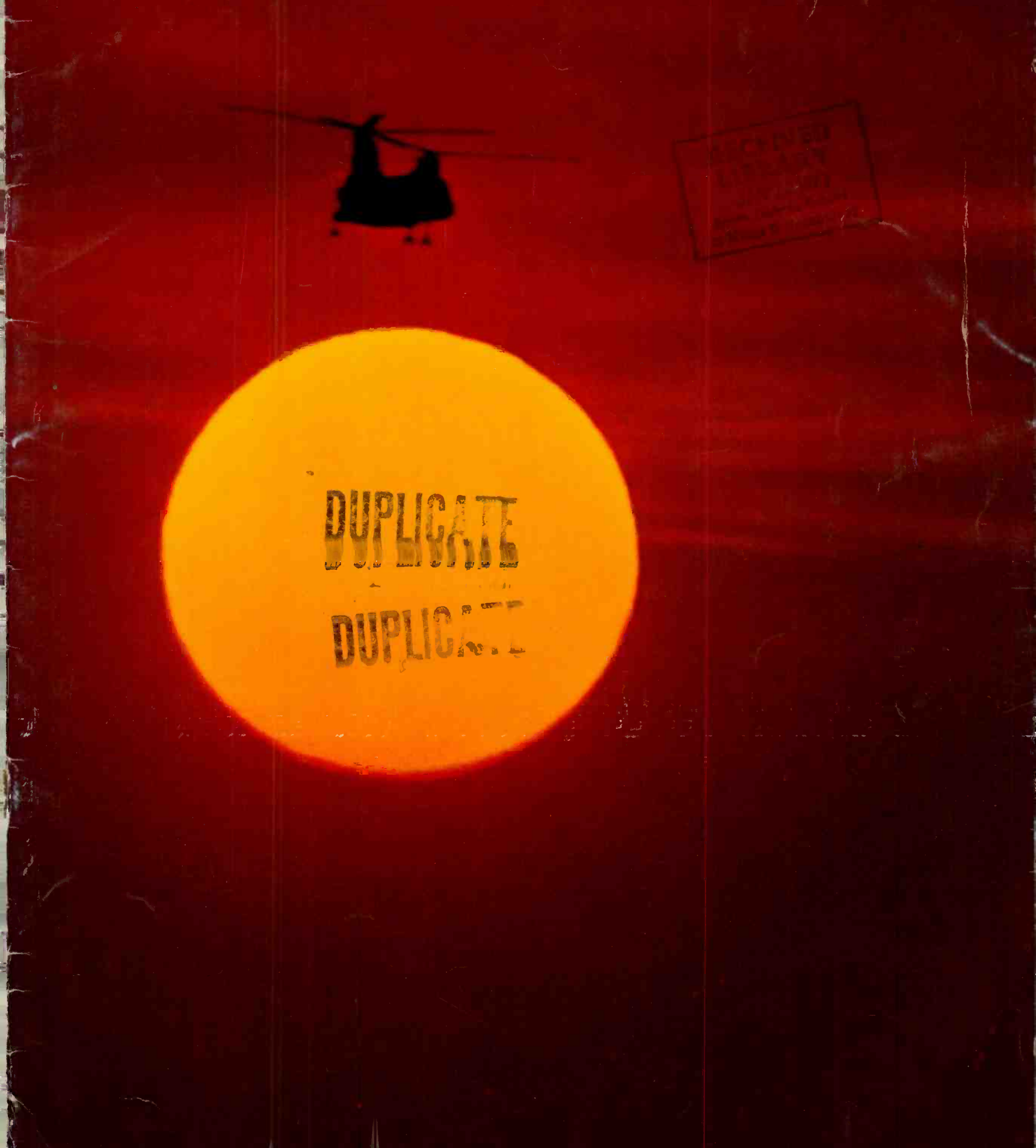
RCA

Electronic Age

Summer 1968



Cover: The serenity of the twilight sky belies the feverish activity in the air. At any given moment during the day as many as 10,000 planes may be in flight, taxing the capacity of airports and resulting in frequent delays for passengers. Controlling this traffic safely and efficiently is the responsibility of 14,000 highly skilled men of the Federal Aviation Administration. They rely on their judgment and the support of a sophisticated communications and information network that spans the nation. An article on how they handle this airborne workload begins on page 7.

Electronic Age

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Government and the Computer

From the Pentagon to the Bureau of Internal Revenue, the computer plays a major role in government operations.

by Robert Cecil

The federal government's first halting steps toward automation took place some 90 years ago when Herman Hollerith, a precocious teen-aged government clerk, in discussing the problems of a harried census department at a Washington tea party, suggested an ingenious "census machine." With this system, encoded punch cards cut processing time by two-thirds. Government had elevated information-handling to a science.

Washington never relinquished its head-start in automated data processing, although, of course, the computer has supplanted Hollerith's tabulator as the prime catalyst of bureaucratic efficiency. In fact, computers had been an effective tool of government long before they were a gleam in industry's eye. Thus, in 1953, when but 25 systems existed in the entire country, the government owned more than half. And by then, Washington already had several years of electronic data processing experience, something no other user could claim.

Today, the federal government is the world's largest computer user with over 2,600 systems in more than 300 cities. These figures are continuously growing. Computers in government have increased thirty-fold in slightly more than a decade, with a growth rate of approximately 40 per cent a year since 1956. This $1.2-billion-a-year market is a Mecca for computer manufacturers.

The Pentagon is by far the best customer of the computer industry, accounting for some 63 per cent of total government business, and both immediate and long-range sales outlooks appear bright.

For the fiscal year beginning this summer, the military expects to spend upward of $1 billion on various computer operations. This is slightly more than the average of the past four years. The extra hardware will handle an increased workload of some 15 per cent and is expected to free several thousand government employees from paperwork.

There is an added plus to military business. Almost half of the Department of Defense computers are purchased rather than leased. For manufacturers caught in a money squeeze over spiraling development costs, this means instant cash rather than payment spread over several years.

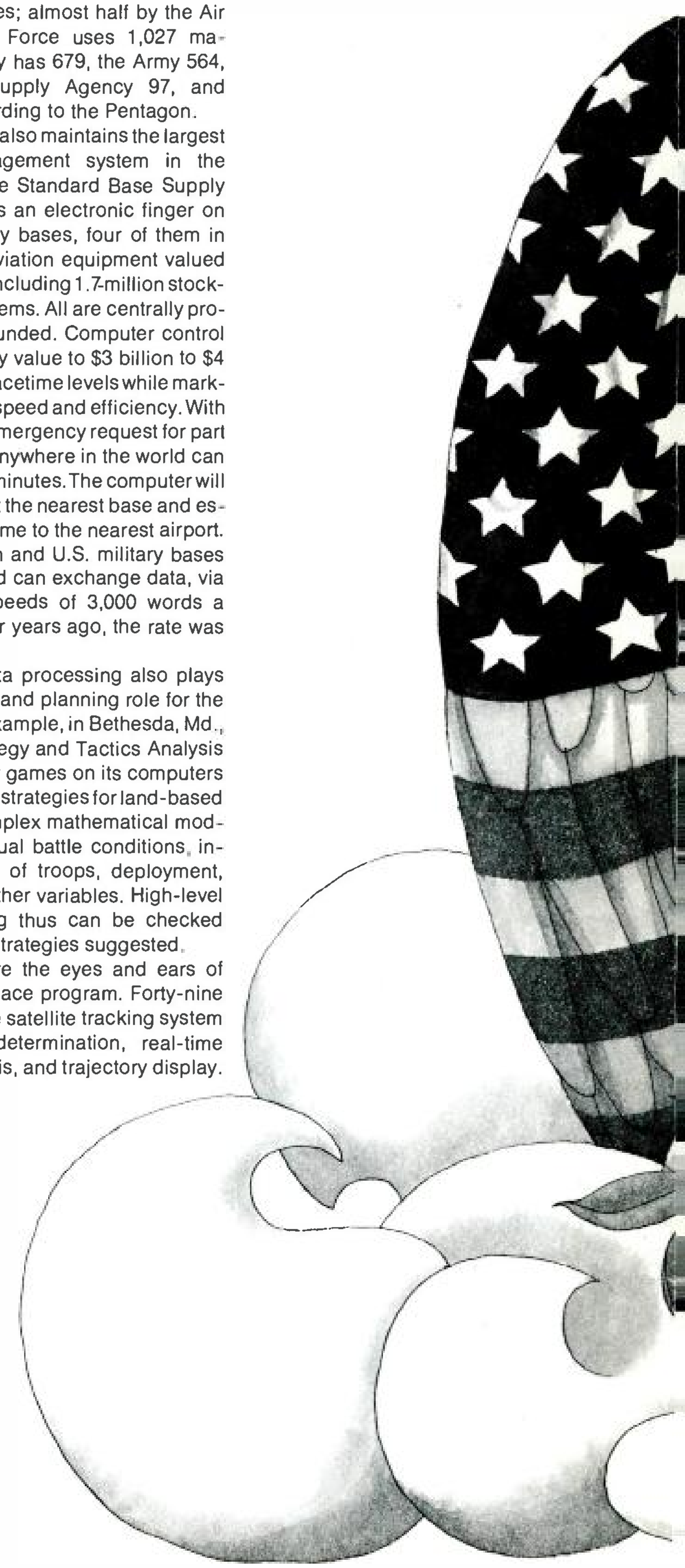
More than 2,400 computers—ranging from $12,000 desk-type machines to $5-million giant EDP systems—are used by defense agencies; almost half by the Air Force. The Air Force uses 1,027 machines, the Navy has 679, the Army 564, the Defense Supply Agency 97, and others 36, according to the Pentagon.

The Air Force also maintains the largest inventory management system in the world, called the Standard Base Supply System. It keeps an electronic finger on 147 large supply bases, four of them in Vietnam, with aviation equipment valued at $11.7 billion, including 1.7-million stock-numbered line items. All are centrally programmed and funded. Computer control has cut inventory value to $3 billion to $4 billion below peacetime levels while markedly increasing speed and efficiency. With this system, an emergency request for part of a jet engine anywhere in the world can be answered in minutes. The computer will locate the item at the nearest base and estimate delivery time to the nearest airport.

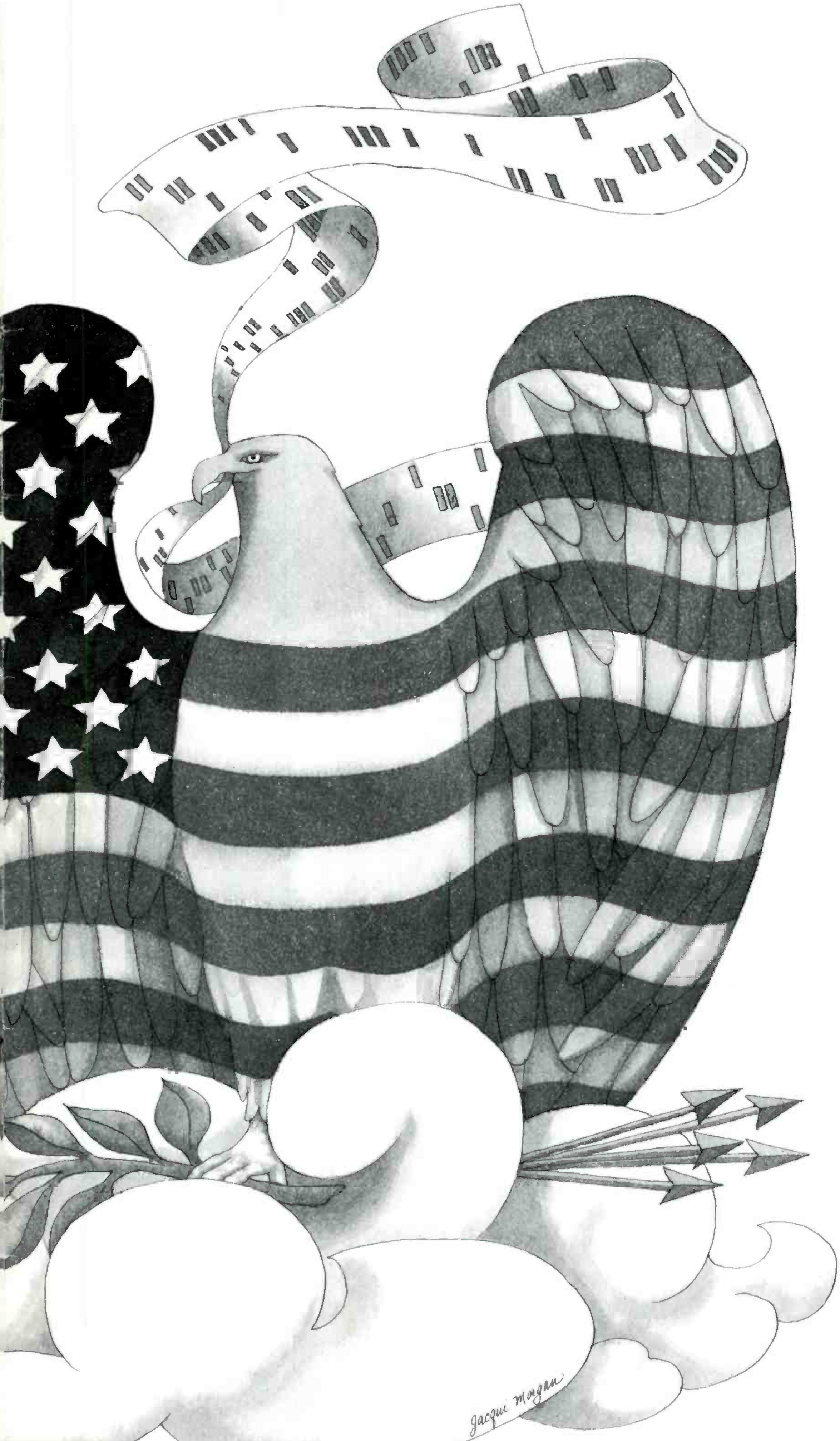
The Pentagon and U.S. military bases around the world can exchange data, via computer, at speeds of 3,000 words a minute. Just four years ago, the rate was 75 a minute.

Electronic data processing also plays a major training and planning role for the Pentagon. For example, in Bethesda, Md., the Army's Strategy and Tactics Analysis Group plays war games on its computers to provide viable strategies for land-based operations. Complex mathematical models simulate actual battle conditions, including number of troops, deployment, weapons, and other variables. High-level military planning thus can be checked and alternative strategies suggested.

Computers are the eyes and ears of the American space program. Forty-nine computers in the satellite tracking system perform orbit determination, real-time telemetry analysis, and trajectory display.



Robert Cecil is on the staff of the RCA Information Systems Division.


Jacque Morgan

But the one application directly touching most Americans is found on the whirling tapes of the Internal Revenue Service. Every taxpayer has his own bit of tape; half an inch or less for individuals, up to 10 inches for giant businesses.

The cost for installing these IRS computers figures out to about $50 million. But government officials predict the investment will pay off quickly, besides promising greater accuracy and fairness in collecting more than $130 billion in taxes. In the first year of operation, IRS computers detected arithmetical errors in one out of every eight returns checked—three times as many as their more fallible human counterparts had been finding.

Over-all operational efficiency is apparently on the upswing, too. By mid-March of this year,19.6-million individual returns had been processed, as contrasted with 14.2-million a year ago. Also, $3.48 billion was refunded to taxpayers, a 65 per cent jump over the $2.11 billion a year earlier.

The major system at Martinsburg, W. Va., sometimes called the "monster," keeps a master file on every taxpayer while IRS computers churn out the work around the clock at seven regional centers. Returns are checked for addition and subtraction. When a mistake is found, "good" and "error" reels are spun out. An employee then matches the error register against the filer's return. Later, a "Dear Taxpayer" letter is dispatched.

Martinsburg keeps tape records of salaries and commissions paid some 78-million Americans, as well as interest earned on bank accounts, bonds, and stock dividends. Tapes from the regional offices are matched against these, and the Martinsburg computers produce a new set of good and error tapes. All of these figures are keyed to the social security number of each individual.

The new system awes taxpayers. Cases have been noted where anguished citizens rushed to local IRS offices to declare unreported back income. After all, didn't the government have all the information now?

Yet the growing computerization of government generates problems. Perhaps the biggest administrative headache is simply to keep economy in line with efficiency. Congress passed the Brooke Bill two years ago, designed in part to encourage more economical procurement practices and interagency sharing of computer hardware. Then, wasted computer time was costing as much as almost half a billion dollars a year.

Improvements have already taken place. Today, in Asheville, N.C., the Department of Commerce and the Air Force man a joint computer network devoted to preparing environmental defense studies and processing the worldwide weather picture. The National Weather Records Center is one of the first implementations of the Brooke Bill and is expected to save approximately a quarter of a million dollars annually. More consolidations should follow.

"Actually, the government uses computers very efficiently," comments one industry figure. "They have experts who move fast on good potential applications—at least as fast as their counterparts in industry. Take Social Security. Computers now determine whether departmental files are out, avoiding needless walks for employees. This alone will save $4 million a year in lost time. You'll find the government is always refining techniques... discovering new ways of automating."

Manpower requirements for the computer age are a government as well as industry problem. Civil service ratings have recently been upgraded, resulting in attractive salaries for data processing professionals—especially in the middle and upper management brackets. An operations manager can expect $14,000 to $16,000 a year, while a chief analyst makes $17,500. Even so, Washington sometimes has trouble filling all its needs.

Occasionally, the government goes headhunting. One manufacturer was surprised recently by a call from a Cabinet member who requested the release of a highly productive branch manager "for the good of the country."

The massive governmental processing of data in itself is a human relations problem. As a humorist once remarked, "It's pretty hard to be efficient without being obnoxious." Nowhere is this more evident than in the storm blowing up over the proposed National Data Center. The controversy concerns the advisability of collecting statistical information on Americans from some 20 federal agencies in a central data "bank" administered by the Bureau of the Budget.

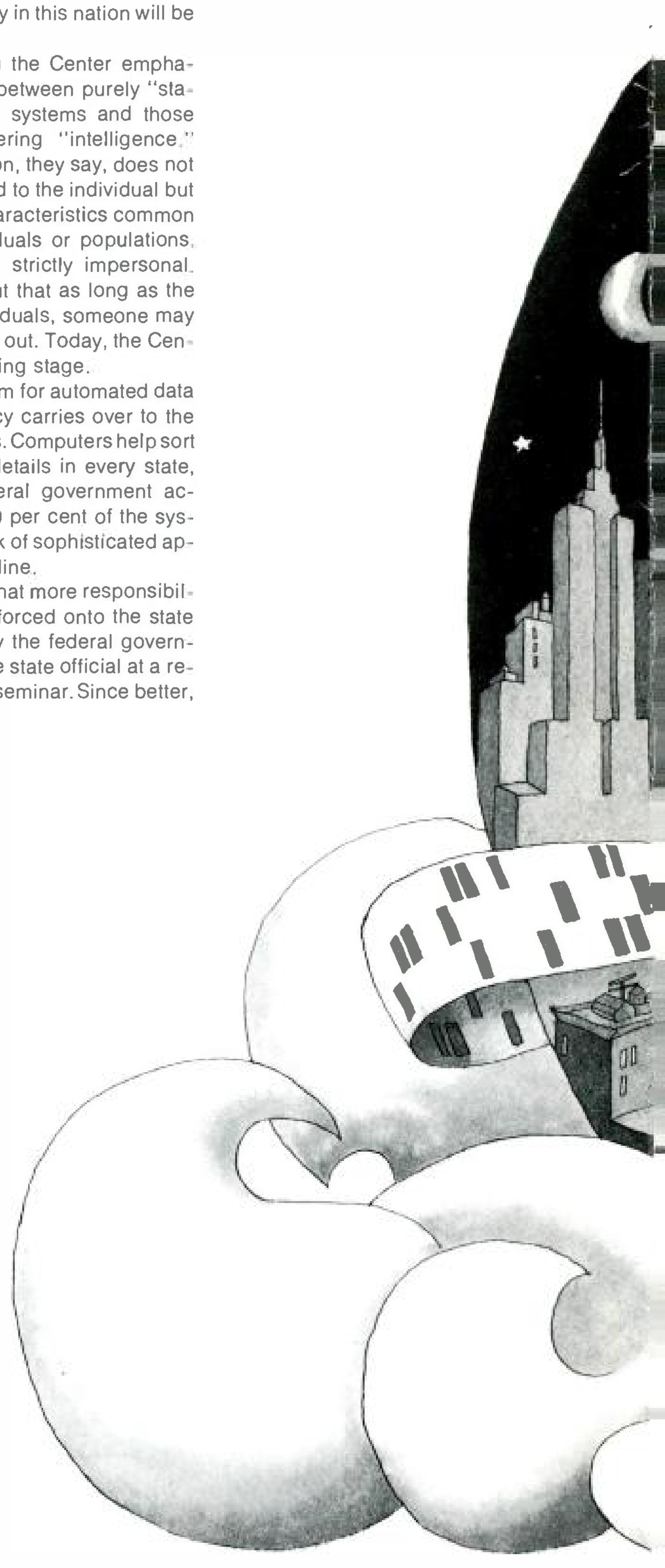
The idea was born in a committee report of the Social Research Council, a private organization fostering academic research. It disclosed that the government had more than 600 bodies of statistical data on thousands of computer tapes and millions of punch cards that could be coordinated for analysis. The raw material was at hand, but scattered. Now it should be combined and translated into useful forms and patterns, the report urged.

