



MAY/JUNE 2012

Home energy

\$15



INSULATING WALL CAVITIES

Deep Energy
Retrofits X10

Pimp My
Blower Door Kit

Measuring Window
U-Factors with IR
Thermometers



Pimp My Blower Door Kit

The Blower Door Makeover

PHOTOGRAPHS BY GREG LABBÉ

BY GREG LABBÉ

In these tough economic times, it's appropriate to invest time in repairing and maintaining things, to make manufactured goods last longer and to save money. Besides, it feels good to repair something yourself, and working on something makes you value that item more—and teaches you something about your equipment, too. So in that vein I recently purchased a jalopy of a blower door kit that was in desperate need of TLC. The machine in question was probably 15 years old; it's a Model 3 blower door made by the Energy Conservatory, with lovely Dwyer Magnehelic gauges. I plugged it in, the speed control worked, and the fan moved air. What could be wrong, I thought, as I handed over the cash, grinning at the deal I had just struck?

My elation dimmed significantly when I got home and inspected things a little more closely. The motor would unexpectedly turn off every three minutes, and then just as suddenly start up again. The red nylon panel on the door frame had come unsewn around the fan opening, to the point that the bungee cord that keeps the canvas tight around the fan body was exposed over a third of its perimeter. The Magnehelic gauge that measures the house pressure registered readings that were significantly lower than those registered by my friend's newer, recently calibrated gauges. The A ring was concentrically cracked along one-third of its circumference. The control overheated to the point that I couldn't hold it with my hand; and it intermittently went out. Luckily, I knew what I was in for, since I once managed 20 in-house energy advisors and did the repairs and diagnostics on their blower door kits routinely.

The Legs of the Machine

The Energy Conservatory's Minneapolis Blower Door uses a superb workhorse of a motor, made by GE, to move 30 minutes of air a day. It's as if they put the engine of a BMW M3 into a 16-foot fishing boat built to last a few generations—as you'd expect from something that's made in America. I knew the motor must have a malfunctioning thermal cutoff, so I spoke to a chap at the manufacturer and asked if he could source a new one for me. "No" was the short but polite answer. "You'd have to buy a new motor." This was not an option, because the motor is worth over a third of the machine's value new. My next-best option was to take it to my dad—Bob's an old-time electrician whose best friend spent his life rewinding and repairing all manner of electrical motors. He called me up the next day to give me the diagnosis. "I found and replaced the high-temp sensor today," he says in his best French Canadian accent. "I cleaned out the motor—an exceptionally well-made motor; there was no sign, visible or in smell, of heat stress." The replacement part cost \$30 online at Amazon. Regarding the motor, if you ever do a job like this yourself, you should clean it and pull out all the dust bunnies from the intake face (see top right photos).

For some reason, the outside grille face of the fan was starting to rust, so I wire-brushed it clean, wiped it down, and spray-painted it a nice flat black. You can get away with using a #3 Phillips head screwdriver to take off the four large bolts that hold the grille in place, but really, it requires a larger automotive screwdriver to prevent the driver from stripping the bolt head.



(top left) Out with the old thermal cut off. (top middle) Replacement thermal cut off. (top right) Pulling dust rabbits out of motor inlet. (left) Spacer between edge and sensor.

With the grille off I was tempted to paint a pattern on the fan blades to give it that funky screw illusion when the fan blades are rotating, but I lost steam on that upgrade.

While the grille was off, I took the time to position the sensor hub by placing a flat $\frac{3}{16}$ -inch spacer on a flat table for the Model 3 fan (see bottom photo above). I placed the whole fan on the table, centering the flow sensor hub on my spacer. Then I loosened the bolt holding the motor to the fan and ensured that both the flow sensor and the black fan housing were sitting flat on the spacer and table respectively. Then I retightened the clamp holding the motor. I flipped it over and checked the alignment with a 4-foot level. Another good deed done. A note of caution: Never detach the clear hose from the flow sensor. Speaking from experience, the hose comes off easily, but the force of pressing it back onto the glued nipple can easily push the nipple into the flow sensor, permanently ruining the sensor.

