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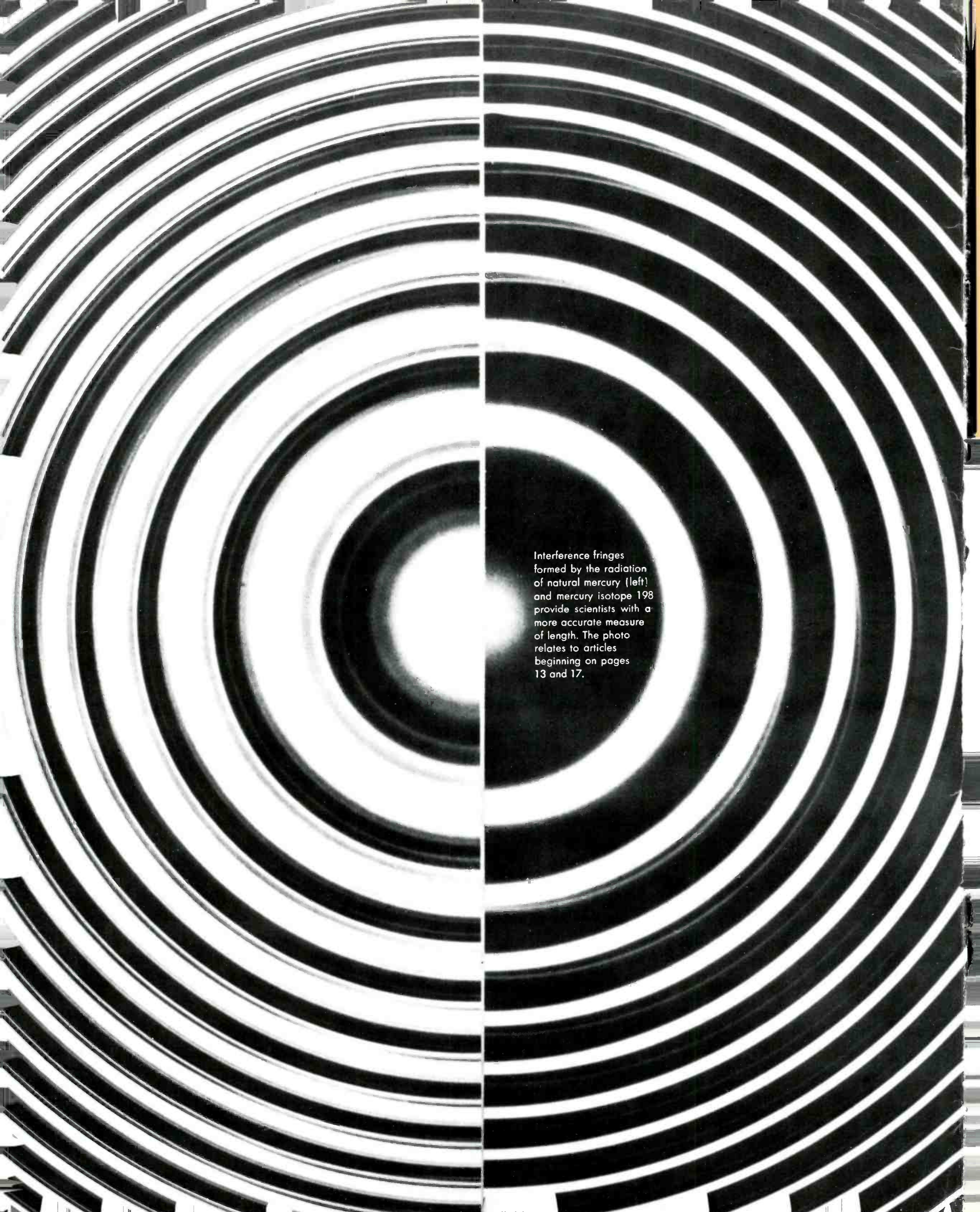

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CONTENTS: WINTER 1967/68 Vol. 27/No. 1

Cover: A team of surgeons operates inside a hyperbaric chamber, a device used in open-heart surgery. The patient breathes pure oxygen while the chamber pressure is increased to three times normal atmospheric pressure. Blood and body tissue become saturated with oxygen, thus giving the surgeon more time to operate and the patient a better chance of recovery. Devices such as these together with new electronic instruments are helping transform medical practice. For an article on the new medicine, see page 2.