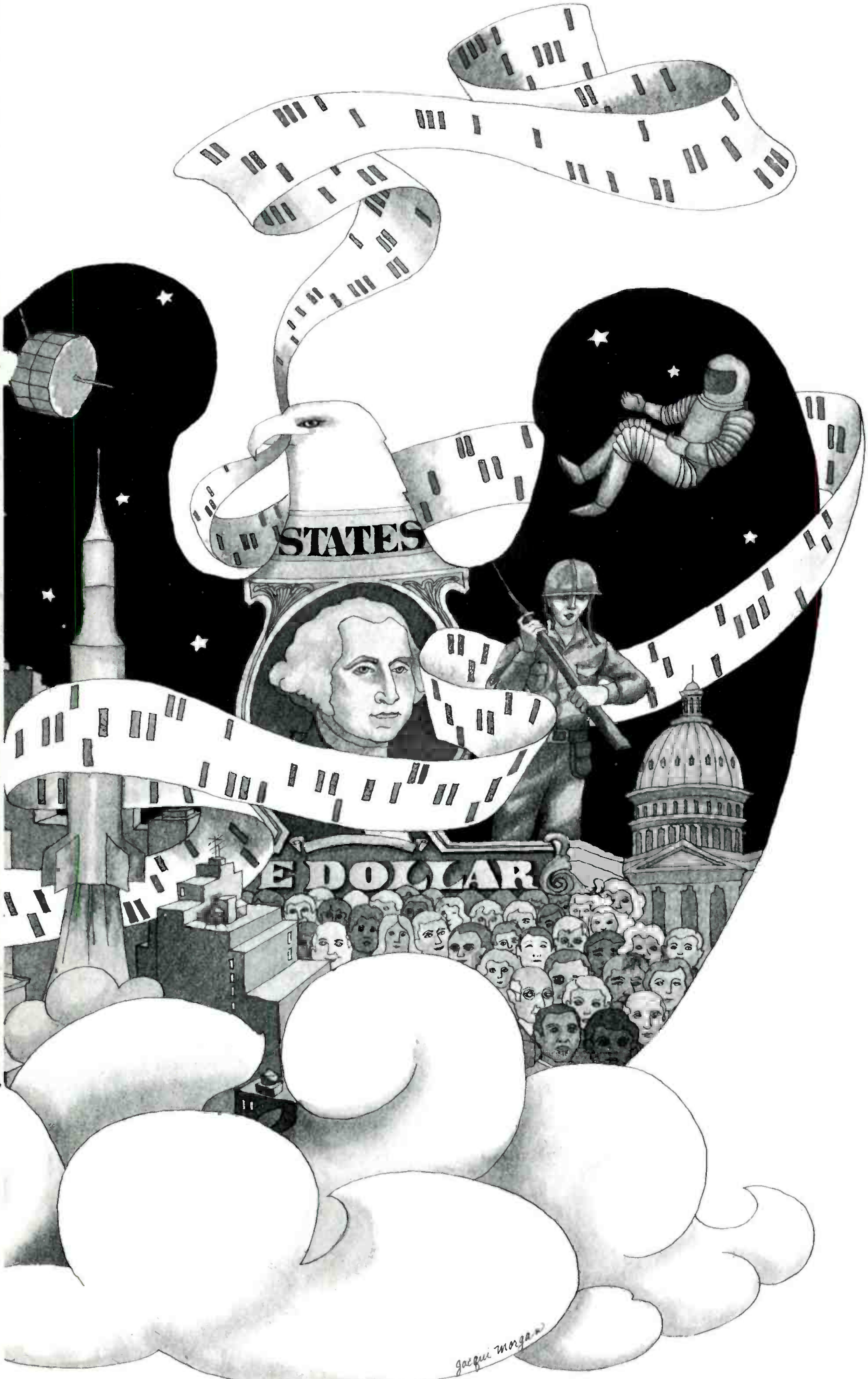
Proponents of the Data Center argue that policy makers and legislators now make decisions involving hundreds of millions of dollars with little or no significant background data. Critics counter that we are letting technology get out of hand without a significant concern for human values. Supreme Court Justice William O. Douglas predicts that if the data bank is established, "privacy in this nation will be drastically diluted."

Those supporting the Center emphasize the distinction between purely "statistical" information systems and those designed for gathering "intelligence." Statistical information, they say, does not produce data related to the individual but merely identifies characteristics common to groups of individuals or populations. Thus, the *output* is strictly impersonal. But, others point out that as long as the *input* involves individuals, someone may figure a way to get it out. Today, the Center is still in the talking stage.

Federal enthusiasm for automated data processing efficiency carries over to the state and local levels. Computers help sort out administrative details in every state, and, while the federal government accounts for nearly 80 per cent of the systems, there is no lack of sophisticated applications down the line.

"It is my opinion that more responsibility...is going to be forced onto the state and local entities by the federal government," declared one state official at a recent public welfare seminar. Since better,





faster service already has been demonstrated in Washington, many administrators feel the states will have to follow suit quickly just to keep up with greatly increased paperwork and the sensibilities of a service-minded electorate.

At the same time, the federal government offers hard cash inducements to automate. One hundred per cent funding is available for computerizing employment security, and substantial grants are offered in law enforcement, housing and urban development, education and welfare, and highway planning.

On the state level, California employs RCA computers in an extensive communications network geared to administering a car/truck population expected to reach 15 million by 1970. The system is designed to link the 144 field offices of the motor vehicle bureau with the computer center at Sacramento and ultimately with one another. Processing ranges from routine driver's license and vehicle registration—on-the-spot service is offered—to handling inquiries from law enforcement agencies and the courts. As a state immersed in modern technology, California leads the nation in number of computers in use, both public and private.

The same emphasis on service is being applied to employment security. Massachusetts has automated benefit payments, writing out checks to claimants via computer while they wait. The system is a pilot program that eventually will be expanded to transmit information on 300,000 claims to any of the state's 43 local unemployment offices.

"The average local office issues 5,000 checks a week during peak periods," says J. William Bellanger, Director of the Division of Employment Security. "Some offices, particularly in Boston, write as many as 100,000 checks a month. Under our new automated system, we expect to identify the claimant, verify his claim, and print his check in less than 30 seconds."

Utah, Florida, and Michigan are working with the U.S. Department of Labor to test a system of matching jobs and applicants on a state- and area-wide basis. An RCA computer in Salt Lake City, for example, will handle processing from local employment service offices over telephone lines. When an employer calls a local office, his specifications are transmitted electronically to the central computer system and, within seconds, a search is made through random access files for persons whose job skills match. The same process occurs when an applicant registers. The file is searched to see if his qualifications jibe with an opening. If not, they are stored electronically for later matches.

The key to the system is a numerical code for classifying jobs known as the Dictionary of Occupational Titles. DOT is similar to codes used by the military, except that it is industry-wide and broader. The program has been designed so that at least three criteria must intermesh to trigger a match. Data processing experts believe the Utah system might be adapted on an interstate or even national basis, not to mention in industry where layoffs at one plant are offset by calls for workers at another site.

State computers are being programmed to grapple with other urgent matters. Air pollution is a case in point. Pennsylvania uses special mobile stations to sample pollutants from industrial air basins. Data are then telemetered to Harrisburg for printout and study. Electronic data processing will make this information far more useful. Planned installation of a computer will place the state's air pollution monitoring system on a real-time basis—that is, pollution trends can be plotted in a time slice as thin as four hours. High-speed disk memories will make needed information rapidly accessible. Thus, in addition to constant surveillance, the network will provide a ready alert warning system.

Further evidence of data processing efficiency is seen in a trend toward consolidation. "You'll often find moves toward unified systems at the local level which overstep boundary lines," comments one expert.

In Cincinnati, a unique Regional Information Center is being built around two large-scale computers that will process data from the city and 36 communities in Hamilton County. When the Center goes on the air this fall, it will handle the data processing needs of virtually every County administrative activity, ranging from hospitals and libraries to public utilities and courts. The county-wide information "utility" also will include a crime information center and communications network serving all urban and rural law enforcement agencies in the County.

According to A. O. Atkinson, Cincinnati Superintendent of Data Processing, the Center is unique, "because it is the first time city and county administrations with different areas of jurisdictional responsibilities have shared computer power."

Many data processing professionals believe that computers themselves will soon settle many difficult political issues. EDP can set tax policy by simulation—creating a mathematical model of the state or community to see what impact could be expected from various tax strategies. Other experts envision lawmakers talking with a central computer from terminal devices in their offices to get up-to-the-minute status reports on the budget and revenue needs. And computers can do a politically neutral and rational job of redistricting, industrial zoning, and scientifically picking optimum sites for fire stations, highways, schools, playgrounds, and the like. They can also be a repository for all state laws, so that when new legislation is drafted, matches can be made to pinpoint possible conflicts.

Computers, right now, streamline the legislative process in Florida and Iowa by keeping track of all state assembly activities. They report daily on the status of thousands of bills, each of which may have to undergo as many as 150 actions.

At the present growth rate of these applications, society will need as many programmers as doctors in a few years, and all levels of government are preparing to meet this demand.

Oklahoma is letting computers themselves tackle the job of developing hard-to-find programming talent. Some 1,000 students are enrolled in full-time two-year or night-school courses. What makes the courses unique is that students learn the fundamentals of programming on a computer—not just from a textbook. They prepare their own programs on punched cards that are read by the computer at their school. Then the "lesson" is transmitted over leased telephone lines to a larger, third-generation computer located at the data center in the capitol building at Oklahoma City. There it is compiled and the diagnostics are returned to the student either in printed or punched-card form, with mistakes pointed out in the program.

Missouri State Penitentiary inmates also are being taught programming. Carl R. Strickland, educational director of the prison, says the unusual training course "provides both an excellent tool in our education and rehabilitation program, and will help to fill the need for computer programmers, both in industry and government." All of the men will soon be eligible for parole, Strickland explains. "We're hoping they'll all do as well as one alumnus who had three job offers from major corporations when he was released. Incidentally, he was named 'most likely to succeed' by his classmates."

The complexity of government, from city administration to space exploration, has changed automated high-speed data processing from a luxury to a necessity. And the computer industry has the tools at hand right now to make sweeping changes in the efficiency of public administration. ■

air traffic control
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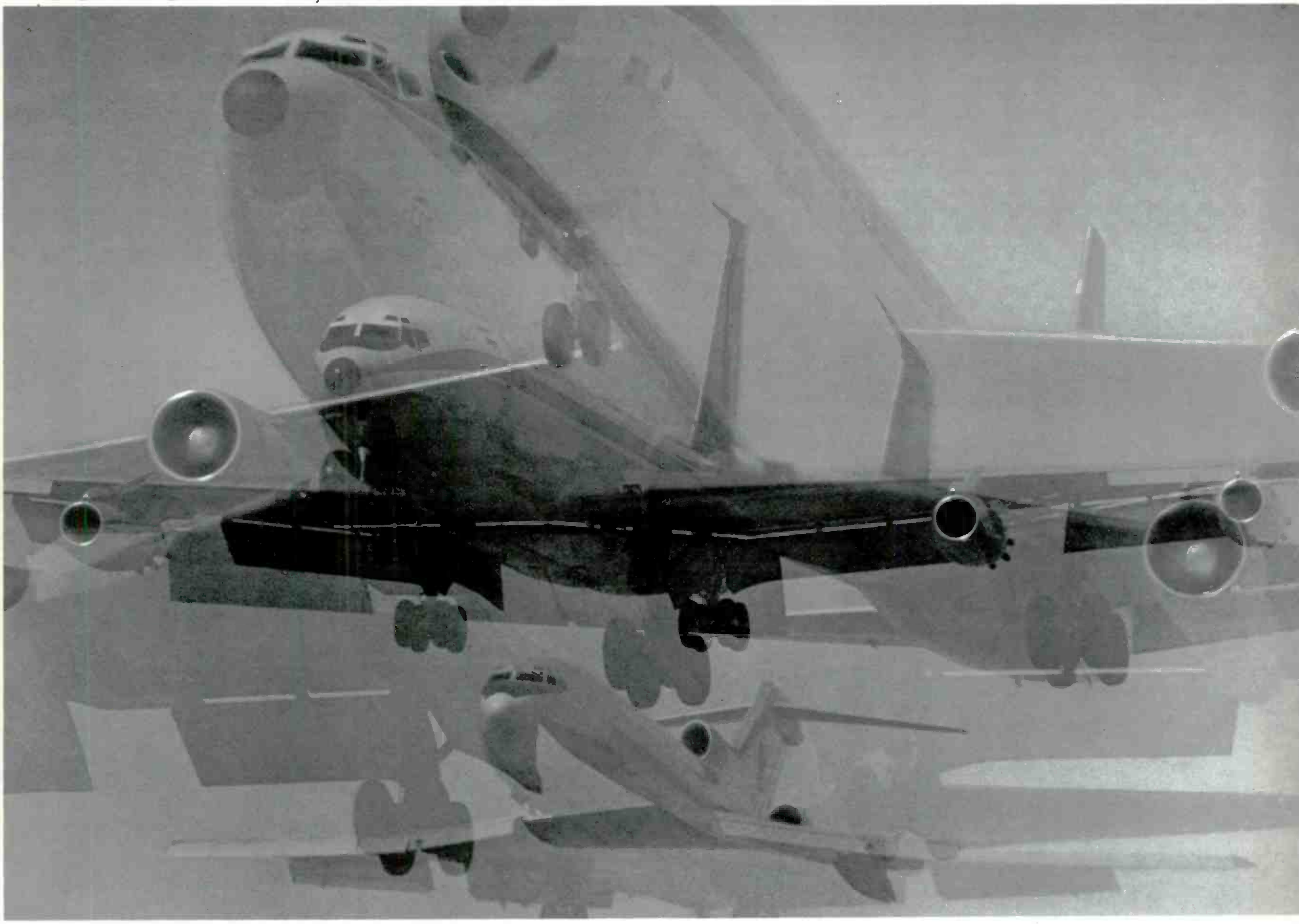
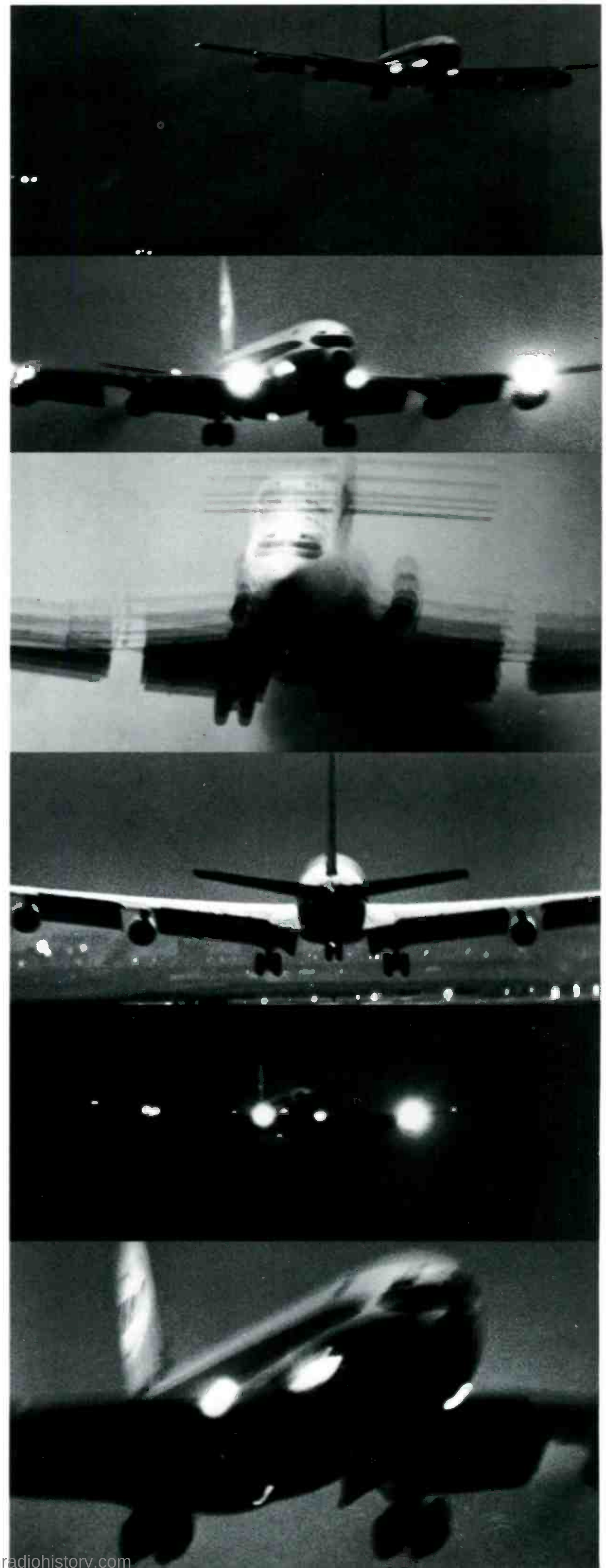
Skilled FAA controllers and their sophisticated electronic radar equipment are not only trying to cope with today's air-traffic congestion but are preparing for the even more crowded skies of tomorrow.

by John W. Ott





More than a hundred years ago when Henry Wadsworth Longfellow wrote of "the infinite meadows of heaven," he was exercising a poetic license that was very much in fashion. To earthbound man, jostled by his neighbor at every turn, the sky represented spacious tranquillity. As an image, it had the advantage of being direct and immediately comprehensible; one had only to look up to see that the heavens were vast and uncluttered.

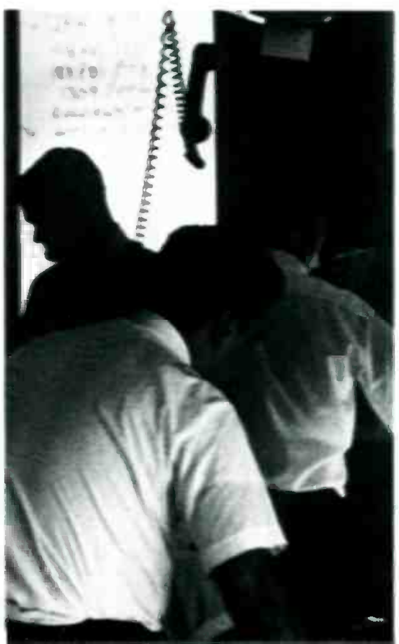
This sense of freedom and exhilaration persisted even after man had learned to fly. The early aviators were generally men of action and not of words, but they were romantics at heart who communicated a sense of wonder at their airborne liberty. The most articulate of these pioneers was the French aviator and author Antoine de Saint-Exupery, who could write as recently as 30 years ago of the majestic loneliness of flight.

Unfortunately, the lyricism of Longfellow and the enthusiasm of Saint-Exupery belong to a vanished age. The air may be as blue and the clouds as majestic, but the skies are no longer lonely. They have become busy and sometimes perilously crowded highways of travel and commerce. At any given moment during the day, as many as 10,000 planes may be crisscrossing the airlanes over the United States, causing congestion at major airports and long delays for travelers.

According to the Federal Aviation Administration, airport traffic control towers last year reported a record of 50-million takeoffs and landings—more than 90 operations each minute—and this, they predict, is only a hint of what is to come. Within 10 years, flight operations at airports with FAA control towers will more than triple, reaching 167 million annually. Other major indicators of aviation activity in the United States will also double, triple, and even quadruple during this period. The number of airline passengers will more than triple to an estimated 444 million. Revenue passenger miles flown by the airlines will nearly quadruple to 342 billion, and the domestic airline fleet will total 3,860 aircraft.

