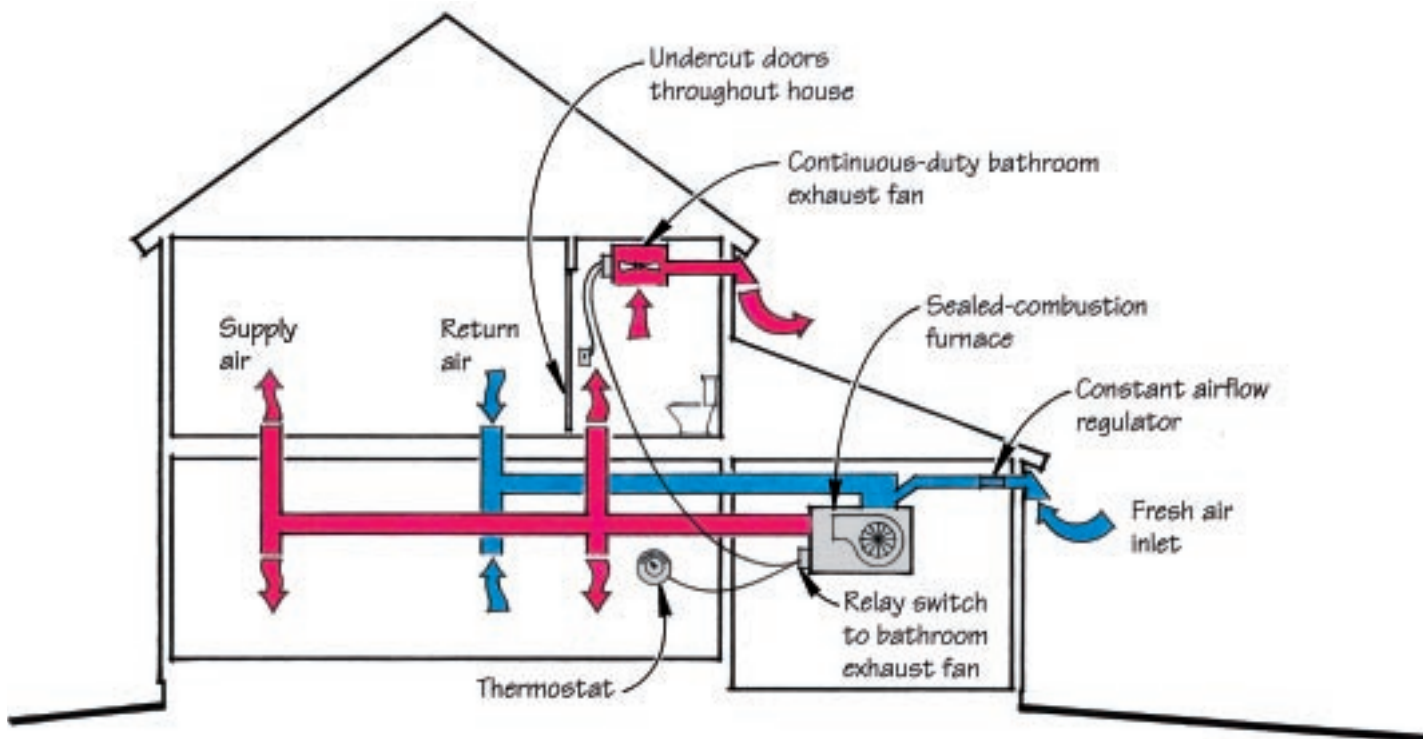


Adding Ventilation to Forced-Air Heat



In this simple ventilation scheme, a constant amount of fresh air is brought into the furnace's return air to be distributed through the house. A slightly greater amount of air is exhausted by the heavy-duty bath fan, which automatically turns on when the furnace blower is operating.

As energy-conscious builders working in a cold climate, we've always provided mechanical ventilation in the houses we build. But our approach to ventilation has changed over the years. At one time, we would put in a 50-cfm (cubic feet per minute) bath fan with some flex vent dropped into the eaves and consider the job done. With today's emphasis on airtight building envelopes and the associated concern with indoor air quality and moisture problems, however, we're taking a much closer look at how we ventilate the houses we build.

