ELECTRONIC AGE

RCA

Autumn 1963

Man-Made Matter Revolutionizes Electronics

ELECTRONIC AGE

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IN THIS ISSUE . . .

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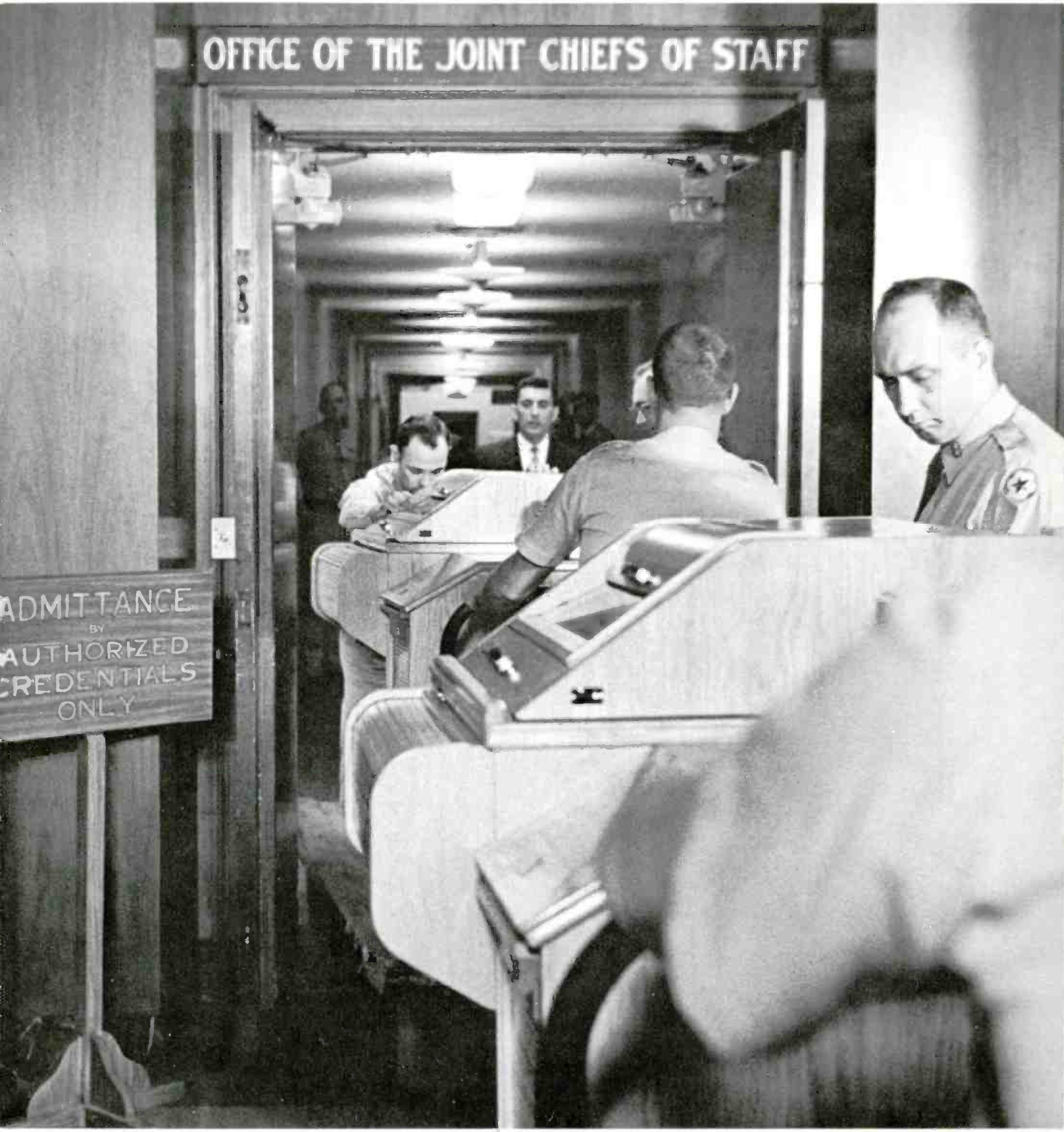
◄ An RCA thermionic converter is shown being placed into nuclear test reactor at the Babcock & Wilcox Nuclear Development Center, Lynchburg, Va. The converter, which operates on the same principle as the power vacuum tube, converts the nuclear heat directly into electricity with no moving mechanical parts.

COVER: Photographic montage shows Dr. Marvin S. Abrahams, RCA Laboratories, using an optical microscope against a background of zinc sulfide crystals magnified 50 times in polarized light. Different colors and character of boundary lines between them give important clues to crystalline structure, surface geography, and composition. A report on the revolution in man-made electronically active materials and their applications starts on page 8.



Russian teletype equipment arrived at the Pentagon terminal of the U.S.-U.S.S.R. direct communications Hot Line system in late summer. Both governments agreed to an exchange of transmitting and receiving equipment.

The Hot Line: Communications Link For Peace

by Frederick W. Roloff

An almost instantaneous communications system is now in operation between Washington and the Kremlin. Its purpose is to prevent an irrevocable and disastrous misunderstanding or miscalculation. It could mean survival in our time.

In the Pentagon office of the Joint Chiefs of Staff in Washington, D.C., and in the Kremlin in Moscow are banks of teletypewriter printers whose clattering and bell-ringing are among the most significant sounds in the world today. For these are the terminal-point machines for the direct communications Hot Line link between the United States and the Soviet Union. These machines, operating 24 hours a day at both ends, could transmit a message between the White House and the Kremlin that might mean survival in our time in case of a misunderstanding or an accidental apparent act of war.

The long-to-be-remembered Cuban-Soviet missile crisis prompted President Kennedy last December to point up the need for a sure, fast way for Washington and Moscow to communicate with each other in an emergency.

In this age when things move and happen too fast for governments to communicate through diplomats exchanging notes at embassies, the need for a Hot Line is obvious. As a result, in March, 1963, the United States Government officially proposed the Hot Line to the Russians at the 18-Nation Disarmament Conference in Geneva.

In April, the Russians agreed to negotiations concerning a Hot Line, and the Defense Communications Agency went ahead and asked the American carriers – including RCA Communications, Inc.– experienced in international communications to propose systems for maximum reliability in communications between the United States and the Soviet Union. On June 20, the Russians signed an agreement at Geneva for the Hot Line – an agreement that President Kennedy called "a limited but practical step forward in arms control and disarmament."

In August, the DCA awarded contracts for the Hot Line to American Cable and Radio Corporation and RCA Communications, Inc., for, respectively, a cable and a direct radio link between Washington and Moscow. Testing of the circuits began immediately, and by the first of September they were operational.

The radio circuit goes directly to Moscow from Washington via an automatic relay booster at Tangier, Morocco. The cable link travels via London, Copenhagen, Stockholm, and Helsinki to Moscow.

There is a general misconception about the Hot Line. It is *not* a personal telephone connection between President Kennedy and Soviet Premier Khrushchev, available to them at any time and at any place. It's not that simple – and for a good reason. The President wanted communications to be not only as fast as possible (the radio link is almost instantaneous) but also in writing, to prevent garbled translation of the spoken word at either end. Although the President – and presumably Premier Khrushchev – can be reached by special telephone anywhere at any time, the actual

The Washington-Moscow Hot Line radio and cable system.

typed messages to and from the Soviet Union are sent from and received in the office of the Joint Chiefs of Staff in the Pentagon. All messages are sent to the Soviet Union in English, and all messages received from there are in Russian. Again, this is to prevent any garbling or misunderstanding of, say, idiom in translation before transmission. According to the terms of the Geneva agreement, the United States provided the Russians with four sets of English page printers, transmitters, and tape reperforators. The Soviet Union, in turn, provided the United States with similar equipment, geared to the Russian language. The expense for all this is divided about equally between the United States and the Soviet Union.

This is how the system operates. If President Kennedy wished to send a message to Premier Khrushchev, it would be typed, checked for errors, and then placed on tape by a typing perforator. This tape is then fed into an automatic transmitter, which puts the signals on the Hot Line channel according to the perforations in the tape. The radio signals are transmitted by RCA Communications to Moscow via its Tangier automatic relay. At Moscow, the receiving teleprinter automatically prints incoming messages in page form in English for translation into Russian. The Soviet signal comes back the same way, except that the machines produce page copy in the Cyrillic alphabet of written Russian for translation into English.

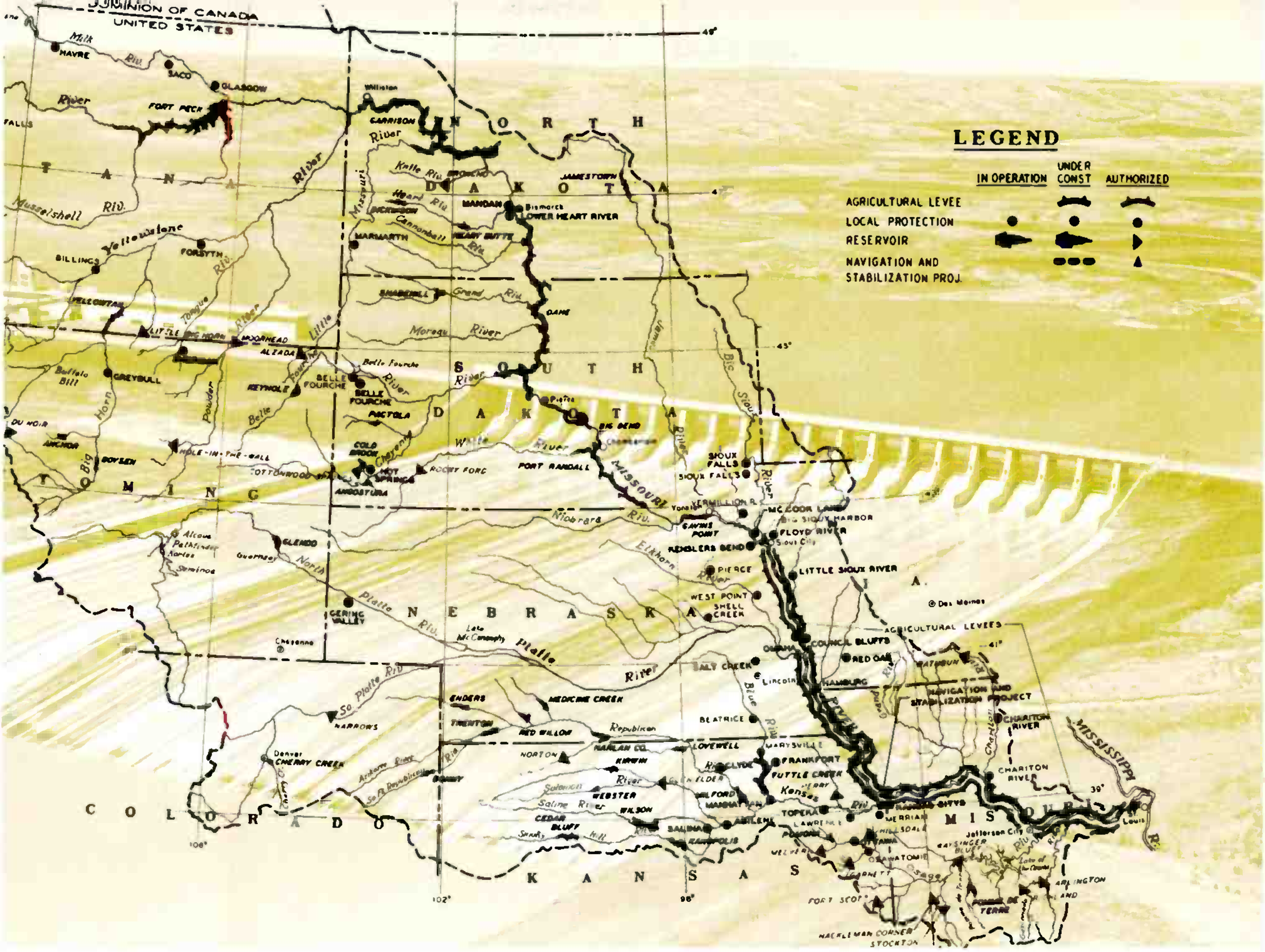
The radio teletypewriter link operates at the standard speed of 66 words a minute and provides the most direct available contact between the two heads of state. The machines are constantly transmitting test messages to make sure the channels are open. As of early fall, there have been no formal or informal diplomatic exchanges.

While the Hot Line to Moscow is undoubtedly the hottest line in existence, for some time banks and businesses have had their own hot lines. For example, RCA Communications, Inc., which provides the radio circuit for *the* Hot Line system operates over 170 leased channels for banks, oil producers, brokerage houses, and other business and industrial concerns that require instantaneous, continuous, and reliable private connection with overseas correspondents all over the world.

Besides commercial hot lines, RCA Communications leases other important channels to the Department of Defense and the Department of State. One example of RCA Communications participation in a recent dramatic space venture was the round-the-clock maintenance of 21 circuits capable of two-way traffic during Project Mercury. In addition, for use by the Weather Bureau, RCA Communications transmits radiophotos of the nephanalysis charts made from the TIROS weather satellite television cameras scanning clouds from space.