These figures represent only commercial airline activity. In addition, the so-called general aviation (privately owned) aircraft fleet will number well over 200,000 airplanes and will fly more than 40-million hours each year. Add to that a constant flow of military traffic, plus the arrival and departure of foreign flag airlines moving through domestic air space, and a picture begins to develop that resembles a crowded expressway during rush hour.

Controlling this traffic safely and efficiently is the awesome responsibility of 14,000 highly skilled men who rely on



John W. Ott is an RCA Public Affairs staff writer.

FAA controller at regional Air Route Traffic Control Center, Islip, N.Y., guides a jetliner through the crowded sky over New York City.

"The skies are no longer lonely. They have become busy and sometimes perilously crowded highways of travel and commerce."

their finely honed judgment and the support of a sophisticated communications and information network that spans the nation. Using electronic radar equipment, controllers on the ground keep track of the exact position of a fast-moving aircraft at every moment from takeoff to touchdown. They advise pilots of nearby traffic, direct changes of course and altitude, and provide information on shifting storm fronts and landing conditions.

When commercial aviation was in its infancy, the information that moved between ground and air was rudimentary at best. The most sophisticated piece of electronic gear on board most aircraft was likely to be a two-way radio. This kept the pilot in touch with the ground and allowed him to avoid bad weather. It even gave him the opportunity to report his position—if he happened to know it. But it had one major shortcoming. The ground was entirely dependent upon the pilot for information. If the pilot wouldn't or couldn't report in, the ground had no way of knowing where the aircraft was. The advent of radar, of course, changed all that. Watchers on the ground could tell whenever an object appeared within the limits of their horizon. A telltale blip of light on a radarscope unerringly kept track of the aircraft, and once radio contact was established, the pilot could be furnished with virtually any information he required.

However, as more aircraft entered service and traffic increased, positive identity began to pose a problem. A radar operator might see a number of targets on his scope without being sure of their identity and altitude. Only repeated and time-consuming radio inquiry could establish order out of potential chaos.

It was in response to this condition that the FAA developed its present system of air traffic control. Essentially, this consisted of dividing the continental United States into what are now 21 areas, and placing an Air Route Traffic Control Center in each area. These Centers are responsible for all aircraft that fly under instrument flight rules through the air

New radar-control system at John F. Kennedy International Airport

"The FAA system allows an aircraft to move anywhere within the continental limits of the United States under continuous visual and radio surveillance."

space that is under their control.

Following the flight of a commercial jetliner from Los Angeles to John F. Kennedy Airport in New York illustrates how the system currently operates. The first step in the chain of events that will transport well over 100 passengers across the country is for the pilot to file a flight plan with the FAA. This will contain such information as proposed takeoff time, cruising altitude, course, speed, and estimated time of arrival. The plan is either telephoned or teletyped to alert all Centers over which the aircraft will fly.

Once the aircraft has cleared the air terminal area, it becomes the responsibility of a controller at the Air Route Traffic Control Center in Palmdale, Calif., which monitors the air space in the Los Angeles area. Having been warned earlier of the takeoff, the controller has prepared a Flight Progress Strip. This Strip —literally a strip of paper slipped into a frame—is one of many placed in a metal rack near the controller's radarscope. Together they represent data on all the aircraft that are flying through or are about to enter the air space for which he has individual responsibility.

This responsibility is direct and unequivocal. When the aircraft is handed off to the controller—passes into the area under his jurisdiction—he identifies the plane and verbally acknowledges his responsibility by landline interphone to the previous controller. This exchange releases one controller of responsibility for the aircraft and assigns it to the next man along the line of flight.

One method of positive identification of the airplane is accomplished by means of a device known as a radar beacon transponder. This piece of electronic equipment is installed on board the aircraft and is designed to augment the reflected radar signal from the ground. When activated by the pilot, it strengthens the electronic impulse directed from the aircraft to the radar antenna, creating a momentary bloom of light on the controller's scope far brighter than the ordinary radar blip.

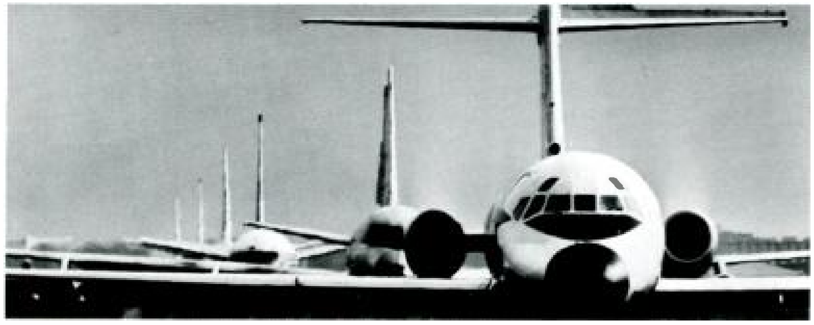
When the controller notices the new blip of light entering his scope, he will ask the aircraft to identify itself by means of the transponder. When the pilot acknowledges the request, the signal on the radarscope will blossom noticeably. The controller has now identified a given radar blip as a particular flight. The name of the flight, together with altitude, speed, and course, are then marked on a plastic chip, commonly known as a "shrimp boat." This chip is placed on the horizontal surface of the radarscope, next to the moving target. As the target moves along the scope, the controller or his assistant moves the shrimp boat along with it. When it is about to leave the area of his responsibility, the next controller is notified and a verbal handoff is effected. This process is repeated from controller to controller across the country until the jetliner is delivered to an air terminal controller who guides it in for a safe landing in New York.

The principal advantage of this system is that it allows an aircraft to move anywhere within the continental limits of the United States under continuous visual and radio surveillance. However, given the staggering increase in air traffic over the past few years, it has serious limitations.

For example, virtually all operations are done manually. Flight Progress Strips are usually written in script; shrimp boats are annotated with china marking pencils and moved manually; the scope itself is set at an unnatural angle that causes a strain on the controller who must lean over it. But worst of all is the crowded condition of many scopes. Controllers sometimes have as many as 20 radar targets moving across their field of vision, and each target represents hundreds of lives. Under these circumstances, a target or blip can occasionally become separated from its shrimp boat marker. When that happens, a controller can no longer be sure of the identity of the target he is tracking. A recurring nightmare is the remote possibility of an errant sleeve brushing all the shrimp boats off the scope.

Another serious drawback to the system is its inability to record changes of altitude. Under present conditions, the radar display is two-dimensional, with the third dimension—altitude—marked by hand on the plastic shrimp boats. If the controller sees two blips on converging courses, he must check each marker to make sure there is sufficient separation between the two aircraft to allow for safe passage.

With present-day speeds, this is an unsatisfactory procedure. As one controller put it, "These planes are coming at each other like bullets, and there's not much time to verify altitude."



The FAA, of course, has long been aware of this condition and has taken steps to correct it. The most significant is the development of a semi-automated air traffic control system, utilizing computers, high-speed printers, and alpha-numeric display terminals, all linked by narrowband digital circuits. Parts of this master plan, known as the National Airspace System (NAS) En Route Stage A, are already in experimental operation at several key Air Route Traffic Control Centers. With more Centers being phased in gradually, the system is scheduled to be fully operative by mid-1973. At that time, virtually all hand operations will be eliminated, freeing controllers for the essential task of concentrating on the aircraft patterns in their areas.

Under the Stage A program, a flight plan will be fed into a computer, which is programmed to furnish such information within minutes to all Center areas concerned. Furthermore, since airlines run on established schedules, once these plans are filed and approved, the procedure need not be repeated unless an update is necessary. The daily 4:30 P.M. flight from Detroit to Dallas, for example, will request the same course and altitude. If it should happen to be 10 minutes late, the computer will receive this information and make appropriate adjustments, sending the revised data to all Centers due to handle the flight.

Best of all, the new system will eliminate the use of shrimp boats. Instead of peering over a horizontal radarscope, the controller will sit before a conveniently angled screen where targets can be identified by electronically produced alpha-numeric data tags that actually travel across the scope, tracking the target as it moves. These tags will print out vital information on the aircraft, such as flight number, course, altitude, and speed. They will even report any change in altitude in 100-foot increments, and an arrow will indicate if the plane is either climbing or descending.

At the heart of this vastly increased capability is an improved type of transponder that can reply in any one of 4,096 different codes, merely by setting a dial on the instrument. In theory, this means that more than 4,000 different aircraft could be flying through an area, each transmitting its own identifying code signal to controllers on the ground.

Under the new system, each flight will be assigned a separate code that will then become part of the data stored in the computer. Immediately after takeoff, the computer will begin to receive the coded signal transmitted by the aircraft. It will search its memory and then automatically display the identity of the aircraft on the scope as part of the information on the alpha-numeric data tag, all without any manual operation. By linking the transponder to the altimeter, an altitude reporting capability is added.

While discussing the potential of the transponder, Joseph R. Shirley, Manager of RCA's Aviation Equipment Department, stated: "Today all aircraft flying above 24,000 feet must be transponder equipped, but the FAA indicates that this limit will soon be lowered to 15,000 feet within the controlled limits of the United States. The next proposed step will be to require transponders on all aircraft flying within certain specified congested areas. At that time we estimate a potential market of roughly 100,000 units. Obviously, the transponder is no longer a luxury for today's pilot," he concluded.

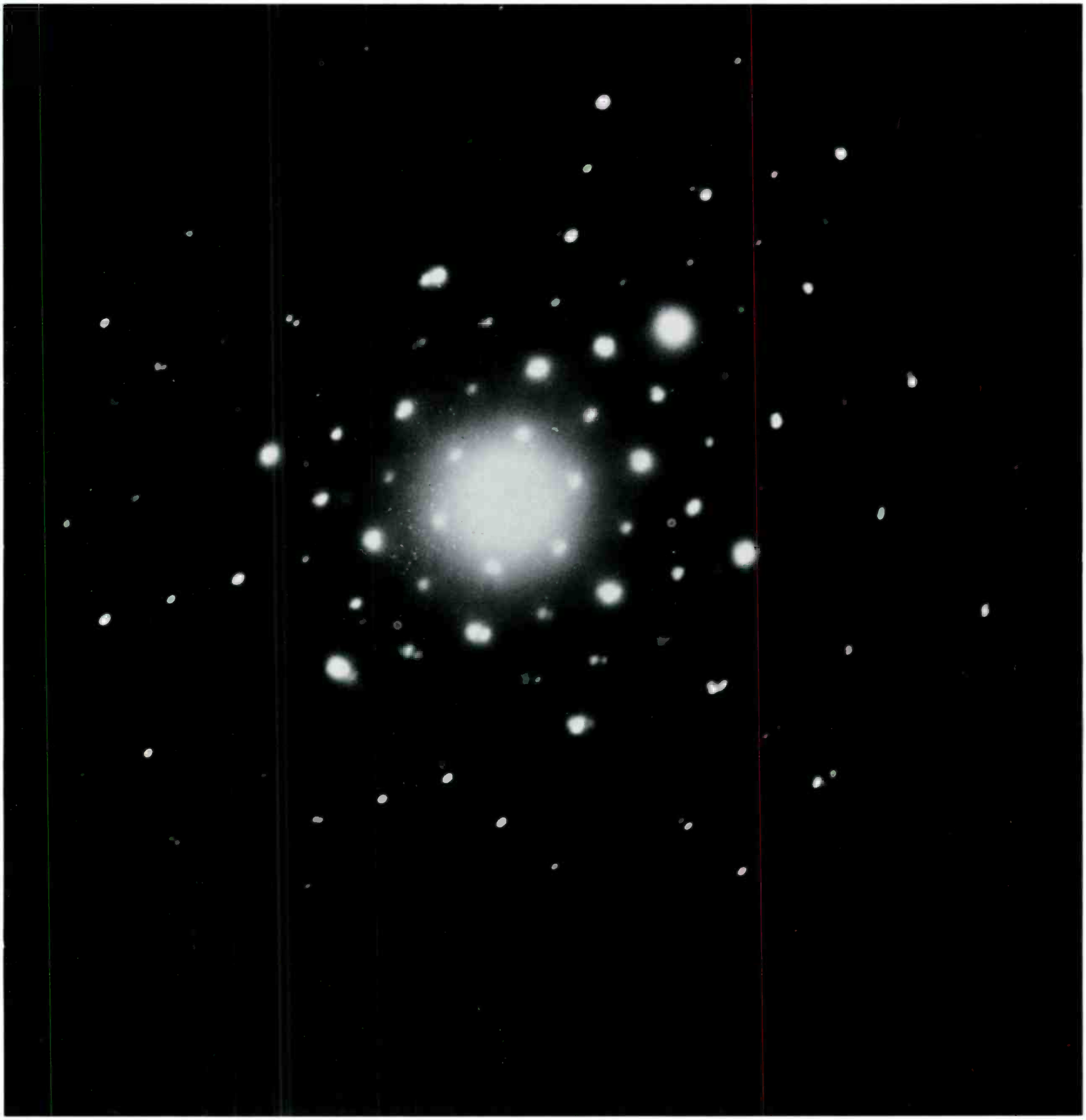
A semi-automated air traffic control system, along with eliminating the need for shrimp boats, may eventually do away with the controller's rack of Flight Progress Strips. When this occurs, and the nation's 350,000-mile network of airways is brought into the system, the United States will be prepared to handle the increased air traffic demands of the future more quickly, efficiently, and safely. ■

Window on Inner Space

The new million-volt electron microscope may push back frontiers in areas of science ranging from metallurgy to biology.

by Edward J. Dudley

Edward J. Dudley is with the RCA Commercial Electronic Systems Division.



Six-pointed star is formed in an RCA electron microscope by a single crystal of tellurium.

A driving stream of electrons, traveling at the science fiction speed of 175,000 miles a second, is extending man's vision deeper into the microcosm than ever before. And from this look into a world—smaller in size than a hundred-millionth of an inch —could come answers that will propel man farther into space and hasten his conquest of many dread diseases.

These electrons are the probing energy of the new million-volt electron microscope, which is 20 times more powerful than the conventional 100,000-volt instrument. The new six-ton system not only provides greater resolving power but also has the capability of handling much thicker specimens than was previously possible. Although researchers are just beginning to work with the new microscope, there are already indications of its potential to push back many scientific frontiers.

Metallurgists, for example, may be able to confirm old theories and postulate new ones on the fine structure of material to explain strength, fatigue, electrical and electronic properties, phase transformations, and chemical reactions. This could lead to the development of new materials for rocket engines and space vehicles, which can better withstand the intense heat and extreme cold of outer space. These new and improved materials also could be expected to find hundreds of earth-bound applications in the home, industry, and national defense.

Biologists see high-voltage microscopy as heightening the chance to study disease-producing viruses and bacteria in minute detail. They may also be able to observe and photograph life functions as they occur. With this new knowledge, the attack on disease and its causes could be pressed as never before.

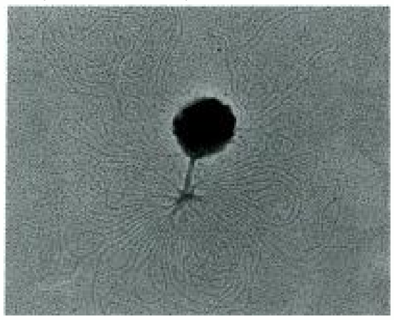
Although the million-volt microscope opens up new horizons of potential applications, it operates on the same principle as the conventional electron microscope now widely employed in medical, scientific, and industrial research. An electron beam is directed at the specimen and some of the particles pass through, creating an image that can be studied on the fluorescent screen of the instrument and photographed for more critical examination at a later time.

The power of the million-volt machine, however, accelerates the electrons to 94 per cent of the speed of light, making them driving pellets able to penetrate specimens several times as thick as those examined by conventional electron microscopy. Thus, it becomes possible for the first time to investigate the bulk properties of materials. Since the beam of the standard electron microscope has relatively low penetrating power, microscopists must work with ultra-thin specimens; in effect, two filmy sides with no body in between. This restricts their observations, for the most part, to surface effects, yet the properties of the inner mass are more interesting to the investigator. The new high-voltage instrument not only permits the use of thicker specimens but eases the exacting task of microtomy (the preparation of samples for study).

The great energy that the electron needs to pass through bulkier samples also has the effect of reducing its wave length. When it reaches maximum acceleration for its trip down the microscope column, the wave length of the electron measures less than 1 per cent, by size, of the atom itself. Since resolving power (the ability to distinguish one particle from another) improves as wave lengths become shorter, the million-volt instrument is expected to resolve structures down to their atomic dimensions.

Thus, the microscopist, studying photographic images made in the instrument, should ultimately be able to detect particles of only two Angstrom size, or approximately 1/250,000,000th of an inch in diameter.

Fowlpox virus micrograph



Even before methods were devised to apply higher voltages, the electron microscope, over a period of nearly three decades, has made important contributions to research in the United States. It has become an invaluable analytical instrument in the laboratory. If a researcher knows a material is strong, detailed microscopic studies of its structure can tell him why. And when he knows the chemical and atomic composition, he has taken a long step toward producing a substitute material or a better one.

The great resolving power of the microscope has enabled biologists to see and study the substructure of the human cell for the first time. They have used it to identify viruses that cause polio, influenza, leukemia, and other diseases in man, and to study those viruses that strike down plant life. The knowledge gained has opened a new frontier in medicine and led to the development of preventive vaccines and many other advances. In agriculture, healthier plants have been grown with the new chemicals that resulted from these studies.

In industry, the electron microscope performs dozens of workaday tasks in production and quality control, and in new product devélopment. Particle size, shape, and dispersion have particular meaning in pigments, and the coverage and durability of many paints are due in no small measure to formulas perfected from microscopic studies. Nearly three decades ago, laboratory work of this kind hastened the development of synthetic rubber, critically needed during World War II, and found substitutes for other materials that were in short supply or unavailable.

With the fine probe of the beam of the microscope, the metallurgist can examine the microstructural components of steels. For example, he can "see" the internal atomic arrangement that results when steel is heat-treated, rolled, drawn, or otherwise processed. With this knowledge, he is providing the superior microstructures that mean stronger, tougher, and more corrosion-resistant alloys for the steel industry.

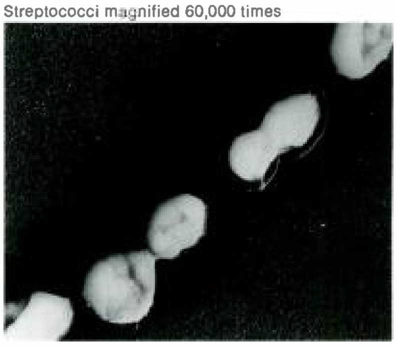
The high magnification of the electron microscope—up to 200,000 times—is made possible by two unique properties of the electron. First is its extreme brightness when harnessed for microscopy. The electron energy from a hot tungsten filament, used in the microscope, is many times more intense than sunlight and entirely adequate to produce visible images at top magnification. In fact, with the fine detail characteristic of electron microscopy, such images often are photographically enlarged up to one million times.

Second, the electron has a short effective wave length at high energy, on the order of .05 Angstroms at 50 kilovolts, or about 100,000 times shorter than light waves used in the best optical microscope. High-voltage microscopy builds on this advantage by using this prodigious energy to shorten the wave length still further, down to about one-fourth of the wave length of electrons used in the conventional instrument. This reduces the scattering or diffraction of the electrons, so that more of the beam penetrates the specimen to produce an image. The microscopist ends up with a better, brighter probe with finer sensitivity. He can see more in the viewing chamber before him as well as in the photographs made with the camera of the instrument.

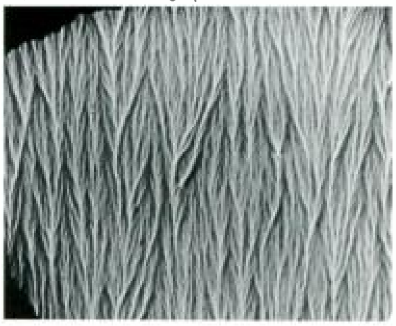
The first million-volt electron microscope designed and built in the United States was delivered by RCA last year to the new U.S. Steel Corporation research laboratory in Monroeville, Pa. More recently, an RCA 500,000-volt instrument of similar design was shipped to the Department of Materials Science at the University of Virginia, where it will be used to study a variety of materials, from biological tissue to metals and ceramics.

Influenza virus cell magnified 120,000 times

Streptococci magnified 60,000 times



Nickel-iron film micrograph

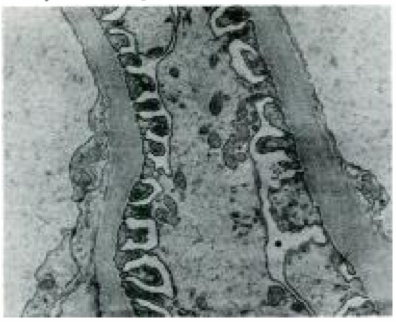


Even with its tremendous power, the million-volt instrument at U.S. Steel can be operated by one man, since many routine operations of its complex system—some 20,000 components—have been automated.