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Wired for Life—Electronic Medicine

The fusing of modern electronics and medical science into a new technology holds great promise for the prevention and cure of many human ills.

by Tom Shachtman

Doctors and engineers now know that the human body is an electrically controlled, electricity-producing machine. What can that fact mean to us? A few of the possibilities are diagnosing illness by computer, analyzing the body by electronics, saving a life before birth, shocking a dead man back to life, preventing heart attacks electronically, "switching off" pain from cancer, and enabling a paraplegic to walk again.

Some of these medical techniques are in use today, and others are just on the horizon. They are made possible by a fusing of modern electronics and medical science into a new technology that holds great promise for the relief of suffering and crippling disease and for the prolongation of life.

Although as recently as 25 years ago a medical journal was still skeptical about the use of the electroencephalograph as an accurate measure of brain activity, today the marriage of electronics and medicine is widespread. There are more than 500 companies in the United States fabricating electronic equipment for medicine. More than a dozen fine recording instruments measure the electrical activity of the brain, and some 35 instruments detect the electrical output of the heart. Firms, such as RCA and the pharmaceutical company, Hoffmann-La Roche, that for years have concentrated their research and manufacturing skills in one field or the other are now working together to develop advanced medical electronic devices.

From diagnosis to therapy, electronics is altering the traditional practice of medicine. In diagnosis, for example, a recent Mayo Clinic study disclosed that doctors could prescribe treatment for 80 per cent of their patients without laboratory tests by committing their medical histories and symptoms to a computer. Important facts concerning the patient, such as previous diagnoses, therapies, and symptoms, combined with a few vital statistics, are recorded on computer tape and a print-out history is prepared for the attending physician. The doctors are enthusiastic; the system will allow them to see more patients more efficiently since they do not have to perform the time-consuming task of taking down information better handled by a computer.

Computers are being used for other diagnostic purposes. In an experimental program being tested by the Chas. Pfizer & Co. drug firm, a urologist can submit to a computer a variety of information about his patient—some symptoms, some observations, some laboratory test results—and the computer will list for the doctor a number of possible diagnoses of the patient's condition.

Chemical laboratories for the analysis of body fluids have been important in diagnosis for some years. In the years to come, they will be even more so as doctors rely on biochemical analyses of the body to provide them with needed diagnostic information. With the help of electronics, such laboratories are now being automated and quality-controlled. At any major hospital today, a doctor can order any number of tests from a series of 150 to 200, excluding X-ray and atomic isotope tests. And, at the National Institutes of Health in Bethesda, Md., the chemical laboratory is so highly automated that all test results are fed automatically into a computer. A doctor orders on a punch card the specific tests he wants, these orders go to the lab along with the specimens, the specimens are automatically assayed (one machine can do 12 different blood tests at one time), and the results are fed into the computer. The doctor then

TOM SHACHTMAN has reported extensively on medical electronics and related subjects as a writer for television.

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Electronically monitored from an adjoining room, an artificial kidney machine automatically filters a patient's blood.

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receives a print-out which tells him, at a glance, the biochemical state of health of his patient.

More conventional tools of electronic medicine are being used routinely throughout the United States for diagnosis. X-ray machines are now being automated and used in connection with more sophisticated film techniques. Ultrasonics, using the principles of sonar, is sounding body cavities and tissues for signs of breakage and unusual occurrences—a typical use is in finding brain tumors without entering the brain. Like X-rays or fluoroscopic pictures, ultrasonic beams pass through the body without the patient's feeling them. Most diagnostic work today is being performed with electronic tools like the ultrasonic or X-ray machine or with electronically controlled tools such as automated chemical laboratories or isotope-counting scanners. Although the principles behind isotope scanners are atomic, the machinery is almost entirely electronic.