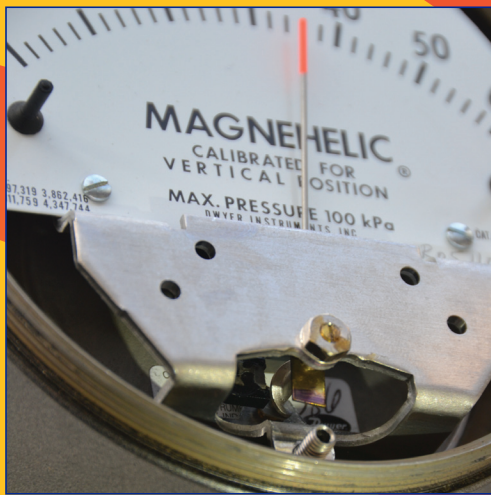
The cream-colored plastic that Minneapolis uses for its fan rings is subject to UV degradation, which discolors the plastic and makes it brittle. The fans also take a beating in transportation, and few of them have fabric covers to ward off the deleterious effect of the sun. The cream-colored plastics should be treated with Armor All or some other UV-protective coating. In my case, the A ring had a 20-inch-long concentric crack. My fix was to take drywall's fiberglass tape, flatten a band of it on the back of the crack, and coat it with a thin paintable silicone caulk. I let it cure, then trimmed off the excess bits for aesthetics. I decided to paint the various rings as a means of protecting them

from further UV degradation. I used a plastic-approved spray paint called Krylon. Note that the inside face of the rings (especially the smaller rings) should not change diameter. If you do paint the inside surfaces, use an incredibly thin, uniform, and blemish-free paint layer so as to not change the shape of the ring or the cross-sectional area inside the ring.

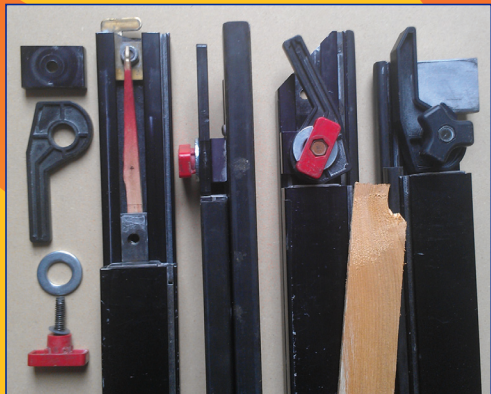
The Brain of the Machine

There are no batteries in the robust and simple Mangnehelic gauges, and yet the Energy Conservatory discontinued them several years back and replaced them with a more compact and flexible gauge. Dwyer Magnehelic gauges are an engineering feat, and I salute the genius who devised this über simple and purely elegant device. If you've ever wondered why they call them "Magnehelic," take them apart and have a look! The axle of the indicator needle is encircled by a helical iron fin, and the diaphragm—which moves up and down in the axis of the indicator needle—has a powerful magnet attached to it (see top photo next page). This magnet is very closely positioned next to the helix, and as the diaphragm moves up and down, it pulls the helix along, which makes the indicator needle turn. You can buy replacement gauges for less than \$140.

Though the Dwyer gauge is very robust in design, its one weakness—aside from the fact that it needs to be level—is that the zeroing adjustment screw seizes up. Not sure if this is so, but perhaps the rubber seal dries over time as it connects internally to a hex head stainless steel setscrew inside the case. If you do



Close up of Magnehelic.



Inserting 14mm washer in cam.



Cleaning Al Sq tubing.



Zig zag sew on nylon.

If you're worth your salt doing blower door tests you've pinched a finger in the assembly and disassembly process because you used excessive force. Why not do something about it?

take the gauge apart, be gentle when you reassemble it, since the setscrew on the crystal needs to mate with the hex head of the setscrew inside the case. Note too that you should be superclean when you work on the gauges. The bezel should be tightened to the point where the case is airtight.

Back to my problem. The house pressure readings I was getting at a select fan speed were lower than my friend's gauges were getting by a consistent 30%, yet when I put them both under pressure with my 10-cc syringe, they both got the same readings! I eventually found a cut in my hose that was causing the low pressure readings. I replaced that bit of hose and was back in business.

Taking on second-hand gauges is always a risky business. The gauges should be referenced with other manometers to see if their performance is within specifications. If your gauges are less than a year old, they are under warranty, and Dwyer will recalibrate them. In my case, the gauges were old as dirt, so sending them back to Dwyer was a nonstarter.

