heat or noxious fumes. In effect, they are batteries that do not wear out, do not need recharging and weigh much less.

While the fuel cells used for power in the two-man Gemini spacecraft weighed less than one astronaut, a conventional battery powerful enough to do the same job would weigh a ton.

Fuel cells come in many varieties. An example of one of the simplest is the hydrogen-oxygen fuel cell containing two electrodes and an electrolyte. Gaseous hydrogen fuel is fed through one porous electrode, and gaseous oxygen fuel is fed through the other porous electrode. The hydrogen and oxygen react to produce water and electric power.

For long space journeys, the water produced would be an essential by-product, not only for the astronauts to drink but for cooling some of the spacecraft's parts. The fuel cell scheduled to provide on-board electrical power and drinking water for the Apollo lunar spacecraft produced 77 gallons of potable water during a simulated space qualification test of 400 hours.

### Earth-bound Considerations

However, practical, earth-bound considerations are not being ignored in either basic or applied research and development of fuel cells. First applications will be as electrical power generators for land forces. Household heating, air conditioning and lighting are still in the future.

Hydrogen can be replaced as a fuel by such hydrocarbons as propane and butane, by carbon monoxide or zinc, among other chemicals. Oxygen from the air can be used as the other fuel, rather than pure oxygen from a tank.

Characteristics such as operating temperature, pressure, type of electrode and kind of electrolyte may also vary.

The fuel cells used in Gemini operate on hydrogen and oxygen with an ion-exchange membrane as the electrolyte, having an electrical output of 2,000 watts. The units were built by General Electric Company.

The fuel cells scheduled for the Apollo lunar spacecraft use all-metal electrodes and an alkaline electrolyte. They are being built by Pratt & Whitney Aircraft, East Hartford, Conn.

An experimental fuel cell system that uses coal as a fuel has been developed at Westinghouse Research Laboratories, Pittsburgh. The power generated directly from the powdered coal has operated a television set. The system was developed under a research contract with the Office of Coal Research, U.S. Department of the Interior.

The research is aimed at the eventual development of a practical, large-scale coal-burning fuel cell system for electric power generation.

Newest attention-getter in the field is the biochemical fuel cell, or biocell, in which bacteria and enzymes are involved in the power production. Biocells use biological materials as catalysts. Because they can operate on such substance as sea water, decaying vegetation or human waste, biocells are seen as essential for specialized applications.

These applications include closed systems for spacecraft or civil defense shelter, sewage conversion systems and buoy power sources. Prototype biocells have been used to operate radio receivers and transmitters, as well as other electrical equipment.

One of these prototypes has led to the suggestion that man on a tropical island may just plug his radio into a coconut to turn it on. Bacteria known as *Aeromonas formicans* will break down the palm tree juice into formic acid, as other bacteria will also do to sugar cane, fruits and yams.

Scientists are hoping to be able to tap ordinary leaves and grass as a source of electricity, although the day when this could happen may be far in the future.

• *Science News, 89:270 April 16, 1966*

## Animal Cruelty Defined

*(Continued from p. 261)*

would act after the harm had been inflicted. This is just as regrettable as the situation that the court operates after the harm in a murder trial. There is hope that penal or penalty laws have some deterrent effect, and this presumably occurs before each violation.

SPCA further argues that the result, if defendant Board were successful, would be that the science teacher would determine when the experiment was justified, balancing his evaluation of the pain and cruelty against the educational value to be derived. This indeed would place an awesome responsibility in the hands of the teacher, but then again the minds of our children are also placed in his hands.

"For the reasons expressed there will be judgment entered for defendants."

Judge Barrett's decision is bound to affect scientific research dependent on live animals for new discoveries in disease and the life processes. The definition of "necessary pain" given here is essential to any such experimentation which would otherwise carry the stigma of animal cruelty.

• *Science News, 89:261 April 16, 1966*

TECHNOLOGY

## Computers Recognize Voices Without Help

➤ A COMPUTER that can identify speakers in a conversation by their voices has been developed at Purdue University, Lafayette, Ind.

Applications of the new pattern recognition system include: distinguishing submarines from fish, detecting and diagnosing disease through brain wave patterns and telling the difference between a missile with a warhead and one without.

Actually the system is not a new type of computer. It is a new method of programming computers to recognize patterns without human help.

Under the direction of Dr. Edward A. Patrick, investigators at the Purdue University's School of Electrical Engineering spent two years searching for the right combination of information with which to "train" the computers in pattern recognition.

The machines need to know what features characterize the human voice, what background noises might exist in the room, how many voices may be involved and whether more than one might be in action at the same time.

Roughly the same type of information is needed before computers can distinguish submarines from fish.

• *Science News, 89:271 April 16, 1966*

TECHNOLOGY

## Plastics and Paints Made From Pine Gum

➤ Amber pine gum of conifers can now be used to make high-quality paints and plastics. The crude pine gum can be converted at low cost into chemicals known as diepoxides, according to the U.S. Department of Agriculture.

The relatively inexpensive chemicals will be used to help produce plastics, adhesives, casting and laminating resins and paints.

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