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New Refrigerator Cools With **Sound**

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Conventional refrigerators use gases that can harm the environment. Steven Garrett and his colleagues at the Naval Postgraduate School in Monterey, California, have developed a prototype for a home refrigerator that cools with **sound**. The only chemicals it uses are inert gases that have no effect on the environment. He described his invention in February, at the annual meeting of the American Association for the Advancement of Science, in San Francisco.

Singing Glass

Glassblowers first noticed the link between **sound** and temperature centuries ago. To blow glass, they attach a blob of molten glass to the end of a long glass tube. The tube is cool so they can touch it with their lips. The glassblowers observed that when the molten glass heated the other end of the tube, it began to "sing." Thermoacoustic refrigeration reverses this process, using **sound** waves to chill.

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The cooling apparatus of the thermoacoustic refrigerator is made up of a tube filled with two inert gases, helium and either xenon or argon. The gases are pressurized to about 21 times normal atmospheric pressure. At one end of the tube, a loudspeaker emits a steady tone thousands of times louder than a rock concert.

The sides of the cooling unit, which must be rigid to hold the pressurized gas, also prevent the loud sounds from escaping. The refrigerator is quieter on the outside than ones now available. "We need a stethoscope to tell if it's running," Garrett told *Science News*.

The vibrations of the speaker create a "standing wave" in the tube. A standing wave does not move through the gas like a wave moving through water. Instead, it causes the molecules in the gas to swing back and forth about one millimeter up and down the tube. When the molecules move toward the speaker, the gas compresses and heats up. When the molecules move away from the speaker, the gas expands and cools.

Heat Absorber

Garrett and his colleagues use the heating and cooling of the gas to cool food and drinks in a separate storage area.

Within the gas chamber is a rolled-up sheet of plastic film, called a stack. The side of the stack farthest from the speaker is cool, because that is where the gas expands and cools. Alcohol flows through tubes at the cool end of the stack and becomes chilled. The tubes circulate the cooled alcohol around the storage area, chilling the food and drinks inside.

Meanwhile, a different set of tubes carries water past the hot end of the stack. The water absorbs heat there and flows to a radiator. An exhaust fan blows air over the warmed water in the radiator, allowing heat to escape into the atmosphere. As a result of the **sound** waves heating and cooling different ends of the stack, heat moves from the food, through the stack and out into the atmosphere.

Space ThermoAcoustics

Garrett and his colleagues began experimenting with thermoacoustic cooling in the early 1980s at Los Alamos National Laboratory in New Mexico. The result of that effort was called the Space ThermoAcoustic Refrigerator. It flew on the space shuttle Discovery in January 1992.

Refrigeration systems on satellites may also be able to use this technology. Traditional cooling units vibrate too much and disrupt sensitive telescope imaging. Garrett's refrigerators vibrate less than conventional ones.

Because it uses inert gases that do not harm the environment, acoustic cooling is an attractive alternative to conventional forms of refrigeration and air conditioning, which use ozone-destroying chlorofluoro-carbons (CFCs) as coolants. Production of CFCs will be banned in 1996.

Garrett calls his latest thermo-acoustic refrigerator the Thermo-Acoustic Life Sciences Refrigerator. It is 40 times more powerful than the refrigerator that flew on the space shuttle. Like conventional refrigerators, it can cool to 4°C (39°F) with 205 watts of energy. Its freezer can chill to -22°C (-8°F).

Acoustic cooling technology might also be used someday in air conditioners and cooling systems for computers.

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