Using electronic testing and data-handling techniques, as well as systems analysis, has led to the evolution of one of the most complete electro-diagnostic systems in the world—the Kaiser Medical Center in Permanente, Calif. At this clinic, a multitest health exam can be given electronically in two to three hours. At the start, the patient gets a clipboard and a stack of punch cards. He fills out an electronically keyed psychological questionnaire and a medical history form while waiting for his tests. Handing completed cards to the computer as he goes through the 20 test stations, the patient submits to a series of electronic measurements of muscle tone, hearing, eyesight, and so forth. Samples of blood and urine are taken and automatically analyzed, and the results go back into the computer. At the end of the series of tests, the computer prints out preliminary advice concerning each patient. A summary of all test reports and this advice are received by a doctor before the patient enters his office.

A patient is wired to an electraencephalograph, an instrument that records the electrical activity of the brain.

Another contribution of electronics to medicine today is in the field of monitoring. Once the province of the hospital nurse, monitoring is becoming increasingly important in medicine, since doctors need to know how a person's condition varies over a period of time. There are a number of factors that should be known at all times about an ill person in a hospital: his heart rate, his temperature, his rate of blood flow, blood pressure, the amount of oxygen in his lungs, the gas content of his blood—just to name a few. All of these can now be monitored by electronic machinery.

For example, doctors at Yale University Medical Center now monitor fetal heart rate and brain waves to decide how the baby is doing—before it is born. If there is an indication of trouble, an operation can be performed immediately to deliver the baby.

The most extensive monitoring equipment in the world is located in the NIH Clinical Center in Bethesda and is used in open-heart surgery. Built primarily for research purposes, NIH's heart surgery installation is an electronic marvel. One medical journal has called it "the ultimate in technology and efficiency." Some 24 different electronic parameters can be continuously monitored in this operating theater, recorded on computer tape, and displayed on boards during the operation. The surgeon sees the various measures of how his patient is doing with one easy glance at a display board—the numbers change every half-second—and hears

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an electronic analogue of a heart-rate sound all during the operation. While the operation is in progress, the surgeon can, if he needs to, call into the recording room to play back a five-minutes-past recording of heart rate so that he can compare it to what is happening at the moment. Visiting surgeons, watching through specially constructed portholes in a gallery above, can be consulted by the physician for help in interpreting certain electrical indications, since they have duplicate boards and other displays in their observation room and communications equipment connecting them to the operating floor.

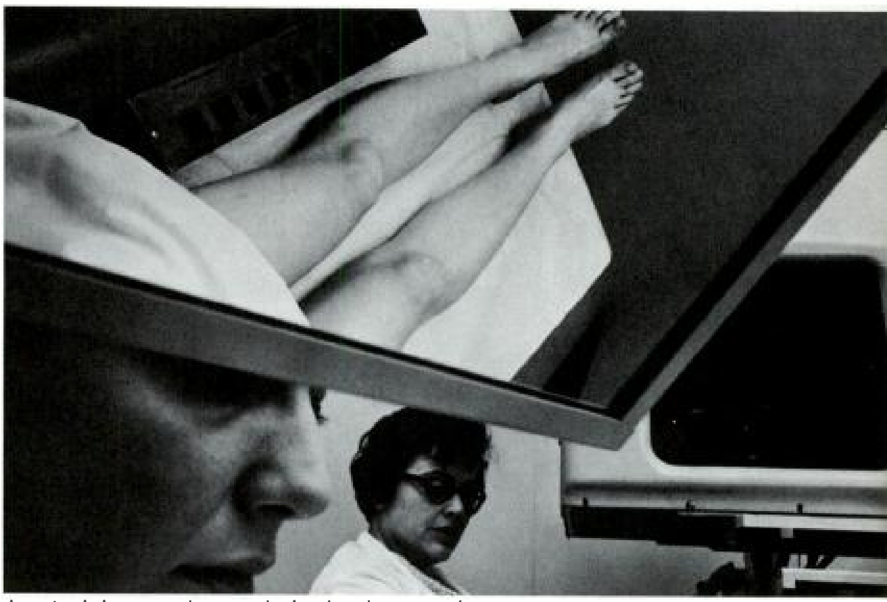
The NIH operating theater is unique. But, in more than 300 hospitals around the country today, other electronic monitoring devices are altering the practice of medicine. These 300 hospitals have intensive-care units. Usually set up to monitor critically ill heart patients, these units continuously monitor critical-list, high-risk patients.

