

## ELECTRONICS

# Revolution in Electronics

A whole new concept of electronics has been made possible by a design and production system that forms ceramic wafers, like building blocks, into rugged circuits for radar.

By ALLEN LONG

► THE WHOLE concept of electronics design and production has been shaken in the last few years by the development of transistors, germanium diodes, subminiature tubes and processed circuits.

The electronics industry today truly is experiencing a new technical and industrial revolution out of which will emerge better and cheaper products for American homes.

Perhaps one of the most startling electronic developments of the 20th Century will prove to be a manufacturing process known as the "Modular Design of Electronics and the Mechanized Production of Electronics" (MDE-MPE).

Because they lacked search radar, some of America's planes sat on the ground during the Korean War. On the home scene, electronic defense plants were going full blast, but their output lagged the demand.

This highlighted a problem that had been of great concern to the Industrial Planning Division of the Navy's Bureau of Aeronautics. America's production of electronics simply could not adequately meet an emergency. In a full-scale, world-wide conflict, this could put the United States at a critical disadvantage.

The Navy joined the National Bureau of Standards in a mutual quest for a way of stepping up the production of vital electronic equipment. After years of experimenting, a whole new concept evolved. A plant was built near Arlington, Va., and the Kaiser Electronics Division of Willys Motors, Inc., was selected to operate it for the Navy.

## "Project Tinkertoy"

Scientists had found a way of licking this bottleneck in electronics production. They nicknamed their work: "Project Tinkertoy."

Because naval electronic equipment being "Tinkertoyed," or mechanized, was classified, America's military experts stamped it "Confidential." However, eventually a need arose for spreading the word to other electronics manufacturers so they would be equipped, able and ready to shift into high-gear emergency military production should America be confronted by an aggressor.

The project was declassified in September, 1953, and the National Bureau of Standards' Technical News Bulletin carried a feature-length article on it. Inquiries poured in from England, France, Switzerland and Sweden, and at least one technical French journal ran an article on it.

The Russians have made no direct in-

quiry, but you may be sure they know a great deal about the project now. Russian scientists can recognize a good thing when they see it.

The MDE-MPE system, as it is now called, fairly sparkles with gems that have been extremely rare in other systems.

Briefly stated, a manufacturer can truck raw materials in one door of his plant and cart away finished radar circuits through the other door. He can make his own resistors, capacitors, tube sockets and coils. This frees him of dependence upon some circuit-components manufacturer who may be already swamped with orders of various priorities from other customers.

The basic unit in the modular system is a ceramic wafer  $\frac{7}{8}$ -inch square by  $\frac{1}{16}$ -inch thick. It is made of non-strategic talc, kaolin clay and barium carbonate. After

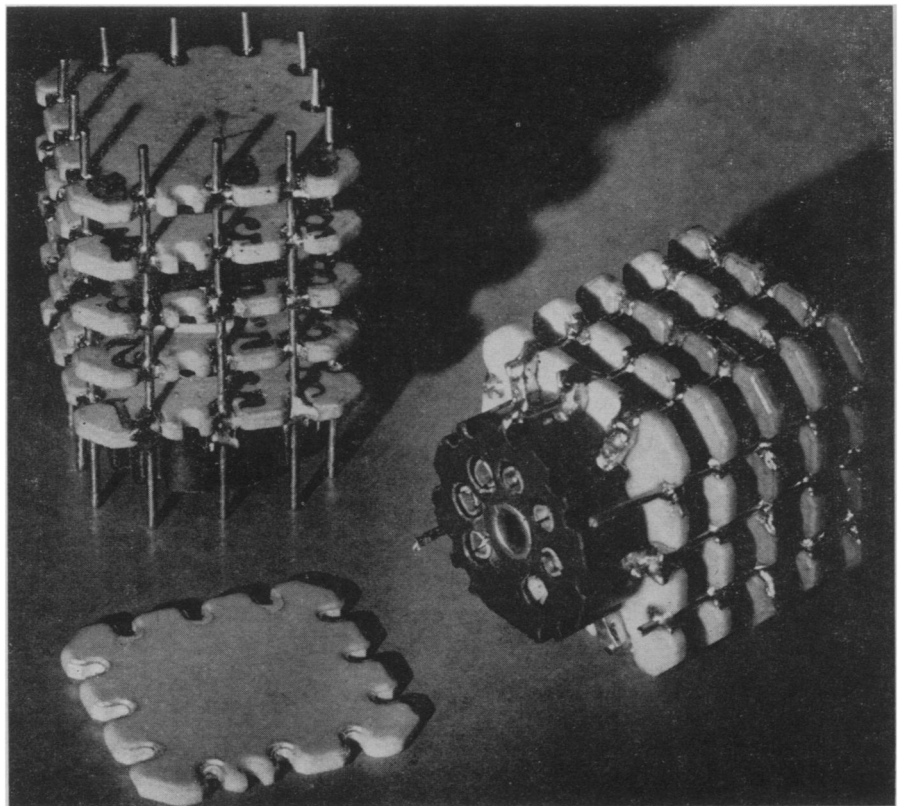
its firing stage, the ceramic wafer possesses excellent electrical characteristics.

