# IEEE notes

## Gathered at the annual meeting of the Institute of Electrical and Electronic Engineers in New York

SEMICONDUCTORS

### Transistors near performance limits

Improved technology has pushed transistors and other semiconductor devices close to the limit of their capabilities, reports E. O. Johnson of R.C.A.

Basic physical constants theoretically limit the amount of power, amplification and frequency that any semiconductor can handle. These limiting factors are the amount of voltage the material can stand without breaking down, and the speed with which a charge can be forced to move through the semiconductor.

By sacrificing some qualities, such as amplification, others such as frequency or power output can be increased. But the upper limit on overall capabilities will remain, he says. Even under ideal conditions, the frequency limit on silicon and germanium will stay at about 20 gigahertz (billion cycles per second).

These limitations don't apply to recently discovered limited-space-charge-accumulation (LSA) devices, says Johnson, because they operate without moving charges through material. LSA diodes, developed by Dr. John A. Copeland of Bell Telephone Laboratories, have operated well above the 20 gigahertz level. High frequency operation opens a communications range that is not as crowded as the lower radio bands.

PRIVACY

### Electronics squelch bugs

Electronic eavesdropping has an antidote in electronic countermeasures, says John E. Foster of Avco/Lycoming. But development of defensive devices has lagged behind.

The serpent was the first to invade the privacy of Adam and Eve, says Foster. Although serpents no longer bug us, we have a pathological fear of bugs, or electronic eavesdroppers, he claims.

Countermeasures include improved means of detecting intruders, scrambling or encoding private information, and suppressing electronic emissions that can be picked up by bugging devices.

He emphasizes that Government control of the use of bugging devices will be necessary to protect privacy.

CYBERNETICS

### Self-repairing computer

A computer that detects its own faults and repairs itself is expected to begin experimental operations this fall at the Jet Propulsion Laboratory, Pasadena, Calif.

Such self-reliant units could be indispensable for guiding spacecraft or supersonic airplanes, or monitoring an operation, says Dr. A. A. Avizienis of JPL.

The computer is supplied with one or more duplicates of every circuit. If an operating circuit malfunctions, the spare is switched in.

Central to the repair operation is a module that monitors all instructions and numbers within the computer and detects any errors. In case of an error signal, the operation is repeated to see if there was only a temporary malfunction. If it happens a second time, the spare is switched in. Replacement takes only a few thousandths of a second.

The repair control module itself has an error detection and repair system. Three identical copies of the module operate at all times; if two of them indicate an error and the third doesn't (or vice versa) the out-of-step module obviously is malfunctioning, and a spare module takes its place.

INFORMATION STORAGE

### Holography stores data in crystals

The combination of color center crystallography with holograms has produced a highly compact information storage device, reports Gabor U. Kalman of Carson Laboratories.

A number of alkali-halide crystals, such as salt (sodium chloride) can be sensitized by X-rays or heating so that they absorb particular frequencies of light (SN: 2/17, p. 168). The phenomenon results when some negative ions in the crystal are knocked out of position, creating holes or color centers that are filled by electrons. Kalman used another alkali-halide, potassium bromide, in which he created a billion billion color centers per cubic centimeter.

With the color centers, the potassium bromide crystals are sensitive to high-intensity light, such as is produced by a laser.

Kalman finds the most efficient way of storing information in the crystal is to create holographic interference patterns within it, using laser light. Once the hologram was created, the information could be read out again, also using a laser. Many holograms can be fitted into one crystal, he reports.

POWER CONTROL

### High-speed switch turns off 12,000 amps

Interrupting large flows of electric current quickly is a problem. As switch contacts are pulled apart, electricity continues to spark across the gap.

A new vacuum interrupter, developed by Westinghouse Electric Corp., can dump 12,000 amperes of current at 15,500 volts in less than a 50th of a second. By way of comparison, a 100-watt bulb draws less than one amp at 120 volts.

The new switch has two copper electrodes in a high vacuum—about one billionth of an atmosphere. Ceramic casing is used, since glass allows helium to seep through.

With so little air between the copper electrodes, the only thing that can support a spark as they are jerked apart is a hot charged vapor of copper metal, which is collected within a few thousandths of a second by a metal arc shield.

Earlier interrupters surrounded the electrodes with insulating oil or gas, which turns to a charged vapor that cannot be dispersed as quickly.