Solar heat with perks

An ingenious new solar water heater is passive, freezeproof, and there's no tank on the roof. How does it work? Would you believe, like Old Faithful?

By MARNIE McPHEE

Amory Lovins, energy and environmental consultant, took one look at an early version of a new solar water heater and ordered one for his Rocky Mountain Institute in Old Snowmass, Colo.

Steve Baer, a solar-energy pioneer and owner of Zomeworks in Albuquerque, N.M., hailed the device as "perhaps the most important invention in solar heating since 1976."

Christopher Flavin of the Worldwatch Institute in Washington, D.C., exclaimed, "It is the most cost-effective solar hot-water system to be developed in the last decade."

The object of these experts' admiration goes by the improbable name Copper Cricket, but it has some impressive attributes: It is freezeproof, efficient, relatively affordable, and not bad looking. And it has no moving (or even electronic) parts. Its working fluid flows through the system courtesy of a "geyser-pumping action," the phenomenon that perks coffee and shoots off Old Faithful.

Development of the system actually started 10 years ago when physicist Dr. Eldon Haines and a colleague began studying geyser pumping, which simply stated is this: As a fluid boils, the force of its vapor lifts liquid upward along with the gas bubbles.

"It was an old art in the patent library," Haines notes. In fact, others have made bubble-lift solar collectors, as he calls them. "But there were always problems," he says. One by one, Haines and a few scientist colleagues found solutions. In 1984 Haines patented his geyser-pumping technique, and in 1986 launched Sage Advance Corp. ("a wise step forward") to market the Copper Cricket. (It makes a faint chirping sound as it works.)

How does it work? Basically, it is a liquid-filled closed-loop system. The sun heats the liquid in the riser tubes of the glazed, flat-plate collector. This heat is transferred to the tap water through a heat exchanger.

Then the innovations begin.

Freeze protection is guaranteed because the system uses a 15-percent methanol-water solution in the collector loop. Haines says they chose methanol because it was "the only material with a relatively low viscosity, low boiling and freezing points, a high heat capacity, and a high rate of pressure change with temperature change." Also, the solution remains slushy and doesn't expand when it freezes, so there's no possibility of burst pipes. Methanol is moderately toxic, though, so the heat exchanger has double walls to isolate it from the potable water.

It's evacuated

The system is evacuated, which allows the methanol solution to boil at a relatively low temperature: 65 degrees F. This increases performance because the lower the operating temperature, the less heat the collector will lose to its surroundings.

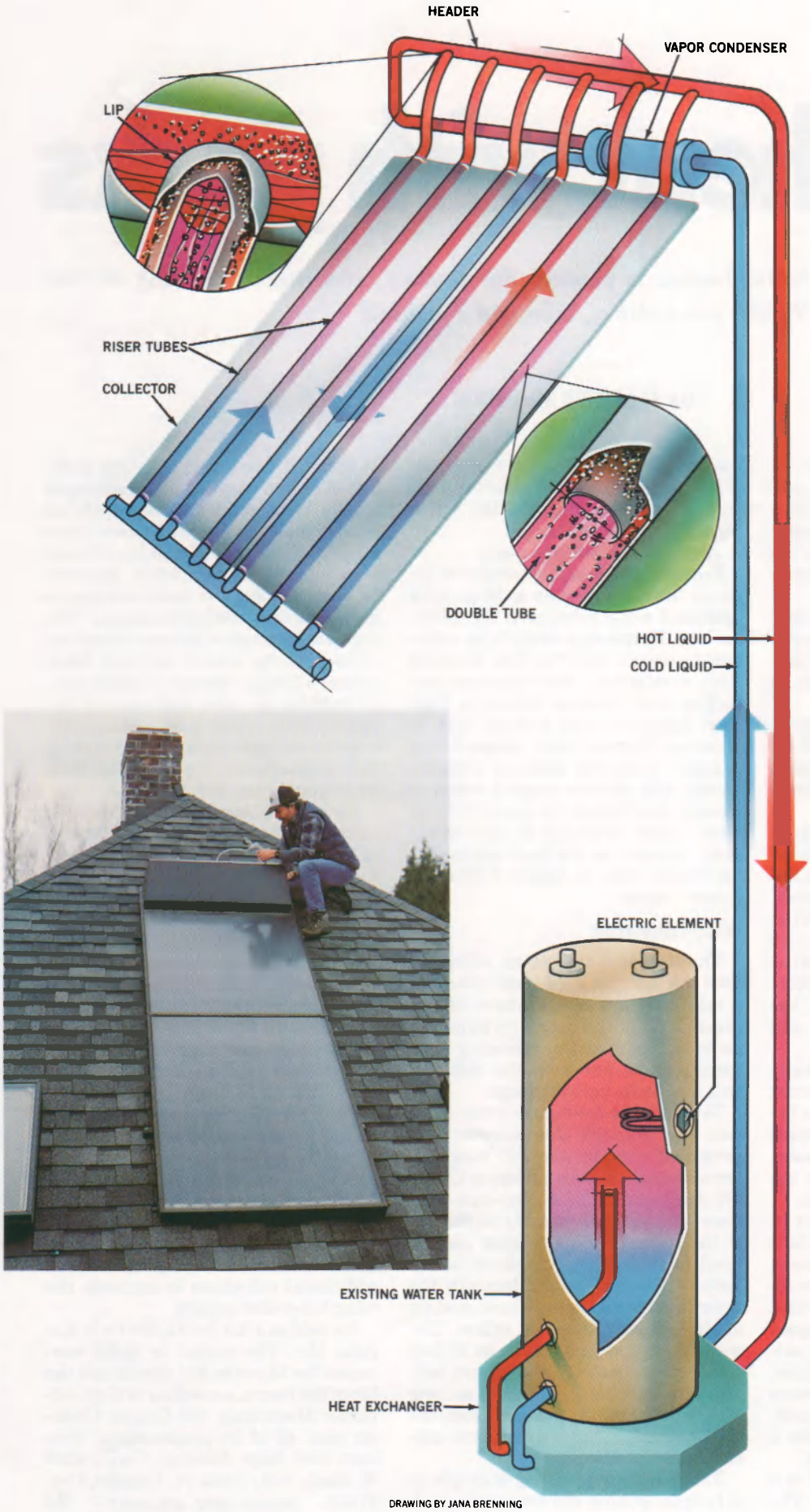
To make the methanol-water solution flow through the collector loop propelled only by the lift from the geyser-pumping action, Copper Cricket's designers added a nine-inch-high riser and header assembly to the top of the collector. This creates enough head to push the liquid down to the heat exchanger, located beneath the water heater inside the house, and up again without pumps or valves. The water tank can be as much as 36 feet below the collector. This passive self-regulated pumping continues as long as the collector is warmer than the storage tank. The drawing and caption give the details.

