



Twenty years ago a hard of hearing student wore a cumbersome two-piece hearing aid (left) weighing nearly two pounds. Today student has unit weighing only 1/4 ounce which slips on behind the ear out of sight. Development of ultra-miniature electronic circuits made smaller size possible. Inset shows Zenith hearing aid unit.

Revolution in Circuitry to Spawn Tiny Computers, TV Receivers

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[First article of a series]

How would you like to have a personal computer the size of a package of cigarettes, a television set no bigger than a deck of cards, and a radio that can be hidden by your thumbnail?

You can and probably will as industry scurries to make use of the newest and one of the most important advances in electronics — ultra-miniaturization.

Called micro-electronics, the new technology permits the construction of electrical circuits [the guts of all electronic equipment] so small that they are about one-fourth the size of match head. And they are so useful that just one of these tiny specks can operate a hearing aid.

One of the major users of micro-electronics for consumer products in Chicago is Zenith Radio corporation, a major maker of hearing aids.

Developed in 1958

First developed in 1958 in a crash program to allow the air force to increase the range of its Minuteman missile by reducing the weight of its electronic equipment, the miniature circuits have made their weightlessness felt only recently in industrial applications.

If your needs require the use of a simple computer, you already can get one built for yourself about the size of two packages of cigarettes.

Opens New Uses

Freedom from the limitations of weight and bulkiness that the miniaturization permits, will bring electronics into areas never dreamed of before, say supporters of the new technology.

Not since man first harnessed fire has anything proved more useful to him than electricity. It turned night into day, ran

machinery, made world-wide communications possible, and performed countless other tasks that enabled man to increase his control over his environment.

Electricity is the name used to describe what happens when electrons, subatomic particles



Closeup of heart of new hearing aid circuit containing 8 transistors, 16 resistors, and 2 capacitors. Unit measures 0.060 by 0.060 by 0.007 of inch.

that normally orbit the nuclei of atoms, run together in groups.

Make Mad Dash

A bolt of lightning represents uncontrolled electricity when an enormous number of electrons make a mad dash from a rain cloud to some object on the ground.

Electrons are produced from moving objects such as a rain drop or the flywheel in an electric generator. By giving the electrons an easy path to follow, as in a copper wire, they will go to work for you. Some materials like wood and rubber do not permit electrons to pass but metals will.

Electricity can be made to do all sorts of tricks thru the use of materials that ease its flow [transistors], resist its flow [resistors], limit the wave length of the electric current [capacitors], or change the wave from one that moves back and forth as in alternating current to one that moves

in only one direction as in direct current [diodes].

These are the four components that make up an electronic circuit. Perhaps the most important of these is the transistor.

Send Specific Waves

Here is how they work: Radio and television stations send out their programs over specific electromagnetic waves. Electromagnetic waves include everything from light to electricity and from infra-red to ultra-violet. Included in this broad family are radio and TV waves.

A radio wave, for example, travels thru the air, unseen and unfelt. It is very weak. A transistor in your radio, however, is very sensitive and can detect the weak waves picked up by the aerial.

Your radio is plugged into the wall outlet and has a powerful supply of electricity at hand, ready to be used. The transistor acts like a signal man. It detects the weak wave coming in at one end, rushes to the other end and tells the strong source of electricity waiting in the wings to send out a similar wave, only much more powerful. This is called amplification of the weak signal.

The first object to perform the job of amplification, and which made electronics possible, was the vacuum tube, invented in 1907.

Invent Transistor Radio

The second revolution came in 1947 with the invention of the solid state transistor. The transistor, much smaller and more reliable than the vacuum tube.

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NEW CIRCUITS SPAWN TINY ELECTRONICS

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permitted the construction of small electronic components and gave birth to the transistor radio.

Micro-electronics is considered to be the third revolution in electronics, further reducing the size of equipment and increasing its reliability.

The latest breakthrough was made possible because of new technology and a deeper understanding of how materials act on the molecular level.

Discarding the traditional materials of electronics [metals and nonmetals] engineers developed a new class of materials called semi-conductors. These are inbetween metals and nonmetals in their ability to conduct electricity and are usually made of silicon and germanium.

Takes Only Slight Change

Since they are on the borderline, a slight change in their makeup can turn them into transistors, resistors, or any of the other components of an electric circuit.

In addition, only a tiny speck of silicon is needed to regulate the flow of electrons on a molecular level, providing the same degree of control as a transistor a hundred times bigger. To make a miniature transistor, for example, all you need is a silicon crystal with a few atoms of an "impurity" placed inside.

The beauty about the whole setup is that you can take a "chip" of the semi-conductor material and with microscopic techniques, make certain small areas on the chips perform the same function normally done by much bigger individual components.

Technicians call this the integrated circuit because all the individual components of an electronic circuit are bound together in one tiny solid piece of material.

[Series concludes tomorrow]