One of the guiding lights behind the intensive-care unit is heart surgeon Dr. Bernard Lown of Peter Bent Brigham Hospital in Boston. Dr. Lown explains that the units monitor heart patients constantly and watch for signs of change. Most of these signs are indicators of electrical disturbances of the heart. Specially trained doctors and nurses, watching for these telltale electrical arrhythmias, can spot them before they have a chance to trigger a major heart attack and can take steps to counter them. Dr. Lown says that his unit has reduced death from electrical instabilities of the heart at Brigham to nearly zero. He believes that, if this experience were generalized over the entire United States, doctors could save from death somewhere between 50,000 and 100,000 Americans annually. Extending his predictions into the future, Dr. Lown envisions the day when high-risk heart patients will—in the course of normal life—wear penny-sized electrocardiograph monitors that will send out a signal to a computer in a nearby hospital. The computer, continuously watching the patient, would tell the doctor—and the patient—when something seemed about to go amiss, and a heart attack might be avoided. In this case of medical electronics, the patient would, of course, be wired for life.

Electronics is having an impact in yet another field of medicine—therapy. That astounding instrument, the heart-lung machine, is an electronic substitute for heart and lungs and is used regularly in heart operations throughout the world today. Its successful use has spurred much of electronic medicine. Almost every operating room today has an electro-cautery, or electro-coagulation machine, that sections tissues and stops bleeding from small blood vessels. And electronic heart pacemakers are becoming more common. Electrically controlled, these small devices take over the normal heart function of stimulating itself to beat electrically and thus take the strain off an inadequate heart, allowing it to work for a few more months or years.

Also important in the operating room is the defibrillator, which uses electrical shocks to bring a man whose heart has stopped—a dead man in previous medical terms—back to life. Dr. Lown explains that the history of the defibrillator is typical of the impact of electronics on medicine. He says that the newer monitoring equipment has made the device almost outmoded since, through monitoring, doctors receive enough advance warning of heart attacks to use drugs, and not last-ditch electrical shocks, to bring a man back to life. Thus,

"The day will come when high-risk heart patients will wear penny-sized electrocardiograph monitors. The patient will then be wired for life."



A patient's legs are photographed with a thermograph, which detects temperature differences within the body.

