SCIENCE NEWS OF THE WEEK

Fastest Electrons in a Semiconductor

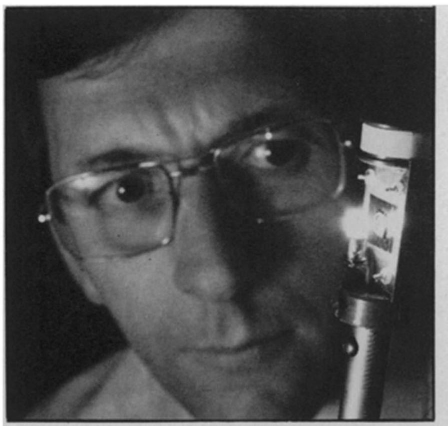
The starship Enterprise is about to blow up because somebody has sabotaged the engines. Chief Engineer Scott, representing the seat-of-the-pants school of operations, is about to go down among the engines to try to find the damage. Second Officer Spock decides to go to the ship's main computer and run a comparison of everything in the ship's present state with the computer's memory of its ideal state. Scott fumes at him for trying so complex a way to solve the problem in the midst of an emergency: "There's no time." "I have time," says Spock. And he does.

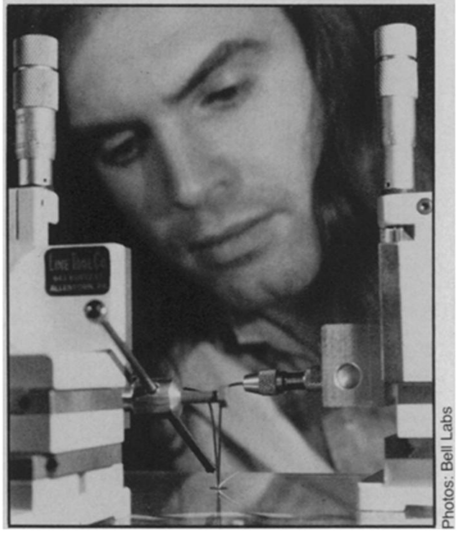
The speed of solid state circuitry has become a literary cliche. It is also an everyday convenience. Who remembers when a radio needed to warm up? The difference between waiting 30 seconds for the Andrews Sisters and getting instant Kiss may seem trivial, but in the real-time world of computer and communications traffic, even more speed than now available would be a distinct advantage. A recent development at Bell Telephone Laboratories that succeeds in speeding the flow of current carriers in semiconductors promises to give such speed to existing solid-state elements and possibly open the way to devices now unknown.

Semiconductors are substances that are neither good electrical conductors nor good insulators. They were largely ignored by early electrical technology, but a more mature technology found that when semiconductors are properly engineered, they can perform many useful functions in electrical circuits, some of which were already being done by thermionic tubes, some of which were entirely new. The results of the change are in almost everybody's pocket.

To get a semiconductor to work the way these devices need to have it work, free electrons beyond those normally available in the material have to be supplied. To do this, foreign atoms, often silicon, are introduced into, say, gallium arsenide. The silicon atoms contribute an electron each to the current carriers. But the remaining silicon ions then have an attraction for the electrons: They tend to slow the current and to try to recombine with the free electrons. The result is a constant tension between the silicon's contribution to the action of the semiconductor and its inhibition of it.

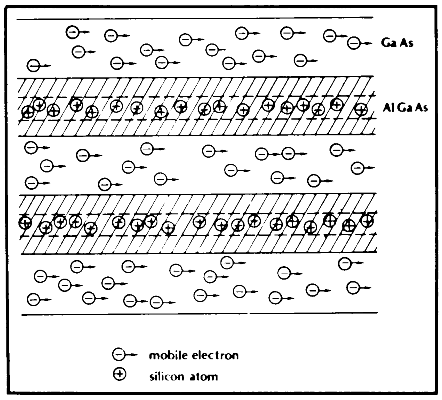
What the four Bell Labs researchers, Raymond Dingle, Horst L. Störmer, A. C. Gossard and W. Wiegmann, did was to use molecular beam epitaxy, a method of building crystals one layer of atoms at a time, to make a crystal in which the silicon ions are segregated from the flowing electrons. The crystal consists of alternating layers of gallium arsenide and aluminum gallium arsenide, each layer being 50 atomic layers thick. The silicon is concentrated in the aluminum gallium arsenide. Electrons are at a lower energy level in gallium arsenide than in aluminum gallium arsenide, so they spontaneously migrate to the gallium arsenide layers. There they are farther from the silicon ions than they would be in an ordinary semiconductor and they are further separated by neutral zones, because the technique seeks to keep the silicon in the centers of the aluminum gallium arsenide layers. The result is a doubling of the electron speed at room temperature. Similar procedures are expected to work with semiconductors other than gallium arsenide.





Dingle examines experimental crystal (above). Störmer welds leads to it (below).

Photos: Bell Labs



Electrons move more freely separated from ions in layered semiconductor.

The result will be speedier operation of current semiconductor devices, especially in computers and communication. Dingle stresses, however, that there will be "a qualitative difference between what exists now" and what is likely to exist then. In these new crystals the current is carried in multiple layers, and, says Dingle, "There is a possibility of etching things on top of each other," circuitry in three dimensions — that would save a lot of space. ☐

U.S.-USSR exchanges reviewed

The U.S.-USSR science exchanges repeatedly have forced a mixing of the oil and water of science and government. And according to scientists' testimonies last week at a review of the exchanges by a House subcommittee, the less the two mix, the better off Soviet dissident scientists will be. Or, as Lipman Bers of Columbia University and Amnesty International more diplomatically put it, most scientists prefer a policy of "benign neglect": "I would like the government to be neutral — in a positive way."

The government should not tell scientists where to visit and when, Robert S. Adelstein of the Committee of Concerned Scientists, Inc., said. Instead, it should "allow individual scientists to use the channels which the government has set up to aid persecuted scientists," he told the Subcommittee on Domestic and International Scientific Planning, Analysis and Cooperation. In addition, Bers said, government officials should be discouraged from telling U.S. scientists not to visit Soviet dissidents in their homes. According to chairman James H. Scheuer (D-N.Y.), the subcommittee was unaware of such a policy and will determine in future investigations whether or not it exists.

Above all, the scientists said, the exchanges must not be halted. Government suspension of the exchanges would be "irresponsible and counter-productive, and would make matters far worse for Soviet scientists," William D. Carey, executive officer of the American Association for the Advancement of Science told the subcommittee. Spontaneous individual boycotts in response to specific human rights violations are far more effective and visi-