The electrons traveling down its nine-foot column are controlled by six magnetic lenses, the largest weighing some 550 pounds. The action of these lenses, actually magnetic fields, on the electrons is somewhat analogous to the effect of a glass lens on the light beam of an optical microscope. The focus can be adjusted by varying the current through the lens coils. Because of the heat generated (up to 1,000 watts in the objective lens), the lens system is cooled constantly by water.

To keep these electrons moving without hindrance, three separate vacuum

Kidney of a rat magnified 40,000 times



Control panel of electron microscope

systems pump down the column and accelerator of the instrument, until the microscope contains only one one-billionth of atmospheric pressure. This is a vacuum 10 times higher than that achieved in the 100,000-volt microscope. The vacuum systems are normally in continuous operation, since the path of the electrons must be kept scrupulously clean. A few molecules settling on the specimen can impair performance.

The U.S. Steel microscope contains three television systems, each employing small transistorized cameras, providing safety to personnel and added versatility to the instrument. Two systems are trained on meters and other points so that the operation can be monitored without exposing the microscopist to radiation. The other system is used for image intensification. With this technique, the strength of the electron beam can be reduced by as much as 50 times to diminish the harmful effects of heat and radiation on the specimen. The relatively dim image that results is brightened electronically so that it can be displayed on TV monitors, piped into a closed-circuit system for viewing at several locations, or recorded on tape.

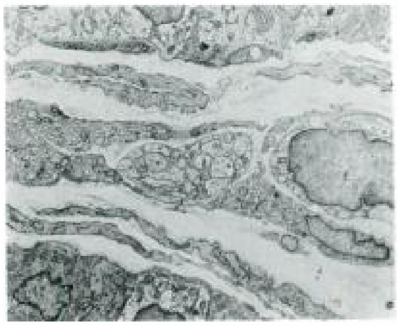
Many researchers believe that image intensification, used with the high-energy beam of the million-volt microscope, offers an opportunity to delve deeply into the study of living matter. This is because the electron beam can penetrate many biological materials without causing damaging chemical changes.

This was not true in the past. When the first RCA electron microscope became commercially available in 1940, biologists saw, in its hundred-fold increase in resolving power over the light microscope, a means for actually seeing structures they suspected must exist. But they learned that the great resolving power of the instrument came about only at the price of seriously restricting the physical properties of specimens used in it. The specimen had to be extremely thin—100 to 500 Angstroms—or several times thinner than the best microtomes could cut before 1948. Since most organic samples produce low-contrast images, it also became necessary to stain the material for improved observation. Even if the living material survived these steps of specimen preparation, it was less likely to stand up to the vacuum environment of the microscope and to the heat and radiation of the electron beam. Thus, the life scientist has been obliged, up to now, to work with dead specimens, a serious research handicap.

With high-voltage microscopy and TV recording capability, the life sciences may be turning a research corner where even transient phenomena—events that occur only once—can be observed, photographed, and captured on tape. Such observations can show, for example, how live viruses enter cells of the body and multiply. This could accelerate the development of now elusive vaccines and drugs that may prevent or cure a myriad of diseases, ranging from cancer to the common cold.

Although scientists are just beginning to work with the million-volt electron microscope, designers already are considering systems with even higher voltages. Where the power of the electron will lead man has yet to be fully determined, but it will play a major part in his explorations —from the galaxies of space to the ultrastructures of the microcosm. ■

Rabbit tissue micrograph



Accelerator for million-volt
electron microscope
at U.S. Steel Corporation

Advances in the generation and control of electromagnetic energy are giving new versatility to microwave power.

by Bruce Shore

Microwave Power

After years as a work horse of the communications industry, microwaves—radio waves that oscillate from 100-million to 33-billion cycles a second—are coming into their own as unique sources of wireless power for industry, home, and national defense.

Employed principally until now as a medium for carrying two-way radio messages, cross-country telephone conversations, and broadcast television programs, microwaves are currently being groomed to handle entirely new tasks requiring high powers. These range from mapping the surfaces of the planets to cooking an epicurean dinner.

They are even being used to investigate the basic nature of matter as in the two-mile-long linear accelerator at Stanford University. Here a gallery of klystron tubes produces microwaves, oscillating nearly three billion times a second, which pump electrons to energies of 20-billion electron volts and to velocities approaching the speed of light. These electrons are then sent crashing into target atoms at the business end of the accelerator and the resulting atomic debris is later collected and analyzed for clues to the composition and architecture of nuclear substance.

The pumping action and acceleration both take place because the electric fields associated with the electrons and those of the electromagnetic microwaves interact to cause the electrons to "surf" on the waves and be whisked the length of the machine like so many electronic surfboard riders.

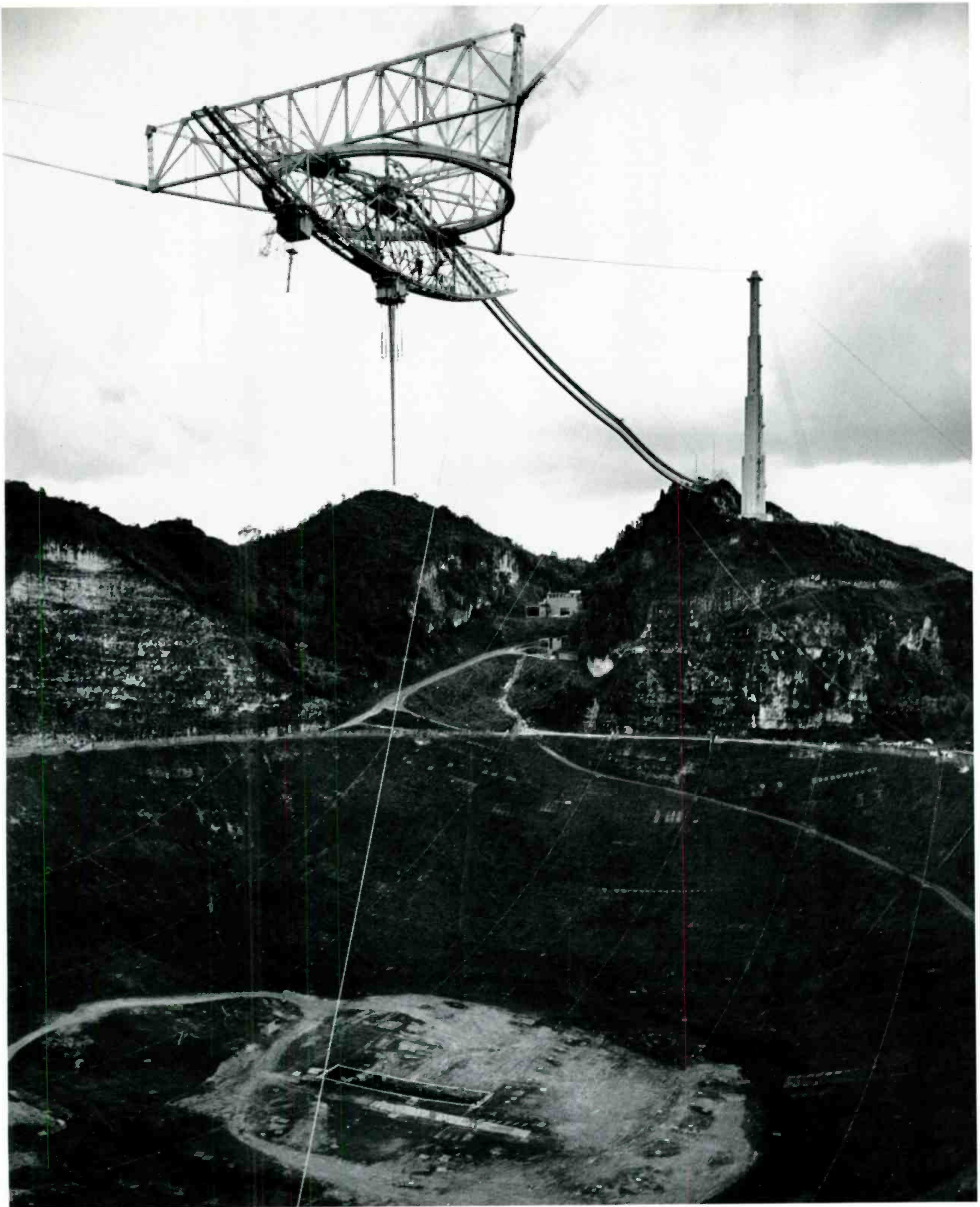
Equally impressive is the use being made of microwave power by Cornell University astronomers working with the 1,000-foot radio telescope at Arecibo, Puerto Rico. Over the past few years, whenever Venus has approached within 50-million miles of earth, they have employed the telescope to send powerful microwave pulses toward the planet and to receive and record the faint return echoes of those pulses. In this way, with the help of computers, they have succeeded in producing a radar map of one-third of the surprisingly rugged Venusian surface. Eventually, they expect to map all of it with the same resolution that would be obtainable with the world's largest optical telescopes were it not for the impenetrable cloud cover of the planet.

Side-looking radar is another ingenious application of microwave power that permits an airplane to make a continuous map of the terrain to either side of its flight path—a map that looks very much like a photograph when fully processed. This is made possible by a type of radar holography in which changes in wave length, produced in a radar pulse as a result of striking objects at various heights and distances on the ground, are converted to an optical interference pattern on film. When a laser beam passes through this film and through a chain of lenses to a second film, a two-dimensional reconstruction of the original scene is immediately registered.

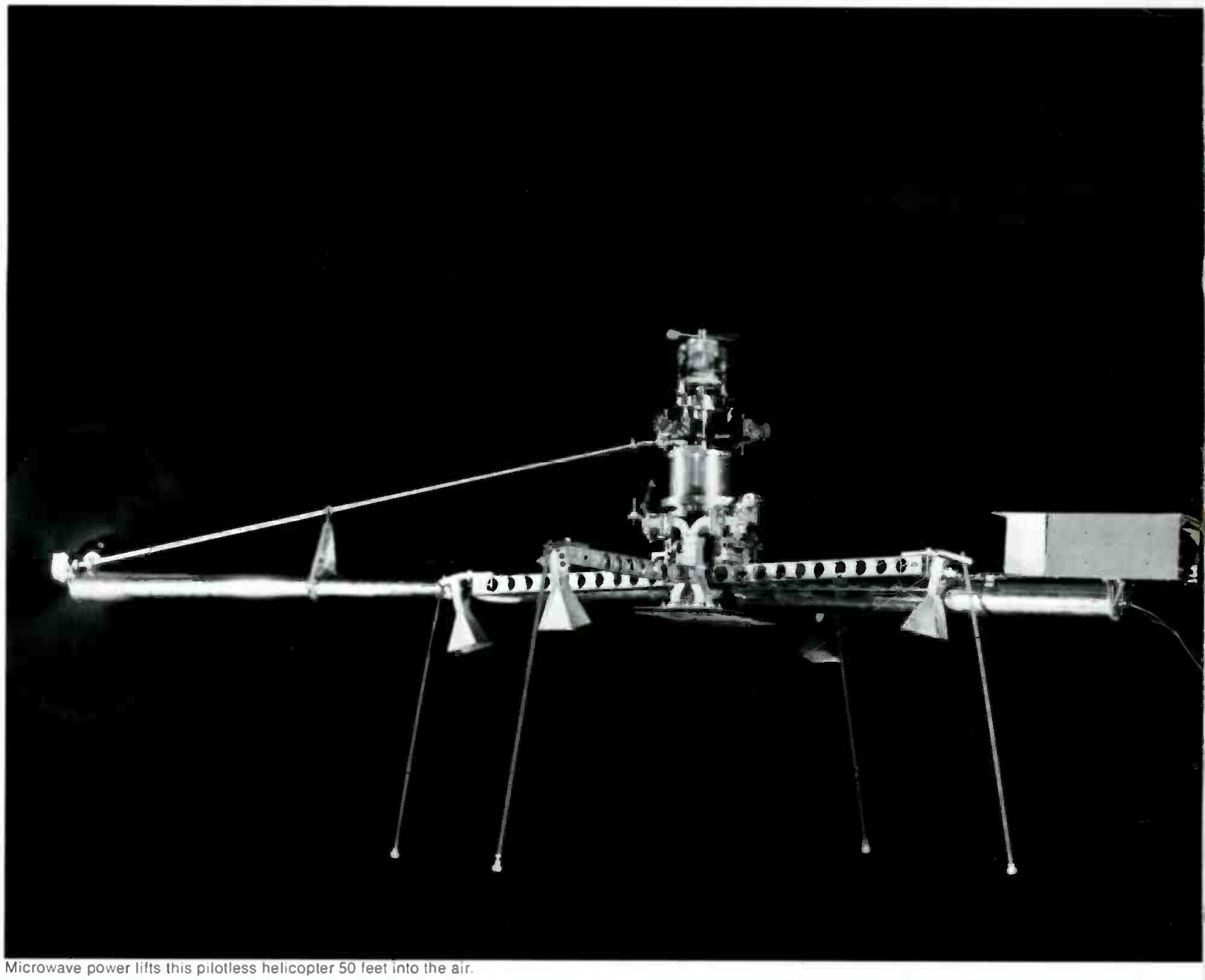
Another novel application of microwaves—the transmission of electric power over short distances without wires—is also being explored by the electronics industry. The Raytheon Company has already developed a small helicopter equipped with a six-foot rotor and arrays of solid-state diodes that convert microwave energy to electric current. This current is then used to power the rotor and lift the helicopter some 50 feet into the air where it hovers as long as microwaves are directed at it from a radar dish below. Such a pilotless helicopter might one day be used as a TV relay, a military observation platform, or a means for directing air or ground traffic.

Finally, there is the resurgent field of microwave cooking and drying. Recently, RCA developed a microwave tube that makes it possible to roast a 16-pound turkey in an hour and 10 minutes, bake a cake in four minutes, or fry strips of bacon in less than 50 seconds. On the same principle, the Coventry *Evening Telegraph* and the London *Evening Standard,* both British newspapers, are currently using microwaves to dry four-color newsprint at rates of 1,000 feet per minute. Both capabilities stem from the fact that water molecules do not have uniform electric charges but are slightly negative on one end and slightly positive on the other. When irradiated by microwaves, they, therefore, begin to rotate at very high speed with the result that the material of which they are part undergoes instant, internal heating through friction.

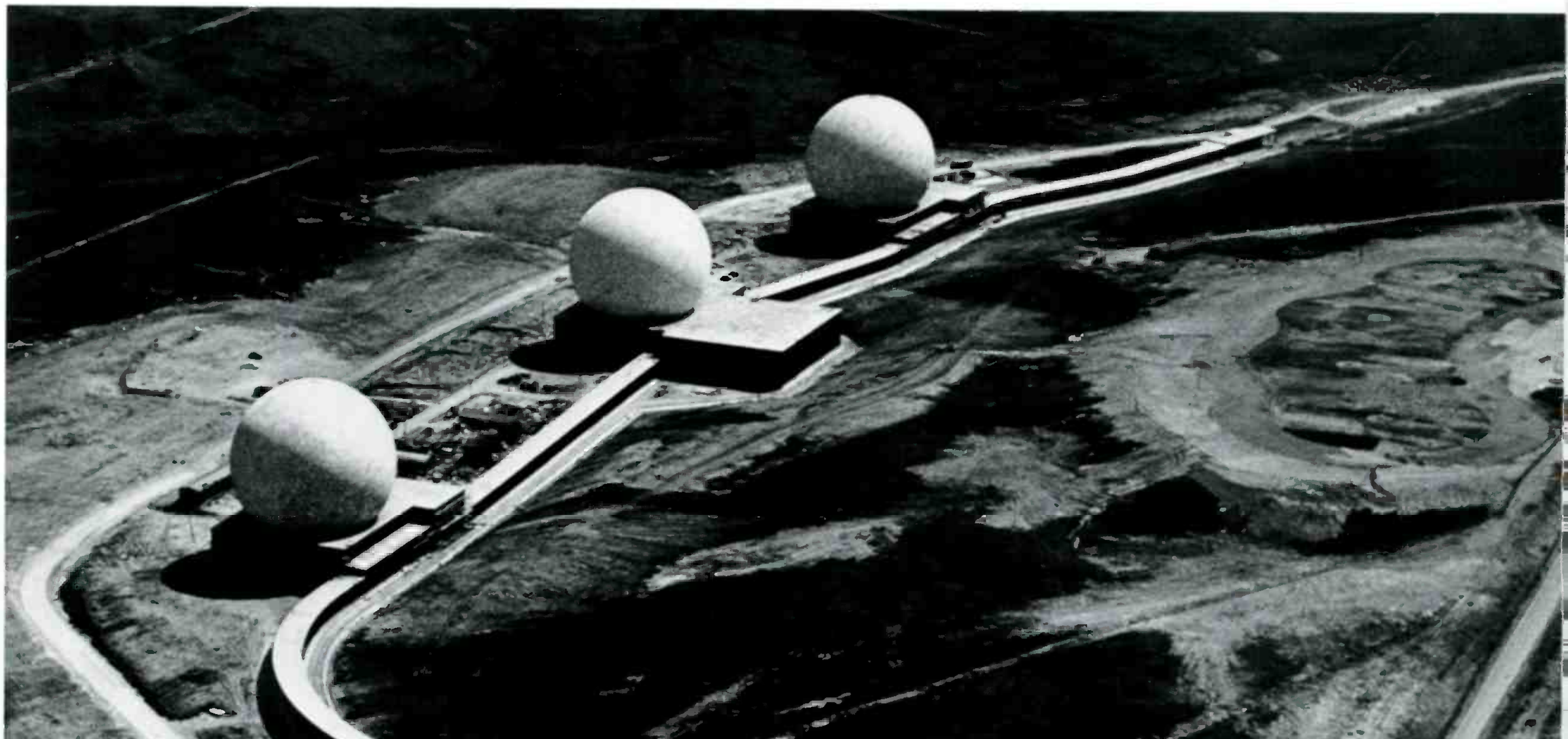
Bruce Shore is on the RCA Public Affairs staff.



Microwave pulses from the giant 1,000-foot radio telescope at Arecibo, Puerto Rico, are helping map the surface of Venus.



Microwave power lifts this pilotless helicopter 50 feet into the air.



High-power radar scans the sky above northern England
to warn NATO allies in case of missile attack.

Although these applications are all fairly recent, microwaves are as old as radio technology itself. In fact, the very first radio waves deliberately produced by man were microwaves—short bursts oscillating at 100-million cycles per second—generated by the German physicist Heinrich Hertz in 1886. However, they had little power and did no more than confirm the existence of radio waves as predicted by James Clerk Maxwell, the famous Scottish physicist, some two decades earlier.

It was a beginning, however. Hertz used an electrical spark jumping periodically between two metal terminals, in the manner of a modern spark plug, to generate his microwaves. (This explains, incidentally, why the starting of a nearby car often creates static in a TV picture. The spark plugs are broadcasting.) As a result, the next quarter-century of radio development was dominated by the use of spark gaps as the primary source of radio waves, though at much lower frequencies. In fact, radio operators the world over acquired the nickname of "Sparks" in amused recognition of the way in which they produced their long-distance dots and dashes.

Even though "sparking" has long since been abandoned as a means of generating man-made radio pulses, it was very recently cited, in its natural form, to explain the existence of "whistlers"—low-frequency radio waves that travel along the lines of force of the earth's magnetic field. These are now known to be generated by lightning, the biggest spark of them all.

The groundwork for replacing the spark gap, and its rather impotent oscillations, was laid in 1907 when Lee De Forest invented the audion. In essence, it was a glass bulb that in a partial vacuum housed a source of electrons (cathode), a faucet for controlling their flow (grid), and a drain (anode) for piping them back to the cathode through an outside circuit.

De Forest found that, when he hooked the audion into a d.c. circuit so that its cathode gained a strong negative charge, its grid a weaker one, and its anode a positive charge, the device could amplify selected radio signals if leads from its grid were run to an antenna that resonated in sympathy with those signals. What was happening was that the charge (voltage) on the grid was varying from more negative to less negative in perfect step with the positive-to-negative oscillations occurring in the incoming radio signal. This, in turn, had the effect of raising and lowering the volume of current flowing through the grid to the anode.