With this application of experience to the Hot Line system, there never will be a repetition of one of the most famous cases in history of a communications lag. During the War of 1812, Andrew Jackson won a decisive battle over the British at New Orleans *after* the peace treaty ending the war had been signed. The reason — it took weeks for the news that the war was over to cross 3,000 miles of ocean and 1,000 miles of early America.

Today, thanks to the Hot Line system, top-level decision-makers work speedily toward reasonable solutions of potentially dangerous situations by means of quick and reliable communications. ■



Flood Control by Computer

by Thomas I. Bradshaw

In his constant battle against the disasters of river floods, man has a new ally – the computer.

Throughout history, man and the river have been partners or enemies, depending on the needs of one and the complex moods of the other.

Take Big Muddy – officially the Missouri – for example, which is the longest single river in the continental United States. Jacques Marquette, the French explorer, found the Missouri too much river to handle in its most cantankerous periods. Until recently, Big Muddy continued to display fits of uncontrolled temper with a resulting loss of billions of dollars in property damage and crop destruction – not to mention a toll in human life.

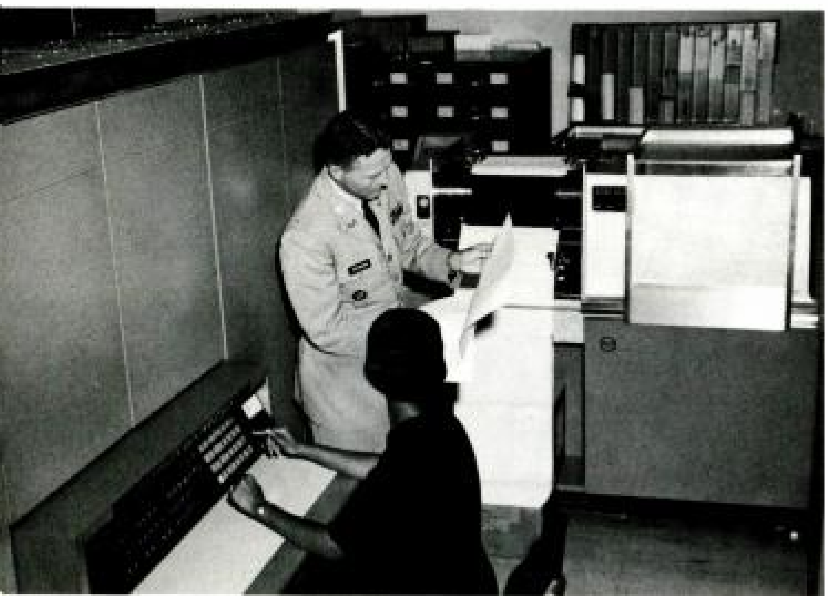
Today, from quarters in an Omaha, Neb., office building an electronic computer is serving man as a unique weapon in his epic struggle with Big Muddy. An RCA 301 data processing system helps the Army Corps of Engineers control the Missouri River network that snakes its way 2,500 miles through seven states from Montana to St. Louis.

For lack of historic records, there is no way of assessing the over-all damage figure from Missouri River floods. In recent years, the story has been fully recorded. There were major floods in 1942, 1943, 1944, 1945, 1947, 1951, 1952, and 1953.

In 1951, half a million persons were driven from their homes along Big Muddy. Damage that year was estimated at $1 billion. Kansas City suffered destruction that took years to erase.

The Flood Control Act of 1944 opened the way for a solution of this mammoth problem. The legislation provided for six huge dams and accompanying reservoirs. These man-made lakes range in size up to 250 miles in length — for flood control, navigation, irrigation, electric power, and recreation.

Where can an electronic computer fit into the flood-control picture? The answer to that question



Computers are used to minimize the damage caused by . . .

is that the computer plays a major role right from the ground up.

Trucks and bulldozers recently delivered the last "deposit" of dirt to a huge earthen bank near Chamberlain, S.D. This put the final touch on a dam behind which is now being formed a vast reservoir — the latest in the Missouri watershed chain.

The construction of a dam is not in itself unusual, but in this instance — and others involving the Army Engineer District, Omaha — the RCA 301 computer played a vital role.

Months before the first piece of construction equipment went into action at the site, comprehensive surveys were conducted with the help of the computer to determine in great detail and with the utmost accuracy how much earth would be needed and how long the massive "moving" job would take.

The computer was brought into play again to determine the specifics of the excavation end of the project, to carry out simulated stress and structural analyses, and to plot in orderly fashion the construction of the powerhouse as well as the great earthen wall across the river.

The new dam and reservoir at Chamberlain, along with counterparts up and down the Missouri, enable Army Engineers to give the river a computer-controlled water transfusion in dry spells and apply the brakes during periods of flood threat.

To cope with the problems Big Muddy is prone to present, a Coordinating Committee for Missouri River Main Stem Reservoir Operations was formed in 1953. Each of the ten Basin States named its top water resources engineer to this body. Other members represent the eight federal agencies with interest in water resources development in the Basin — the Army Engineers, Bureau of Reclamation, Public Health Service, Federal Power Commission, Fish and Wildlife Service, Geological Survey, Weather Bureau, and the Department of Agriculture.

This committee holds regular planning meetings twice a year, with special sessions called when unexpected problems arise. The spring meeting is perhaps the most important of all for it is devoted to formulating the objectives to be incorporated into the next annual operating plan. These objectives serve as the framework for the drafting of a detailed plan by the Reservoir Control Center in the Omaha headquarters of the Corps of Engineers. The Reservoir Control Center consists of a group of specialists in the fields of meteorology, hydrology, hydraulics, and power generation.

Each July, when the current year's water supply has been well established, the operations schedules for the remainder of the current year and the ensuing calendar year are spelled out. Calling on the memory capacity and electronically swift mathematical abilities of the RCA 301 data processing *figure was held to $9 million.*

system, the Reservoir Control Center drafts the annual operating plan for submission to the Coordinating Committee, which in turn puts this "blueprint" for river control and management into final form.

The Basin-wide plan provides for flood protection, water storage, irrigation, improvement of navigation, hydroelectric-power development, conservation and related benefits in water supply, pollution abatement, recreation, and propagation of fish and wildlife.

Of these, flood control is far and away the most dramatic and urgent. It is here that the computer becomes an invaluable tool. Flood damage averted by the main stem dams under computer guidance thus far in 1963 has amounted to an estimated $10.9 million.

The 301 — a compact electronic data processing system developed by the Radio Corporation of America for a wide variety of business, industrial, and government uses — graphically proved its capability during the Missouri Basin floods in the spring of 1962, providing endangered cities as much as five days' advance notice of predicted water level peaks and levee locations requiring extraordinary attention.

Armed with snow cover and melt reports from key points along the tributaries of the Missouri River, engineers of the Omaha District estimated the potential peak discharges at strategic spots and used the RCA 301 to compute a series of water surface "profiles" for anticipated peak discharges.

A profile for the Floyd River was delivered to Sioux City, Iowa, five days before the high-water mark was reached — and the prediction was within 2/10 of a foot of the actual peak. Another profile of the Big Sioux River, reaching Sioux City three days before the crest, indicated the need to reinforce the flood wall along a road bordering that stream.

In the post-flood period, the RCA 301 was put to work turning out flood damage and levee evaluation reports.

The data processing system is performing a variety of scientific and engineering tasks. On the basis of surveys made with the assistance of the RCA 301, Army Engineers conduct river stabilization studies, determining where dikes should be erected, how much dirt or other material will be required, and where in the immediate area it can best be obtained.

In the upper reaches of the Missouri Basin, a lower rainfall rate has created the need for extensive irrigation. The computer gives the Army Engineers a projection five years into the future, enabling them to plan better the requirements for water storage.

With more than two million tons of shipping using the Missouri during the navigation season, the computer system also helps maintain a proper water depth in the navigation channel. Fluctuations stemming from excessive rainfall or drought are compensated for.

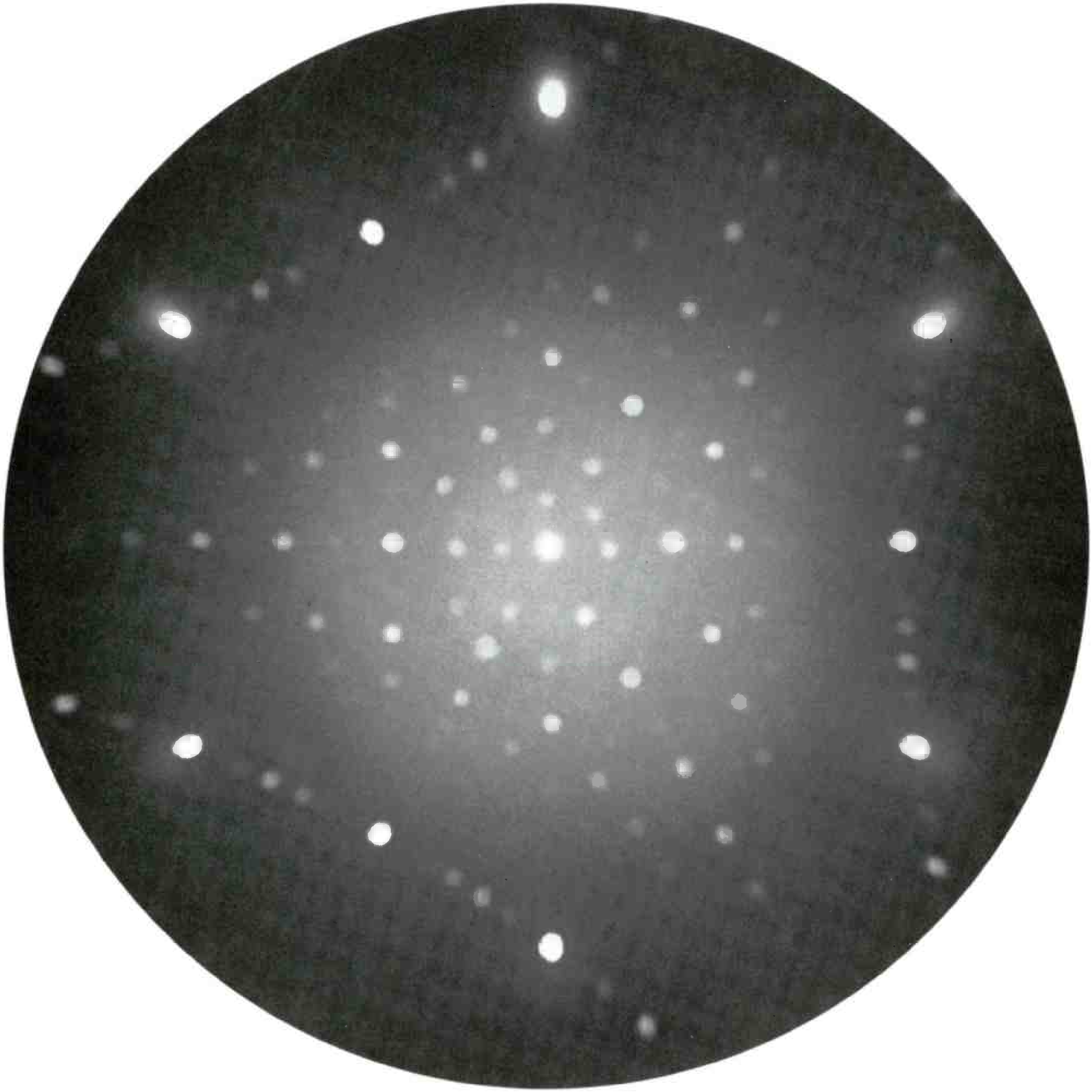
. . . disasters such as this Kansas River flood.

Besides helping regulate the interstate necklace of reservoirs, the computer is used to conduct stress studies on materials employed in the construction of retaining walls, powerhouses, and other structures — all of which must be earthquake proof because of the occasional ground tremors experienced in the Basin.

Big Muddy still is not entirely broken to harness, but giant strides have been taken. In the years immediately ahead, the Missouri will be under as tight control as any great river can be — and a computer is leading the way. ■

Man-Made Matter: Revolution in Electronics

by Bruce Shore



This X-ray diffraction photograph shows triangular arrangement of atomic layers in a tungsten crystal. Bright spots represent reflections from symmetrical atomic layers.

A report on the significance of research now being conducted on exotic man-made materials.

In an assault that would gladden the heart of the toughest battlefield commander, materials scientists are storming across the atomic frontiers of solid matter in a steadily mounting campaign to subjugate and exploit the rich electron populations known to inhabit these realms.

Committed to this offensive in electronics laboratories everywhere is a host of materials specialists from chemists and physicists to ceramists, metallurgists, spectroscopists, and crystallographers.

Armed with electron microscopes, mass spectrographs, electric furnaces, and an altogether dazzling array of scientific siege weapons, these men and women are writing an inspiring saga of patient research and fundamental discovery that is reshaping the world around us.