Silver current-carrying lines are printed on the wafer to form one small section of an electronic circuit. Then tape resistors or thin titanate ceramic capacitors are bonded in place on the wafers. A selected group of wafers is fed into a machine which solders them together with 12 riser wires that join notches on the edges of the wafers. An amplifying stage for a radio or radar set is complete when a tube is plugged into the top wafer.

## Reliable Modules Made

The finished module is an inch or so tall. It resembles a miniature office building under construction, its exposed floors supported by vertical girders.

MDE-MPE equipment is reliable. Each wafer-like component is automatically checked by machine. This helps insure the proper functioning of the radar, the bomb sight or the airplane's electronic gun-control system.



**ELECTRICAL BUILDING BLOCKS**—The ceramic wafer in the foreground is the building block in the new "modular design of electronics" system. An assembled module is shown at the top. The view at the right shows the top wafer made as a seven-pin tube socket. The whole unit is an amplifying stage for electronic equipment.

The finished modules are heat-resistant. This helps solve a problem that has plagued military aviation experts. A modern plane is jammed with electronic equipment that is tucked away in every available nook and cranny. Air circulation in these places is poor and the equipment generates high heat. Glass-enclosed vacuum tubes have been known to twist and bulge because of the excessive temperature.

MDE-MPE equipment is rugged. Modules can take the battering around of rough, untrained hands. This is important in military service where conditions often make it impossible to appreciate fully the delicate sensitivity of electronic equipment. It also fortifies the equipment against severe buffeting and vibration a bomber may endure while executing its mission.

The modules are moisture-resistant. This gives them an edge over unprotected equipment in humid climates or on spray-soaked decks of Navy ships.

### Comparable Production Costs

Production costs of the MDE-MPE system have fallen to a level comparable with the costs of conventional production systems. This does not mean, however, that your next portable radio or television set will be based upon the modular system.

However, it does mean that industry is more likely to apply these new principles to civilian products fairly soon.

You, the consumer, will benefit from these latest developments pioneered by scientists who are ever seeking better ways of doing things.

There is a definite industrial trend today toward automation — machines that mind themselves, that work steadily and accurately while guided only by punched cards, magnetic tape or other control means.

The MDE-MPE system is almost entirely automatic.

### Keyed Notch Used

A keying notch is formed into one edge of each wafer to facilitate machine-handling. By twisting the wafer or flipping it over and turning it some more, machines are able to position the wafer properly so that parts are attached in the right places.

Wafers can be any of three types, or a seven- or nine-pin tube socket. When stacked like hotcakes and linked by the tiny wires, the module is completed.

Electrically, this module could be an amplifying stage so built that it could be unplugged if something goes wrong with it. A whole new assembly would be substituted for it. This would simplify repair of the electronic gear, and would help technicians service the equipment with less training.

In time of war, the armed services, who have to train thousands of technicians, thus would benefit materially from this feature.