Thus, De Forest had devised a mechanism for impressing the weak oscillatory likeness of a train of radio waves, propagating through space onto a relatively powerful electric current flowing in a circuit. Such is the basis for radio wave amplification even today.

Since the audion was an amplifier, it did not replace the spark gap as a source of radio waves. But, it did give ideas to several radio engineers and, in 1914, led Alexander Meissner, in Germany, to build a similar tube into a circuit that sent part of its output back to its cathode and grid. This caused the tube to oscillate or "ring," just as a water pipe oscillates when there is pressure feedback between faucet and main water valve. In the case of Meissner's circuit, however, the vibrations were electromagnetic, not mechanical, and the first vacuum tube oscillator for generating radio waves was born.

By the mid-1920s, triodes of this kind had been perfected to the point where they were producing radio waves in the millions-of-cycles-per-second range with powers up to 20,000 watts. Not only did these devices usher in the era of voice broadcasting, but they prepared the way for such men as Sir Robert Watson Watt in England, Dr. Robert Page of the U.S. Naval Research Laboratory in Washington, and Drs. Irving Wolff and Ernest Linder of RCA to realize the next major outgrowth of radio research—radar.

The fact that radio waves are reflected by metal objects or other electrical conductors in their paths had been known since the turn of the century. And, as early as 1922, radio pioneer Guglielmo Marconi had proposed that transmitters be installed on ships to detect the presence and range of other boats in the vicinity, especially at night or in a fog. Three years later, the first actual use of radar occurred when British physicists Edward Appleton and Myles Barnett measured the height, as well as proved the existence, of the ionosphere by bouncing a radio signal off it. The concept of such an electrically conducting layer in the earth's upper atmosphere had been postulated by Arthur Kennelly of Harvard University and Oliver Heaviside in England in 1902, to explain how radio waves propagate around the world. Its existence was by no means certain, however, until Appleton and Barnett performed their critical radar experiment.

Despite this achievement, radar was slow in reaching its potential, largely because the radio frequencies that man could generate were too low and their power was too meager. Low frequencies meant long wave lengths—hundreds of feet from crest to crest in the propagating waves. As far as meaningful detection was concerned, this was just too long to reflect anything smaller than the broadside of an ocean liner.

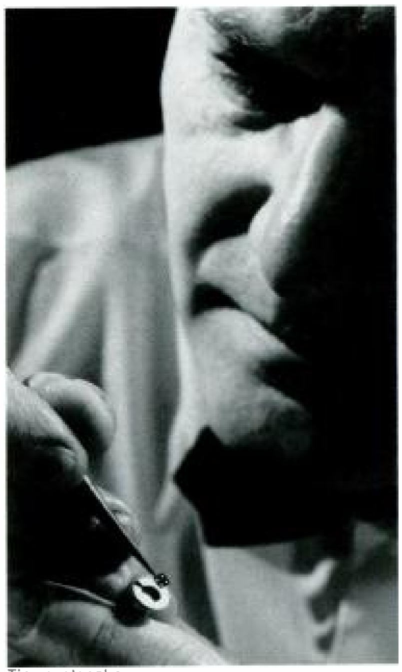
Shorter wave lengths, higher frequencies, and much more power were needed. By 1935, all three were achieved by the high-frequency triode. This device oscillated at well above 100-million cycles per second and, in some cases, radiated thousands of watts of power to produce radio waves that were only a few feet from crest to crest; short enough to detect airplanes.

Though the triode proved to be more than a match for the German air force during the Battle of Britain, it was not so successful in meeting the challenge of the German submarines that began to prowl the shipping lanes of the North Atlantic in the early 1940s. What was required there was an oscillator that would produce radio waves measured in inches, short enough to be reflected from slender periscopes when they poked above the ocean surface.

To meet this requirement, radio engineers turned to the magnetron, a special type of vacuum tube invented by Albert Hull of the General Electric Company in 1921 and brought to a state of practicality for high frequencies six years later by Jinjiro Okabe in Japan. The magnetron produced shorter radio waves by "boiling" electrons from a central cathode surrounded by a split cylindrical anode, each half of which is alternately negative and then positive. By means of a magnetic field stretched along the length of the tube, electrons can be forced to go consistently to the negative half of the anode. This causes the tube to oscillate in the billions-of-cycles-per-second range with powers measured in the thousands of watts.

In 1939, using the theory of "velocity modulation" expounded by Frederick Llewellyn at Bell Laboratories six years before, Russell and Sigurd Varian, two talented brothers working at Stanford University on the problem of generating microwave power at high frequency, invented the klystron tube.

"Microwaves are as old as radio technology itself; in fact, they were the very first radio waves deliberately produced by man."



Tiny avalanche diodes can generate great power.

The klystron differed from the triode in that the mobs of electrons streaming from its cathode did not rush in a helter-skelter fashion through a grid toward an anode. Instead, they passed through a circular metal cavity shaped like an automobile tire. When an alternating electric current was applied to this cavity, it tended to form the electron stream into a salami-shaped string of electron bunches by regularly slowing down the fast electrons and speeding up the slow ones. The stream then passed through a second cavity where the uneven electric fields associated with these bunches induced uneven or fluctuating image currents on the inner surface of the cavity. Part of these were fed back to the first cavity, causing the whole tube to "ring" at very high frequencies, like an electromagnetic tuning fork. The rest were sent to a microwave antenna that behaved, as always, like a great electromagnetic sounding board for transmission purposes.

Thus, it was the effort to achieve long-distance, high-resolution radar that first gave man the ability to generate significant amounts of microwave power, and it was perfection of the high-frequency triode that made it possible.

Although the triode, the magnetron, and the klystron are now being challenged by such solid-state microwave sources as "overlay" transistors, avalanche diodes, and Gunn effect oscillators, none so far has been able to match the vacuum tube as a source of power. The tiny semiconductor chips of which they are made just have not been able to take the punishing voltages, electric currents, and heat associated with the generation of superpower.

However, this situation may be about to change. Cornell University scientists W. Keith Kennedy, Jr., and Lester Eastman recently reported driving a Gunn effect device to oscillate at 7.7-billion cycles per second in pulses with a whopping 615 watts of power. Similarly, H. John Prager and Sherman Weisbrod, working under the direction of Dr. Kern Chang at RCA Laboratories, recently discovered a new effect in certain avalanche diodes that has made it possible for them to generate one-billion-cycle-per-second pulses with a power of 435 watts.

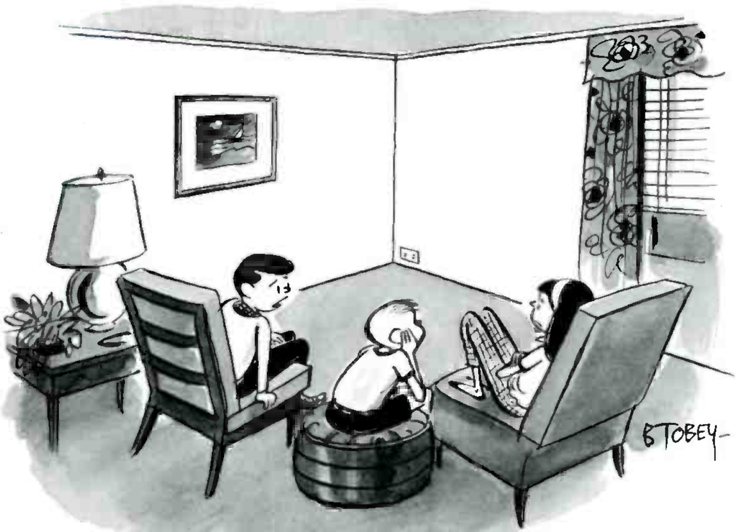
"Microwaves are being used to investigate the basic nature of matter."

These are incredible powers to emanate from solid-state devices so tiny they would fit comfortably under a fingernail. When coupled with recent advances made in building integrated circuits for microwave equipment, they give promise that up to one million watts of pulsed microwave power may one day be available from a few poker-chip-size wafers of semiconductor material. Indeed, steps in that direction are already being taken by such firms as Texas Instruments, Emerson Electric Company, and RCA, which are attempting, independently, to build "phased array" radars. These are a new type of radar that uses solid-state circuits to scan the sky electronically rather than mechanically.

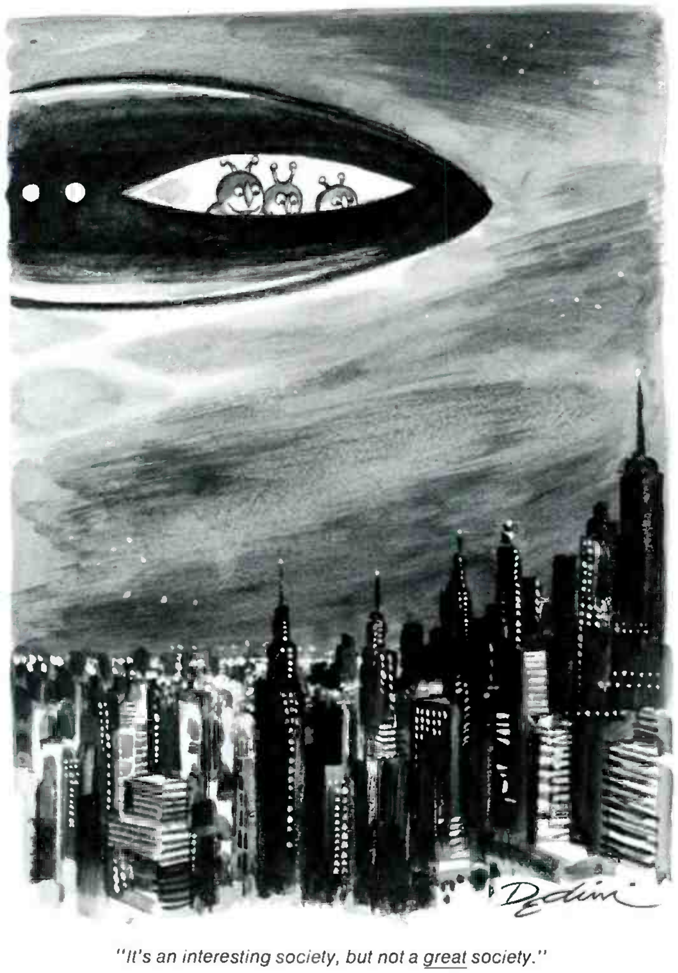
Advances in electron tube technology, applied to the generation and control of electromagnetic energy at microwave frequencies, have opened many new areas to this power source. And new solid-state technology, now on the horizon, promises to extend microwave versatility still further in the years ahead. ■

This Electronic Age...

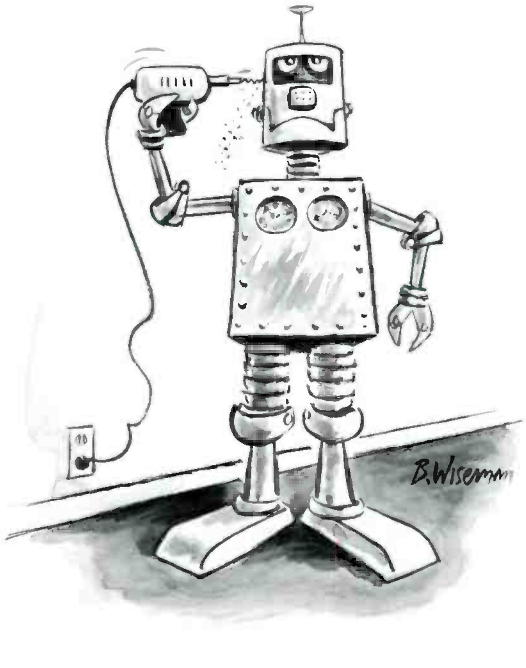
"Several of us are getting together to watch Mildred's operation on closed-circuit television in color. Care to join us?"

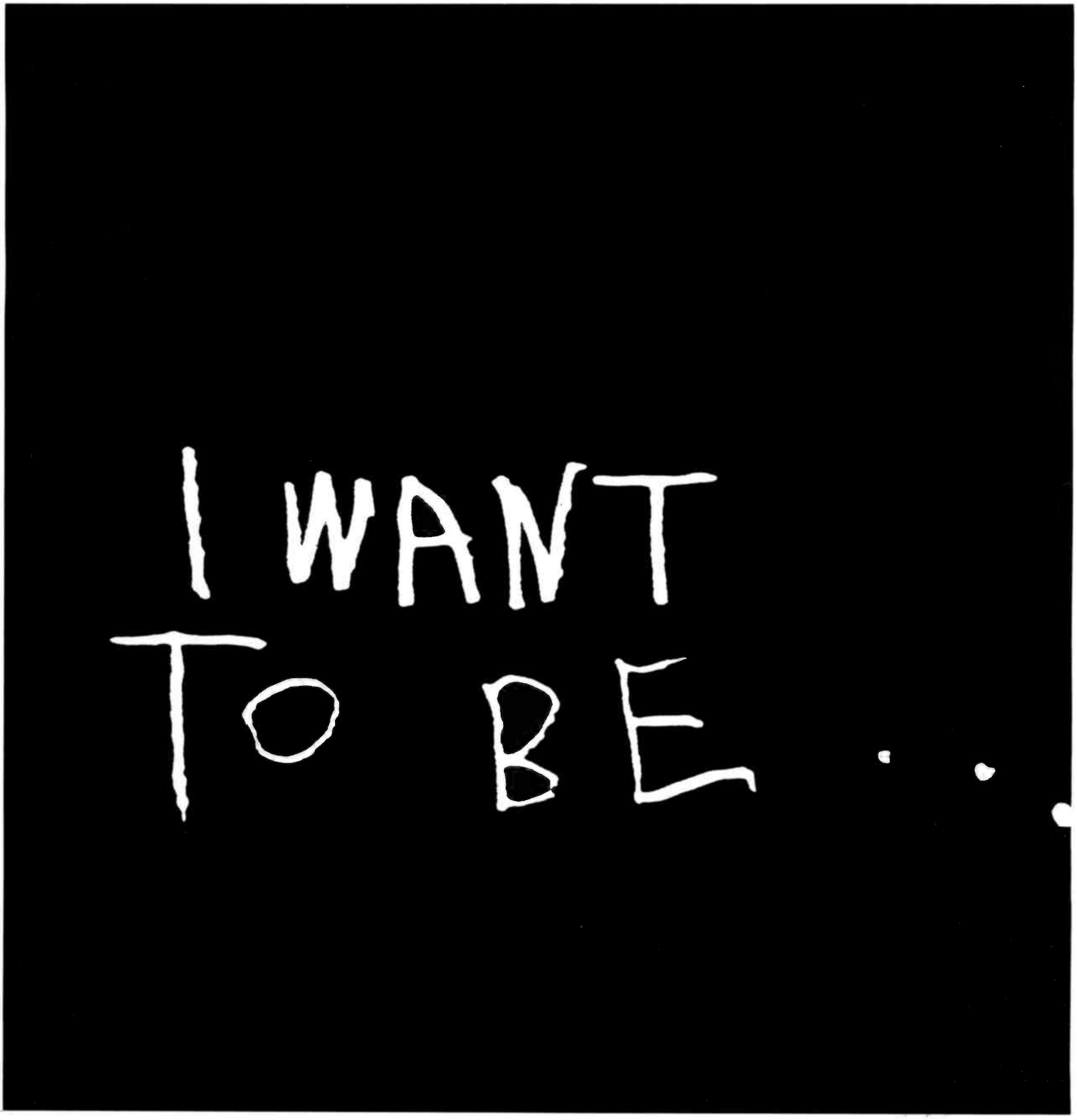


"The next time they take it back to the shop they're taking me along with it."



"It's an interesting society, but not a great society."




I WANT
TO BE . . .

Computer-Assisted Instruction, demonstrated at HemisFair '68, provides for the needs and capabilities of each student as an individual.

Visitors to HemisFair '68 are getting a firsthand glimpse of the "classroom of tomorrow"—a personalized electronic answer to the problem of education in a world in which man's store of knowledge doubles every decade or less.

The exhibit of educational technology is part of the RCA pavilion at the Texas international exposition, the third world's fair in North America during the past five years. Located in downtown San Antonio, the fair combines the international flavor of Expo 67 (more than 30 nations have exhibits) with the industrial emphasis of the New York fair.

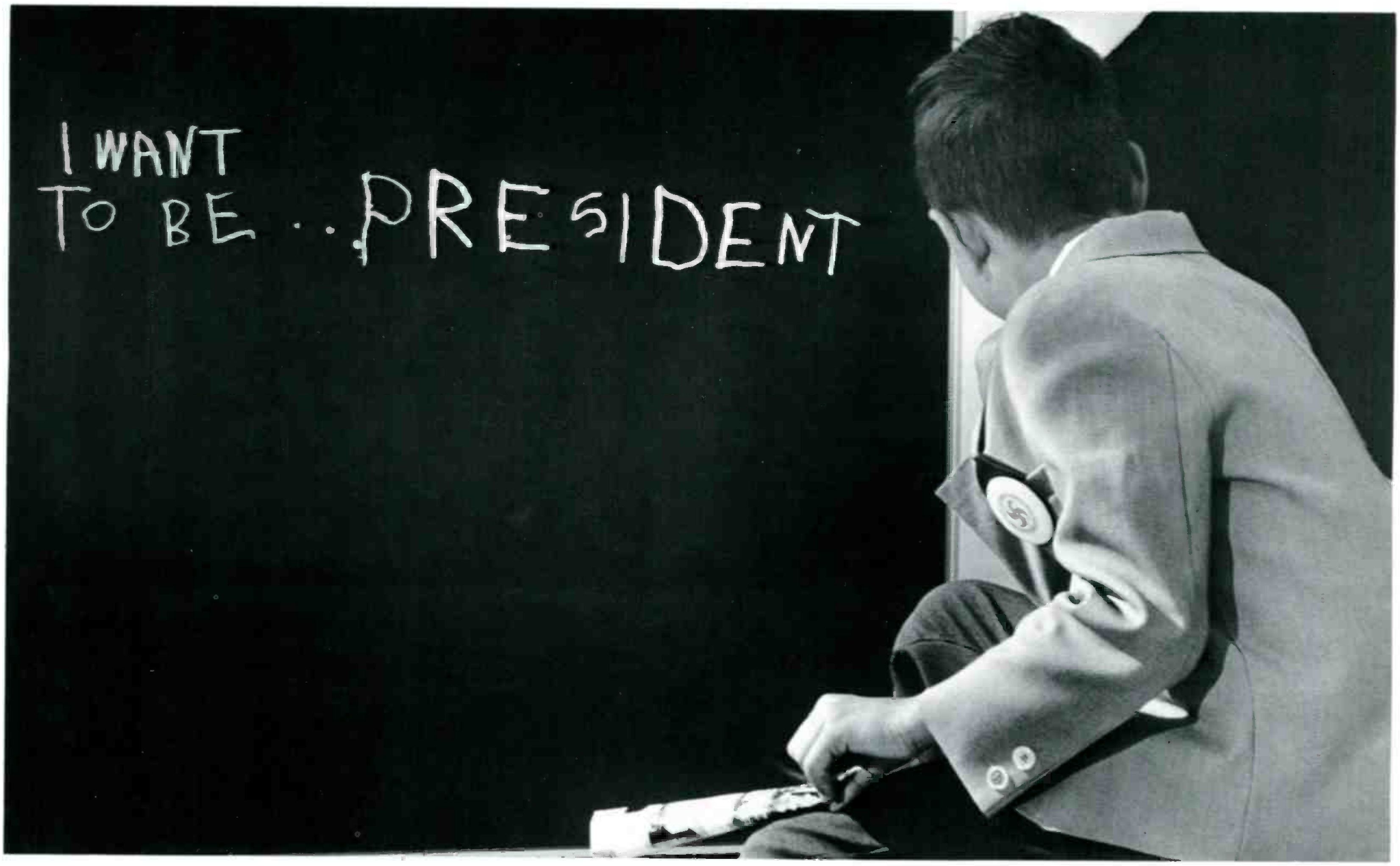
The RCA exhibit utilizes graphic displays, audio-visual techniques, and live demonstrations to show how electronic technology is gearing education to meet the needs of the individual child. At the heart of the display is an advanced RCA Spectra 70 computer linked to remote student consoles and video units. The huge data storage and processing capacity of this computer makes it possible for the machine to test the child to determine his level of understanding and then gear questions to his specific learning rate. The computer can continuously adjust this drill difficulty level to drill performance. On the administrative side, it can retrieve records, schedule classes, and even grade students.