With a recent series of lightning incursions into the electron fastnesses of germanium, silicon, and gallium arsenide, for example, scientists have succeeded in bringing solid-state electrons under their dominion sufficiently to produce the transistor and tunnel diode for amplifying radio signals or controlling electron flow in a circuit; the solar cell for converting sunlight to electricity; the thermocouple for transforming heat to significant amounts of electric power; and the semiconductor laser for converting electric current to coherent light.

Before this, materials science in the electronics industry was a more or less sporadic affair — a few brilliant expeditions into the electronic heartland of matter to discover barium strontium oxides for the production of electrons in vacuum tubes; the ferrites, ferrimagnetic compounds that give computers their memory and electron beams their sense of direction in cathode ray tubes; and the zinc sulfide type phosphors that convert the energy of electrons to the images on today's television screens.

The difference between these two sets of exploits — the one bracketing the period 1920 to 1948 and the other the period 1948 to the present — is a measure, perhaps, of how materials science has broadened in range of interests and grown in sophistication since the birth of the electronics industry a half century ago.

In the early days, electronics scientists and engineers were interested in electrons only after they had been freed from the materials to which they were attached. All they asked of materials science was that it create or uncover substances that, upon the application of heat, would readily spew their electrons into a vacuum where they could be controlled by electric or magnetic fields.

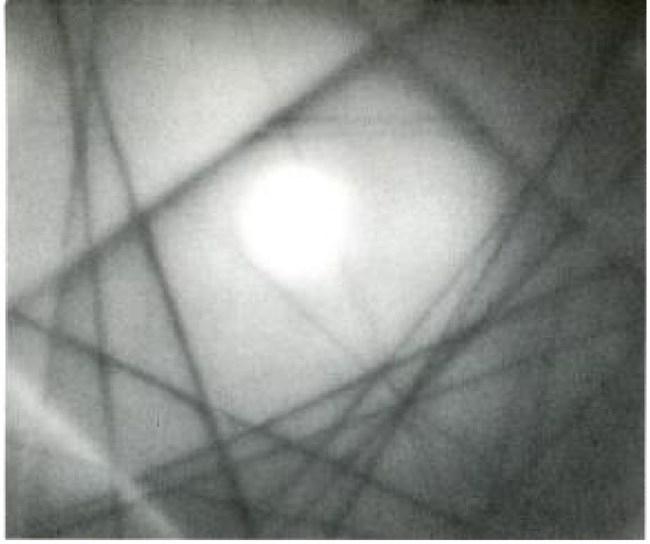
Later, when the effort to produce television got up steam in the 1930s, these same engineers went further and requested that materials be found to convert electron energies to visible light. Materials scientists such as H. W. Leverenz, presently Associate Director of RCA Laboratories, figured prominently in this search and helped to realize the sulfide phosphors that serve the TV industry today.

The achievement of commercial television hinged also on the development of a material that could control the movement of the electron beams that traced pictures on these phosphors by scanning back and forth across them. Here again, scientists such as Mr. Leverenz came to the rescue with a new family of iron oxide compounds called ferrites.

With these and other special materials, the electronics industry was able to produce national telephone networks, radio broadcasting, movie sound systems, the electron microscope, television, microwave radar, and the computer — a rather impressive array of products to derive from a few phosphors and oxides.

By the late 1940s, however, electronics customers were demanding more from their equipment than some of these materials could provide. What was wanted were radio transmitters and receivers that would operate at extremely high frequencies, computers that would process millions of bits of information per second, and electronic circuitry that was simple, cheap, and reliable.

To meet these new goals, materials researchers at the Bell Telephone Laboratories in Murray Hill, N.J., decided on a novel approach to the most critical function of all electronic circuitry —



Hallmark of a perfect silicon crystal consists of these "Kikuchi lines" produced by an electron beam that ricocheted from one layer of the crystal's atoms to another.

Producing temperatures that melt iron and pressures that equal an ocean depth of 2,000 feet, this autoclave is creating gallium phosphide, a new semiconductor material.

Fundamentally, the electronics revolution of today is a materials revolution ...

amplification. Remembering the solid and puzzling galena rectifier used in the early crystal radio sets to detect incoming radio signals, they felt confident a solid-state device could also be developed to amplify such signals. Several years of intensive materials effort followed, culminating in the achievement of the germanium transistor in 1948.

The impact of this development was immediate and far-reaching. Not only did it give the electronics industry a wholly new breed of circuit component but it gave materials research within that industry a new set of values and a new sense of direction. There were many reasons for this:

The transistor represented the first use of a semiconductor to amplify radio waves; it boasted a materials purity down to one foreign atom in every 10 million atoms composing it; it was the first application of quantum mechanics to achieve a practical electronic device; it was the first of a new family of components realized solely through materials processing rather than parts fabrication; and it was the first active component to do its work not by releasing electrons but by controlling them.

The transistor was only a beginning, however — a first step. Its behavior required a great deal more understanding and elucidation before its performance and reliability could be improved and still newer devices built upon its principles.

At RCA Laboratories, as elsewhere, interdisciplinary teams of materials scientists were formed to study solids — to elaborate quantum mechanical theory with regard to them, to develop new means for purifying and synthesizing them, and to map their atomic composition and architecture.

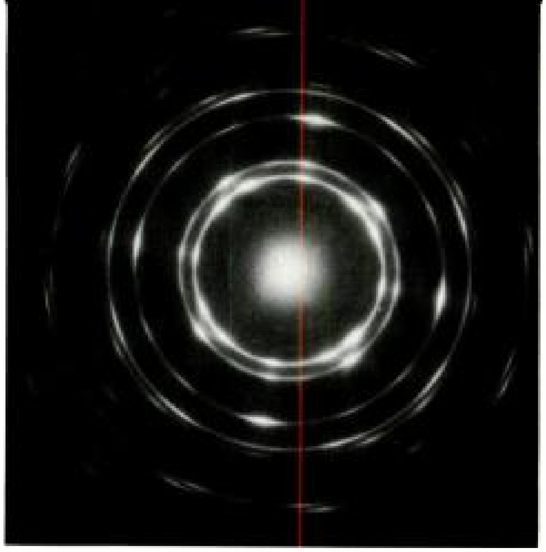
From these concerted investigations, the industry went on to build its first germanium and, later, its first silicon product lines, including both transistors and diodes. By 1958, ten years after its announcement, the transistor had fathered a flourishing new semiconductor industry, an offshoot of its vacuum components activities that was already in the $100-million-a-year sales class.

That very year, 1958, saw the next major breakthrough achieved by the new materials science — the tunnel diode. Another marvel of processed germanium, this device used an obscure outcropping of quantum mechanical theory, called "tunneling," to achieve switching speeds and sensitivities at least a hundred times greater than transistors, while requiring even less power to operate.

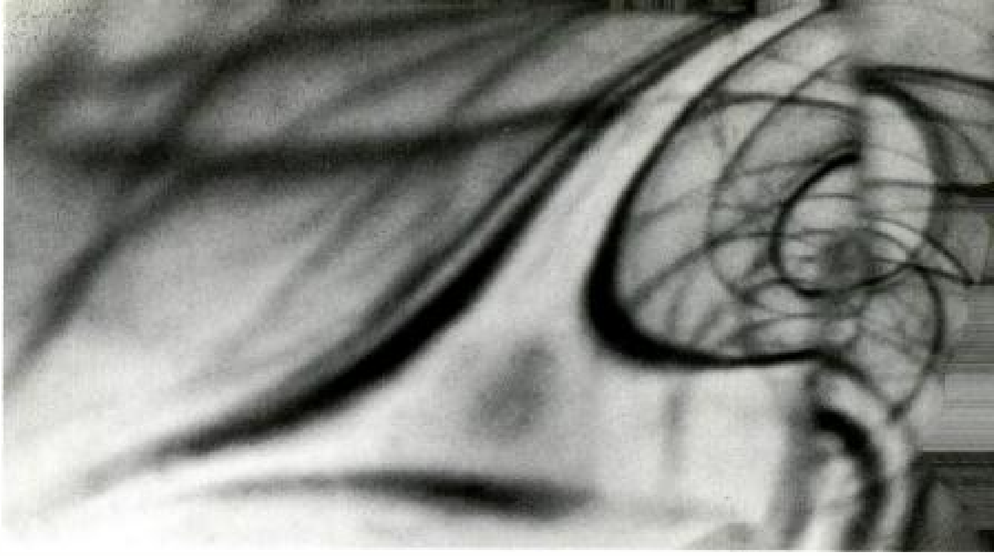
With this second solid-state development, the pace of materials research quickened. Not only were semiconductors being investigated but even conductors like the semimetal bismuth, and insulators such as barium titanate and calcium tungstate.

On the purification side, materials were being refined down to the one impurity atom in every 10 billion level, and new structural concepts such as the "epitaxial" layer and the "planar" surface for transistors and semiconductor diodes were burrowing their way out of the laboratory and into the production line.

Then, early in 1960, materials scientists at the Hughes Semiconductor Division in California went to work on a man-made boule of aluminum oxide containing traces of chromium. Later, this



This ring pattern is made by an electron beam passing through atomic structure of nickel chromium film of a thickness of 1/2,000,000 of an inch.



Strain lines swirl around fault in atomic structure of this germanium crystal, which is magnified 320,000 times. Such dislocations affect a material's electronic performance.

artificial ruby gave birth to the first laser, a tiny polished section of the parent crystal that uncorked a tremendous flash of coherent red light when exposed briefly to a high-intensity light source.

About this time, too, a materials research group under the leadership of Dr. Fred Rosi, of RCA Laboratories, canvased the periodic table to find a practical thermoelectric material for use in the production of electric power from heat. Previously, most thermoelectric research had been in the area of cooling.

Several years before, for instance, Nils Lindenblad, also of RCA Laboratories, had developed bismuth-telluride alloys to produce thermoelectric cooling on a scale that had made possible the construction of a model room cooled in this way. This room was demonstrated to the press in 1956.

Late in 1961, the alternative quest for thermoelectric power also succeeded, and a new germanium-silicon alloy was demonstrated which could take higher temperatures and deliver higher amounts of electricity at those temperatures than any substance made or mined. The technology for making these alloys was quickly transferred to the Electron Tube Division plant in Harrison, N.J. Today, it is being used to produce thermocouples to supply electric power from the heat of a nuclear reactor that will be launched into orbit next year as part of the SNAP (Space Nuclear Auxiliary Power) program being conducted by the National Aeronautics and Space Administration.

At about the same time, another materials group under Dr. Rosi developed a new process for producing niobium tin films continuously on ribbons of various metals, including certain steel alloys. The impact of this development has not been fully realized as yet but is expected to be prodigious in the new field of superconductivity. Already, such ribbons have been wound in a superconductive magnet for nuclear research at Brookhaven National Laboratory on Long Island and have generated a magnetic field 110,000 times stronger that that of the earth. This unit — slightly larger than a football — consumes virtually no power after initial activation by a common storage battery.

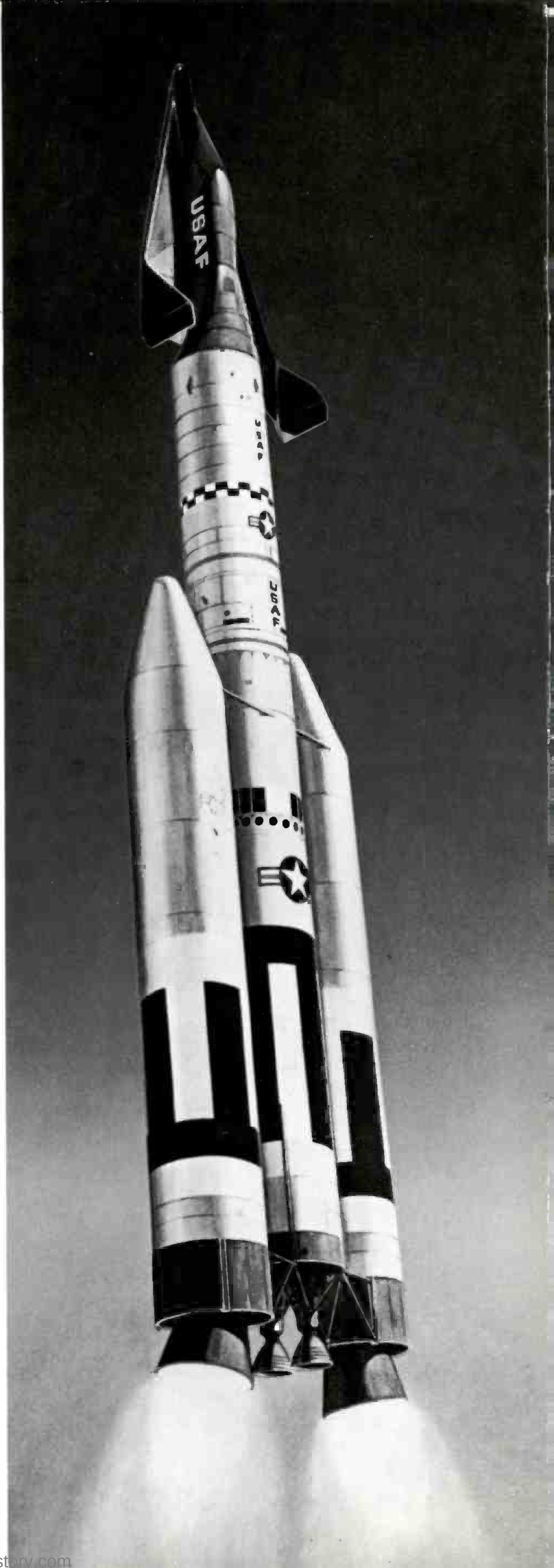
In still another area, a second materials research program at RCA Laboratories, under the authority of Dr. Simon Larach, is solving some of the age-old mysteries of solid-state luminescence, photoconductivity, ferrimagnetism, and the conduction of electrons in such fierce-to-make insulators as hafnium and zirconium oxides. In fact, his laboratory has one of the few machines in the world — an arc image furnace — that is capable of growing these exotic substances in the single-crystal form required to study them.