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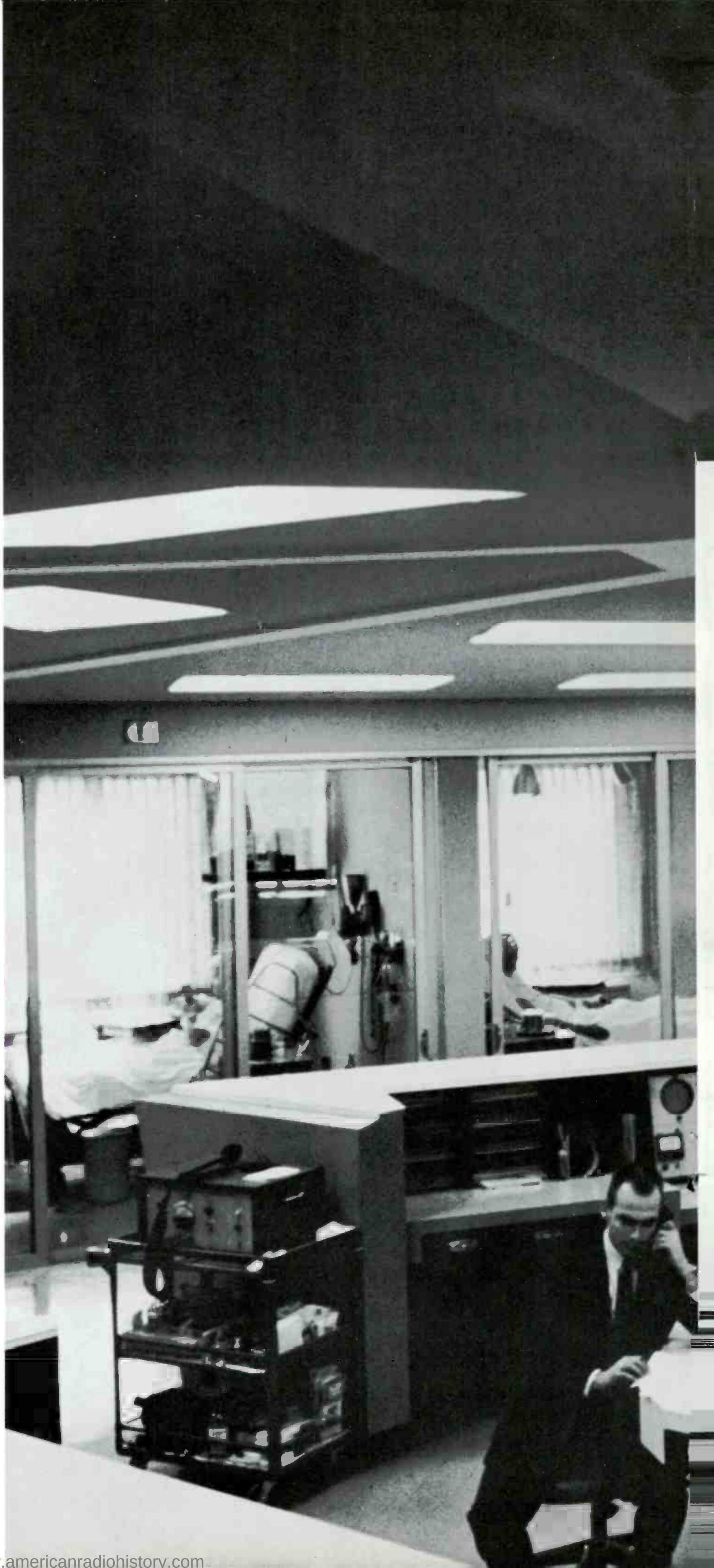
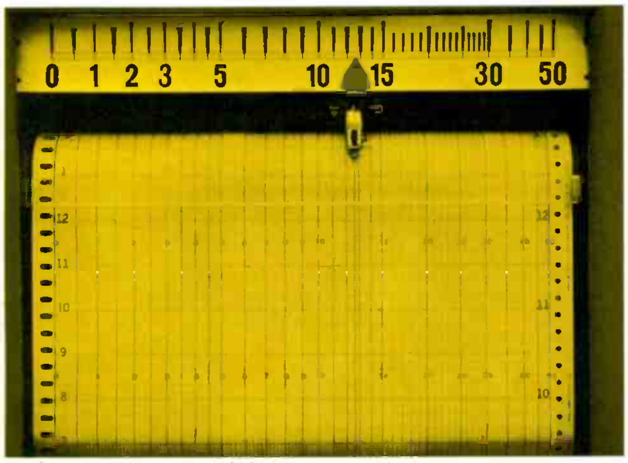
Critically ill heart patients are monitored constantly with electronic equipment in this intensive-care hospital room in Newport News, Va.





Operation of the artificial kidney is monitored on this readout device.