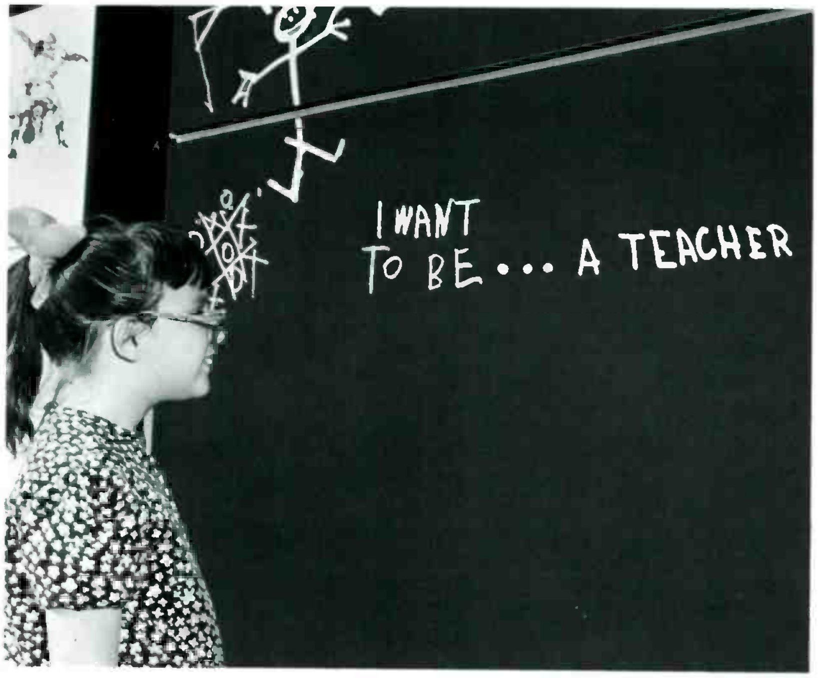
Computer-assisted instruction (CAI) is not a substitute for the teacher. Rather, it is a means of freeing him from many routine tasks so he can devote more of his time to the creative aspects of education.

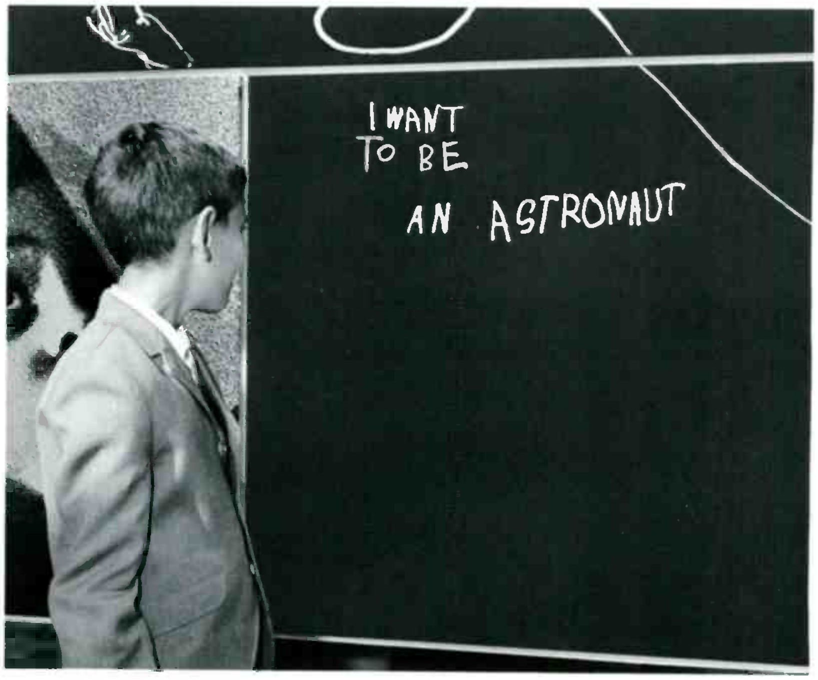
At the pavilion, the visitor enters a glass-enclosed theater overlooking an array of electronic computer equipment. On a rear wall are several screens, on which are projected multiple images of both color slides and films during a ten-minute showing. This presentation deals with the impact of electronics—including CAI, educational television, language laboratories, and dial access systems—on learning rate and retention. Woven into the kaleidoscopic show is a live demonstration of CAI by a San Antonio youngster sitting at a teletype terminal and receiving his lessons from the computer. Also demonstrated is a TV-type visual display unit, which enables teachers to call up any needed material from the computer system in a fraction of a second.

However, the electronically assisted "classroom" is more than demonstration hardware. When HemisFair closes in the fall, the RCA pavilion and its computer system will be put to work by the Inter-American Education Center, with headquarters in San Antonio. It will be the nucleus of the first state-wide computer complex for schools, aiding in the education of 180,000 pupils in a 14-county Texas school region.

Initially, it will be used to handle a wide variety of school administrative and accounting functions, including maintaining an up-to-date inventory of textbooks,



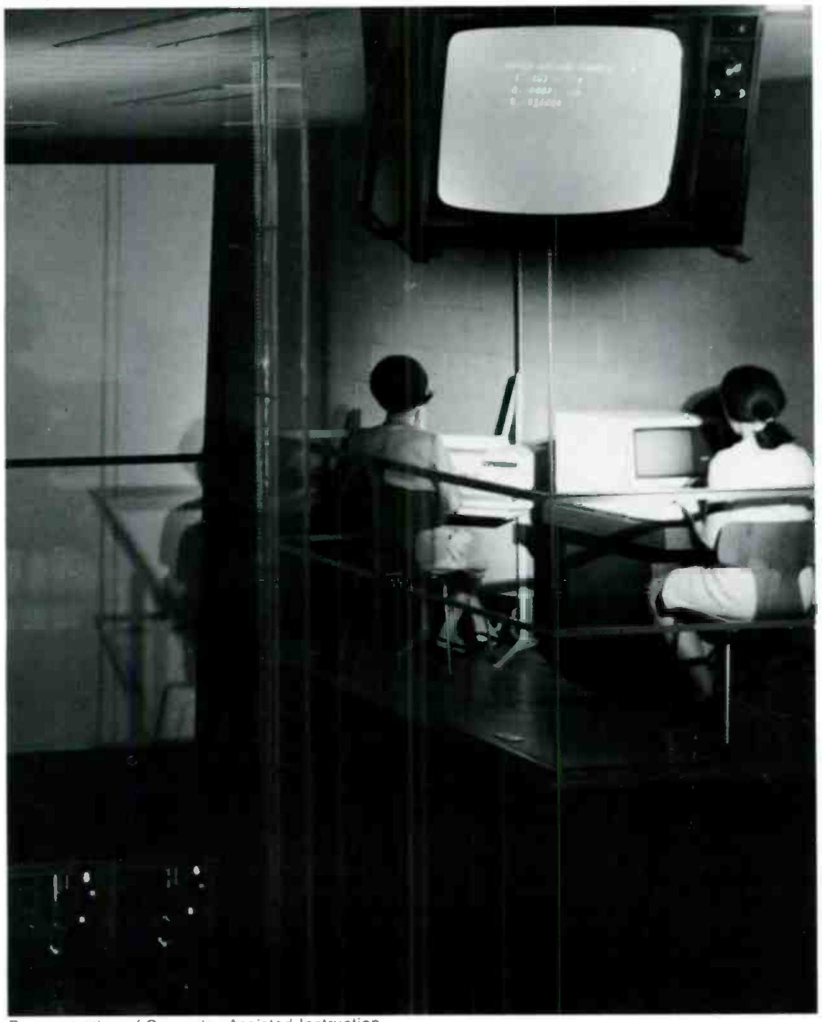


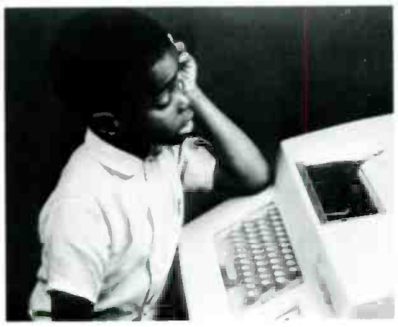


pencils, pads, school buses, and other assets. The computer also will process a payroll exceeding $123 million a year. When applied to classroom instruction in two or three years, it will be capable of handling up to 200 remote terminals simultaneously, communicating with students through typewriter and video communication devices. The computer also will be used this year to teach computer programming techniques at a number of Texas schools, according to Dr. Dwayne Estes, director of IAEC.

The RCA exhibit demonstrates that electronics will personalize rather than dehumanize education. Instead of gearing instruction to a common denominator, the new classroom technology will focus on the specific needs of each child in each learning situation. ■


RCA pavilion at HemisFair '68


Demonstration of Computer-Assisted Instruction

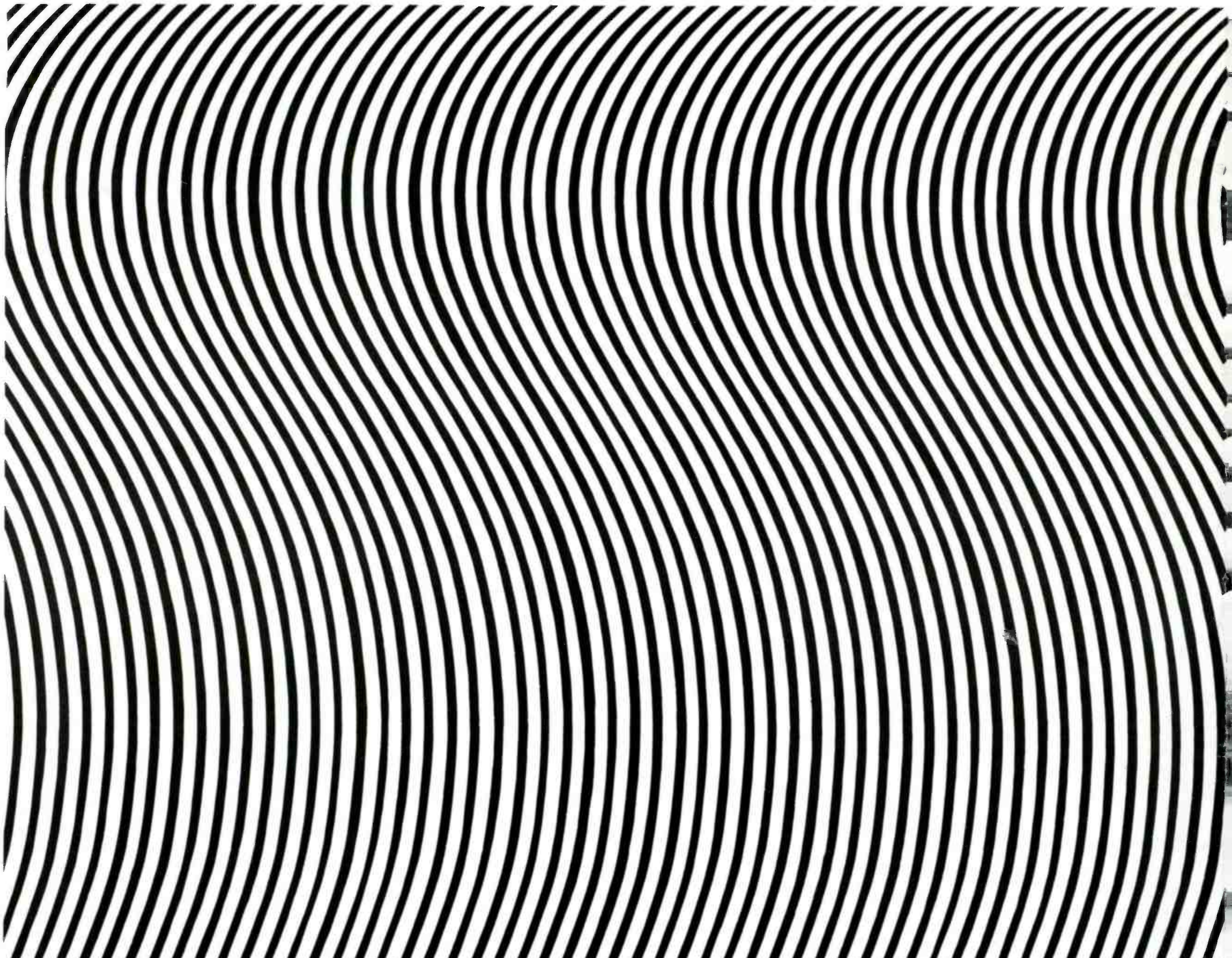



Youngsters (above and right) sitting at student terminal units solve arithmetic problems.

Acoustics in the Concert Hall

A fine music hall, like a great conductor, helps to blend and shape the sounds of the orchestra into a cohesive musical experience for the audience.

by Edward McIntyre



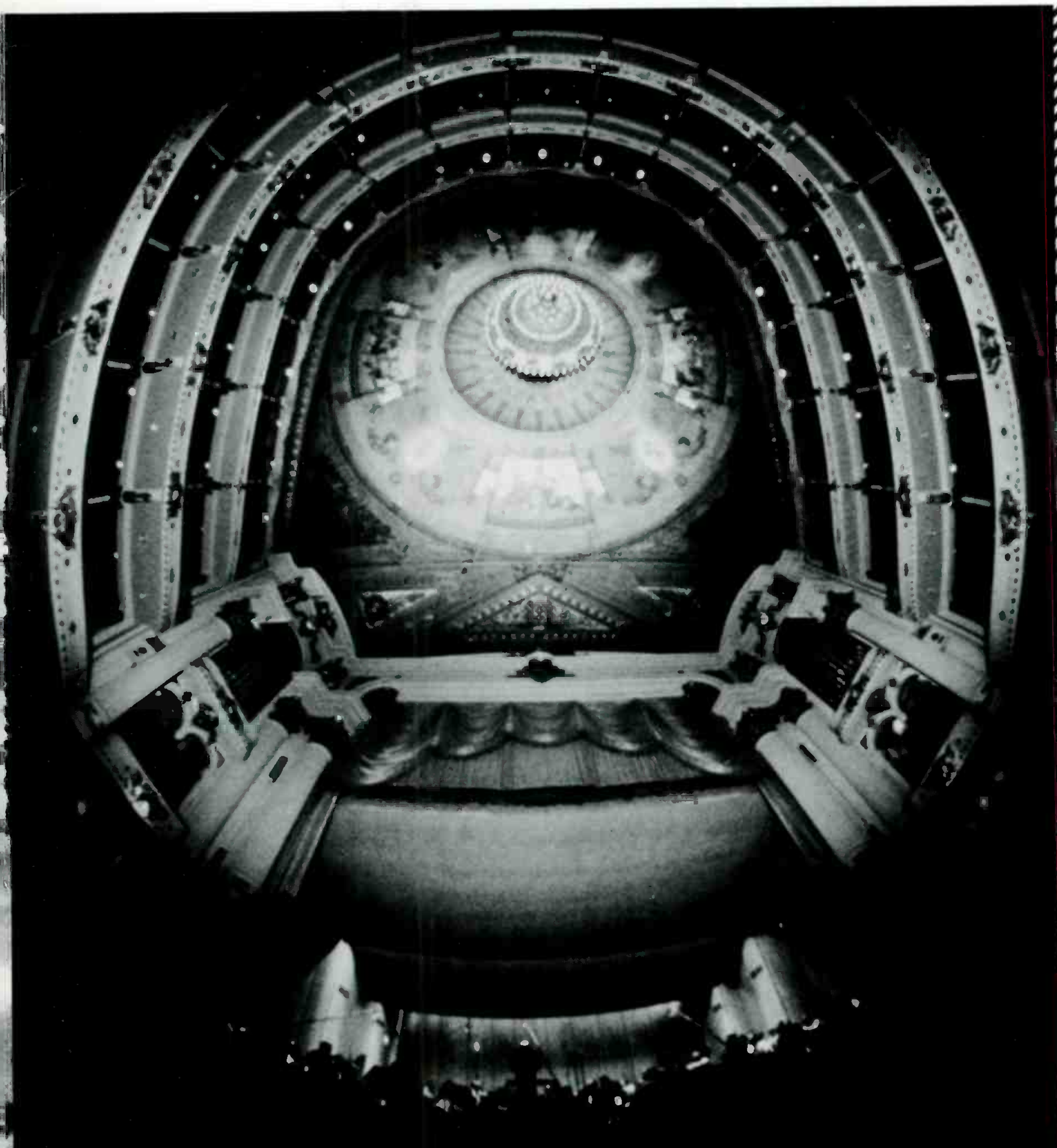
Throughout history, the concert hall has been as much a part of music as the instruments and the conductor at the podium. Sounds that reverberate off walls, ceiling, and floor are even more crucial than direct sound in forming the blends of tones that make up an enjoyable musical performance.

A "live" (reverberant) hall imparts fullness of tone, yet, on the other hand, too much reverberation will muddle the music. If the time gap between direct sound and reverberation is small, the audience will have a sense of presence or intimacy with the orchestra. A good hall also imparts envelopment, an exotic feeling of being surrounded by the music. The stage and pit design, together with ceiling construction, are major factors in blending the music so that the sound from the various instruments seems harmonious to the audience. In short, the concert hall is an acoustical envelope for the music.

The importance of the acoustical envelope has been known since the ancient Greeks built their amphitheaters on Athenian hillsides, with a wall behind the stage to reflect the voices of the performers back into the audience. From the Middle Ages to the end of the eighteenth century, most composers deliberately shaped their music to meet acoustical requirements of performance sites, usually cathedrals, drawing rooms, or outdoors. For example, the forms used by Mozart and Haydn in their chamber and orchestra music are identical; but the counterpoint, ornamentation, layout of chords, and the rate at which harmonies change vary according to whether the piece is room music, concert music, or street music. And, it is no coincidence that Gregorian chants sound best in a hall acoustically resembling a medieval cathedral, where reverberation time is as long as 10 seconds.

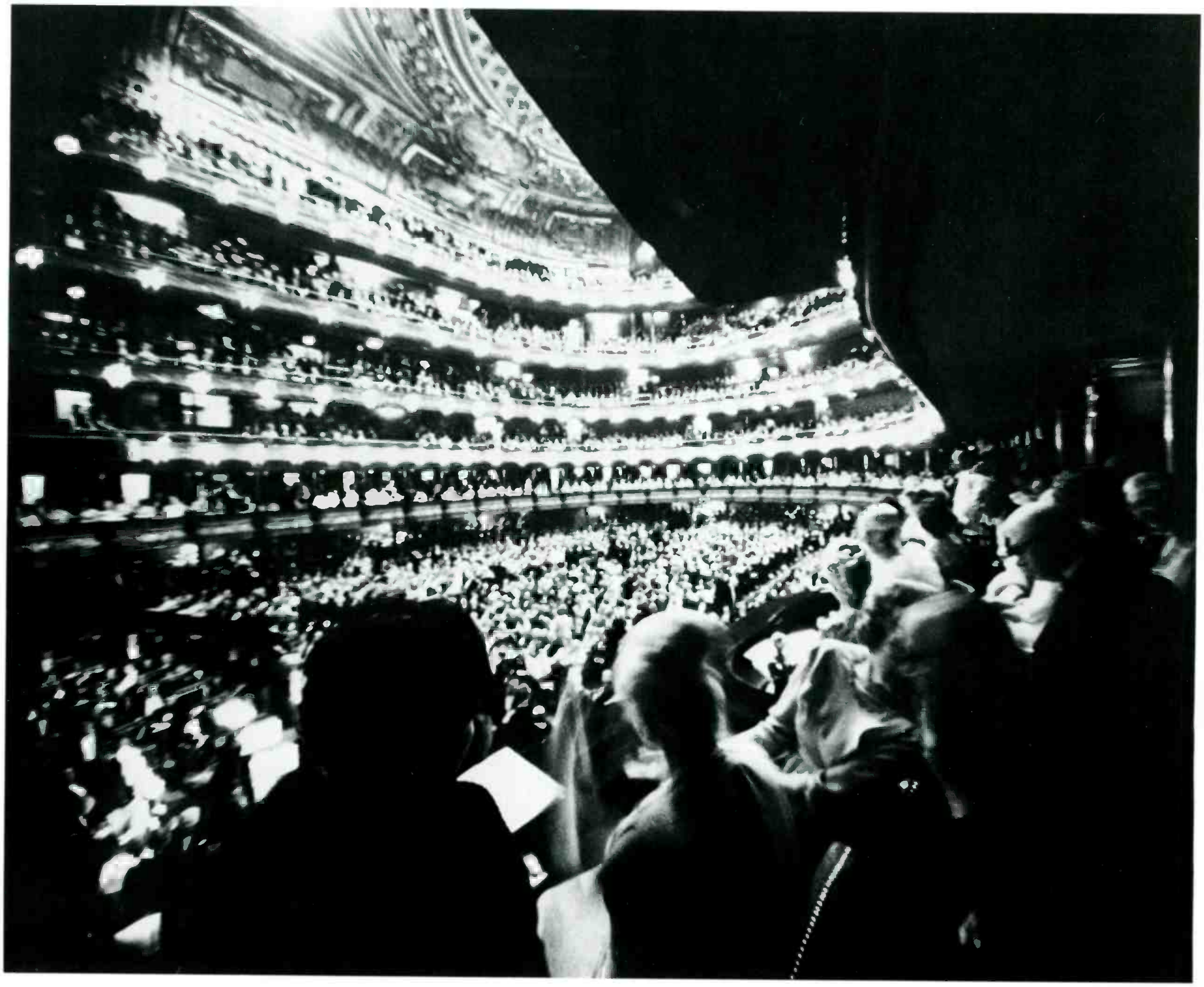
The maverick was Richard Wagner, who broke with the Baroque-like opera tradition to create personalized, rich, stirring music. However, in order to achieve a

Edward McIntyre is a freelance writer whose articles have appeared in the New York *Times* and other publications.