Resistors, which limit the flow of current in a circuit, usually are cylinder-shaped. A common variety of small resistor measures about an eighth of an inch in diameter and about three-eighths of an inch long. A

wire protrudes from each end and must be soldered into the equipment.

MDE-MPE resistors, however, are flat bits of tape bonded to the ceramic base. A large square of protective tape material may cover them. They are made of a heat-resistant asbestos paper known as Quinterra, polyethylene tape, carbon black or graphite, resin, and a solvent.

A 75-foot roll of it will produce over 10,000 resistors ranging in value from 10 ohms (an ohm is the unit of resistance) to 10,000,000 ohms, depending upon the mixture used.

### Capacitors Wafer-Mounted

MDE-MPE capacitors, which store electricity and which are vital in converting a radar signal into information for the radar screen, are made in half-inch squares for wafer mounting. Compounded of a non-porous ceramic — usually of magnesium, barium, calcium and strontium titanates of high purity—they are about a fiftieth of an inch thick.

Their capacity may be varied from 10 micro-micro farads (10 billionths of a farad, the unit of capacitance) to .01 microfarads by changing the proportions of minerals used in them. Raw material batches weighing about five pounds will make 100,000 capacitors.

As labor costs are reduced by machines, raw materials costs grow in importance in the manufacturer's economy. The availability and costs of MDE-MPE production materials are believed to be two of the system's biggest selling points today, and are expected to entice more manufacturers to use the system in the near future.

A kit containing subminiature tube, ceramic capacitor, germanium diode, transistor and two ceramic modular wafers, one a resistor and the other a capacitor has been prepared by Science Service. A booklet accompanying the kit describes these important electronic circuit components.

These kits are available at 75 cents each from Science Service, 1719 N. St., N.W., Washington 6, D. C. Ask for the Modern Electronics Unit.

Science News Letter, September 4, 1954

### VETERINARY MEDICINE

## Little Pig Can't Go To Market on Sugar

► LITTLE PIGS won't go to market or even live to stay home and eat bread and butter if they are fed sugar of the kind chemists call sucrose. However, if they get glucose, or dextrose, they do all right. The newborn pig lacks the ability to utilize sucrose or, in chemical terms, to hydrolyze the glycosidic bond of sucrose. These findings are reported by Drs. D. E. Becker, D. E. Ullrey, S. W. Terrill and R. A. Notzold of the University of Illinois, in *Science* (Aug. 27).

Science News Letter, September 4, 1954

*Tuberculosis*, in seventh place as a cause of death in the U.S., attacks 110,000 persons a year.

### VETERINARY MEDICINE

## Cattle Menaced By Polluted Water

► GUARD AGAINST water pollution and rats to protect cattle from leptospirosis, the nation's farmers and cattle raisers were warned at the American Veterinary Medical Association meeting in Seattle.

Leptospirosis is considered one of the most serious disease threats to the livestock industry today. It is caused by a spiral shaped germ related to some germs that cause human diseases.

The cattle disease is also a potential menace to humans, Dr. Herbert G. Stoenner of the U. S. Department of Health, Education and Welfare, pointed out. He advised pasteurization of milk and avoidance of swimming in ponds and streams contaminated by cattle as safety measures for humans.

Cattle, he said, may be carriers of the spiral germs of the disease for some time after they have recovered from the sickness. They can act like the Typhoid Marys among humans. Healthy cattle, therefore, as well as humans, should be kept away from streams, ponds and other water sources that the leptospirosis carriers may contaminate.

Vaccines are effective only when administered to the uninfected animals in the early stage of an outbreak or when new animals are added to the herd.

The disease is usually not fatal to cattle, but may cause heavy economic losses in abortions, decreased milk production, and weight declines.

Rats and other rodents may carry the disease and swine may serve as possible reservoirs. The American Veterinary Medical Association therefore advises a rodent control program and keeping cattle and swine on separate feed lots as possible means of curbing the disease.

Science News Letter, September 4, 1954

## GOLF: Your LEFT SHOULDER makes the amazing difference!



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