Typically, the best comparison is to do at least a three-point check with one measurement each on the low, medium, and high end of the scale. In the gauge manual, Dwyer recommends a calibration *check*: "Select a second gage [gauge] or manometer of known accuracy and in an appropriate range. Using short lengths of rubber or vinyl tubing, connect the high-pressure side of the Magnehelic gage and the test gage to two legs of a tee. Very slowly apply pressure through the third leg. Allow a few seconds for pressure to equalize, fluid to drain, etc., and compare readings." Dwyer's tolerances are plus or minus 2% of full scale at 21.1°C.

Manifolds may be available at medical supply or aquarium stores. A10-cc syringe should suffice to compress air for the 60 Pa gauges, and a 60-cc syringe should work for the bottom gauge. If you buy new gauges, I suggest keeping the old gauges for parts. You can reuse the faceplate with the graduations you like, as long as you buy the gauge with the same range—that is, 0–60 Pa for house pressure, and so on. Also, you can use the crystal and the setscrew assembly, should the new gauges break.

Though it's a more involved procedure, Dwyer does have instructions in the manual mentioned above that show you how to recalibrate the gauges. You have to pull the reading or faceplate out and move a clamp held fast by a hex setscrew up or down a blue spring steel vertical strip.

Instrument *checks* should be done routinely and only against a new gauge of known calibration that has been recently tested by a reputable lab. Ideally, a qualified technician who can issue a new certificate that will ratify the accuracy and precision of the gauge should do an instrument *calibration*.

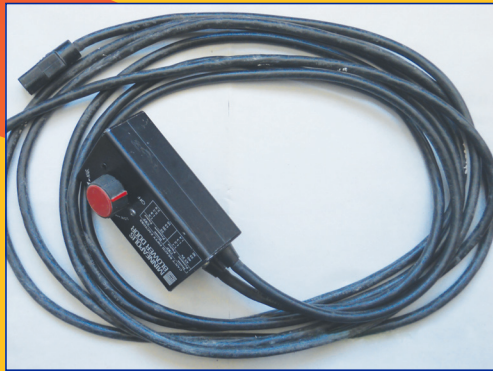
I also found that the clear, long hose that comes with every Minneapolis Blower Door kit is a high-quality hose, but the internal diameter is smaller than that of either the red or green hose, so be careful when using this longer, narrower hose; it will take your gauge significantly longer to equilibrate. I bought a 20-foot hose with a larger internal diameter at the aquarium store for \$6, and the house pressure gauge settles much more quickly with that hose.

The Bones of the Machine

The extruded-aluminum door frame of my Model 3 was frail, and it rattled when I assembled it. When I cammed it in place to do a test on a house, it withstood no more than 30 Pa of house pressure before suddenly popping out of the door. I discovered that the vintage cams were not camming as well as they once did. There were two reasons: The old cams were made of a thinner, more-rounded stock than the new cams, which have a wider face, and the red screw handles used to lock the sliding block in place had four thin plastic postings around the stem that were worn. This allowed a lot of play in the camming lever.

I easily fixed this last problem by carefully unscrewing the bolts out of the sliding block—the screw threads were crimped on the end to prevent them from being unscrewed—then placing a 14-mm washer between the outside face of the cam and the red handle (see second from top photo on previous page). Installing this large washer made the whole door assembly significantly less floppy when I carry the assembled door frame between new houses for sequential testing. This was a simple 30¢ fix as opposed to the more-expensive and involved fixes that I had in mind, which were to build up the face with epoxy, or build a new cam out of a solid piece of wood or plastic. A note of caution when unscrewing the crimped bolt: This is a risky technique; you may have to upgrade the bolt and cut a new thread. But it did work well for me; I worked the thread back and forth an eighth of a turn at a time.

If you're worth your salt doing blower door tests you've pinched a finger in the assembly and disassembly process because you used excessive force. Why not do something about it? The two long vertical pieces of the door frame have four ends of aluminum square tubing that mate with the top and



The good.



The bad.



The ugly.

Typically, the best comparison of pressure gauges is to do at least a three-point check with one measurement each on the low, medium, and high end of the scale.