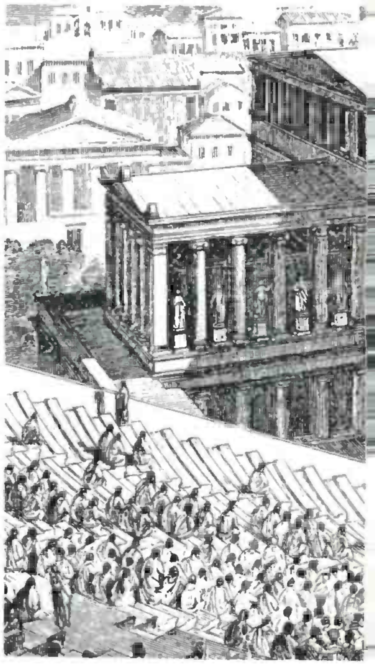


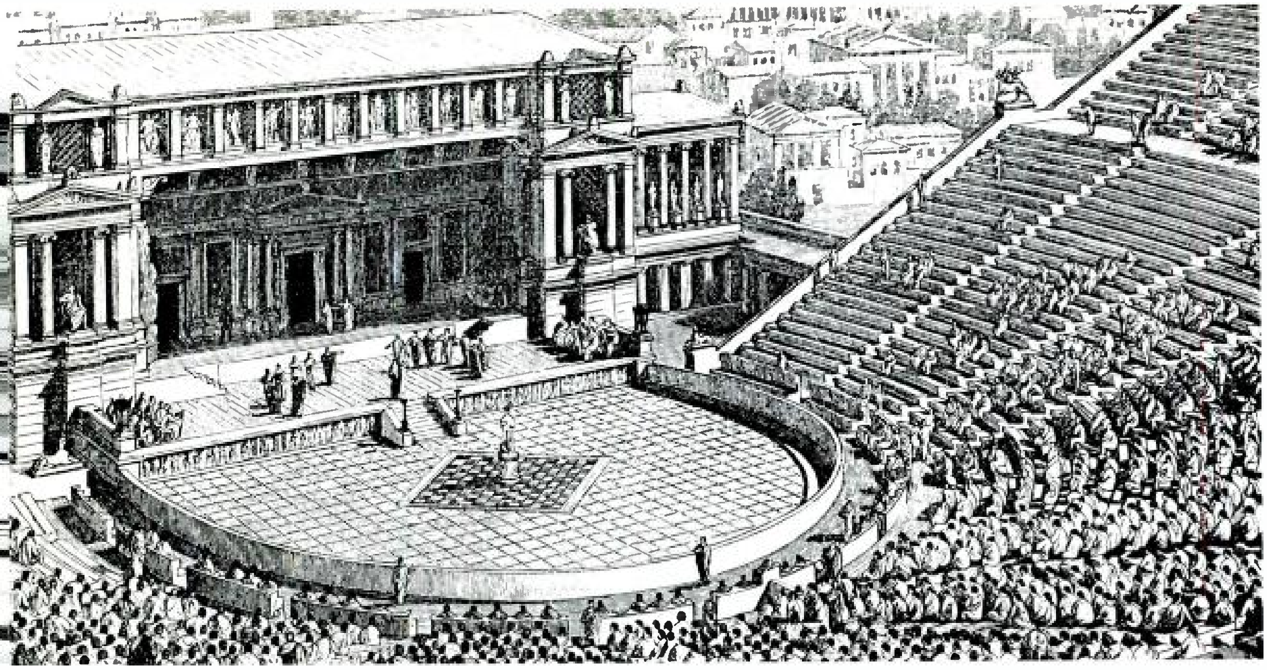
Academy of Music, Philadelphia

Old Metropolitan
Opera House



Reconstructed
Theater of
Dionysus, Athens





Wolfgang Amadeus Mozart shaped much of his music to acoustical conditions of the performance site.

"Designing optimum acoustics into a large concert hall . . . is at best chancy. Blueprints and engineering drawings simply cannot precisely predict the acoustical qualities of a filled auditorium."

good acoustical environment for his musical style,he also had to design his own opera house. The Festspielhaus in Bayreuth, Germany, which combines a relatively long reverberation time with thoroughly blended orchestral tones, today is literally a monument to Wagner's music. Most musicians claim his music sounds best there, while it is a relatively poor hall for almost all other compositions.

The era of the contemporary concert hall began some 200 years ago, perhaps with the opening of Milan's famed La Scala opera house with its much copied horseshoe design. On the whole, these early halls were built narrower than their modern counterparts, with smaller and more concentrated seating areas—less room for each seat. For example, La Scala has a present capacity of only 2,289 seats, many with obstructed views of the stage, and allows just five and a half square feet of space per person, compared to the American standard of seven and a half square feet for comfort and safety. This is a major part of the reason for the intimacy and the richness of sound that have made the Italian opera house and other old classical music halls world-renowned.

According to a leading authority, an American concert hall of the same magnitude would require a seating area of about double that of La Scala and would have to be laid out for optimum viewing as well as listening. This could be obtained only with a certain loss of richness and intimacy. An audience absorbs sound the way a thick carpet does; in proportion to the area, not the number of tufts comprising it.

Acoustical engineering for the concert hall is a complex craft in America today for both economic and architectural reasons. Major concert halls in this country must seat at least three to four thousand persons to be profitable. Since indirect sounds or reverberations become an even greater musical factor in a large auditorium, more variables face the designer. Another acoustical handicap is caused by the fact that almost all halls must serve a variety of purposes, ranging from symphonic and chamber music performances to plays and lectures. Howard Taubman, music critic of the New York *Times*, tactfully understated the problem this way. "One must feel that multi-purpose acoustics are not the ideal solution for strictly musical purposes." A reverberant hall that would be excellent for a symphony orchestra may make an articulate lecturer sound muddled.

Designing optimum acoustics into a large concert hall, even for purely musical purposes, is at best chancy. Blueprints and engineering drawings simply cannot precisely predict the acoustical qualities of a filled auditorium. For example, Philharmonic Hall in New York, heralded as the ultimate in acoustical sophistication, was criticized after its opening for being too thin in sound, lacking power, and being weak in bass tones. Major architectural alterations, at a cost of some $2 million, have corrected these faults although not to everyone's satisfaction. In Orchestra Hall in Chicago, strange pockets of acoustical configurations make the sound of the harp overpower all other instruments in certain boxes. For half a century, this phenomenon has defied correction.

Perfect acoustics, however, is more than a matter of the projection of faint sounds from the stage to the most distant seats. "But I don't want to hear a pin drop. I want to hear an orchestra," replied Eugene Ormandy, conductor of the Philadelphia Symphony, to the manager of a world-famous concert hall who claimed that his auditorium had perfect acoustics because the entire audience could hear a pin drop on the stage.

The ideal concert hall will bring a balance of tones to listeners in all parts of the auditorium. It will strike an optimum balance between richness and clarity of sound and create a feeling of intimacy. It will also give the audience an illusion of being entirely surrounded by music.

Although this dream hall probably does not exist, most auditoriums can be improved either architecturally or electronically. The traditional method has been to change the physical structure of the interior, but this is usually very expensive, partly because it is basically a trial-and-error proposition. The multimillion-dollar alteration of Philharmonic Hall is a case in point.

The original design of the Hall aimed for a combination of acoustical qualities, including a reverberation time of 2 to 2.22 seconds (considered ideal for symphonic music) and strong first reflections to create intimacy. Most experts believe that intimacy stems from having the first in a series of reflections that make up the reverberation come in strongly and quickly—within 20 to 50 thousandths of a second—after the original sound from the stage. To produce such a quick bounce, there must be a reflecting surface near every member of the audience. But many seats in Philharmonic Hall, particularly in the front and center, were too far away from the side walls. To overcome this handicap, shield-shaped "clouds" were installed below the ceiling to provide quick first reflections to all parts of the Hall. These clouds were employed, rather than simply lowering the ceiling, to allow part of the sound to go right through to the top of the Hall, thus aiding the reverberation time. This part of the design was successful. The reverberation time was electronically measured at 2.2 seconds,

"The importance of the acoustical envelope has been known since the ancient Greeks built their amphitheaters on Athenian hillsides."

ample in nearly every hall for a full, rich sound. However, the first-night audience received clarity of sound, but with very dry, as opposed to rich, bass tones and no feeling of the power of the music, exactly opposite of what was expected.

Although there is still some controversy, most acousticians believe that the particular sizes and spacings of these clouds had an anti-bass focusing effect, emphasizing instead the sounds of violins and cymbals. In addition, they believe that the balance between the early reflections bouncing off the clouds and the later ones coming off the ceiling was out of line, cutting down on the power of sound.

In any case, the concept of separated clouds was drastically revised. The clouds were raised and the space between them and the ceiling was filled in. Reflecting surfaces were strengthened in some parts of the Hall, with more wood being used. (It is still debatable whether wood is the ideal reflecting surface for a concert hall.) Improvements have been noticed. Philharmonic Hall has a much warmer and deeper tone than when it opened.

The twentieth century has no monopoly on acoustical disasters. The oval-shaped, 5,000-seat Royal Albert Hall built nearly 100 years ago is so wide that the reverberation from the far walls creates strong echoes. A bitter quip of music critics some years ago was that Albert Hall was their favorite spot for music because they got two and sometimes three concerts at the same time for the price of one. In recent years, the strength of the echoes has been reduced by installing large sound-absorbing surfaces, such as fiberglass, that cut down on reflected sound. But, this does nothing to change the sensation of being miles away from the orchestra.

Recently, electronics has been playing an increasing role in the concert hall, much to the chagrin of certain musical purists. There is a widespread feeling that once sound has come through a loudspeaker it is no longer "pure"—that it is an intrusion between musician and audience. This is understandable since many electronic systems still used on the Broadway stage and in local amphitheaters range in quality from poor to fair.

However, professional concert hall systems of today put out sound that is indistinguishable from the original. Used with sophistication, an electronic system can lift the weak elements of a hall without changing the basic "hall sound." Electronics has aided concert halls without any listener being aware of its presence.

For example, electronics adds richness to the clarity of tone at the Royal Festival Hall, which was built in London 17 years ago. The designers of the auditorium initially managed to get the clarity they were after, and the Hall had what was supposed to be an acceptable reverberation time. However, the sound was too dry and lacked resonance and power. Since the interior surfaces were made strongly reflective of sound, there was no architectural way of increasing reverberation time short of making the Hall larger. So management went to electronics for help.

Without any public announcement, a series of microphones was installed in the ceiling to pick up the reverberant sound, rather than the direct sound from the stage. These sounds were then fed into amplifiers and loud-speakers to be projected back at a higher volume level. This system gave birth to the term "assisted resonance" since its aim was simply to strengthen the natural resonances of the Hall. Critics, without knowing why, found the Hall much richer after the system got under way and only after the improvement had been noted did the management give the reason.

Electronics does nearly everything at the mammoth Palace of Congress in the Kremlin. Since the hall has 6,000 seats, top-flight musical acoustics would be out of the question by any other means. The hall was made rather sound-absorbent to avoid the echoes caused by long-traveled reverberation, and literally hundreds of speakers were installed, controlled by a skilled operator at a panel. To create intimacy, he can custom-feed a quick first reflection everywhere in the hall to coincide with the direct sound from the stage. He can also delay reflections with the right characteristics for a pleasing reverberation in all sections of the auditorium. In fact, the operator has such complete control over the reverberation that he can adjust it for each style of music and even for individual pieces. This versatile acoustical system has made the Kremlin hall an all-purpose auditorium. It can create an ideal acoustical envelope for a symphony orchestra or it can be adjusted for lectures or dramas that require great clarity and little reverberation. Since this system requires high musical and technical skill at the control panel, there is a school in Moscow to train operators.

In America as well as Europe, electronics has heightened the enjoyment of the musical audience. For example, it not only improves acoustical qualities at the Philadelphia Civic Auditorium, but, in addition, it gives opera performances three full dimensions. Music had previously never been heard well there for the same reason that makes any large hall risky for music; many seats were simply too far away.

John H. Volkman of RCA Laboratories studied the problem and recommended an "auditory perspective" system. This means that the microphones and speakers would be placed in locations that would convey a sense of movement to the audience.

The system uses seven channels with the microphones placed in an oval pattern covering a specific area of the stage. The seven speakers are in the ceiling in a corresponding pattern, each delivering sound to the whole Auditorium from a slightly different location. Acoustically, the system is designed to work with the natural reverberation in the hall. The combination of the spatial pattern of the speakers and the visual action on the stage gives the audience a convincing sense that the sound is coming from a particular singer at a specific location. The performers themselves are kept aware of how they sound out in the hall by means of seven subsidiary speakers trained on the stage.

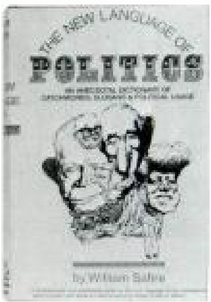
The use of seven channels, rather than just two or three, allows the system to be self-adjusting to a degree. The operator is not under pressure to follow ups and downs of volume, because the singer moves from the area of one microphone to another.

The latest application of electronic aid to music is also in Philadelphia, at the Academy of Music. This auditorium had long been noted for great clarity, but it suffered from dryness. The reverberation time was simply too short for full rich sounds. Although local audiences have adjusted to the sound for live performances, it was entirely unsatisfactory for recordings.

Mr. Volkman, together with John Pfeiffer, an executive producer of RCA Red Seal records, designed an electronic system that increased reverberation time from a low of 1.4 seconds to a fine full 2.2 seconds. A recent recording session with the Philadelphia Symphony Orchestra showed the tremendous improvement in the concert hall.

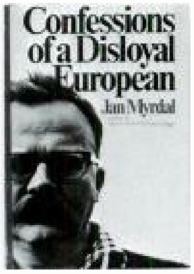
The future of electronics in the concert hall is very promising. It is an economical and efficient answer to the acoustical problems that are almost inherent in giant multipurpose auditoriums of today. According to Mr. Pfeiffer, "If the direct sound from the orchestra is pleasant and not out of balance by improper stage reflectors, modern electronics makes it economically feasible to improve acoustically a concert hall of any size and quality." ■

Books at Random...



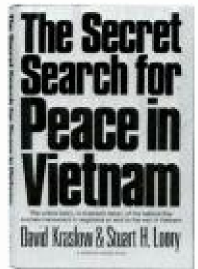
The New Language of Politics
by William Safire (Random House)

This volume, subtitled "An Anecdotal Dictionary of Catchwords, Slogans, and Political Usage," is a comprehensive and entertaining guide to the vivid language of the contemporary political scene. Color and bite permeate this language designed to rally many men, to destroy some, and to change the minds of others. Part of the language is the private argot politicians use in talking to other insiders, and another part is about politics, from the "smoke-filled room" and "whistlestopping" to a "passion for anonymity." Mr. Safire brings to the subject a wealth of firsthand experience based on his past service as a key aide in Nixon, Rockefeller, and Javits campaigns.



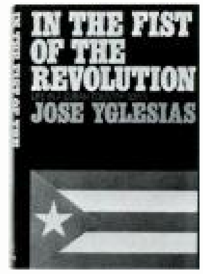
Confessions of a Disloyal European
by Jan Myrdal (Pantheon)

This book presents a blend of biography and fiction by one of Europe's most outspoken young critics. Myrdal follows his fictionalized self through a series of confrontations and reminiscences, from his world as a child in New York to that of a young man facing love and death in Sweden, and ultimately to his discovery, in India, of the gulf between East and West. The author offers a fascinating and complex picture of what it means to come of age—intellectually, morally, politically, and sexually. JM's transformation into the disloyal European of the title can be followed through the series of vignette-like pieces that systematically reveal the decadence and irrelevance he finds in Western life and values.



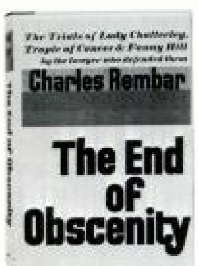
The Secret Search for Peace in Vietnam
by David Kraslow and Stuart H. Loory (Random House)

Early in 1967, a rumor swept through diplomatic circles that the United States had ruined its most promising opportunity to negotiate peace in Vietnam by escalating its bombing of the North at a critical time. This book presents evidence that the collapse of this negotiation, code-named "Marigold," was not an isolated instance. Several potential peace initiatives, the authors claim, were halted by purposeful or inadvertent bombing of North Vietnam. The authors reveal the labyrinthine record of the peace diplomacy accompanying the escalation of the Vietnamese war and how the first breakthrough to a meeting in Paris was accomplished.



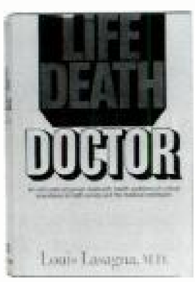
In the Fist of the Revolution: Life in a Cuban Country Town
by Jose Yglesias (Pantheon)

In 1967, at the request of Pantheon Books, Jose Yglesias went to a small sugarcane-producing town in Cuba to find out what life was like some eight years after the revolution. During his three-month stay, he talked with a variety of people, drawing out their opinions, life stories, anecdotes, and criticisms on such topics as Castro, the United States, the lack of goods, education, and sex. The result is a blend of personal observation and history in the making, a rich and complex picture of a revolutionary society. *In the Fist of the Revolution* is the latest in a series of books devoted to viewing of the social changes taking place in the lives of people throughout the world—by letting people speak for themselves.



The End of Obscenity
by Charles Rembar (Random House)

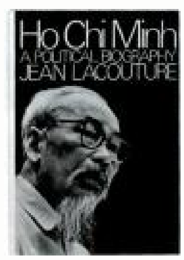
The inside story of three of the most important literary trials of our time—*Lady Chatterley's Lover, Tropic of Cancer,* and *Fanny Hill*—is told by the lawyer who successfully defended these controversial novels, from post office hearings to the Supreme Court. The book, characterized by Norman Mailer as "a quiet and essentially modest account of a legal revolution," is not only the story of these trials but also a series of anecdotes, little-known historical facts, comic interludes, and some unorthodox ideas—not just about the law.

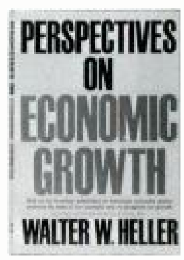


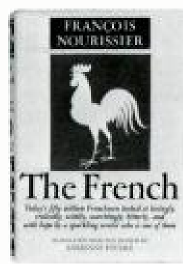
Life, Death, and the Doctor
by Louis Lasagna, M.D. (Alfred A. Knopf)

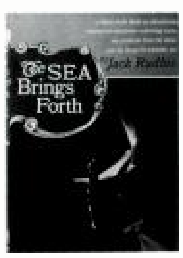
While not an "anti-doctor" book, *Life, Death, and the Doctor* demonstrates that the health problems of society and the physician's role need continuing debate and reappraisal. Dr. Lasagna, a widely respected teacher and consultant at the Johns Hopkins University Medical School, speaks out on the full spectrum of the problems involved in today's health crisis: the need for continuing education of American doctors; public enlightenment about the prevention of disease and new techniques; cigarette smoking and health; the pill; abortion; Mongoloid children; heredity; drugs; and euthanasia.

