Technician invents new engine

Fueled by hot and cold water

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A technician at Lawrence Berkeley Laboratory has invented an engine fueled by hot and cold water that lights tiny light bulbs and could produce electricity in the future.

The engine is non-polluting and capable of converting sunlight, geothermal steam and the hot water wastes of nuclear plants into useful energy.

This the second part of a five-part report on new ways of producing energy being developed at UC's Lawrence Berkeley Laboratory.

Inventor Ridgway Banks calls his new device a nitinol engine. It looks nothing like what we think of as an engine. It is little more than a series of U-shaped metal wires with their ends attached to hollow rods which slide along the spokes of a wheel.

When the hanging loops are placed in adjacent hot and cold water baths, the wheel spins, producing motion that can be turned into electricity.

The engine's power comes from the expansion and contraction of the six inch-long loops. These wires are made from an alloy of nickel and titanium called nitinol.

"Each of these wires is itself

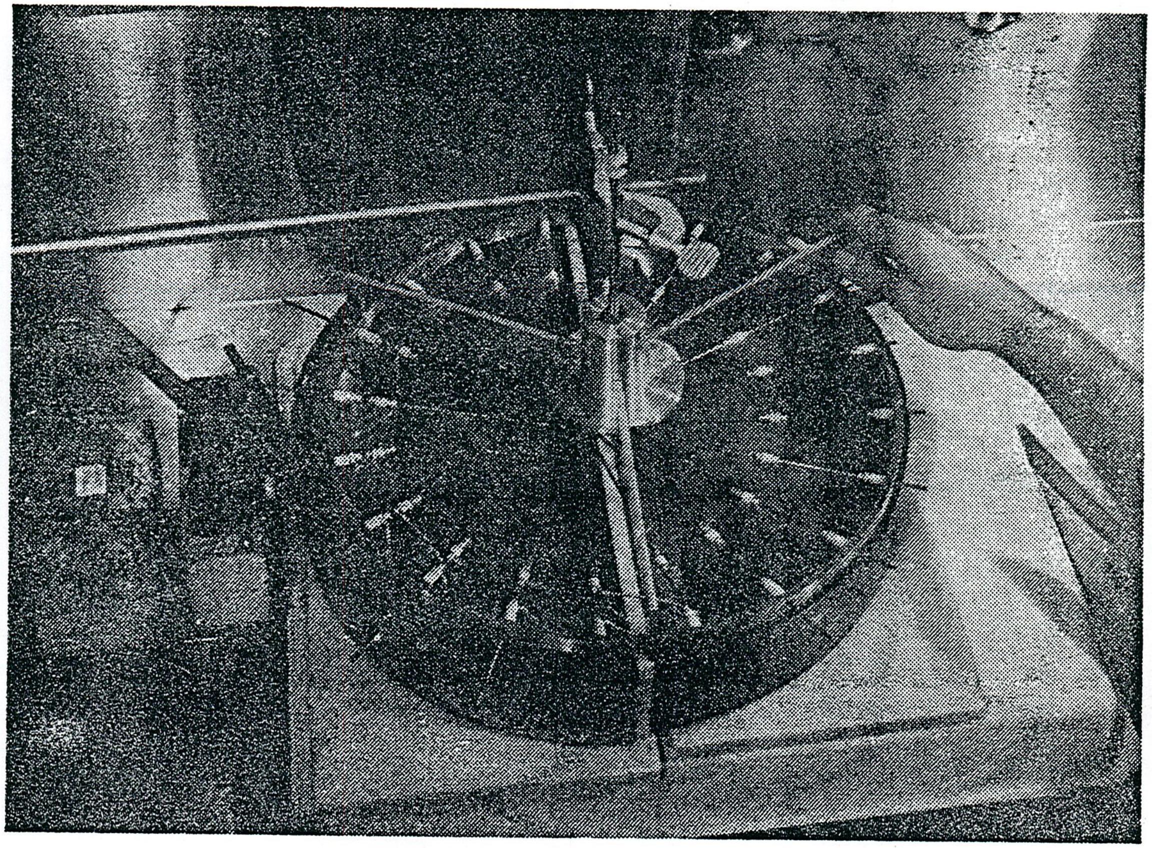
parable in function to the pistons of an automobile engine.

