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THE MECHANICS OF HOME BUILDING

BY JUSTIN FINK

Ground-source heat pumps

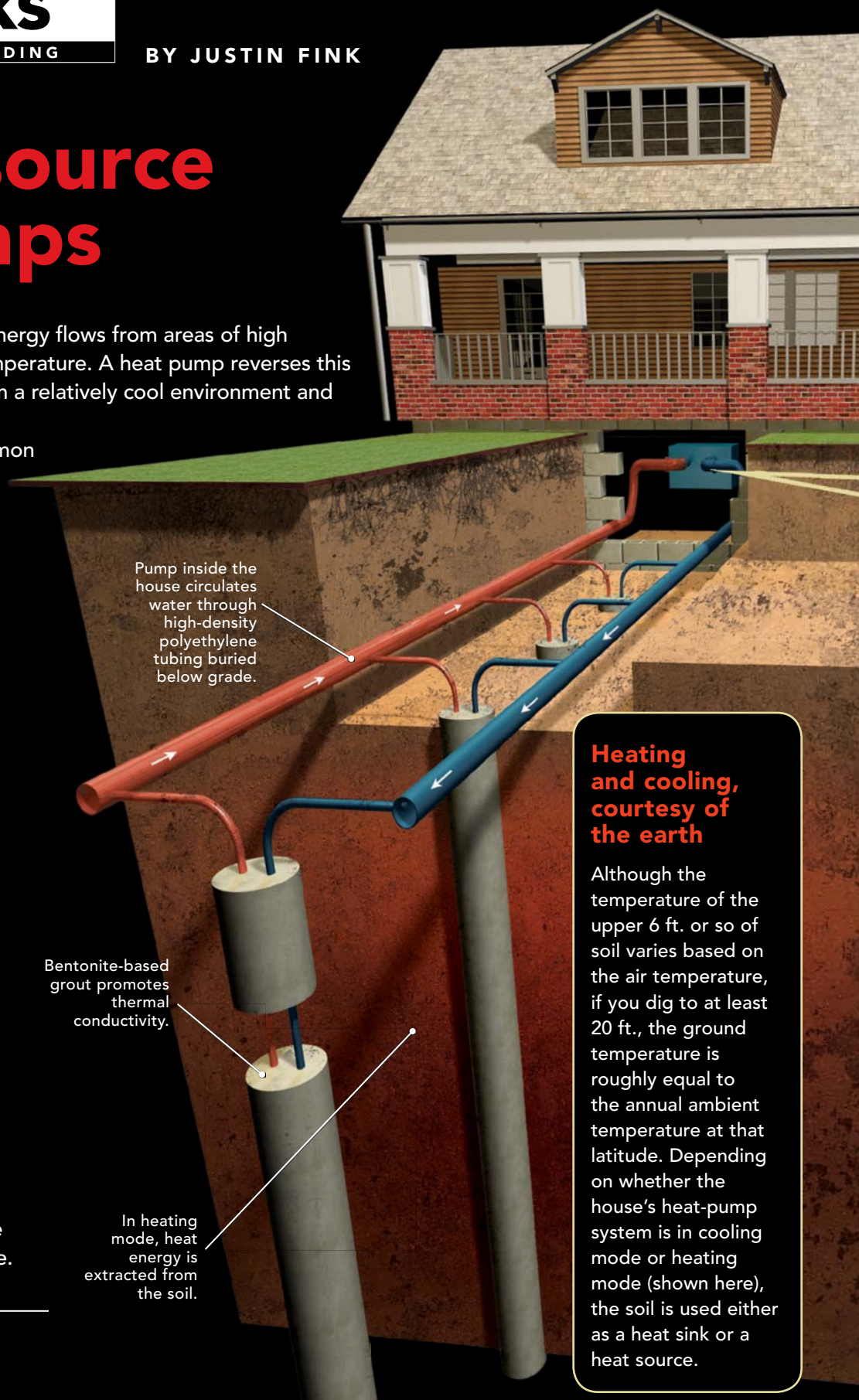
Left to its natural devices, heat energy flows from areas of high temperature to areas of low temperature. A heat pump reverses this natural process, absorbing heat from a relatively cool environment and moving it to a warmer area.

A window air conditioner is a common example of a heat pump. The interior of a room is not cooled by pumping it full of cold air; rather, it's cooled by extracting heat from the room and dumping it outside. A heat pump can also be used to warm a room by reversing the process—that is, pulling heat energy from the exterior air and distributing it inside.

The flaw of air-source heat pumps (ASHPs), the most common type, is that their efficiency decreases with increased temperature extremes. The more frigid the air outside your house, for example, the harder the ASHP has to work to extract usable heat energy. That's why many homes are relying on ground-source heat pumps (GSHPs) for air-conditioning and heating at a higher level of efficiency.

Instead of air, a GSHP uses the relatively stable temperature of the earth as either a heat source or a heat sink depending on whether the system is in cooling or heating mode. Here's how it works.

Justin Fink is Project House editor.



Heating and cooling, courtesy of the earth

Although the temperature of the upper 6 ft. or so of soil varies based on the air temperature, if you dig to at least 20 ft., the ground temperature is roughly equal to the annual ambient temperature at that latitude. Depending on whether the house's heat-pump system is in cooling mode or heating mode (shown here), the soil is used either as a heat sink or a heat source.

