TECHNOLOGY

New recording and logic devices

Researchers at IBM's Thomas J. Watson Research Center, Yorktown Heights, N.Y., have developed a new image recording process and the most complex superconducting "logic" circuit yet reported. Both are described in the June IBM Research Highlights.

The new approach to recording light images involves photo-induced electrochromism (PIE) and works like ordinary film photography except that the images can be erased. In the experimental set-up, a liquid film of pyrazoline molecules is placed between two glass plates and exposed to light. When an electric field is applied, an image develops and persists even after the field is turned off. If the field is reversed, however, the image is erased. Such a process may someday be useful in computer display terminals.

The new superconducting circuit is the latest advance made using so-called "Josephson junctions"—named for the British scientist that discovered them and predicted to be the fundamental element of the next generation of computers (SN: 9/13/75, p. 170). The problem in putting these junctions into miniaturized circuits that can perform logical or arithmetic functions in a computer is that their metal conductors must be separated by a layer of insulation material only 10 to 20 atoms thick. The reported circuit is on a chip one-quarter inch square and can handle four "bits" of information with a cycle time of 6.67 nanoseconds. Though more development will be necessary before commercial application, in terms of power requirements and speed the device is already 1,000 times better than present semiconductor circuitry, IBM scientists say.

Membrane to save fuel

An ultrathin membrane that allows molecules of oxygen to pass through more readily than those of nitrogen may lead to substantial fuel savings by providing an enriched atmosphere for burning. The membrane was developed at the General Electric Research and Development Center, Schenectady, N.Y.

The new membrane is only a thousandth as thick as a human hair and allows gases to pass through at rates 100 to 1,000 times faster than the rubber membranes now available. The air that emerges has a 30 to 50 percent higher oxygen content than the normal atmosphere, making flames burn hotter and reducing fuel consumption by as much as 50 percent in some industrial applications.

GE is not telling yet how the thin polymeric film is created, nor is it commercially available yet. But a large developmental unit is already being constructed for one of the company's own manufacturing plants, and officials predict fuel savings and cost reduction for many industries, in the future.

Report critical of nuclear safety

The congressional General Accounting Office (GAO) has issued a report critical of safety procedures taken by the Energy Research and Development Administration (ERDA) in handling nuclear materials. The criticisms include:

- ERDA has "vague and outdated requirements which have resulted in inconsistent inspection practices and lack of specific numerical criteria when responding to missing special nuclear material."
- ERDA needs to strengthen and clarify security requirements regarding radiation detectors.
- ERDA needs better communication with field offices and contractors, with whom it has "not communicated effectively" on physical security programs. Also, new security regulations need to be established for handling some radioactive materials.

PHYSICAL SCIENCES

Neutron waves: Fresnel diffraction

The principle that every physical particle is accompanied by a wave is one of the basic tenets of modern theoretical physics. Most physicists would not like to be challenged for a philosophical definition of just what such waves are, but matter waves look more like real waves all the time. Some time ago we reported successful interferometry with neutron waves (SN: 4/24/76, p. 268). Now, in the Aug. 2 Physical Review Letters, A. G. Klein and G. I. Opat of the University of Melbourne describe another quasi-optical effect of neutron waves, Fresnel diffraction.

Optically, the phenomenon is caused by a slight bending of light waves around an obstacle. If a beam of light is shone on a straightedge, examination of the edge of the shadow will show a characteristic pattern of light and dark stripes caused by interference of the bent waves.

In the neutron case, the equivalent of the straightedge is the boundary between two domains of oppositely directed magnetic fields. Magnetic fields rotate the direction of the spin of the neutrons. Oppositely directed fields rotate it in opposite ways. According to theory, rotating the direction of a neutron's spin changes the phase of its wave. Phase shifts produced by opposite rotations on the two sides of the magnetic boundary set up the conditions for diffraction. Since the waves tell where neutrons are likely to be found, detection of the neutrons should exhibit the diffraction pattern of the waves.

The magnetically altered neutrons (they had come from a high-flux reactor at the Institut Laue-Langevin in Grenoble, France) were imaged by an apparatus consisting of a slab of boron carbide and a sheet of cellulose nitrate. A neutron striking a boron nucleus produces an alpha particle. The alpha particles make tracks in the cellulose nitrate that can be brought out by etching. The tracks show the characteristic Fresnel pattern.

A new way to look for solar neutrinos

According to astrophysical theory, the nuclear fusion processes in the sun should cause it to emit a flux of neutrinos, but the famous experiment of Raymond Davis Jr., and collaborators, which has been running for years, has failed to find them (SN: 3/27/76, p. 199).

In the Aug. 2 Physical Review Letters, R. S. Raghavan of Bell Laboratories at Murray Hill, N.J., points out that the Davis experiment is sensitive to high-energy neutrinos, and the flux of these one expects depends critically on one's theory of the solar interior. Raghavan urges the need for a search for low-energy neutrinos that come from proton-proton fusion. Their expected flux, he says, is not dependent on the details of different models but merely on the assumption that nuclear fusion is the sun's basic energy-producing medium and that neutrinos are stable particles.

The substance he suggests for a detector is indium 115. When an indium 115 nucleus captures a neutrino, it turns into an excited state of tin 115. The tin 115 then deexcites itself by emitting two characteristic gamma rays.

This, says Raghavan, has the advantage of a delayed coincidence signal for the capture of the neutrino. First comes an electron emitted at the capture of the neutrino, and then after 3.26 microseconds come the deexcitation gamma rays. This provides a double-check that the event truly is a neutrino capture, a feature lacking in some other proposals.

Furthermore, he points out, the indium is highly sensitive to low-energy neutrinos and has a high capture rate. Also natural indium has almost no admixture of isotopes other than 115 so the amount necessary for one neutrino capture a day would be only about 3 tons, much less than other materials proposed.