Though geyser pumping is simple in principle, getting the system to work in the real world was not. One problem that had plagued other attempts to use it in solar-heating systems slowed down the Copper Cricket team for a year. "In any closed-loop boiler, after it has boiled for a while, you have to keep upping the temperature to keep it boiling," Haines explains. "The problem is you start to lose nucleation sites—points where bubbles form around a foreign substance, in this case, air bubbles. As more and more air dissolves into solution it becomes harder to get the liquid to boil." You end up with a superheated liquid (hotter than its boiling point) but no vapor.

Haines and his colleagues came upon a solution to the problem while trying to solve another. "We wanted to make the throat size of the riser tubes smaller so that the bubbles would lift better," Haines relates. "So we tried inserting a smaller tube within each riser tube for about a third of its length. That left a thin sheet of stagnant liquid between the inner and outer tubes. We soon found that the liquid there quickly boils and becomes superheated steam, and that provides the nucleation sites for more bubbles to form."

The Copper Cricket is a one-size-fits-all system designed to provide 100 percent of the hot water for a three- to four-person household during the summer. This keeps costs down and prevents summer overheating, but delivers less of the annual load than would a larger system (see table). Some people install additional collectors to increase the solar hot-water supply.

It's sold as a kit for $1,880 f.o.b. Eugene, Ore. The system is under warrantee for 10 years, but should last the life of the house, according to Sage Advance. More than 100 Copper Crickets (and 40 of its predecessors) have been sold. Sage Advance Corp., 4209 W. Sixth Ave., Suite A, Eugene, Ore. 97402. **Phone (503) 485-1947** PS



DRAWING BY JANA BRENNING

Solar energy absorbed in the Copper Cricket heats and boils the liquid, a methanol-water solution, in the narrow passage between inner and outer tubes in the top third of the collector. Steam bubbles push out of the lower end of that passage, forming nucleation sites for the formation of more steam. Soon pressure is high enough there to push the column of liquid above out into the header, along with a burst of vapor.

The riser tubes extend about halfway into the header tube, forming a lip that keeps the liquid from flowing back down the riser tubes. The header tube is higher on the left side so the hot liquid flows into the tube connecting it to the heat exchanger (which, because liquid seeks its own level, is already filled to the same level as the riser tubes in the collector).

As the additional hot liquid piles up above the liquid already in the tube, it accumulates enough head to push that column of liquid down through the heat exchanger (where it gives up heat to the cooler water that passes through the other side) and back up the return tube and into the vapor condenser.

Meanwhile, the vapor up in the header rises to the top of the tube and is sucked into the vapor condenser because the cool returning liquid creates a low-pressure area there. Once the vapor meets the cool liquid, it condenses, and the whole batch flows back to the bottom of the collector to repeat the cycle.

The potable water flows through its side of the heat exchanger in a thermosiphon cycle; no pump is used.

The Copper Cricket solar water heater is evacuated with a hand pump after installation (photo left). The low-profile bronze-anodized-aluminum collector mounts directly on any roof with a pitch from 2/12 (two inches of rise per foot or run) to 21/12.

What would it do for you?

Last summer the Copper Cricket was tested by the independent Solar Rating and Certification Corp. [June '83]. Using the SRCC's rating, 22,000 Btu/day, and guidelines established by the Oregon Department of Energy*, here's an estimate of how much of the annual hot-water load a Copper Cricket would provide in five areas.

Location	Contribution
Boston MA	43%
Columbia MO	54%
Medford OR	55%
Tampa FL	82%
Phoenix AZ	91%

*Hot water tank is assumed to be insulated and set at 120 degrees F. A household consists of 3.4 persons.