Supporting the work of both Dr. Rosi and Dr. Larach are two branch laboratories maintained by RCA overseas. Laboratories RCA, Ltd., in Zurich, Switzerland, headed by Dr. Walter J. Merz, is engaged primarily in research on photoconductive and photoluminescent materials. Laboratories RCA, Inc., in Tokyo, Japan, led by Dr. Maurice Glicksman, is currently absorbed in studies of one of matter's most bizarre manifestations — hole-electron plasmas in semiconductors.

Fundamentally, the electronics revolution of today is a materials revolution blueprinted in quantum mechanics, initiated by the transistor, and led by an enterprising group of imaginative materials scientists. ■

The Space Glider

by William C. Moore



The X-20 (Dyna-Soar) will bridge the gap between satellite and conventional airplane. Dyna-Soar will be able to operate in space, re-enter the atmosphere, and glide to a landing of its pilot's choice.

On March 17, 1884, John Joseph Montgomery climbed into rickety, winged contraption sitting on a knoll in Otay, Calif., and someone pushed the whole assembly off the hill. Thus, for the first time that anybody took note of, man glided successfully.

This event was perhaps more the progenitor of the modern space mission called X-20 (Dyna-Soar) than were the first flights of the Wright brothers some 20 years later, or even those of the Mercury astronauts.

The reason is that the X-20 "dynamic-soaring" vehicle is a glider.

Even more like the mission of the X-20 than Mr. Montgomery's 30 pounds of fabric and wood which carried him into the history books, was a glider built by William G. Swan in 1931. On June 4 of that year, Mr. Swan strapped several sets of skyrockets to his machine and launched himself 200 feet in the air off the end of the Steel Pier in Atlantic City, N.J. Swan soared over the astounded early summer tourists for eight minutes and became the world's first rocket-launched glider pilot.

Sometime in 1966, the United States Air Force, a group characterized by much of the ingenuity of Messrs. Swan and Montgomery, will hook a two-million-pound-thrust Titan missile to its X-20 glider and blast it and its pilot clear into outer space.

This latest and possibly ultimate of gliders will orbit the earth at 18,000 miles per hour as a ballistic device similar to any manned or unmanned satellite. But when it re-enters the atmosphere, it will become a glider.

The X-20 will glide through the high-temperature re-entry phase for as long as half an hour, as contrasted with the few minutes the ballistic Mercury capsules took to burn their way into the atmosphere.

It will enter a landing pattern at an altitude of 100,000 feet at a speed of about 3,000 miles per hour, make one 360-degree turn, and land at a conventional airport at 140 knots.

From this brief description of X-20's mission, it is obvious that the performance of the aerospace craft as a glider contrasts considerably with the machines flown by Montgomery and Swan. In the words of one of the pilots assigned to fly it, "The X-20 glides like a light brick."

However, test pilots have been gliding the "light brick" called the X-15, the air-launched, rocket-powered experimental aircraft, to safe airport landings from 60 miles above the earth for many months now, and the six Dyna-Soar pilots express no misgivings about touching down the X-20 spacecraft, which can land at a large airport of the pilot's choosing "anywhere between Point Barrow, Alaska, and San Diego, Calif.," as former Boeing program manager George Stoner put it.

The X-20 (Dyna-Soar) glider is shown atop a Titan IIIC rocket vehicle in an artist's conception of the initial stages of flight with solid-propellant rockets thrusting. After burnout, they will drop off and the modified Titan II liquid-propellant core rocket will put the glider into orbit.

Although manned ballistic flight has been explored by the Mercury program and high-speed landings by low-lift aircraft have become commonplace not only through the X-15 but even by fighter aircraft on the "hotter" side, the first X-20 flights will, nonetheless, be true space-age adventures. One reason is that no one has flown a winged aircraft at hypersonic speeds — beyond Mach 6 or over 4,000 miles per hour.

George Snyder, Vice President of The Boeing Company which is building the X-20, says that the X-20 will explore speed ranges "now out of reach of the X-15 and beyond the maneuvering capabilities of the Mercury and Vostok ballistic capsules. In terms of speed alone, this regime represents a gap in our knowledge of roughly 14,000 miles per hour."

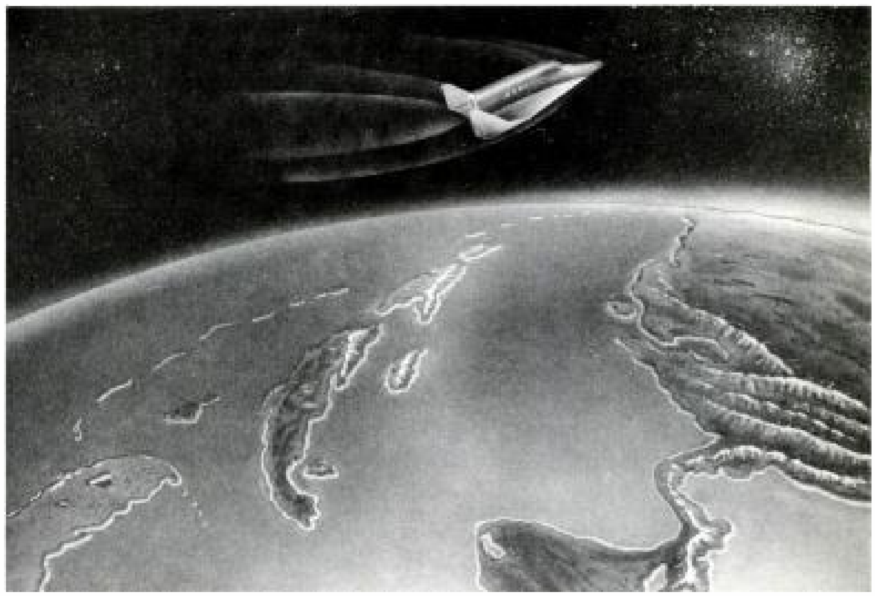
To ensure that the first pilot to hurtle his X-20 out of space into the searing atmosphere will be as safe as it is possible to make him, an exhaustive test program is being conducted. Virtually every major wind tunnel in the country has been used to test the performance of the X-20. These tests have included every wind environment from a tunnel simulating the gentle sea breezes to be expected while the spacecraft sits atop its Titan III booster at Cape Canaveral to the hypersonic blasts from "hot shot" and shock tube tunnels with wind speeds of 14,000 miles per hour. In all, about 30 wind tunnels have been involved in the design of the X-20.

And while aerodynamic shape is tested in wind tunnels, skin panels for the new bird are subjected to the banshee-like screams of re-entry sound at The Boeing Company's sonic testing facility.

As with the Mercury manned orbital flights, the re-entry phase of the Dyna-Soar flights will be critical — but much different. Mercury capsules plunged into the atmosphere and dissipated the intense but short-lived heat by ablative materials which boiled off taking the heat with them. The X-20 pilot, possibly conserving energy for a far distant landing, can hold his glider in the re-entry phase for over half an hour. Because of the gradual re-entry, heat levels will not be so great over most of the surface of the bird — from 2,000 to 5,000 degrees Fahrenheit — and the nickel-alloy steel, molybdenum, columbium, and ceramic materials of the X-20 will radiate away this re-entry heat.

However, at X-20's nose there will be a "stagna-

One of six men chosen to fly the orbital glider, X-20 pilot Maj. James Wood is briefed on the spacecraft's control seat model. A full-scale mock-up of the X-20 is in background.



In this artist's conception, the X-20 is shown assuming glide attitude and beginning re-entry after space flight. New communications equipment will combat ion sheath "blackout."

tion point" where air will heat up to 20,000 degrees or more and bathe the entire glider in a fireball called a "plasma sheath." From the ground, X-20 will look like a shooting star blazing across the sky. The significance of this sheath is not its heat but its ability to screen the spacecraft from normal communications. Imagine those anxious moments the Mercury astronauts were cut off by this "re-entry blackout" being stretched to half an hour or more.

The Dyna-Soar project office at Wright-Patterson Air Force Base, Ohio, believes they have this problem solved, too. The Radio Corporation of America, an associate contractor on the X-20 program, has developed a communications system employing frequencies far above our UHF television stations, frequencies of such short wave length they will "slide in between the ions" of the plasma sheath and provide communications with the pilot throughout the entire flight. Because of its narrow beam, the communications system will also be used for tracking the X-20 in certain flight phases. RCA will begin flight testing the new system using conventional aircraft this fall.

Another problem unique to the X-20 boost-glide program was the design of a suitable landing gear. Since ordinary rubber tires and lubricated bearings could not withstand the heat of re-entry, the Goodyear Tire and Rubber Company developed a main landing gear for the X-20 that looks like wire brushes mounted on skis. These wire skids also perform the function of brakes. Bendix Corporation developed the nose "wheel." It resembles a shallow kitchen dishpan, and X-20 will slide along on the pan's convex side.

Flight tests of the X-20 itself are expected to begin in 1965 when the glider will be dropped from a B-52 "mother" aircraft to test the vehicle's stability and control at slow speeds and to allow the pilots to perfect landing techniques. Later, the X-20 will be air-dropped and rocket-powered for supersonic tests, similar to the X-15 flights. Finally, the aerospace craft will sit atop that powerful composite of solid and liquid rockets called Titan III at Cape Canaveral, and shortly afterward a completely new type of spacecraft will rocket into space.

Although the X-20 (Dyna-Soar) has had no military mission assigned to it, it is, according to General Thomas D. White, former Air Force Chief of Staff, the first vehicle to combine the advantages of manned aircraft and missiles into a single system. In the words of Secretary of Defense Robert S. McNamara, "The military applications of manned orbital flight of the type toward which Dyna-Soar is directed are likely to be great." ■

Music and Art

A unique combination of fine art reproductions with great musical recordings provides the music lover with both a music and an art library.

Record album art (top, left to right): Cézanne, Signorelli, attributed to van der Mast, Picasso, El Greco; (bottom, left to right):

"Mine eyes have perceived and mine ears heard, and through them, I have experienced the glory of life."
—Gustave Le Fevre

Man's search for beauty has been present to some degree in every age of history. There have been periods during which the search has withered, giving way to such eras as the Dark Ages. And there have been other eras when man's thirst for beauty could no longer be contained by the evils of the times, and the search has flowered; the Renaissance was such a time.

If the rumblings of destiny and visions of potential doom bring sights and sounds to torment modern-day man, they also have intensified his seeking after the beauties of existence in a cultural explosion such as the world has never known.

Music provides a glory of sound; art, the highest manifestation of beauty through sight. It is not unusual, then, that any marriage between these two art forms can and does excite man aesthetically.

Ludwig van Beethoven, for instance, after a walking trip through the hills of Bavaria, com-

Holbein, Rouault, Carpaccio, van der Goes, and a Bayreuth Festival painting of a contemporary "Die Walküre" set.

posed his immortal "Pastoral" symphony, describing it as "sound inspired by the wonder of sight."

"Progress is the result of man's inventiveness, but the milestones of progress are the cultures he has developed to please his eyes and ears," Benjamin Franklin once declared.

Music and art complement each other. Together, they can achieve a lasting monument to beauty.

Richard Wagner defied the views on music and drama of his day by demonstrating in each of his operas that the sound and the sight are equally important and that either is incomplete without the other.

When the New York Metropolitan Museum of Art purchased the famed Rembrandt painting "Aristotle Contemplating the Bust of Homer" for the largest price ever paid for a painting, two viewers captured in a brief conversation the painting's value. Questioned the first: "Why do you suppose they paid such a price for it?" The reply: "It is so beautifully real, I can almost hear what he's contemplating."

It is not at all unusual, then, that the phono-

The album (left) of "A Midsummer Night's Dream" contains Boydell etchings. A Hobbema painting marks the cover of "The Pastoral" album (right), and a van Gogh is included inside.

graph record, which is a means of capturing music for posterity, would one day be wedded to art. For some years, record companies have seen the esoteric importance of combining music and art, and there have been many notable instances in which such combinations have provided beauty through magnificent collections.