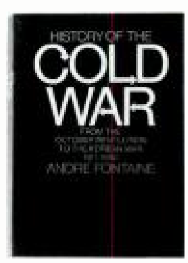
Other Recent Random House Books

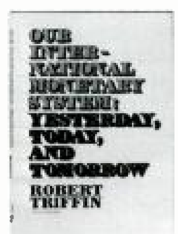






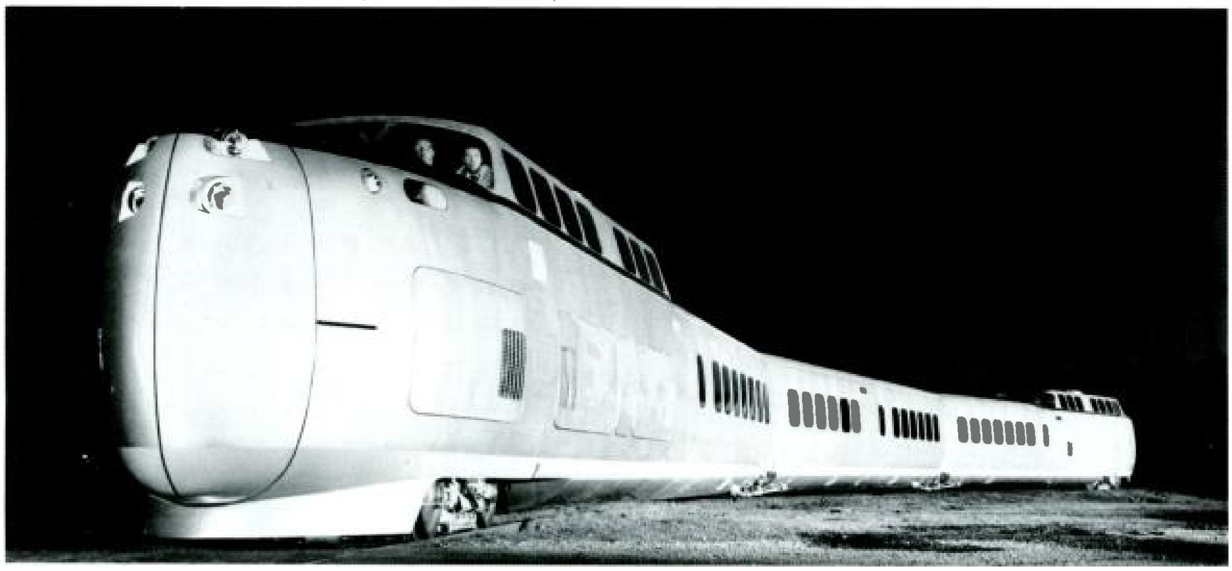






"States are turning to industry for basic information systems and long-range planning to replace 'political intuition.'"

The "TurboTrain," built by United Aircraft, is a partial answer to the rail problem in the Northeast Corridor.



gram for the state's Office of Economic Development.

The objective of Project Headstart on a national scale is to overcome at least part of the poverty child's handicap by enabling him to enter first grade on a par with his more advantaged counterpart. It is intended to help compensate for the books, conversation, and intellectual stimuli found in most middle-class households.

While the major Headstart objective is the same everywhere, the approach must vary according to local factors. The New Mexico programs provided a unique challenge owing to the absence of kindergarten classes and the presence of a tri-cultural population, including many Mexican-American and Indian children with little if any contact with the English language. Special concentration had to be placed on the development of interpersonal relationships and language comprehension to prepare children for entry into formal educational settings where restrictions and limitations must occur.

RCA's approach included interviews with administration officials on state and local levels, visits to classrooms, actual participation in the programs, as well as conferences with Headstart teachers, parents of participants, and community leaders. The study concentrated on coordination of programs, supervision, in-service training for teachers and administrators, summer workshops, and the communication and interchange of ideas, procedures, techniques, and methods that could contribute to over-all effectiveness. At the end of the study, which took several months, the company set up evaluation guidelines and suggested course content as well as methods of teaching and approach.

New York State looked to Republic Aviation Division of Fairchild Hiller to conduct a feasibility study, leading to the design of a safer automobile. The study considered the human factors, such as braking reaction time, together with the mechanical parts of the vehicle and the road surface. Republic came up with a design concept that would allow motorists to walk away from collisions at 50 mph—a speed that encompasses 75 per cent of all injury-producing accidents. The key is a shock-absorbing structure that protects the passenger compartment of an automobile.

Industry has also become involved with the problems of society that cross state borders. Various aerospace companies have conducted studies to solve the transportation tangle in the highly populous Northeast Corridor linking Boston, New York, and Washington. United Aircraft Corporation adapted its aeronautical gas-turbine engine for ground use and provided a partial answer at least to the rail problem. Working closely with state transportation officials in the Northeast, the corporation built an economical, new turbine-powered high-speed train that will soon enter service on the Boston to New York run. However, the "TurboTrain" can be adapted for commuter and even intra-city rapid transit uses. Although the train achieved a speed of more than 170 mph during a test run last December, it will enter passenger-carrying service with a top speed of about 120 mph.

A major development problem was to keep the new train compatible with existing roadbeds. This was solved by means of computers, which simulated possible train operations over present trackage, including all curves, crossings, and grades. As a result of data obtained, the "TurboTrain" cars were built two and one-half feet lower than conventional ones. This lower center of gravity, combined with a pendulous suspension system and guided axles, enables the train to round curves 40 per cent faster than its diesel counterpart, with even greater passenger comfort and safety.

In addition to these achievements, other new developments are linking private enterprise to state government. For one, the federal government is encouraging the states to adopt modern management techniques. Proposed legislation would make at least $125 million in grants available for this purpose on a participation basis.

The states, as a political group, have already formalized systems planning. The Institute on State Programming for the '70s was created last year, funded by the Carnegie Corporation. It works closely with the Governors' Conference to stimulate day-to-day analytical planning as well as long-range programming. Its Industrial Advisory Committee, composed of aerospace and electronic industry and trade association representatives, is adapting industrial management techniques to state government operations. And, specific recommendations in the areas of statewide data processing, budgeting, table of organization, viable planning, and legislative-executive relations were spelled out at the Governors' Conference that was held this summer.

Former Governor Jack M. Campbell of New Mexico, chairman of the Institute, in a recent interview said that this "is an opportunity to prove whether pragmatic competitive market techniques can deal with state problems where the subjective variable of politics plays a role."

The private and public sectors have long been successful partners in national defense and more recently in the space program. The same relationship in state government will go a long way toward solving the vital economic and social problems of today. ■

For the Records...

Rimsky-Korsakoff: Symphony No. 2 ("Antar") and Miaskovsky: Symphony No. 21
Morton Gould conducting the Chicago Symphony Orchestra LM/LSC-3022

Through their Red Seal recorded collaborations, Morton Gould and the Chicago Symphony Orchestra have added a number of neglected classical works to the standard music repertoire. In this album, they present two Russian symphonies, both of which are first recordings for RCA. The "Antar" Symphony of Rimsky-Korsakoff, written in 1861 as a symphonic suite, is based on a story by Syenkovsky about a seventh-century poet. Coupled with "Antar" is the 21st symphony of Nikolai Miaskovsky, one of the great "undiscovered" composers of this century.

Beethoven: The Five Middle Quartets
The Guarneri Quartet VCM/VCS-6415

In the two years since making its RCA Red Seal album debut, the Guarneri Quartet has made several successful recordings in the classical field. With this latest release, a four-record set, first violinist Arnold Steinhardt, second violinist John Dalley, cellist David Soyer, and violist Michael Tree are embarking on a series covering the entire Beethoven repertoire for string quartet. The Guarneri begins with the composer's Five Middle Quartets, centering around his "Rasumovsky" Quartets, Op. 59 and including the "Harp" Quartet, Op. 74 and the Quartet in F Minor, Op. 95.

Ginastera: Concerto for Piano and Orchestra; Variaciones Concertantes (1961)
João Carlos Martins, pianist
Erich Leinsdorf conducting the Boston Symphony Orchestra LM/LSC-3029

The Ginastera Piano Concerto received its premiere in Washington, D.C., in April, 1961 with the young Brazilian pianist João Carlos Martins appearing as soloist. Seven years later, at New York's Philharmonic Hall, Mr. Martins again performed the work with Erich Leinsdorf and the Boston Symphony Orchestra. Shortly thereafter, these performers reassembled in Boston's Symphony Hall for a Red Seal recording of the work, coupling it with the composer's earlier Variaciones Concertantes.

Belafonte Sings of Love
LPM/LSP-3938

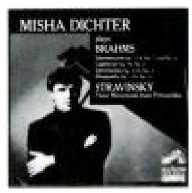
After more than a decade of popularizing folk music and calypso rhythms before mass audiences in tent and theater-in-the-round concerts, as well as on his RCA albums, Harry Belafonte now devotes himself to an album of contemporary ballads that speak of love. In addition to the Grammy award-winning "By the Time I Get to Phoenix," the unusual Nillson ballad "Sleep Late, My Lady Friend," and "A Day in the Life of a Fool"—the bossa nova theme from the film, *Black Orpheus,* Belafonte introduces eight love songs for today.

Rossini Rarities
Montserrat Caballé LM/LSC-3015

"Rossini Rarities" was prompted by two major factors. First, it commemorates the forthcoming centenary of the death of Gioacchino Rossini on November 13. Second, it follows the successful Montserrat Caballé RCA Red Seal collection, "Verdi Rarities," which was released early in 1968. These rarely sung Rossini arias represent the composer in almost every phase of his output—frivolous, tragic, and religious. Included are arias from "La Donna del Lago," "Otello," "Stabat Mater," "Armida," "Tancredi," and "L'Assedio di Cortino." Accompanying Miss Caballé are the RCA Italiana Opera Orchestra and Chorus, conducted by Carlo Felice Cillario.

Handel: The Six Organ Concertos, Op. 7
Carl Weinrich, organist
The Arthur Fiedler Sinfonietta
Arthur Fiedler, conductor LM/LSC-7052

As a companion piece to the Red Seal collection of the Six Organ Concertos comprising Handel's Opus 4, organist Carl Weinrich and Arthur Fiedler conducting his famed Sinfonietta have now collaborated on the half-dozen concertos of the composer's Opus 7. The concertos, written between 1740 and 1751 and published two years after Handel's death, are played on the world-famous Holtkamp organ of New York's General Theological Seminary. The first, third, and sixth concertos are in B-flat, the second in A, the fourth in D Minor, and the fifth in G Minor.



Other Current RCA Releases

Electronically Speaking...

News in Brief of Current Developments in Electronics

Satellites to Eliminate Communications Gap Between Astronauts and Earth

Placing two satellites in stationary orbits around the earth could eliminate one of the major problems of space flights today—the communications gap between astronauts and their mission controllers on earth. An RCA Astro-Electronics Division study, prepared for NASA, suggests that two synchronous satellites acting as relay stations in space and working with two ground stations could provide unbroken communications with a spacecraft operating in virtually any orbit.

Currently, spacecraft circling the earth are out of communications with ground stations during significant portions of each orbit. This is because stations can exchange signals with a satellite only when it is above the horizon and within "line-of-sight." No contact is possible before the craft rises above the horizon or after it dips below it.

Because of this limitation, during previous American manned space flights the astronauts were in touch with each individual tracking station for a maximum of only four to five minutes on each orbit. Thus, it is impractical if not impossible to establish enough ground stations to maintain continuous contact with an orbiting vehicle.

However, the study shows that, when they work in conjunction with two synchronous orbiting satellites, only two ground stations are required for uninterrupted communications with a spacecraft during its entire orbit. From their vantage points in space, the communications satellites would provide constant line-of-sight contact with any vehicle 100 to 2,000 miles high.

In addition to voice communications, the satellites could also relay TV, telemetry data on spacecraft and astronaut status, and tracking signals between the earth and the spacecraft. Each satellite could perform these functions for two spacecraft simultaneously.

The study suggests that the satellites be placed in synchronous orbits approximately 20,000 miles above the equator on opposite sides of the globe. At this altitude, a satellite's orbital speed can be made to match the rotation of the earth, so that the craft appears to remain stationary with respect to a given point. Ground stations would be located in the Western Pacific area and the continental United States.

Addition of a third satellite to the system would increase reliability and quality of coverage and would offer greater flexibility in locating ground stations.

Besides serving as a link between the earth and manned spacecraft, the communications satellites would also be useful for relaying data to and from unmanned scientific and practical applications space vehicles.

Two-Way Radio System for New York Buses

A two-way radio system is helping to control and reroute bus traffic and at the same time serves as a deterrent to crime in New York City. In operation since late spring, it will eventually link all 4,200 public buses of the city's Transit Authority with their headquarters, making it the largest such commercial system to date.

Designed by RCA, the system permits the drivers to communicate with their headquarters or with a supervisor carrying a portable radio at curbside by lifting a telephone-type handset. Each bus also is equipped with internal and external public address speakers, so the driver can make announcements or sound an emergency call.

Unlike conventional radios, the system units have no "on-off" switches, but are in operation and ready to receive messages when the driver turns on the ignition to begin his run. Lifting the handset automatically turns on the transmitter.

The system has 19 radio base stations located in Transit Authority garages throughout the city. In normal use, these stations are operated remotely from the master control center to which they are connected by leased telephone lines. However, each base station may be operated locally if required.

At the control center, each of the 19 stations is represented by a transmitting-receiving console manned by a dispatcher who faces a map of his assigned coverage area. One console is capable of handling up to five base stations.

The network also includes two high-power base stations, for communications with TA maintenance, supervisory, and patrol vehicles on city streets. The stations use RCA Super-Basefone equipment, a transistorized unit capable of handling up to four communications channels. The transistorized radios in both the base stations and buses operate on 12-volt batteries, assuring uninterrupted service in the event of a power failure.

New Aid for Electronic Displays

A novel television-type tube whose images can be held for long periods with the power off and erased in whole or in part with an outside light source has potential uses ranging from Wall Street to the airport. The experimental device could eventually simplify electronic equipment for displaying stock quotations, airline arrival and departure schedules, computer data, and any other information that changes periodically instead of constantly.

Called a "cathode ray storage tube," the unit differs from ordinary picture tubes by having a "photochromic" instead of a phosphor layer on its inside face where the pictures or other information are traced by high-speed electron beam. The photochromic materials in the tube do not emit light like phosphors but rather change color when struck by an electron beam. Thus, they display information "written" on them and retain it—even with the power off—until their normal color returns. And, since they are sensitive to selected light frequencies as well, it is possible to use a light pen to write on them, to erase part of the data they contain, or to use a diffuse light source to erase data altogether.

The photochromic storage tube was developed at RCA Laboratories by Drs. Zoltan Kiss and William Phillips. It requires only one electron gun—as against the two used in storage tubes with phosphor faceplates—and is more rugged, simpler, and easier to fabricate. The tube has high resolution because the width of the electron beam doing the writing determines the width of the display. The tube also has a grey-scale capability and can reproduce photographs, since the intensity of the writing depends upon the intensity of the electron beam.

Information can be written on the new tube as quickly as on a television tube. Because of its long storage period, a photochromic storage tube could be used as an educational or other display device receiving information through narrow bandwidth telephone lines. RCA is also investigating photochromic storage tubes with projection capabilities for use in military display and radar rooms.

India Joins Satellite Network

The first commercial communications satellite earth station in India is scheduled for completion next year. The project, which is being financed under the Canadian External Aid Program, marks India's entry into the global satellite communications network providing an intercontinental high-quality, multicircuit telecommunications and television exchange.

Under the terms of the project, Indian engineers and Canadian government technicians are building the earth station complex at Poona, 120 miles east of Bombay. The station will connect India's domestic communications service with the global satellite network, via an Intelsat III synchronous satellite located over the Indian Ocean. In addition, the project will include a microwave communications exchange in Bombay.

The specialized electronic apparatus for satellite tracking and communications that will be supplied to India has been developed by engineers of RCA Victor Company, Ltd., of Canada.

Scanner Speeds Color Photos into Print

A continuous-tone electronic color scanner is helping to make it possible for daily newspapers to publish photos of fast-breaking news events in color. The Sacramento (Calif.) *Union*, for example, has installed the RCA 8800 Color Scanner as part of a switchover to offset printing, and significantly reduced the time needed to prepare full-color illustrations for the press. With this new system, it takes approximately three hours to get from an undeveloped photograph to press-ready color plates—including the processes of developing, scanning, screening, contacting, and platemaking. The new production system also increases the quality of color printing for the daily.

The Scanner "reads" a color photograph with a tiny beam of light, scanning it 500 or 1,000 times every inch. The light beam information is converted into electrical signals and fed to computer-like electronic circuitry that directs the exposure of each of the four color separations needed in such a printing process.

The RCA Color Scanner saves time by making all color corrections automatically while the separations are being made, including everything from accenting the highlights to reducing shadow areas. In addition, the equipment provides higher quality and more consistent separations.

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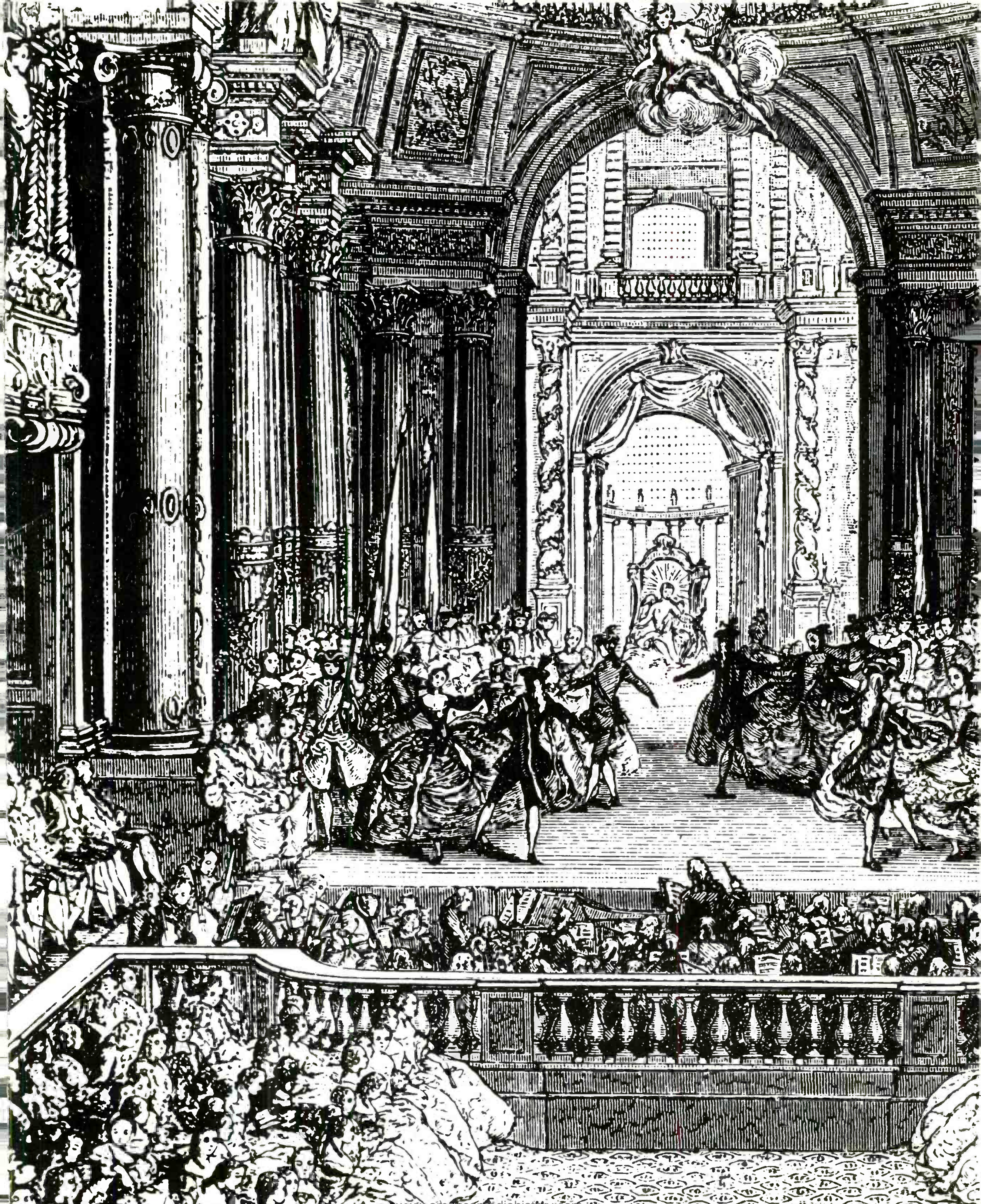
Music hall in the court of Louis XIV, Versailles

For an article on acoustics in the concert hall, see page 26.



RCA

Electronic Age

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