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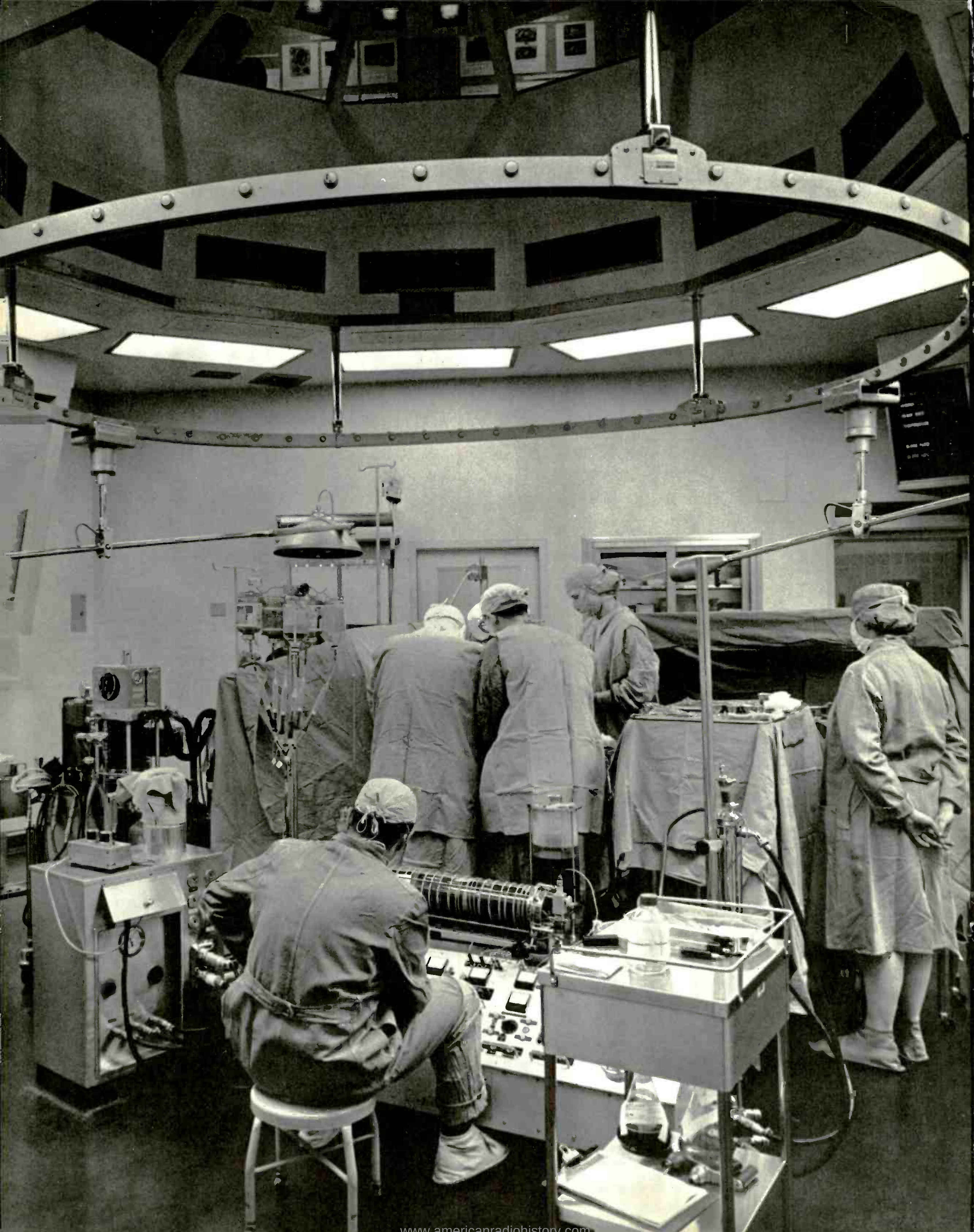

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medical electronics moves medicine from therapy to prevention, a big step toward the doctor's ideal of preventive care.

Electronic pacemakers control the heart electronically, but what about the brain? Can that be controlled through electricity as well? For many years, the doctor's answer to this question was a resounding "no," but not any more. Recent research has shown that electronic signals can be used as an anesthetic to put patients to sleep. An electronically controlled current is sent through the patient's brain, and he goes immediately to painless sleep, to wake up when the electrodes are removed with no recollection of pain—or the operation. Although this technique has been used experimentally, U.S. doctors have not sanctioned its use because its safety has not yet been established. However, in Israel, the U.S.S.R., and some other East European countries, a technique called electro-sleep has been used in therapy, and the anesthetic uses of electrical tones are being further explored.

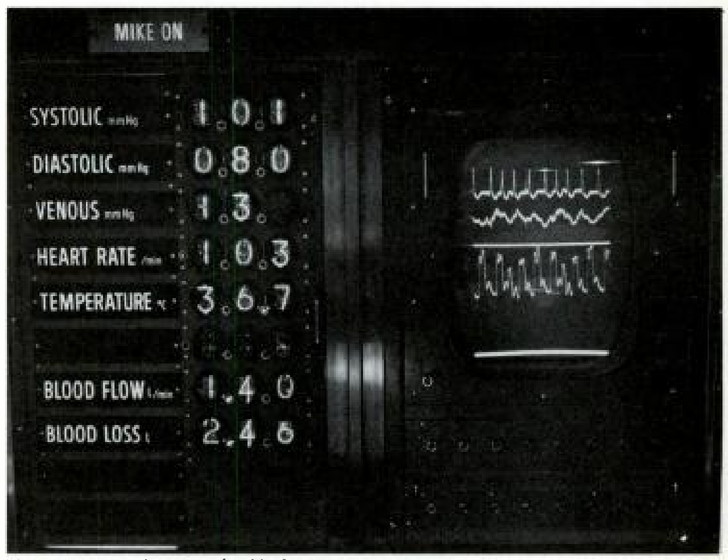
The electronic control of pain has its medical converts, among them Dr. Frank Ervin of Massachusetts General Hospital in Boston. Dr. Ervin places electrodes deep in the brain of his patients, at the neurological seat of the pain, and connects these electrodes to an outside stimulator. By giving the patient control of the stimulator, Dr. Ervin allows him to override the pain electronically when it becomes unbearable. So far, nearly a dozen terminal cancer patients and others with intractable pain have been given freedom from stultifying drugs and allowed to live out the short remainder of their lives comfortably. Dr. Ervin is working on a similar process that may help epileptics control their own seizures.