RCA Victor Records has been one of the leaders in this field. When Beethoven's "Pastoral" was recorded recently, it was combined in a deluxe set with color reproductions of great paintings dealing with nature. A recording of Mendelssohn's "A Midsummer Night's Dream" became an art portfolio in which Boydell etchings from the Imperial Shakespeare Folio of 1804 were reproduced. A collection of Horowitz piano performances also provided a full-color tour through the famous Horowitz collection of paintings. The aforementioned Rembrandt masterpiece became the cover for a magnificent recording of Beethoven's "Eroica" symphony — each masterpiece heroic in its domain.

The great art treasures of the world, some in museums and some in obscure chapels and private collections, have been brought to a broader public's attention through record albums.

On these pages are examples in which art and music have been combined to provide living testaments to man's eternal search for beauty. ■

Radio Comes on Strong

by Desmond Smith

The constant availability and increasing portability of radio are reflected in the continued rise of radio set sales and a growing 24-hour-a-day audience of listeners.

Anybody who spends much time with radio people nowadays finds two words cropping up in the conversation – change and mobility; these are terms which go with an entertainment medium that only a dozen years ago was supposed to be down for the count. K.O.'d by television. Well, last year the public went out and bought nearly 25 million radios. It was radio's all-time record year. What happened is worth a closer look.

In 1947, there were approximately 2,000 radio stations in the United States. Look at any radio map of this country today. The red dots representing AM (amplitude modulation) stations number nearly 4,000, while the blue dots, representing FM (frequency modulation) stations, add up to more than 1,200 stations. Moreover, there are at least 100 stereo stations multiplexing to an ever-increasing audience of high-fidelity enthusiasts (known affectionately in the trade as "nuts"). And the rush for licenses to operate new radio stations has become so great that the Federal Communications Commission, last year, ordered a partial freeze on AM applications.

Change has meant new opportunities for the immense radio-manufacturing industry. But many people say that it was the radio manufacturers themselves – operating in a fiercely competitive business – who created the opportunity out of the challenge of television.

When television sets began to reach the consumer market in volume during the late forties, it was the radio industry's backlog of know-how and experience that provided the solid base for television's rocket-like take-off. With much trial and error eliminated from the new industry, sales kept right on soaring when the consumer discovered that TV sets were relatively trouble-free.

But as television set sales climbed, radio listening kept on dropping. During the prime evening hours (7–10 P.M.) the radio home audience shrank from 17 million to less than 3 million.

Within the home, television swiftly replaced radio as the main source of evening entertainment. The mass nationwide audiences who had, over the years, listened so loyally to such programs as the A & P Gypsies, Amos 'n' Andy, and Goodrich's Silver Masked Tenor were now deserting by the block to television. And it was network radio, which had carried the big radio shows, that suffered the greatest audience losses. Listeners, it seemed clear, were no longer prepared to stay home just to catch their favorite comedy show on radio.

While millions of fascinated viewers were glued to their TV sets watching endless roller derbies and Milton Berle, radio manufacturers such as RCA noted something that the critics of radio had missed. People were continuing to replace their radios at exactly the same rate that they did before television. Then, in 1955, a peak TV viewing year, the radio industry sold 14 million radio sets – three million more sets than were sold in radio's last big pre-television year, 1949.

The size of this jump surprised even radio people. Audience researchers decided to take another look at the market. They discovered that, al-

Desmond Smith, New York correspondent for *The Economist* of London, is a frequent contributor to American magazines.

..."about all that 1963 radio has in common with 1946 radio is that a great many people listen."

though family listening had gone down, individual listening had gone up. And in television's weaker morning hours (6–9 A.M.), the size of the radio home audience had increased by about a million homes. Obviously, the clue to this new kind of market was going to be flexibility. Yet, if the four-legged corner radio console, anchored to the wall, was no longer the prime source of evening entertainment for the family, with what was it to be replaced? Designed as a piece of furniture, it was hard, often impossible, to shift around the house. RCA, which had led the field in the thirties by pioneering a portable radio, began design development on a radio that would satisfy public demand. What the public chose offers a significant insight into the kind of radio programing the audience was looking for in the television age.

Around 1950, a clock with a portable type of radio was introduced. The results were spectacular. Overnight, radio lost its period look. The clock-radio was an instant success with the public. A sleepy America was soon waking up to music. Martin Bennett, RCA Vice President, Distributor and Commercial Relations, explains: "The entire concept of the clock-radio was an exciting one. Right from the outset it opened up a whole new usage for the medium." Moreover, the radio industry had stumbled across a "work horse." Engineers and designers, using the same logic that has worked so effectively in the automobile industry, started with a basic must-have item and soon festooned it with extras. The Detroit influence is most obvious in the myriad features that now come with the clock-radio. Wake-ups, warning tick-tocks, night-light, slumber switches, calendar, barometer, and appliance outlets — there seems to be no limit to the clock-radio's potential for versatility.

It can be argued that there is perhaps an overabundance of gadgetry. RCA's Tucker P. Madawick, Manager of Home Instruments Industrial Design, disagrees. "We are simply filling a need," he declared recently. "It is the housewife herself who demands that her radio match her environment. All we did was add those features that fit into that environment. Today, a housewife is surrounded with batteries of precision instruments, from her stove to her automatic washing machine. We have kept the radio in the same tenor — given it the look of precision."

Whatever the purist may think, the public continues to favor clock-radios. Today, their popularity is exceeded only by that of the transistor radio, which has had a staggering growth. Last year, Americans bought more than 11 million portable radios; most of them were transistorized units.

Now that the "furniture" look is no longer the factor it was in the days before television, consumers are concentrating on other design features. Acknowledging this trend, Martin Bennett observes: "Today, 98 per cent of all radios bought in this country are bought on 'sound quality,' and it's in this area that we've tried to place our efforts."

Amoeba-like, radio today is split into at least three major segments: the plug-in home audience, the battery-portable audience, and the auto-radio audience. Even the location of the plug-in radio has changed since 1946. Then, better than 90 per cent of plug-ins were located in the living room. Bedroom and kitchen penetration of radio was so small as to be insignificant. Today, 66 per cent of all bedrooms and 56 per cent of all kitchens have radios.

Probably no event in this period of radio's big change has influenced programing more than the remarkable growth of the out-of-home listening audience. Since the development of the tiny transistor set, a radio has become almost as easy to carry as a pocketbook or a billfold. People listen to radio today in a variety of places — the supermarket, in the parks, at the beach. These listeners have become the biggest segment of radio's audience.

In 1946, less than 9 million cars were equipped with radio. Last year, car radios had skyrocketed to almost 50 million. Since 1958, radios have ranked as the leading extra that new car dealers sell, and Sindlinger, an audience-measuring service, estimates that as many as 44 million adults listen to their car radios every day.

Given this situation, it is not surprising that any appraisal of radio today must consider the frac-


Radio: 1924 . . . Radio: 1963.

tionation of the audience and its mobility. With the relative decline of radio-network influence, there has been a subsequent scramble among the independent stations to create an image for their call-letters. This has tended to become a matter of programing a certain "sound." Although there are stations specializing in jazz, rock 'n' roll (euphemistically dubbed "contemporary"), big band, talk, show albums, and concert-music programing, it is the music and news format that has achieved the greatest popularity with station owners. Within the industry, such stations have often drawn criticism. It has been argued by their supporters that music and news have the unique advantage over television in that the listener need not devote his full attention to the radio. On the other hand, the high proportion of commercial announcements that frequently appear before and immediately following a record has alienated many listeners. "A station," according to E. William Henry, Chairman of the FCC, "submitted some program logs to us recently which bear, at appropriate places, the following unforgettable note to disc jockeys: 'Play a record between each commercial.' "

Not surprisingly, the number of performances of musical compositions broadcast by radio stations (excluding networks) has climbed from 40 million a year to almost 200 million. These figures raise an interesting question: Why hasn't this emphasis on recorded music stimulated a shift in listening values? FM supporters insist that it has had this effect. They point to the growth of FM from fewer than 50 stations in 1946 to more than 1,200 in 1962. They reason that the increased demand for FM is, in part, a revolt against the so-called music and news station's programing. At the same time, the obvious advantage over AM can be heard in the high-fidelity reproduction of music.

In any case, RCA and other radio manufacturers are watching the situation with interest. "We have moved forward into the stereo-hi-fi field," declares Bennett. "RCA pioneered the Victrola phonograph during a period that historians might call early 'hi-fi,' and we intend to keep the market under close scrutiny."

As the evidence of the last decade has demonstrated, radio is far from dead. Today, it seems livelier than ever; paradoxically, this is probably due to the impact of television. But it is not just the ability of radio to make money (before-tax profits in radio broadcasting in 1961 were $29.4 million). The fact is that radio has shown itself capable of readjusting itself to life in the television age. This flair for turning a losing run into a winning streak is probably due to the radio industry's willingness to take a chance on a new idea.

But what new idea could possibly top the clock-radio?

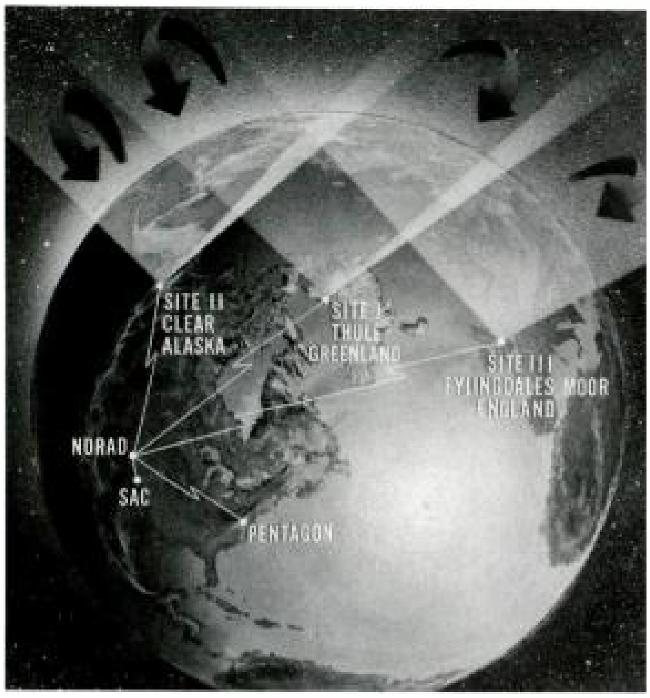
Says Martin Bennett: "Just visualize a stack of funny-looking minerals and what not, encased so that it can't be taken apart. It won't be any larger than a book of matches, and it will be a disposable item — like that $1.19 butane lighter — you'll just throw away when it wears out."

Change and mobility — that's the way it is in radio these days. ■

The latest accomplishment in man's historic search for defense against a surprise attack is the Ballistic Missile Early Warning radar system, which is now in full operation. Here is a report on...

BMEWS: 20th Century Watchtowers

by Robert L. Moora



Global diagram shows how the three BMEWS sites will spread radar fans over Europe and Asia to provide prompt warning of any ballistic missiles launched against North America or Great Britain over the top of the world.

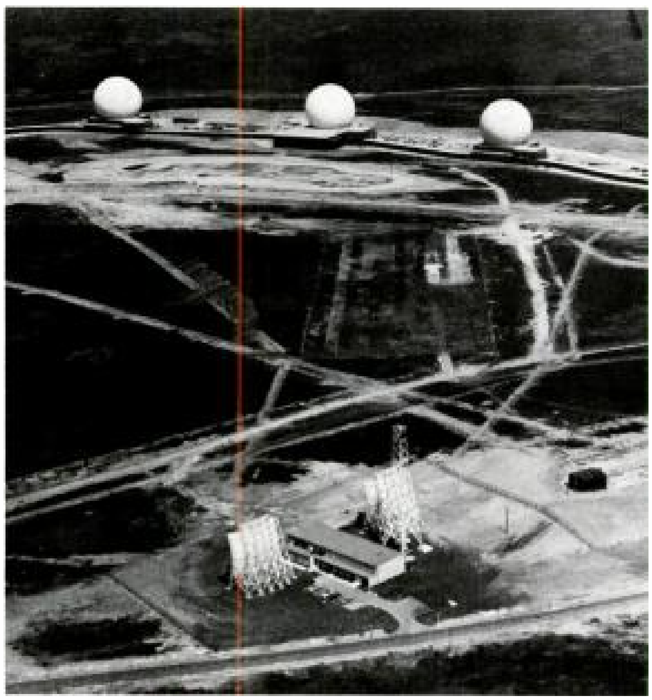
On England's North Sea coast, in the vicinity of the little Yorkshire resort towns so popular with northern Englishmen, there stand today the remains of a number of stone watchtowers built around A.D. 300 by the Roman conquerors of Britain. Connected by stone highway with the Roman legions' huge citadel at York, 50 miles away, these towers served in those ancient times as an early warning system in the event of attack by barbarians from the continent.

Some 20 miles inland, on the purple-heathered moors of Fylingdales, a brand-new watchtower went into use this fall. The new sentry post is the third major radar base of the Ballistic Missile Early Warning System (BMEWS). With its counterpart stations in Thule, Greenland, 600 miles north of the Arctic Circle, and Clear, Alaska, just north of Mt. McKinley, the base provides a blanket of radar extending out 3,000 miles across Europe and Asia.