One end of each loop is fixed to the edge of the wheel, and the other to a sliding rod (or piston) which, in turn, has its other end fixed to a "crankshaft."

Banks built his engine in 1973, after discovering that loops of nitinol wire open forcefully when warmed and instantaneously return to their original looped shape when cooled.

To use this unusual property of nitinol, Banks divided a circular bath into hot and cold sides, and mounted the wheel on its side above the bath so that the loops hang into the bath. As the loops expand on the hot side and contract on the cold side, the "pistons" attached to them push and pull on a device mounted on the wheel's shaft, causing the whole wheel to spin. As it does, the loops are dragged up gentle ramps leading out of each bath and then allowed to drop into the bath on the other side of the circle, keeping the cycle going.

The wheel, which is about the size of a large pizza in Banks' model, revolves approximately 60 times per minute, depending on the temperature difference between the baths



The wheel-like National engine in operation.

Only a nine-degree difference in temperature between the hot and cold water baths is needed to send the nitinol engine spinning. And as the temperature difference between the two baths increases, so does the rate of spin, generating a maximum of a watt and a half of electricity—enough to light a tiny peanut-sized light bulb.

Since 1973, Banks' engine has made 22 million revolu-

wires remain unbroken and unworn. Unlike other metals, nitinol can be stretched and bent many times without fracturing.

The engine not only lacks signs of wear, but has become more efficient. It is spinning 50 per cent faster now than it was three-and-a-half years ago.

Banks said the efficiency has increased because nitinol wires become "trained" after a large

wires then expand and contract even more rapidly than when new.

"The more these wires work, the easier they are to stretch," he added.

In spite of this flexibility, the wires are powerful. It is extremely difficult, using bare hands only, to keep a loop from expanding when it is placed in warm water.

The nitinol engine is cur-

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rently nothing more than a laboratory demonstration. No one knows whether it can be developed into a useful device or not. But the potential is exciting.

Nitinol wires do not corrode, so the engine could be used in salty ocean water or geothermal steam, both of which normally corrode metal pipes and wires.

The nitinol engine could, for example, convert the difference in sea water temperatures — warm near the surface of the ocean and cooler at the bottom — into useful mechanical energy.

Hot water that escapes from within the earth as steam could also be used. Many geothermal sources aren't hot enough to power modern high-efficiency turbines, but they might power Banks' nitinol engine.

"An ideal source of heat for the engine are the hot water wastes of nuclear power plants," Banks said. "Thermal energy which is often wasted could be converted into useful mechanical energy."

Solar energy also looks attractive when coupled with the Banks engine. Today, devices that utilize the sun's energy must produce high temperatures that are difficult to generate. But in his own solar experiments Banks discovered that generating electricity at milder temperatures is a snap.

The nitinol engine can also operate without hot water. Different amounts of nickel and titanium in the nitinol alloy cause the wire to bend and snap back at different temperatures. All that is needed to run the Banks engine is a temperature difference of at least nine degrees.

The nitinol engine could even run on ice. Where air and ice temperatures in the Arctic are different, for example, the engine could convert that difference into energy.

Considering the useful energy generated and the durability of the wire, nitinol is relatively inexpensive. Banks obtained all the wire needed to construct his engine for seven dollars from the popular Edmund Scientific mail-order company.

And some metallurgists say that when demand for the wire increases, nitinol will cost even less.

Nitinol engines in the future will probably not resemble Banks' merry-go-round laboratory model. Banks is already working on the prototype of an engine using nitinol wire bows, where the wire is stretched straight, rather than formed into a loop. This would allow for a more efficient use of the metal's properties.

Banks hopes that within a year simple machines that pump water or generate electricity will be constructed.

"The technology could happen very fast if the most efficient use of nitinol wire is found," he said.

Banks, who obtained a college degree in music and spends part of his time composing, is hard at work to invent other uses for nitinol wire.

It may seem strange that an LBL technician once majored in music, Banks said. "but inventing instruments and composing music really seem no different to me."