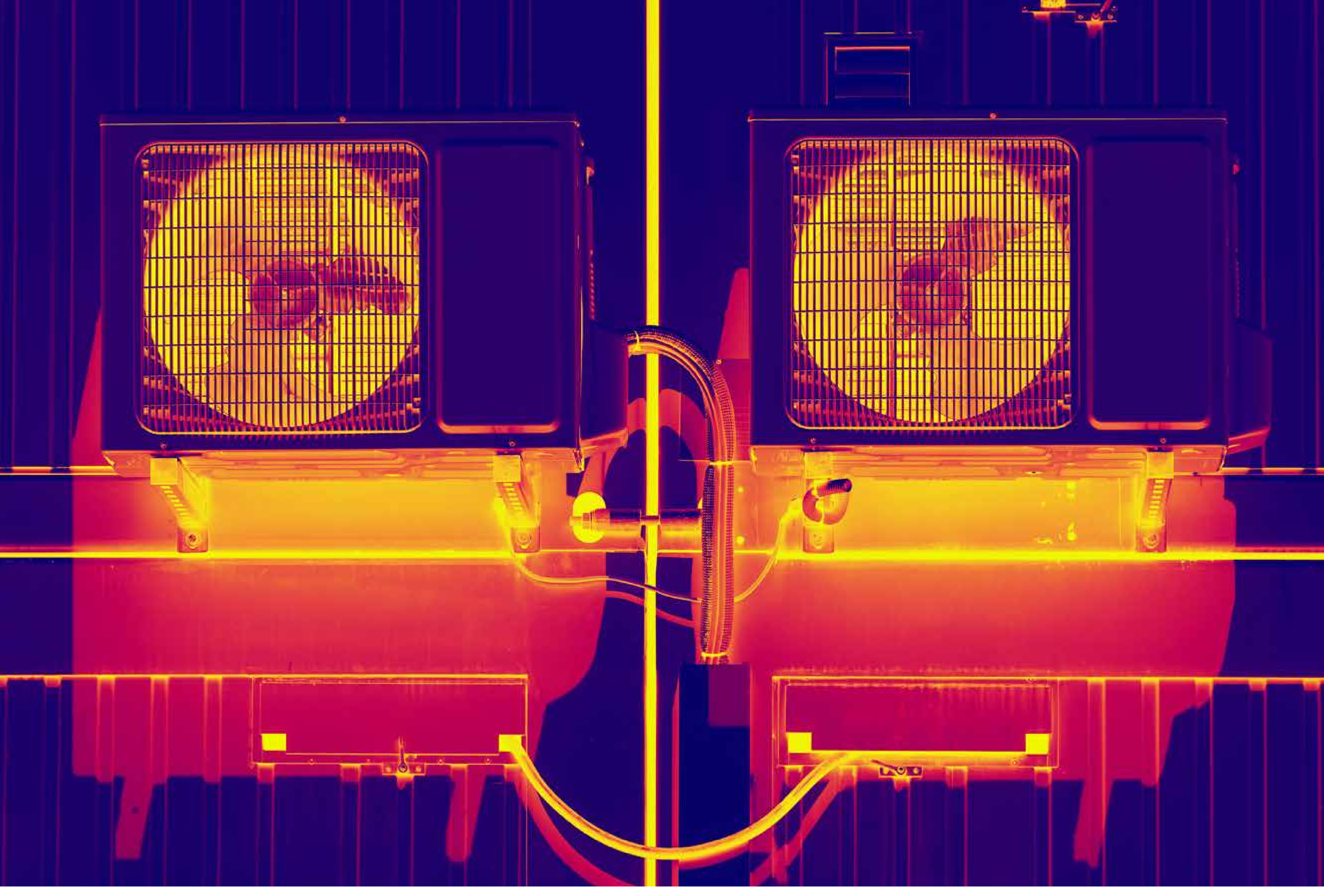


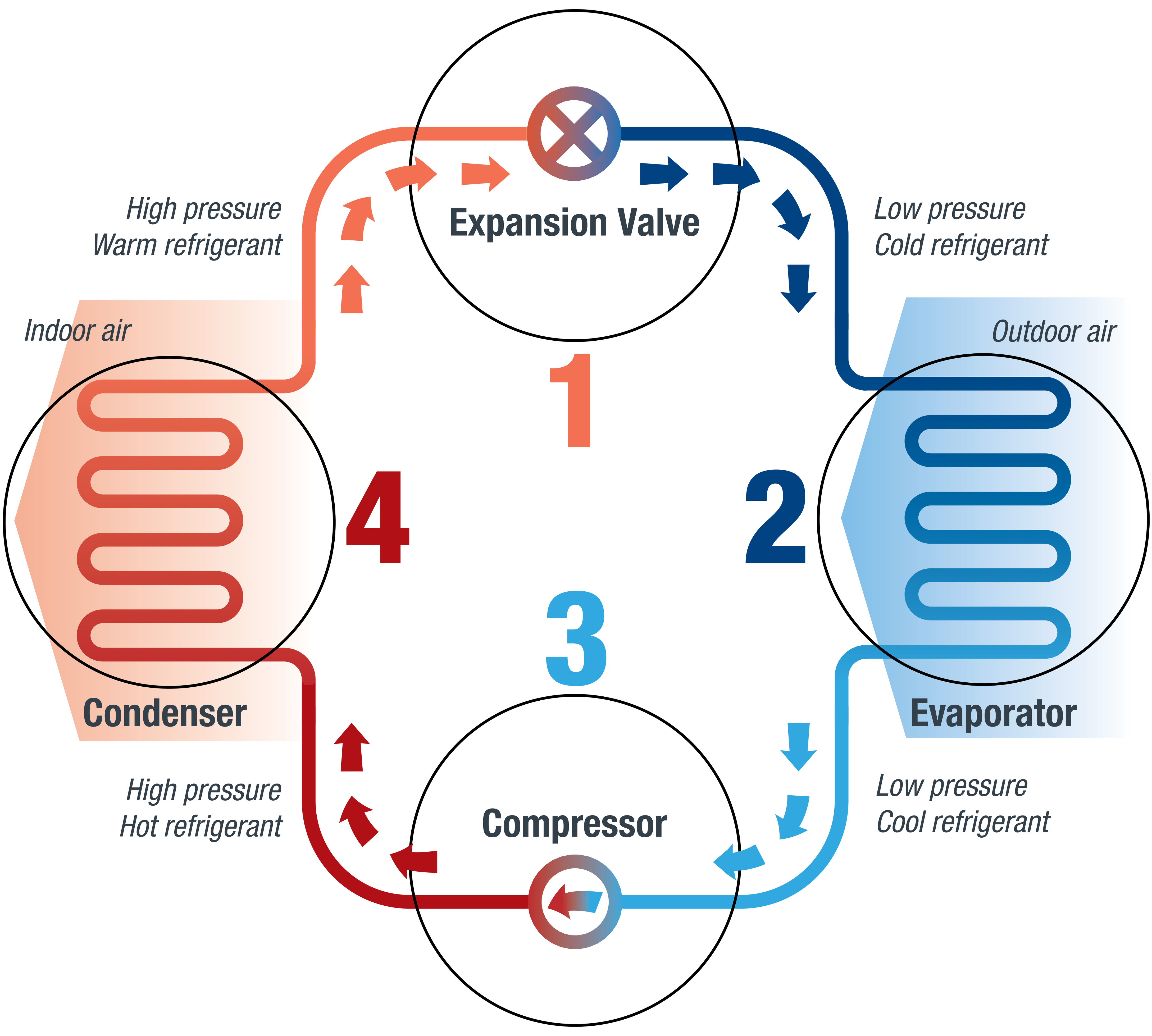
How Heat Pumps Work

BY JEFFREY WINTERS

One of the most hard-to-replace applications for fossil fuels is space heating. When you burn fuel, most of the released energy is in the form of heat, which can be applied directly to heating the air. One alternative is resistive heating, which uses electricity to warm up coils. The cost of electricity per Btu is generally several times higher than gas, which makes resistive heating more expensive even if all the electricity is converted to heat.

Heat pumps improve on standard electric heating. Rather than use electricity directly, heat pumps take advantage of the thermodynamic properties of a refrigerant to move heat from one place to another. By some estimates, the amount of heat a heat pump can bring to a space can be as much as twice the energy content of the electricity needed to run the device.

That sounds like magic, but heat pumps involve standard engineering. Here's how they work.



Heat pumps have a lot in common with air conditioners or refrigerators. They all have two sets of coils, with a motor to move refrigerant from one side to the other and back. The key is finding a refrigerant fluid with a low boiling point, so that it can absorb heat from low-temperature sources, such as the outside air on a frigidly cold day, as it makes a round trip through the system.

1. EXPANSION VALVE

As the working fluid moves through the heat pump, it passes through the expansion valve, which reduces the pressure of the fluid. In the process, the fluid goes from being a warm, high-pressure liquid to a cold, low-pressure fluid.

2. OUTDOOR HEAT EXCHANGER

It may not seem as if air as cold as 20 °F has any heat, but the low-pressure refrigerant is even colder. As the refrigerant passes through the heat exchanger (on this side, it's called an evaporator), it absorbs some of the energy from the outside air. Under low-pressure conditions, even the outdoor temperatures on a cold day are warm enough to boil the refrigerant. In some systems, the heat exchanger draws energy from water circulating in pipes underground.

3. COMPRESSOR

The slightly warmed refrigerant gas reaches a compressor, which increases the pressure on the gas and raises its temperature. The pressure also increases the boiling point of the refrigerant.

4. INDOOR HEAT EXCHANGER

The higher boiling point for the pressurized gas enables it to condense at a temperature far above room temperature. The phase change from gas to liquid releases energy—including the energy the gas absorbed in the outdoor heat exchanger—into the indoor air. Now that the high temperature gas has condensed into a warm liquid, it can complete the round trip and start the cycle at the expansion valve all over again.

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