Should intercontinental ballistic missiles (ICBMs) or intermediate range missiles (IRBMs) rise from anywhere in Red territory and take threatening courses toward North America or the United Kingdom, BMEWS would instantly send the necessary warning signals to its own citadel — in this case the headquarters of the North American Air Defense Command, at Colorado Springs. NORAD, in turn, would instantly and automatically relay the warning to the USAF Strategic Air Command at Omaha, Neb., and the RAF Fighter Command at Stanmore, England, as well as to command posts in the Pentagon in Washington and the British Air Ministry in London, so that the Western Allies' nuclear bombers and long-range missiles would be on their way in a counter-assault so devastating that it would cripple the aggressor.

So long as a potential attacker knows we have the warning time necessary to mount this massive retaliation, it will not venture such an assault, Western strategists believe. That is the *raison d'être* of BMEWS — a billion-dollar-plus insurance policy for global peace.

The mighty task of designing, developing, and managing the implementation of this system was assigned by the United States Air Force in 1958 to the Radio Corporation of America, with headquarters for the project at the company's Missile and Surface Radar Division at Moorestown, N.J.



Aerial view of the BMEWS site III at Fylingdales Moor, England, shows the three radomes facing north and east; part of the support area in lower right; and a tropospheric scatter communications installation in center foreground.

With the "switching on" of Site III on Fylingdales Moor September 17, the vast program had been completed — on time and within budget, as USAF and RCA officials are proud to note.

The task of operating BMEWS — all three sites — is another chore assigned to RCA, this time the Service Company, with headquarters at Cherry Hill, N.J., and project office at Riverton, N.J.

Many a member of RCA's Missile and Surface Radar Division and the Service Company who has participated in the BMEWS project has a parka and a pair of Arctic shoepacks in his closet, attesting to service in Greenland or Alaska, where temperatures drop to 40 below and there is 24-hour daylight in summer and 24-hour darkness in winter. Even Yorkshire's Fylingdales Moor inflicts Arctic conditions occasionally on its visitors from New Jersey and its other, mostly British, personnel. Winds across the moors in winter can reach more than 100 miles an hour, and last winter — England's worst in at least a century — blizzards were so severe that personnel at the site on several occasions were snowbound for several days and had to be supplied or airlifted to safety by RAF helicopters.

Motorists on the New Jersey Turnpike have been familiar for the last four years with the big radome, known to Moorestown folk as "The Golf Ball," which stands on the RCA property to the west of the pike. From the highway, this radome does not appear very large — but distance is deceptive. The structure is actually as tall as a 15-story building, composed of a 140-foot dome atop a two-story building jammed with electronic gear.

Few passersby know what the installation is, other than being an integral part of RCA's radar programs. Actually, it contains an 84-foot rotating radar antenna, designed to detect and track various space objects, primarily missiles.

The radome, built primarily for BMEWS test purposes, was the prototype for others in use in the BMEWS system itself. One of them has been in service at the Thule site for nearly two years. Three others went into operation in September at the Fylingdales station.

But the Moorestown radome has not been restricted solely to BMEWS service. With a capability of detecting and tracking an object the size of a house door 3,000 miles away — and of detecting larger objects out as far as 40,000,000 miles — it is an ideal instrument for the study of near-earth, or "outer-space," environment. Thus it has been used, in periods when not needed for BMEWS work, in a variety of scientific missions.

Its key role today, under contract to the Air Force, is to track satellites and feed the information into the Air Defense Command's SPADATS (space detection and tracking system) headquarters at Colorado Springs. At any given moment, SPADATS officers can tell precisely how many space objects — operating satellites, "dead" satellites and space debris; namely, parts of satellites and their boosters discarded in space — are circling man's earth. On September 17, for instance, at the commissioning ceremony at Fylingdales Moor, an officer at Colorado Springs ticked off the scoreboard in a dramatic (and loud and clear) phone call to the Yorkshire radar station: Total man-made objects in space, 357; payloads, 72; "debris," 285.

Besides its key role in space tracking, the Moorestown radar has been used in numerous experiments in the constant search for evidence to confirm scientists' conjectures about astronomical statistics and space vehicle operations.

An Air Defense Command officer checks orbiting space traffic in Air Force SPACETRACK Center at Colorado Springs. Operations Center for the North American Air Defense Command keeps track of orbiting, man-made space objects.

Besides the tracking radar — known in the industry as the AN-FPS-49 — another type of radar is used at the Thule and Clear sites. This is a stationary surveillance radar, 165 feet long and 450 feet tall, bigger than a football field turned upright. The Greenland site has four of these, the Alaskan site three. Facing out across the polar regions, these huge antennas likewise send their pulses out 3,000 or more miles to detect instantly any threatening object and send their computer-analyzed information back to NORAD.

Significantly, the entire system has been programed to reject information about anything that could not be a missile — meteorites, aurora borealis interference, faraway planets, etc.

Information from BMEWS flows constantly by multiple-channel communications — microwave radio relay, submarine cable, land lines, and even tropospheric scatter systems — into a huge room, not unlike a "little theater" in size and layout, known as the Combat Operations Center in NORAD's headquarters at Ent Air Force Base, Colorado Springs. Likewise, information reaches the same facility from other warning systems — the Dew (Distant Early Warning) Line across the Arctic, the Mid-Canada Line and the Pinetree Line in Canada, as well as radar-equipped aircraft guarding the flanks of the continent.

The BMEWS information flashes through an RCA computer known as the Display Information Processor. Instantly it shows up on a huge plexiglass map of the Northern Hemisphere mounted on a wall where all in the operation center can see it. It takes the form of ellipses, or small dots, indicating where missiles have been detected and what course they are following. As the attack progresses, circles form around the ellipses and numbers appear within them, indicating the number of missiles detected. Above the display are signs denoting the "level of alarm," depending on the computer's evaluation of the threat, and "time to go" before the first missile will impact.

To the right of this display is an even larger one — a map of the United States and Canada. As each missile threat appears on the other map, a related one appears on this one, showing where the missiles are expected to impact. This is based on an instantaneous computer calculation of the data transmitted by the BMEWS bases — the location of the missiles, their course, speed, trajectory, probable launch points, and general impact areas.

At the NORAD center, teams of men from the United States Air Force and the Royal Canadian Air Force stand guard 24 hours a day, the displays before them and the "hot lines" to the Pentagon, to the White House, to Ottawa and London beside them.

Should an actual attack appear on the giant plexiglass displays, the men in command would know instantly what action to take, for they undergo daily practice in handling threat situations.

Every day of the week, without exception, several ballistic missile "attacks" are launched against the United States and the United Kingdom. They are simulated attacks — imaginary, but based on realistic data and realistic possibilities. They are planned by a USAF strategy team, recorded on magnetic tape by a group of computer programmers from the RCA Service Company, and "played" through the BMEWS system to appear, as real attacks would appear, on the lighted displays.

The purpose of the simulated attacks is threefold:

1. Of prime importance, they provide training to assure that the men in command would, in the event of real emergency, be able to cope with virtually any situation that might arise.

2. They check the operational status and capability of BMEWS at any given moment.

3. They enable maintenance personnel to determine if any parts of the system are beginning to deteriorate and thus need corrective maintenance action.

The simulated attacks are mapped out by a strategy team of officers of the USAF Air Defense Command.

The "attacks" are worked out laboriously on paper, using hard intelligence data from the Western Allies' military branches.

In its paper plan for an attack — which might take weeks or months to prepare — the ADC team theoretically launches missiles from European or Asian bases that are known to exist.

It establishes the missiles' speed, trajectory, probable impact points and time of impact, based on the known capabilities of other nations' missiles.

The team chooses a number of targets that would logically be struck in North America and/or the United Kingdom.

The strategy team then turns its attack plan over to a group of computer programmers from the RCA Service Company at Colorado Springs and Riverton, N.J. The RCA programmers take all of the details of the "attack" — the launch points, the type of missiles being used, the location, speed, trajectory, probable impact points, etc. — and program the information on punched tape or magnetic tape to be "played" through the elaborate data processing systems that serve BMEWS.

The result is a visual display of the "attack" on the lighted panels in the half-darkened control center at NORAD as well as on other displays at command posts throughout the Western Allies' defense network.

Libraries of such test tapes, continuously updated, are in store at all of the BMEWS forward sites and are "played" periodically through the system to NORAD and other control centers. President Kennedy watched one of these "attacks" in a visit to NORAD in June, 1963.

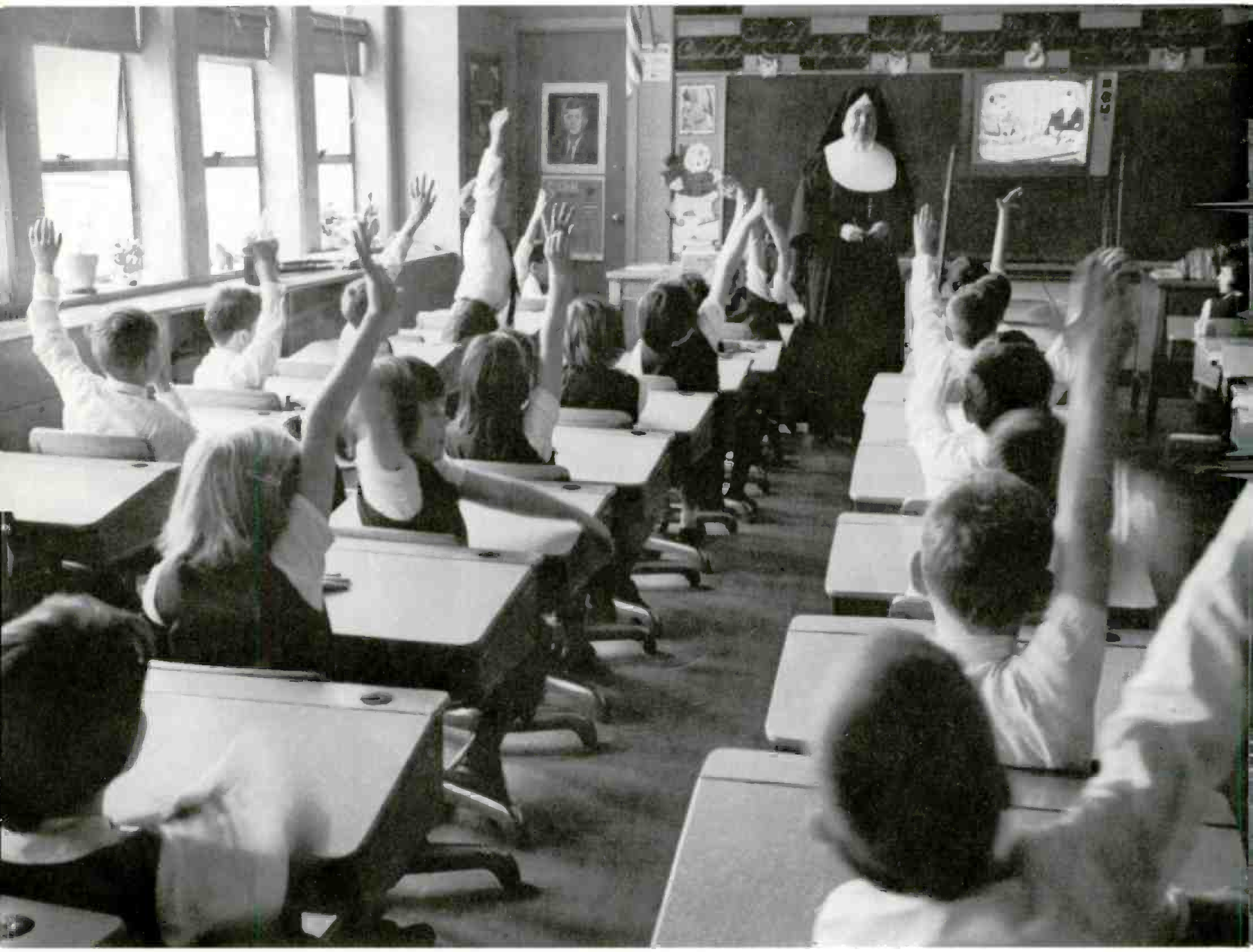
Above the display, during each simulated attack is an important word, spelled out in bright yellow lights: TEST. Should BMEWS detect an actual attack during one of these exercises, the

Canadian and U.S. personnel staff NORAD Air Defense Headquarters at Colorado Springs around the clock to receive warning information in event of a missile attack. Circles on map displays are simulated "attacks."

system automatically would switch from its TEST status to an OPERATING condition.