My company mainly builds multifamily housing and a variety of commercial buildings. Because commercial

building codes require an automated fresh air supply, we're quite familiar with mechanical ventilation schemes. Only recently has the need for

An upgraded bathroom exhaust fan and a fresh air intake to the furnace's cold air return provide inexpensive balanced ventilation

by Tim Duff

mechanical fresh air ventilation started to gain notice in residential construction. But because multifamily units are built on a tight budget, what works in a commercial building may not meet the cost and space limitations of multifamily construction.

Drawing on our commercial experience, we developed an economical but dependable ventilation system for our multifamily units. The design integrates the operation of the bath fan with the forced-hot-air furnace. Fresh air from outside is distributed through the furnace supply ducts, while the bath fan exhausts a slightly greater amount of stale indoor air. Here's how the system works.



Figure 1. Fresh air from an outside intake (right) is drawn into the furnace return air through a short length of duct, insulated to prevent condensation (above).

Fresh Air Supply

We start with a tight building envelope. Blower-door tests show that our multifamily units have an infiltration rate of between .2 and .3 air changes per hour. In our climate (northern New England), houses this tight will have excessive condensation on windows in the winter unless adequate ventilation is provided.

We typically install a sealed-combustion gas-fired furnace, working closely with our hvac sub in sizing and installation of the ductwork. Proper duct sealing is critically important: A leaky duct system can create havoc by pressurizing the floor system, forcing out warm, moist air that condenses against the band joist.

The forced-hot-air system provides us with the blower and ductwork to distribute fresh air throughout the house. It's simple and inexpensive to connect a fresh air duct (insulated to prevent condensation) from outside directly into the return air duct (Figure 1). Fresh air is drawn in by the furnace, mixed with return air, heated, and distributed throughout the home. (This is similar to the fresh air ducts typically required by code in commercial buildings.)

Controlling the Fresh Air Supply

For our ventilation system to work properly, and for the furnace's supply and return ductwork to remain bal-

anced, we have to regulate the amount of fresh air that enters the return air. If we simply terminated the fresh air duct on the exterior wall without any kind of control damper, the amount of air coming in would fluctuate, depending on outside temperature and wind conditions.

To regulate the fresh air coming in, we install a Constant Airflow Regulator (CAR), made by American Aldes (4537 Northgate Ct., Sarasota, FL 34234; 813/351-3441) in the fresh air supply duct near the intake. This unique device has a silicone bulb that inflates as the air velocity through it increases (Figure 2). As the bulb expands, it restricts the opening, allowing a constant, measured amount of air-

flow. The CAR installs directly inside the round metal duct, and is available for standard-diameter ductwork and in many different cfm settings.

How much fresh air should we bring in? Most codes reference ASHRAE (American Society of Heating, Refrigerating and Air-Conditioning Engineers) standard 62-1989, which requires a minimum of 15 cfm fresh air per person during occupancy periods. The calculation is based on two people for the first bedroom and one person for each additional bedroom. So in our two-bedroom townhouses, for example, we design a system capable of delivering at least 45 cfm of fresh air. The ASHRAE number is a minimum — we actually try to provide more air by using a CAR that delivers 60 cfm of fresh air.

Exhaust Fan

To exhaust the stale air from the house, we rely on an upgraded bathroom fan rated for continuous use. Because occupants will often turn off a mechanical ventilation system if it's too noisy, we use a Broan 360, which, at 1.5 sones, is very quiet (Figure 3). To ensure adequate air circulation throughout the house, we undercut the bathroom door so that the fan can still pull air from the rest of the house even when the door is closed. The Broan 360 is rated at 110 cfm at .1 inch of water column.

We link the operation of the bath fan to the operation of the furnace with an electrical relay (Figure 4). When the thermostat calls for heat by closing its contacts and energizing the low-voltage



Figure 2. The Constant Airflow Regulator (CAR) installs inside standard round ductwork. As static air pressure increases, the silicone bulb inside the CAR automatically inflates, restricting the free area of the opening to maintain a constant measured airflow. CARs are available in a variety of standard sizes and capacities.



Figure 3. The Broan 360 Losone Ventilator provides exhaust for the author's ventilation system (inset). Undercutting interior passage doors helps ensure adequate airflow throughout the home, even when doors are shut (above).

line to the furnace control system, the electrical relay closes and energizes a 110-volt circuit to the bath fan.

