A new, sound way to refrigerate

The steam engine, the internal combustion engine, the Stirling engine, the refrigerator and the heat pump are all examples of heat engines. At a recent meeting of the Acoustical Society of America, physicist John C. Wheatley of the Los Alamos National Laboratory reported a new addition to the list: the "acoustic heat engine," which uses sound waves to generate temperature changes. This acoustic device is an application of general principles that open up the possibility of a new class of heat engines, says Wheatley.

Wheatley's acoustic engine consists of a 1-meter-long tube, about 3 centimeters in diameter and closed at one end. A stack of fiberglass plates, about 10 centimeters long and spaced a millimeter apart, sits inside the tube (see diagram). The tube is filled with a gas (helium, in this case) and closed by a piston that can vibrate at acoustic frequencies, from 150 to 1,000 cycles per second. If the plates were not present, the piston's vibrations would simply cause the tube walls to heat up. When the plates are inserted and the piston vibrates at such a frequency that acoustic resonance occurs, "then something really remarkable happens," says Wheatley. One end of the plates rapidly becomes cold while the other heats up. In a few minutes, the temperature difference may be 100°C or more.

Wheatley says that as the gas in the tube oscillates across a plate's surface, heat flows out of one end of the plate, through the gas along the plate's surface and back into the other end. "As the temperature difference develops between the two ends, the amount of heat that flows decreases, and there is a more-or-less limiting value of the temperature difference, depending mainly upon the gas," he says.

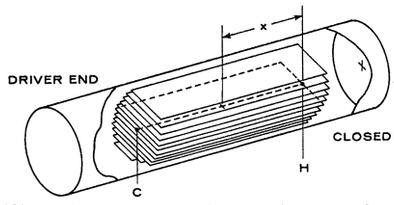
"The plate material doesn't matter," says Wheatley. "However, if you want to develop a longitudinal gradient, then it's important that you not short out the effect by having all the heat you're pumping in the gas come skidding back down this solid material." A thermal insulator like fiberglass works better than a metal.

Wheatley acknowledges that an enormous amount of prior work has been done on thermal acoustics. For example, "creating sound from heat is a most exceedingly ancient topic," he says. What's new is the insertion of plates inside a tube and the potential use of such a device as a kind of refrigerator (by utilizing the cold end).

More significant, Wheatley says, is that the principles embodied in the acoustic heat engine may apply to a broad range of physical systems. Instead of a gas and plates, any two thermally active materials in reciprocating motion with respect to each other can be used. The effect would occur as long as several thermodynamic conditions are met. These general principles can apply, for example, to magnetic solids oscillating in a magnetic field. "They may apply to other physical processes that on the surface aren't remotely connected with the general thought of heat engines," says Wheatley.

What's next? "Thought," says Wheatley. "We're going to do a quantitative study of heat flow, work flow and so on in this engine. Then we are going to try to think of ways of making it into a cooling engine."

"It's really important to note that we do not have any kind of a practical device,"



Wheatley/Los Alamos

Wheatley cautions. It may be possible to achieve cooling to cryogenic temperatures, but several more ingredients have to be added. Meanwhile, Wheatley and his group have submitted a paper on the basic ideas behind the acoustic heat engine to PHYSICAL REVIEW LETTERS. —*I. Peterson*

Yellow rain continues to fall, says U.S. gov't.

The State Department last week presented what it considers to be conclusive proof that Soviet-supplied fungal toxin weapons continue to be used to battle resistance forces in Southeast Asia and Afghanistan. A report detailing this evidence was sent by Secretary of State George P. Shultz to the Congress and United Nations.

Use of chemical weapons is internationally outlawed by the 1925 Geneva Protocol. Since September 1981, State Department officials have released various pieces of evidence, including analyses of vegetation from battle areas, in an attempt to document Soviet use of "yellow rain," a chemical weapon based on a poison produced by the fungus *Fusarium* (SN: 10/17/81, p. 250; 5/22/82, p. 343). Thus far, the department's attempts to call worldwide attention to the issue have resulted only in independent, inconclusive reports by the Canadian government and a U.N. team and official statements of condemnation by the British and Thai governments. "These efforts have not led the Soviets and their allies to halt their illegal use of chemical and toxin weapons," Shultz said in a preface to the latest report.

Among the evidence of this continued use of chemical weapons is the finding of traces of yellow rain components on two captured Soviet gas masks that had been used in Afghanistan, the State Department's Gary Crocker announced at a press conference. Crocker said that one of the masks had been taken from the head of a dead Soviet soldier somewhere in Afghanistan, and the other was obtained in the capital city of Kabul. The masks were analyzed at the U.S. Army Chemical Systems Laboratory in Aberdeen, Md., the recently released report states.

After reading this latest report, Matthew Meselson of Harvard University in Cambridge, Mass., told SCIENCE NEWS, "The time has finally come for the U.S. government ... to ask the National Academy of Sciences, or any other reputable organization of American science, to put together a panel of highly respected, senior scientists and to put in their hands everything it possibly can in the way of evidence." Meselson, who has in the past counseled the Defense Department on chemical warfare matters, has criticized the current administration's handling of the yellow rain issue. He says there still are questions about whether all the laboratory analyses for yellow rain have followed accepted scientific procedure — for example, by including analyses of control, as well as presumed contaminated, samples. Meselson also said, "Now that there is a new Soviet regime, we should [approach it] at the highest level possible to find some way to get a much franker discussion of this issue than we have gotten in the past."

— *L. Garmon*

Creation law voided

Federal District Judge Adrian Duplantier on Nov. 22 granted a request for summary judgment to plaintiffs challenging Louisiana's creation-science law. The judge ruled that the First Amendment to the Constitution prohibits the government from dictating not only what subjects be taught but also how they will be taught. The Louisiana law, passed last year, would have required that schools teaching the theory of evolution must also teach "creation science" — a theory that all of the universe and life within it were created "from nothing," that man and apes have separate ancestry, and that mutation alone cannot account for the variety of lifeforms on earth (SN: 1/2/82, p. 12).

Had this law not been struck down, the plaintiffs (including the Louisiana State Board of Elementary and Secondary Education and the American Civil Liberties Union) were prepared to argue that creation science as described in the law was a thinly veiled disguise for the fundamentalist Christian view of creation derived from the Bible. As such, they charge that teaching creationism in public schools would violate the separation of church and state guaranteed by the First Amendment.

A similar law in Arkansas was struck down earlier this year (SN: 1/16/82, 46). Unlike Arkansas, it appears the state of Louisiana will appeal the ruling. □