Then the officers manning the consoles and control panels — and the "hot lines" to the Pentagon, the White House, and other key points — would proceed in accordance with what they had learned from the "attacks" provided for them on ordinary magnetic tape. ■

Boston's Archdiocesan Television Center:



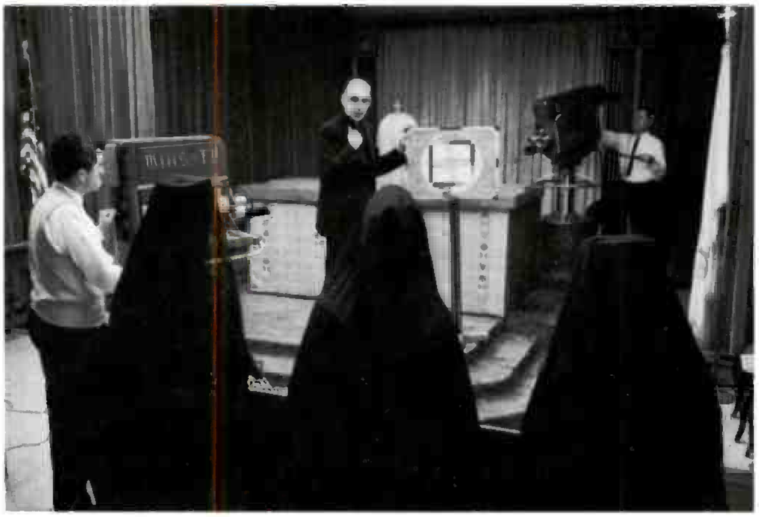
Famous for the Tea Party, Bunker Hill, and Paul Revere's ride, Boston is about to experience another historical event—the start of the nation's first diocesan-owned television station next year in the Greater Boston area. The station's network will reach more than 168,000 pupils in 340 elementary and secondary schools, and will beam its own programs over ultra-high-frequency (UHF) Channel 38 to schools, churches, convents, and any other sites with UHF receivers within the Boston Roman Catholic Archdiocese, from Newburyport to Plymouth, Mass.

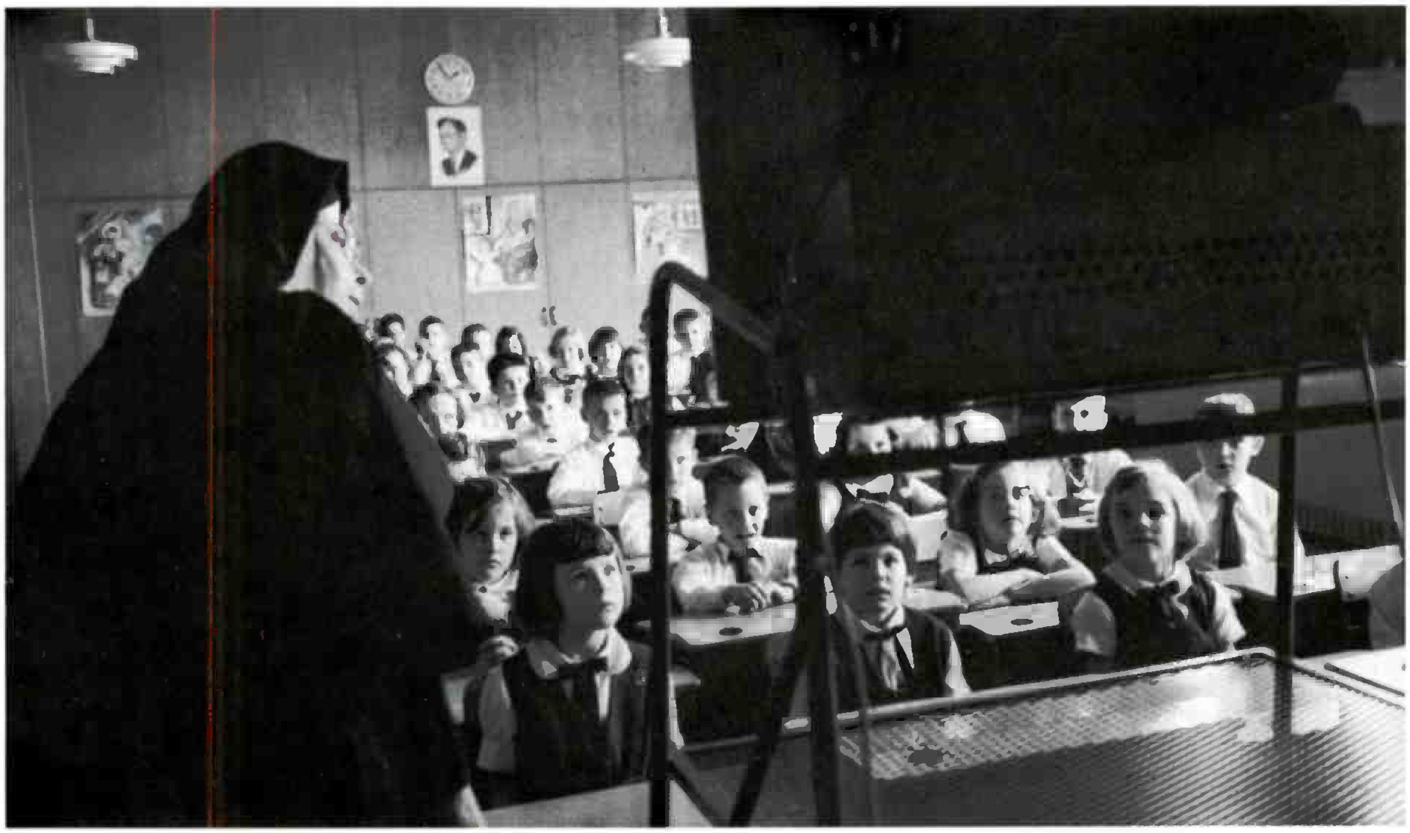
The Archdiocesan Television Center for the station, identified by the call letters WIHS-TV, has over $300,000 worth of electronic equipment, including RCA television cameras and receivers, and is prepared to commit that much and more for a transmitter and other necessary fixtures.

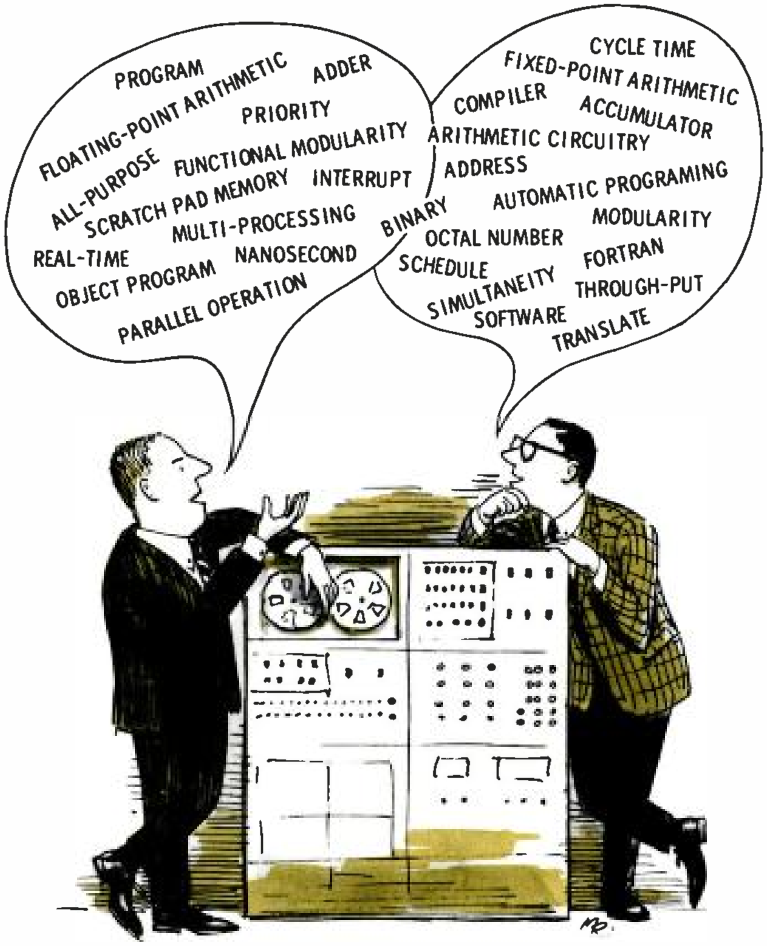
Aside from normal classroom television, which will be offered on a regular basis, the new station will also provide teacher-training courses. The same broader application will be used in nurse-training courses, which the Archdiocese currently telecasts by closed circuit to a nearby hospital.

On these pages are scenes from a broadcast demonstration held several months ago over Channel 2 in Boston showing the preparation, equipment, use—and, of course, the children—involved in a network for educational television.

Milestone in Education by TV







Computer Patois

by Ken Kizer

Along with the growth and development of electronic data processing, a new and necessary use of the English language has evolved.

It was FDR who invented the WPA, NRA, and TVA. WWII didn't help with its LST, SHAPE, BuWeps, and others. Despite campaign promises that Republicans would put an end to the Democrats' alphabet soup, things went from bad to worse with ICBM, ComLogNet, and BMEWS.

English has been described as a tough language to learn. It took the Americans to make English tougher by pluralizing collective singulars (equipments), employing adjectives as verbs (duplexed), and popularizing the acronym for household use (A-OK, TIROS).

The fracture is compounded by segments of business and government having their own gobbledy-gook. In the electronics industry, for instance, it would put the uninitiated to quite a bit of digging to define "real-time," "through-put," or even a word like "word."

COBOL, for instance, does not mean a boy and girl having a hilarious time but stands for *CO*mmon *B*usiness *O*riented *L*anguage, a technique pioneered and perfected by RCA to aid programmers to express computer problems in the English language.

An instruction in COBOL might read: RECORD-CHECK. Read Transaction-File; If Trans-Number is Greater than Master-Number Go to Get-Master; If Equal to Process-Routine Add Trans-Amount to Stock-Amount and Go to Print.

That's English? Perhaps it would help to know that the word "if" is used as a verb.

Grammatical purists would retreat in horror upon learning of the electronic definition of such commonplace words as configuration, address, compiler, memory, simultaneity, and storage, to list but a few.

A casual visitor to an RCA computer room might wonder upon hearing, "Joe, mount the PLT on the 10 kc station, set P to 2,000 and hit start, please."

He probably would not know that one was telling the other to place the program library tape on the 10,000-character-per-second tape station, set the program register to location 2,000 in the high-speed memory, and depress the start button on the computer.

Below is a definition of an often-used term which, hopefully, will serve to help solve the problem, not become part of it. You'll notice it takes definitions to define definitions:

Access, immediate — pertaining to the ability to obtain data from, or place data in, a *storage* device, or *register,* directly without serial delay due to other units of data, and usually in a relatively short period of time.

(Storage — term preferred to "memory"; pertaining to a device in which data can be stored and from which they can be obtained at a later time. The means of storing data may be chemical, electrical, or mechanical.)

(Register — hardware device used to store a certain number of *bits* or characters. A register is usually constructed of elements such as transistors and usually contains approximately one word of information.)

(Bits — an abbreviation of binary digit, a single character in a binary number or a single pulse in a group of pulses. It is also a unit of information capacity of a storage device, the capacity in bits of a storage device being the logarithm to the base two of the number of possible states of the device.)

Obviously, space and a layman's knowledge of the subject matter dictate a far simpler glossary than the above. In alphabetical order, here are some terms and, briefly, what they mean:

Accumulator Device which stores results of an arithmetic operation.

Adder Device to supply sum of two or more quantities placed into it.

Address Instruction code used to locate specific data within a storage unit.

All-Purpose Computer combining the specific talents heretofore assigned solely to a general-purpose or special-purpose computer (scientific or business)—for example, the RCA 3301.

Arithmetic Circuitry High-speed arithmetic unit which provides fixed and floating-point operations in one computer. (See Fixed point, Floating point.)

Automatic Programing Technique employing the computer to translate instructions from a form easy for a human being to produce and understand into a form suitable for computer use.

Binary Number system using only the digits 0 and 1.

Compiler Translator which reduces a problem-oriented language program into machine language.

Cycle Time Interval between the call for and delivery of information from storage unit or device.

Fixed-Point Arithmetic A type of arithmetic in which the operands and results of all arithmetic operations must be properly scaled so as to have a magnitude between certain fixed values.

Floating-Point Arithmetic A method of calculation that automatically accounts for the location of the radix point. This is usually accomplished by handling the number as a signed mantissa times the radix raised to an integral exponent — e.g., the decimal number + 88.3 might be written as $+.883\text{x}10^2$; the binary number $-.0011$ as $-.11\text{x}2^{-2}$.

Fortran Acronym for *FOR*mula *TRAN*slator, a programing system that translates into computer language statements expressed in a format similar to algebraic equations.

Functional Modularity Addition of modules to a basic data processing system that broadens the scope or concept of the system as well as adding to its capacity.

Interrupt To disrupt temporarily the normal operation of a routine by a special signal from the computer. Usually the normal operation can be resumed from that point at a later time.

Modularity Makeup of a system resulting from the assembly of the whole by the addition of sub-units, or modules.

Multi-Processing Processing several programs concurrently.

Nanosecond One-billionth of a second.

Object Program A set of machine-language instructions for the solution of a specific problem.