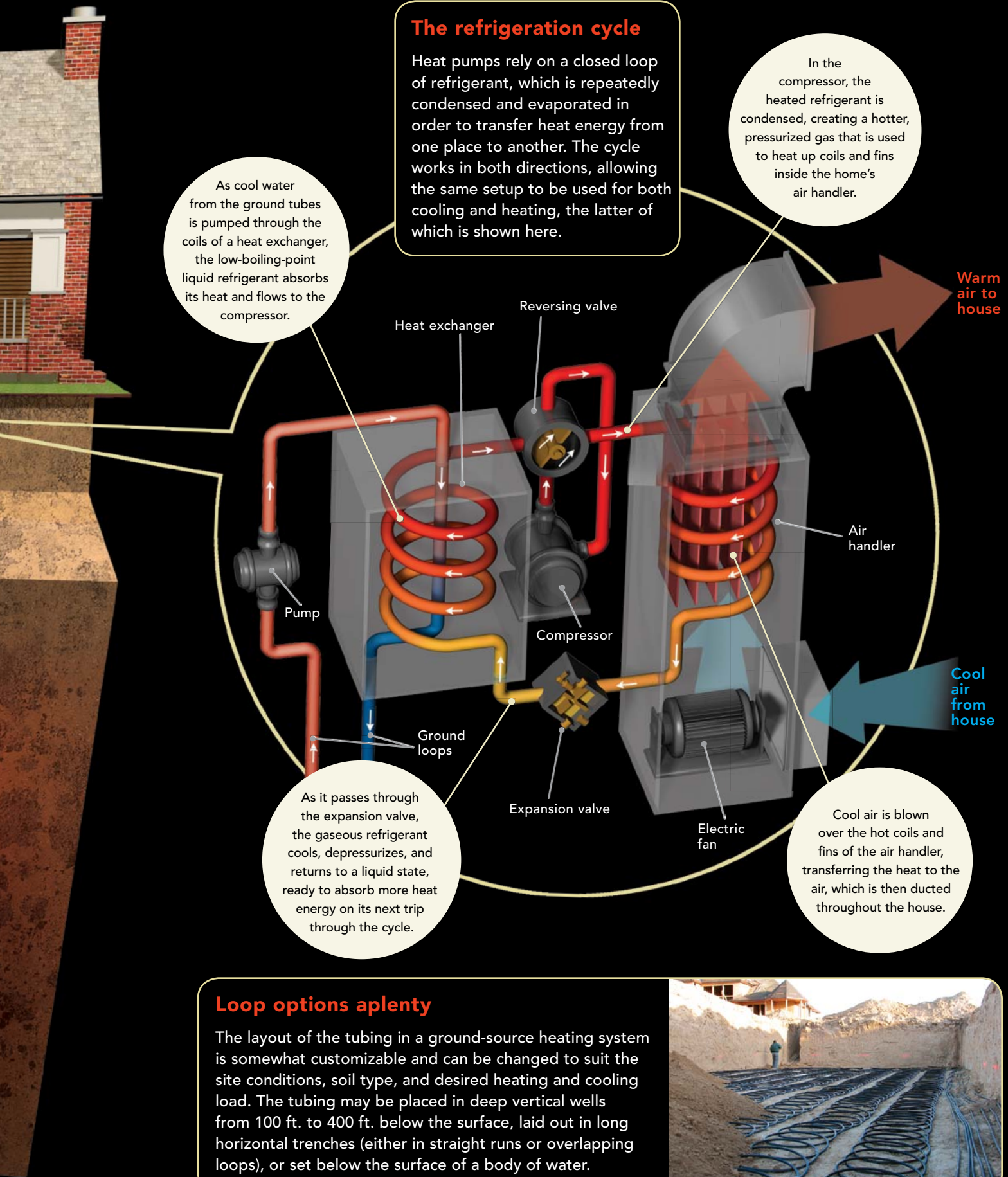
Drawings: Don Foley

The refrigeration cycle

Heat pumps rely on a closed loop of refrigerant, which is repeatedly condensed and evaporated in order to transfer heat energy from one place to another. The cycle works in both directions, allowing the same setup to be used for both cooling and heating, the latter of which is shown here.

In the compressor, the heated refrigerant is condensed, creating a hotter, pressurized gas that is used to heat up coils and fins inside the home's air handler.

As cool water from the ground tubes is pumped through the coils of a heat exchanger, the low-boiling-point liquid refrigerant absorbs its heat and flows to the compressor.



As it passes through the expansion valve, the gaseous refrigerant cools, depressurizes, and returns to a liquid state, ready to absorb more heat energy on its next trip through the cycle.

Cool air is blown over the hot coils and fins of the air handler, transferring the heat to the air, which is then ducted throughout the house.

Loop options aplenty

The layout of the tubing in a ground-source heating system is somewhat customizable and can be changed to suit the site conditions, soil type, and desired heating and cooling load. The tubing may be placed in deep vertical wells from 100 ft. to 400 ft. below the surface, laid out in long horizontal trenches (either in straight runs or overlapping loops), or set below the surface of a body of water.

Photo: courtesy of Idaho Geothermal, idahogeothermal.com