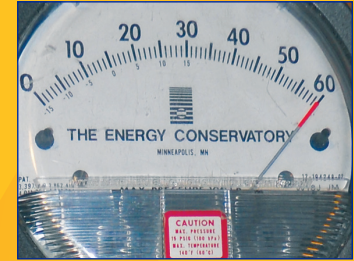
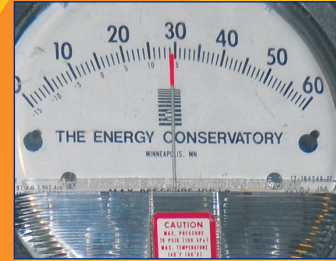
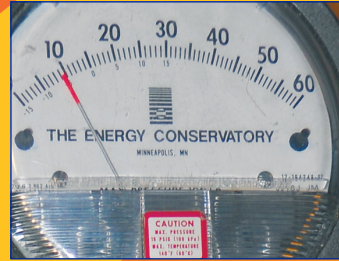
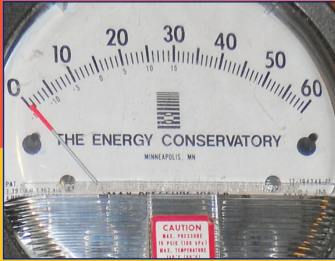
bottom crosspieces. You slide them into the horizontal crosspieces and snap lock them into place. The issue here was severe oxidation of the bare aluminum crosspiece. I had to use too much force to assemble and disassemble the door frame for transportation.

I took the four ends of aluminum square tubing off and discovered that they were held in place with steel bolts and nylon lock nuts. Many of these bolts and nuts were heavily rusted. For less than \$4, I bought new stainless steel bolts and nylon nuts (see photo second from the bottom on p. 48). I'm hoping that this simple replacement may reduce the amount of what I suspect is galvanic reaction taking place between the dissimilar metals in contact with each other. I rubbed the oxide off the aluminum tubing and sprayed it down with Bostik's TopCote product. Assembly and disassembly are now a pleasure. A note of caution: Don't spray the TopCote product in the channel of the frame where the camming blocks will have to bind, as it will cause your camming assembly to slide!

The Face of Minneapolis

The red nylon panel of the Model 3 blower door was tattered and torn and needed a face-lift. The bungee cord that kept the panel collar snugly fit around the fan body had broken out of the nylon, making the door panel completely useless. Because the edge of the nylon was badly frayed, there wasn't enough material to sew a proper hemming seam to lock the edge of the fabric into the seam. I pulled out the finest red polyester I had and sewed the bungee cord back in its cloth pocket with a simple running stitch to close up the seam. Once the seam was secured, I switched to a wide zigzag stitch that helped lock the frayed edge of the red nylon collar in place (see bottom photo on p. 48).

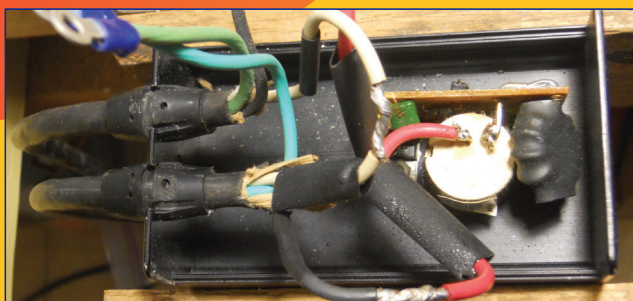
The Velcro closures were charged with a dozen years of fuzz and thread. They all needed to be "dethatched." I did this by hand, by pulling out the fuzz with my thumb and forefinger. I have recently heard that you can buy a Velcro cleaning device. Once it was cleaned out, the Velcro on the middle crossbar once again supported the weight of the fan! A free, 10-minute upgrade.



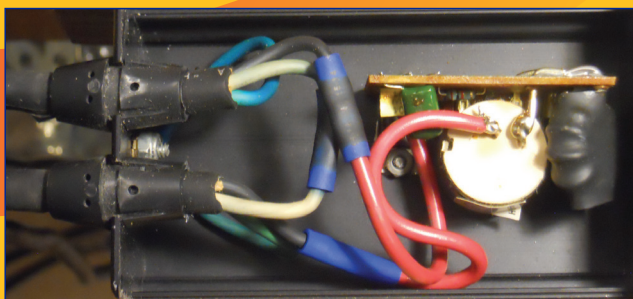
The Central Nervous System

The fan controls for the Minneapolis have come a long way in their design. The problems in the old controls were always the same—cords with broken conductors at the point of entry into the black box and excess heat. This heat was generated either by the transistor, causing the transistor to become unsoldered from the wafer board, or by crimped connections overheating. It's worthwhile to look at these problems in a bit of detail.