Octal Number A number of one or more figures, representing a sum in which the quantity represented by each figure is based on a radix of eight; figures are 0 through 7. (Compare decimal number with a radix of ten — 0 through 9.)

Parallel Operation Flow of data through a single processor using two or more channels simultaneously.

Priority Value assigned to a program to specify the relative processing sequence.

Program Series of instructions causing a data processing system to process a specific application.

Real-Time Processing data with virtually no time lag between the event, computer decision, and response.

Schedule Time and sequence designation for projected operations.

Scratch Pad Memory High-speed memory device used to store the location of an interrupted program and to retrieve the latter after the interrupting program has been completed.

Simultaneity Communication between various units of a system at the same instant.

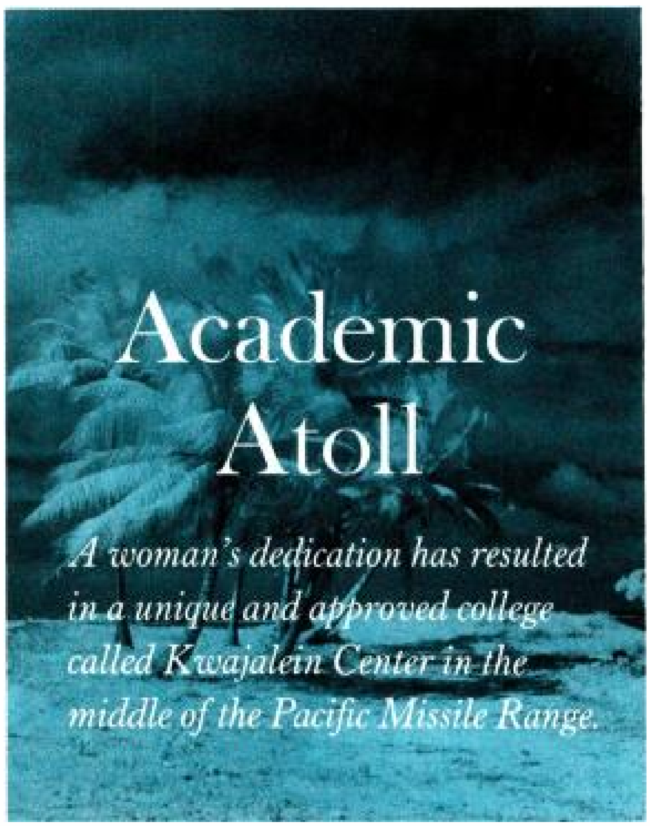
Software Programs, routines, procedures, and the like to augment and support a computer system.

Through-Put Productive work accomplished by the combined efforts of programmers, system operators, and the system itself.

Translate Producing a statement in one language equivalent to a statement in a different language.

Variable Word Length Refers to a storage device in which the capacity can accommodate units of data in varying lengths.

Word Set of characters, occupying one storage location, treated as a unit. ■



Like most of the innumerable coral atolls jutting out of the Pacific Ocean, Kwajalein is merely a dot on the map. Part of the group of islands known as the Marshalls, Kwajalein serves the United States as a radar tracking station and naval base.

Yet, Kwajalein is distinct from other Pacific spots of land, all because of the dedication of one woman to the cause of education. The monument to her enterprise and determination is the Kwajalein Center of the University of Hawaii.

Kwajalein Center is unique in the field of higher education. In substance, it is an arm of the University of Hawaii, a Center that provides college credit courses. But the real story lies in the establishment of the Center, and the woman who made it possible.

The story began when John O'Shea of Radio Corporation of America's Defense Electronic Products activity was transferred from New Jersey to Kwajalein in 1961 to become Manager of the Tradex (radar) operation on the island. His wife, Audrey, learning that all Kwajalein wives are "expected to work," began investigating where she could do the most good.

Audrey C. O'Shea had about 10 years of part-time college teaching, and out of this love of her profession grew the idea for conducting college courses in this remote part of the Pacific.

At first, the University of Hawaii was cool to her plan as set forth in her correspondence to the school. Later interviews with University officials convinced them the idea was worth pursuing.

In September, 1961, upon arrival at Kwajalein, Mrs. O'Shea wasted no time in contacting the island Navy Commander, Captain P. A. Holmberg. Mrs. O'Shea won approval, and Captain Holmberg accepted sponsorship of the program.

With the island Commander's backing as a springboard, Mrs. O'Shea began a diligent "selling job." She made calls on all managers of companies operating on Kwajalein. In every case, she recalls, enthusiastic support was promised — a "let me know what we can do to help" attitude.

Armed with this support, Mrs. O'Shea tackled her next problem: a qualified faculty. As she well knew, a university is only as good as its teachers. Surprisingly, Mrs. O'Shea relates, qualified faculty applicants were not hard to find.

"The University of Hawaii requires an advanced degree in the subject taught, and preference is given to those with previous teaching experience at the college level. We learned many people enjoy teaching, and even though they are busy people during the day they give generously of themselves."

The Board of Regents of the University unanimously gave its approval for a Kwajalein Center after being presented with Mrs. O'Shea's planned curriculum and faculty. Kwajalein Center launched its first semester in January, 1962.

Today, the Center is in its sixth semester with an enrollment of 125 students. Each semester is 14 weeks, and more graduate courses are being offered because of a growing interest in this area.

Many problems cropped up, understandably, in a pioneering venture such as Kwajalein Center. Experience has dictated many changes: some courses were canceled, others expanded. Growth of enrollment from the first semester's 78 also has caused a reshuffling of classes.

Some of the courses offered today include several in mathematics, general engineering, electrical engineering, business analysis and statistics, economics, history, and accounting.

Tuition fee is $20 per credit hour. Several local contractors provide educational aid to their employees. Military personnel also can avail themselves of tuition assistance provided by their personnel offices.

All course standards and requirements are on a par with those that apply on the Honolulu campus. Students may transfer to other American and foreign universities on the same basis as students of other American universities.

A feature of courses at Kwajalein Center is the recognition that both students and instructors may be required to work evenings at their regular jobs. Adjustments are worked out. Night classes usually are held at the high school two nights a week.

The student body is made up of a diverse group of men and women. Last year, for instance, students included three women who had regular daytime jobs, a housewife with three children, four male students engaged on regular Wake Island flights, and several nonresidents of Kwajalein.

Several students came from Roi Namur, from which they had to commute by air to meet class schedules. Many others made a boat trip from Enylabegan to attend school.

Four Marshallese, residents of Ebeye, at one time were registered at Kwajalein Center. According to Mrs. O'Shea, this was an area in which she, as the then Program Director, was much interested. The belief is that educational opportunity is very important in order to carry out the provisions of "Trust Territory." Kwajalein is part of this U.S. Trust Territory that evolved after U.S. Forces liberated the area during World War II.

The language barrier is a formidable one. According to Mrs. O'Shea, no Marshallese are currently registered because "we learned that the Marshallese are not facile enough in the English language to keep up." However, she adds, "when we find an English language teacher with an advanced degree, we hope to bring in more Marshallese students."

Among the Kwajalein inhabitants who attend the school are men and women with the Navy, the Army, the Weather Bureau, and companies like RCA, Douglas Aircraft, Western Electric, and the Lincoln Laboratory of the Massachusetts Institute of Technology.

How do the students feel about the Kwajalein Center? Enthusiastic, to put it mildly. As one student put it: "I never thought I'd be able to go to college here."

Creator of this growing Center, Mrs. O'Shea is no longer active and has had no connection with the Center since she and her husband left Kwajalein last May. Currently, Mrs. O'Shea is a lecturer in economics at Drexel Institute of Technology in Philadelphia, while her husband is systems project manager of the Tradex Press Group at RCA's Missile and Surface Radar Division at Moorestown, N.J. Replacing Mrs. O'Shea as Program Director of the Center is Mrs. Janna K. Lhotka, the wife of an employee of the Transport Company of Texas stationed on Kwajalein. Like Mrs. O'Shea, Mrs. Lhotka earned her advanced degrees at the University of California at Berkeley.

At a Pacific crossroads . . . Mrs. O'Shea founded . . .

the college called Kwajalein Center.

One of the best tributes to Mrs. O'Shea's experiment in education came from Rear Admiral John E. Clark, Pacific Missile Range Commander. He said:

"I am proud to have the Kwajalein Center as part of the Pacific Missile Range." ■

Electronically Speaking

News of current developments briefly told.

CHECK CHECKING BY COMPUTER

An extremely fast, fully expandable system designed around an RCA 301 electronic data processor was recently introduced to handle efficiently the banking industry's increasing flow of encoded checks and documents. This new RCA 301 Transit System is capable of reading, sorting, and listing up to 180,000 checks an hour.

According to the Federal Reserve System, an all-time high of 78.7 per cent of all checks collected through Federal Reserve Banks contained preprinted magnetic ink symbols. This figure compares with 68.3 per cent in August, 1962, and 54.6 per cent six months earlier.

Over 99 per cent of all banking offices doing business with the Federal Reserve System are issuing preprinted checks, a daily total exceeding 13,800,000 documents.

The basic equipment consists of a 301 electronic processor with 10,000 characters of memory linked to a printer (with a speed of 1,900 lines a minute), a document sorter, and a paper-tape reader.

By employing two sorter-readers, the user of the system doubles the entire single-sorter system to reach an output of 3,800 lines per minute, or 180,000 documents each hour.

SEEING EYE HIGHWAYS

Automatic, electronic vehicle counters at work on the New Jersey Garden State Parkway and a model of an electronic "trail of lights" — a warning system demonstrated recently in Montreal — represent developments of new electronic highway control.

RCA's electronic detection equipment at work on the New Jersey parkway automatically counts vehicles passing through "exact change" toll lanes. The 42 RCA "Ve-Det" units on the parkway replaced the treadles that previously performed the counting job.

The new detection systems are unseen by the motorist since they operate from a wire loop embedded in the toll-lane pavement. A vehicle passing over the wire loop causes circuit changes, sending a signal to a transistorized detector unit, which in turn actuates paper-tape recording equipment.

The electronic detectors can be used in time of poor visibility to set up a "trail of lights" behind a vehicle as a visual warning to following cars.

The model demonstrated in Montreal depicted how a series of red, amber, and green lights flush-mounted in the pavement at 25-foot intervals will inform a driver of his distance from the car ahead, which activates the lights. As the first car moves forward, the first three lights directly behind it are red; the next three are amber; and the three farthest away from it are green.

UNGARBLING THE GARBLED

Confusion or mystification from blurred or garbled text may be reduced in the future for the U.S. Army as a result of a contract awarded by the Army to RCA to develop techniques enabling machines to make sense of such text.

Methods will be developed to give character recognition devices the ability to read text containing unintelligible words by determining the correct word from the context of the material.

DAVID SARNOFF INDUSTRY-SCIENCE TEACHING PROGRAM EXPANDS

The success of the first pilot year of the David Sarnoff Industry-Science Teaching Program has led to its expansion in New York City schools. Inaugurated in 1962 in conjunction with the New York City Board of Education, the program implements RCA Board Chairman David Sarnoff's concept of improving science education with the aid of scientists and engineers recruited from industry to assist in classroom teaching in the nation's schools.

During the 1963-64 school year, the program will reach approximately twice as many students as it did last year. Eight leading corporations will join in providing scientists for a lecture series in one phase of the project. The new participants are: Bell Telephone Laboratories; Consolidated Edison Company of New York; International Business Machines Corporation; Chas. Pfizer & Company; Shell Chemical Company; Standard Oil Company (New Jersey); Union Carbide Corporation; and United States Steel Corporation.

At the right are seven of the RCA scientists and engineers with some demonstration units they will use in the David Sarnoff Industry-Science Teaching Program. Shown here are (front, left to right) Drs. G. Goldsmith (Nuclear Physics); W. Helwig (Energy Conversion); T. T. Reboul (Space Technology); and (rear, left to right) D. McCoy (Acoustics); M. Nowogrodzki (Electron Tubes); E. R. Walthall (Space Technology); and J. C. Hepburn (Communications Theory). ➤


PLATE
GRID

Action—"Faster than Lightning"

CAPTURED BY AN RCA ELECTRON TUBE

The violent single stroke of a lightning flash is far more complex than your eye perceives. It is often preceded by up to 30 "leader" bolts in a thousandth of a second.

Today a new RCA electron tube makes it possible to photograph high-speed events—*thousands of times faster than a lightning sequence!* Known as an Image Converter, it acts as a super-speed shutter to take "snapshots" in 1/200 millionths of a second—the time it takes light to travel about four-and-a-half feet.

With this revolutionary device man can for the first time "freeze" and study such instantaneous phenomena as blast effects, gaseous discharges, laser beams and plasma pinch effects.

Image Converter tubes are another of the many ways RCA electron tube research helps advance man's understanding of the world he lives in—and control its forces for his benefit.

RCA Image Converter Tube amplifies light more than 50 times—then "snaps" a picture in 1/200 millionths of a second.

RCA ELECTRONIC COMPONENTS AND DEVICES

RCA® **The Most Trusted Name in Electronics**