There is still another area in which electronic medicine is making great strides. This is in rehabilitation medicine. Many researchers are trying to use electrical stimulation of the muscles with recent paraplegics or others who have lost muscular control. In one startling experiment, Dr. Adrian Kantrowitz of Maimonides Medical Center in Brooklyn shocked a slumping, sitting paraplegic into a standing position with a 20-volt jolt. Dr. Kantrowitz envisions a great future in this area, although development at the moment is waiting on electronics engineers and systems analysts who can design machinery to do the correct shocking procedures in a sequence necessary for normal movement.

In another experiment, done at the Case Institute in Cleveland, electricity from the muscles, called myoelectricity, is being used to help muscle-damage victims. Using the little-worked muscles of the shoulder, paralyzed patients have been given control over atrophied bladder muscles and over the important muscles of the arm and hand, thus giving them the power to help themselves. One such patient from Case is using myoelectricity from his own body—in conjunction with a motorized wheelchair—to live a fairly normal life and fulfill a cherished dream: he is attending college.

In the rash of experiments and new devices that characterize medical electronics, an ultimate purpose can be discerned. As in all medical practice, it is to prevent disease before it starts, not merely cure it when it occurs. This goal is not new. Doctors have striven for it for thousands of years. But, with the help of the watchful eyes, ears, and memories of medical electronics, the goal may be reached in the not too distant future. ■

"Doctors at Yale University Medical Center now monitor fetal heart rate and brain waves to decide how the baby is doing—before it is born."



Measurements of various bodily functions of a patient undergoing an operation are continuously displayed on this board.

Cardiac operating room at the National Institutes of Health in Bethesda, Md., is an electronic marvel. Heart-lung machine is in the foreground.

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Retooling the Engineer

Rapid technological change has intensified the engineer's need to continue his education throughout his working career.

by Timothy H. Mulligan

Today's knowledge explosion has had no greater impact than on the engineer. Every year, 10 per cent of his knowledge becomes obsolete because of new technological and scientific discoveries. College engineering textbooks are outdated in some aspects the day they are published. Even the terminology of engineering constantly shifts with each new addition of knowledge.

To cope with this vast intellectual impermanence, engineers by the thousands are returning to school under various sponsorships to update their professional knowledge. The explosive accretion of new knowledge and the accelerating obsolescence of the old have intensified every engineer's need to pursue his education throughout his working life, if only to keep abreast of the literature in the field. Continuing education, moreover, enhances the engineer's total job competence. The valuable engineer of the future, he knows, will be the one who is able to solve engineering problems not yet conceived, and the trends in both undergraduate and graduate education are underlining this.

The engineer who graduated before 1953 concentrated heavily on how-to-do-it courses; what used to be called "cook book" engineering. But by then, a whole set of exciting new technologies were beginning to emerge from the engineering and research laboratories—rocket propulsion, nuclear engineering, and solid-state electronics. By the 1960s, a new set of "hot" fields had opened up, such as plasma physics, computer technology, and extra-terrestrial engineering. By 1975, the practice of engineering is expected to change further to include such new areas as self-organizing machines and electro-optics.

Under this onslaught of new technologies, the theoretical foundations and tools of engineering have changed. The teaching of college physics, for example, has shifted from the old emphasis on Newtonian mechanics and macroscopic phenomena toward quantum mechanics and phenomena at the atomic and subatomic levels. Semiconductors, a subject of particular importance to the electronic engineer, include such new devices as transistors, injection lasers, thryistors, and tunnel diodes—all unknown until recently. Digital computers have largely replaced the slide rule as the essential engineering tool, and the modern engineer must learn basic programming techniques as well as the fundamentals of computer technology.