The most important reason for wiring the exhaust fan in unison with the furnace operation is to avoid over-pressurizing the home. If we were to simply allow fresh outside air in without exhausting at least as much, the addition of outside air into the home would create a positive indoor pressure, forc-

ing warm, moist interior air into wall and ceiling cavities where it would condense and cause long-term moisture problems. We purposely try to exhaust more air than we bring in, to keep the house at a slight negative pressure. It's absolutely essential to use sealed-combustion appliances with a system like this — otherwise, indoor negative pressure could pull dangerous combustion gases back into the house.

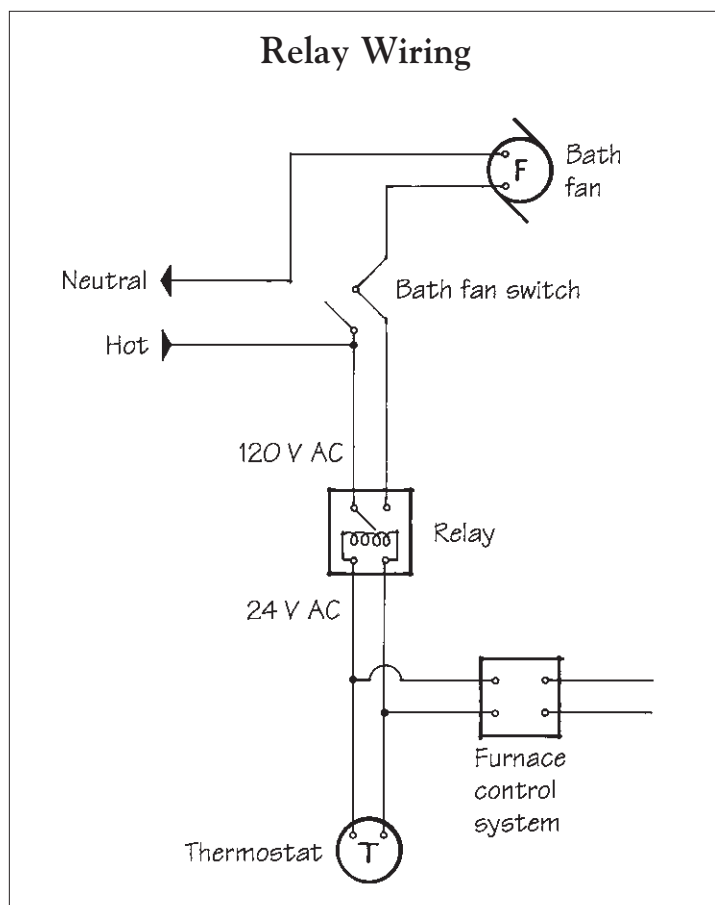


Figure 4. The Broan exhaust fan is coupled to the furnace blower with a low-voltage relay. When the thermostat turns on the furnace control, the relay closes a 120-volt circuit, turning on the bath fan. A switch in the bathroom is wired in parallel to allow for manual operation of the fan.

We install the bath fan with as short and straight a duct run as possible, to minimize static pressure loss. (If you use flexible vent and have lots of elbows and a long duct run, you may find the 50-cfm gerbil wheel you have been installing for a fan is hardly moving any air at all.) We seal the exhaust ductwork just as carefully as we seal the furnace ductwork.

Operation of the System

One problem associated with residential mechanical ventilation is that many people think they are “wasting” heated air when they run their bathroom exhaust fan, for example, so they avoid using it. This is a misconception. The reality is that the energy penalty for heating the fresh air supplied through controlled ventilation is really quite low when balanced against the need for healthy indoor air. (In cold climates, we spend at least 80% of our time indoors during the winter.) So our design doesn't even give the homeowner the option of cutting off the ventilation system. But because the bath fan switch is wired in parallel, the homeowner can still turn the bath fan on and off manually. If the relay from the thermostat has already closed the circuit, the fan will stay on until the furnace blower stops.

We've been using this system in our multifamily units for about four years. From our standpoint, the results are nothing short of miraculous. In past years, when we built identical multifamily units without this ventilation system, we would typically get calls about condensation on the windows during the winter. Those calls have dried up. In addition, no residents have complained about noise from the intermittent operation of the bath fan.

In the future, we may explore the use of a low-level continuous ventilation system. But for now we're satisfied with this system. The bottom line is that by adding and upgrading a few components in our homes, we've added the benefits of controlled ventilation and good indoor air quality while still maintaining low overall fuel costs. ■

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