Take the power cord issue. If you flex a rubber power cord at the same place repeatedly, the flexible rubber will take the strain, but the braided copper conductor will not. (see “The Good, the Bad, and the Ugly” on previous page.) The conductor eventually breaks, one strand at a time. Next thing you know, the control is cutting out the internal break, generating so much heat that it becomes uncomfortably hot to the touch. It should be noted that at 16 AWG (American wire gauge), replacing the



Newer control. with fresh solder connector.



Newer control. with overheated solder connector.

power cords with a heavier braided conductor (14 AWG) might be advisable, especially if you find you need a bit more length. Over the years, Minneapolis has changed much about the design of its box, but the rubber grommets are still too stubby and inflexible and should be replaced with a more generous strain relief.

The good news is that this is an easy fix. Change your cord wrapping/storage ways. Cut off 6 inches of cord and solder them to replace the old, crimped connection inside the black box (see photos above). Before you solder you might consider slipping a 3-inch length of snugly fitting rubber hose over the cord as a strain relief adjacent to the black box. It is worthwhile pointing out that the transistor must be bolted and bonded to the hull of the control box with heat sink compound, to help dissipate heat effectively. I am pleased to report that after I soldered that internal connection, there was a significant reduction in the amount of heat generated, and I can now hold the box in my hand comfortably for a test.

The design inside the box has come a long way. The new controls are perforated for airflow and come equipped with a mini-cooling fan to clear the heat. The new controls also have a plug-in to allow a computer to control the speed of the fan. So aside from the lack of good strain relief on the power cords, expect the new controls to last significantly longer than the old ones if you store them properly.

The old controls can be repaired, however. Usually this means taking the black box apart and resoldering the transistor to the wafer board. I've had mixed results doing this, since I lack the necessary fine soldering skills. You might find a local electronic repair shop to help. The people at these shops have the skills and tools to do the job properly. You may find that paying for the repair makes buying a new control with its better design look more palatable the next time the control goes on the fritz.

Closing Remarks

All told, I put in a full day shopping for parts, cleaners, and lubricants at a cost of about \$50; and I put a lot of elbow grease into this kit. The end result: I now have a work-

ing blower door kit that's good for a few more years. I have also gained a greater appreciation for what makes my machine tick and how to take care of it. I know what its strengths and weaknesses are, too, so I will be sure to monitor the weakest links. Maybe next year I'll upgrade to a new digital gauge and better speed control if business picks up. If not, back to the shop it will go for round two of repairs!

Epilogue

It's been a month since I made my repairs. The good news: The fan runs brilliantly, the control stays cool to the touch, the frame stays in the doorway. The bad news: The paint is chipping off the plastic rings and the cams are sliding a bit. On this last point I have to make a confession. I sprayed the TopCoat product along the entire length of the frame, and even after I cleaned the frame and lightly scraped off the TopCoat, the cams slip a bit. Would I do it all over again? Absolutely. 

Greg Labbé graduated from Trent University in environmental science. In 1999, after working as an analytical chemist for several years, he joined a nonprofit and turned his attention to low-income weatherization. He's never looked back. Greg was instru-

mental in transforming that nonprofit from a rusty two-panel van operation to a thriving seven-cube van operation, replete with spray foam capability and over 20 energy advisors. He currently runs his own consulting business doing diagnostics, energy modeling, new-home testing, and teaching.

>> learn more

For help in taking apart the Model 3 blower door kit, download the manual at www.energyconservatory.com/download/bdmanual.pdf and see Figure 11, on page 59.

You can buy new Dwyer Magnehelic gauges for \$134 online at www.itm.com/shop/itemDetail.do?itm_id=143674&itm_index=25&item=2000-60P.

For operating instructions for the Dwyer gauges, download the PDF at http://ppd.fnal.gov/experiments/e907/TPC/Gas/Magnehelic_Gauge.pdf.

You can buy a new thermal cutoff switch online at www.amazon.com/dp/B002ZVBE5C/ref=asc_df_B002ZVBE5C1737444?smid=AMMYL3DA7B6AX&tag=nextagusmp0382435-20&linkCode=asn&creative=395105&creativeASIN=B002ZVBE5C.

For information about cleaning Velcro, go to www.youtube.com/watch?v=DAPk9IRMZ_M.