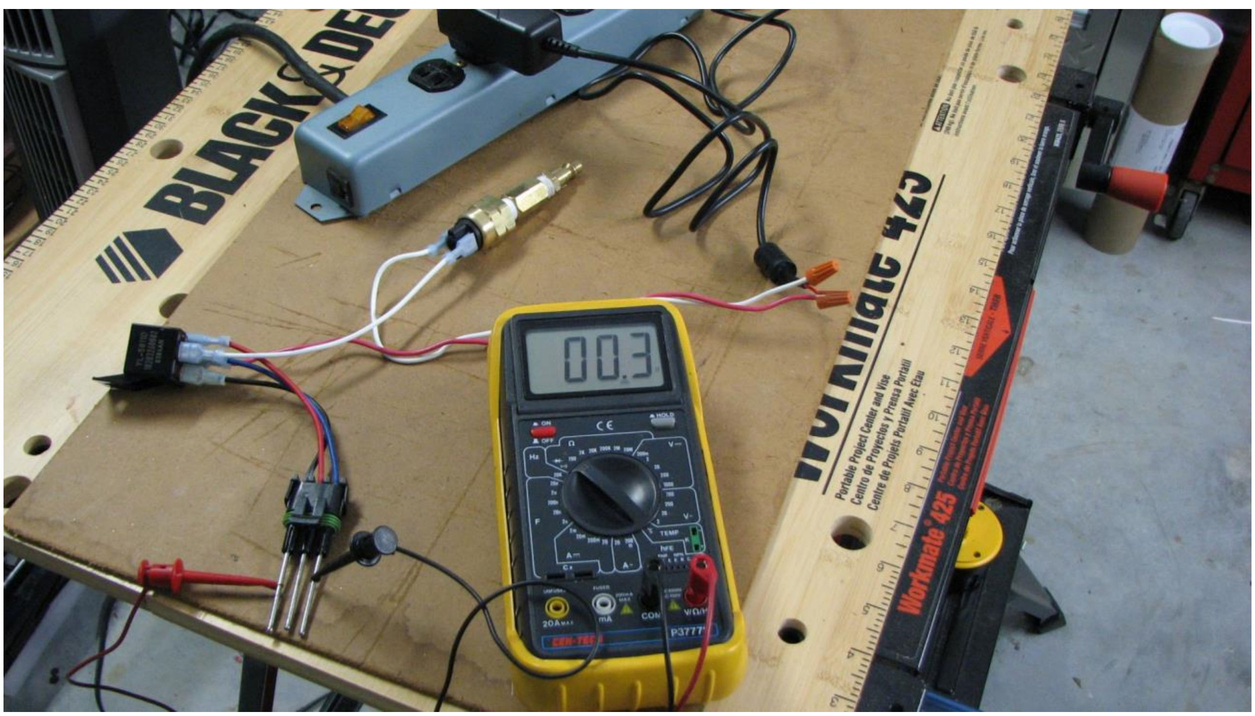

Figure 18 Black to Blue circuit no air

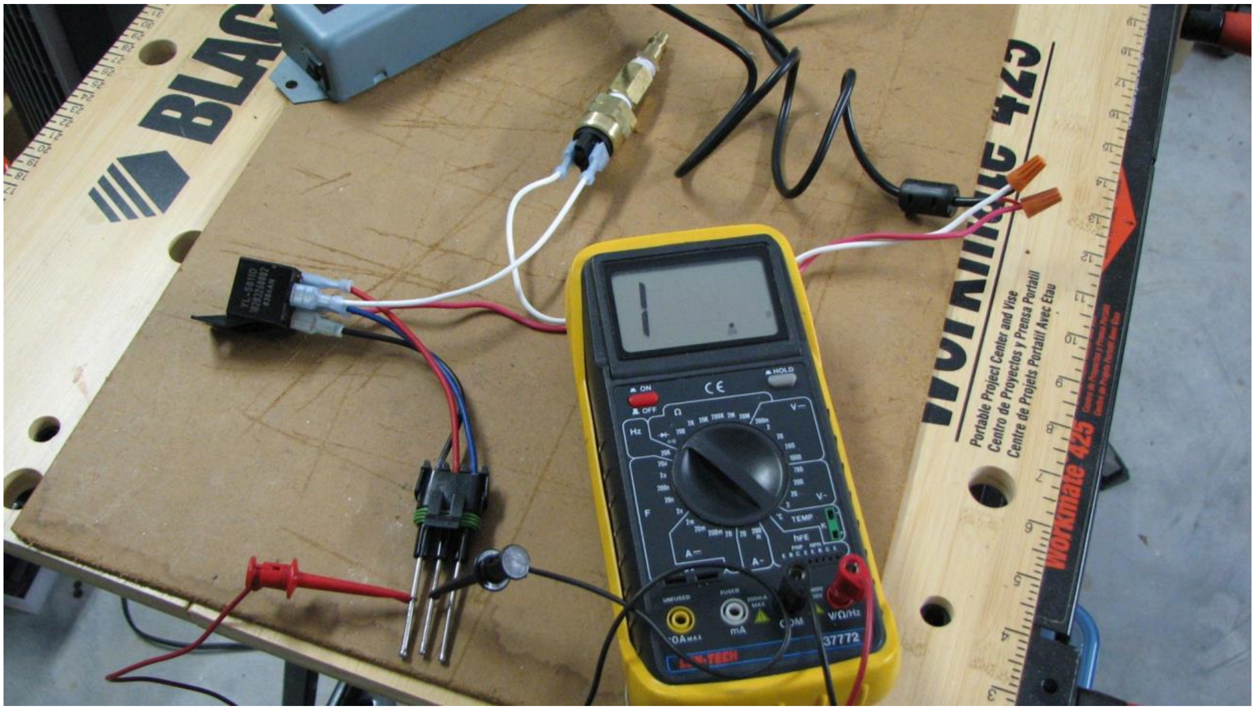

Figure 19 Black to Red circuit no air

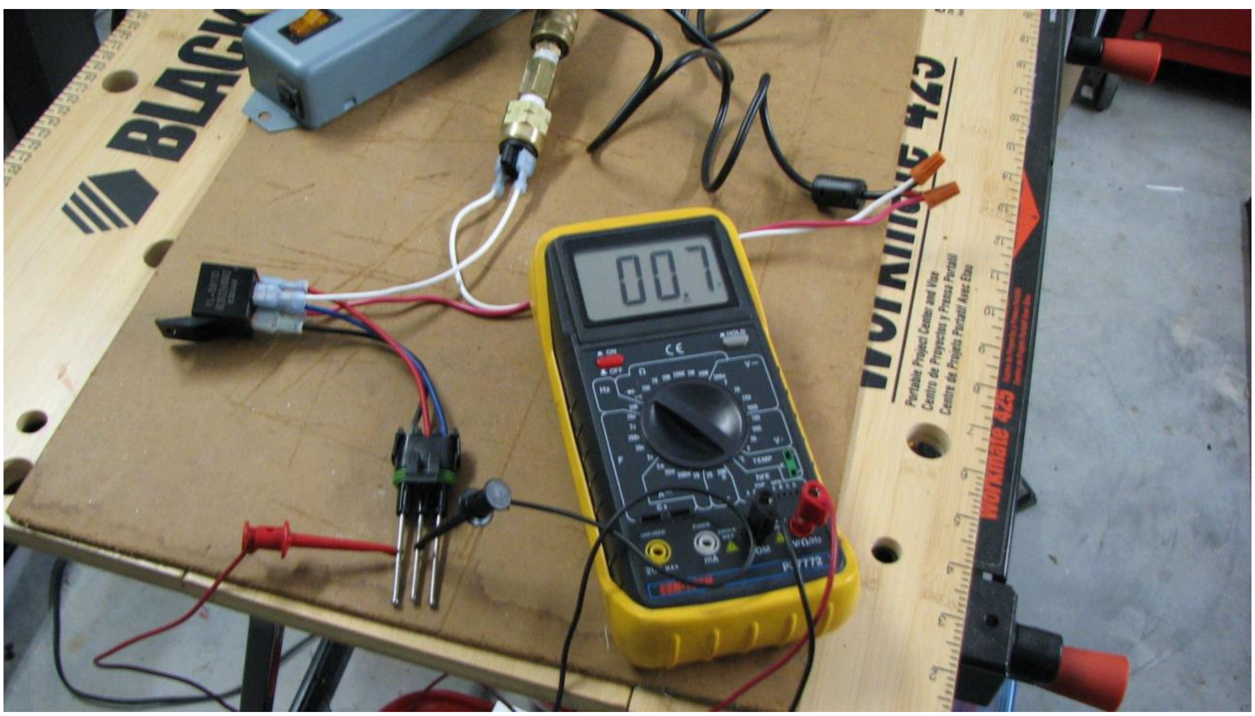

Figure 20 Black to Red circuit air applied

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[i] The information in this document is based on the author's own experience and work and is not backed by data or testing. The purpose of this document is to describe the author's findings and solution and any use of the information herein is at the reader's own risk.

[ii] **Nason Company**
1307 S. Highway 11
Walhalla, SC 29691
800-229-4955

http://www.nasonptc.com/

[iii] **ZF Electronics Corporation**
11200 88th Avenue
Pleasant Prairie, WI 53158
Phone: 262.942.6500
Web: www.cherrycorp.com
Email: cep_sales@zf.com
Fax: 262.942.6566

http://cherryswitches.com/us/

[iv]Cole-Parmer
United States
1-800-323-4340
www.coleparmer.com

Follow the link below to order the pressure switch
Pressure Switch 50 To 150 PSI Normally Open Spst 1 4 NPT M Brass Fitting from Cole-Parmer

[v] Autozone
www.autozone.com

Follow the link below to purchase the relay
http://www.autozone.com/autozone/accessories/Santech-5-pin-universal-double-pole-single-throw-relay/_/N-2659?itemIdentifier=946083_0_0_

[vi]This link downloads a PDF specification file on Bosch relays
http://bowery.com/maserati/home/files/bosch%20relays.pdf