On the undergraduate and graduate levels, the subject matter of learning has expanded to keep pace with the "new" engineering. Such courses as introductory physical electronics, transistor circuit design, energy conversion devices, optical systems, masers and microwave devices, modern algebra, communication and control systems, and fundamentals of infrared technology were not even offered a few years ago. Studies in computer use range from intensive general courses that provide engineers with an over-all appreciation of the application of computers to such specialized needs as numerical methods, optimization techniques, and process simulation.

Today, the emphasis is more and more upon a broad scientific background of fundamentals. Engineering has evolved into an interdisciplinary field, and boundaries are hard to define. Oceanography, for example, is a combination of several disciplines, among them chemical, mechanical, and electrical engineering. The engineer with a broad background in fundamentals is at least equipped to understand the language in allied disciplines and can, therefore, assimilate new information that is of value to his own field.

To enable the graduate engineer to continue his education, industry, the universities, and the engineering societies are sponsoring dozens of training and retraining programs. Costing perhaps $50 million a year, these programs vary from full-year, in-school graduate courses, to a week or two of intensive work in one specific area, to company courses offered during business hours, to seminars and symposia.

Traditionally, universities have been the stronghold of engineering and scientific education. Today, however, industry is becoming more and more involved in the educational process. Many companies have set up extensive formal programs of in-company engineering education as well as programs with neighboring universities. Their general philosophy is to broaden the base of knowledge while helping the engineer to keep abreast of new developments in his specialty as well. Those at Western Electric and RCA are especially noteworthy.

At Western Electric, the program is aimed at familiarizing the new engineer with the complex technical environment of his company in particular as well as the industry at large. For the experienced engineer, the goals are to reinforce and expand his knowledge, not only in his field of specialization but also in allied fields, and to introduce him to the communications arts. In line with the new concept of engineering needs, general background is emphasized, with strong consideration given to the economic and humanistic aspects of today's environment.

All engineers are required to attend an introductory

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course on the company's engineering methods and technical practices. Following this is a course in general development, which gives the engineer increased depth in a wide range of technical subjects associated with his area of the company.

The next phase of the program is advanced development. Here the emphasis is on both the fundamental and the theoretical, with the courses directed toward the extension of basic knowledge and promoting skills required to meet short- and long-range engineering goals. The courses in these three programs range from fundamental chemistry, to methods of experimental research, to skills in communications—a program designed to help the engineer communicate with the layman.

RCA has also played a long and active role in continuing education for its personnel. But, in 1963, the company felt that the problem had become so important that major new programs should be developed. Out of this grew a program known as "Current Concepts in Science and Engineering." Its purpose is to update the technical knowledge of the engineering supervisor, develop knowledge of new engineering methods, and promote understanding of the major unifying concepts common to many scientific and engineering disciplines.

Participants are organized into classes of approximately 40 to 50 students, each class meeting for a total of 12 two-day sessions at nominal intervals of three weeks. The program is based on a combination of class work and outside study assignments, with class activities including lectures, films, discussions, and occasional workshop periods. Lectures are delivered by members of the program staff, college professors, specialists from the RCA Laboratories, and members of various RCA engineering groups.

As background study, each participant receives refresher materials in physics, mathematics, and basic electronics in advance of the first class, as well as study guides, reference manuals, and reprints of articles on specialized topics.

Both the company and the participant benefit from the program. The engineer receives updated knowledge of science and technology necessary to his development as well as an increased awareness of current RCA programs. The company, on the other hand, derives its benefits from increased technological competence in a highly competitive arena.

Universities are also offering expanded programs for the working engineer. Northeastern University, for example, gives off-campus courses to engineers who work along Route 128 outside Boston. The University of California at Los Angeles has a six-week modern engineering course for technological managers. The Illinois Institute of Technology has "specific action programs" for industry engineers who spend 24 weeks in residence. But perhaps the most interesting development has been at the Massachusetts Institute of Technology in Cambridge.

In 1964, the Institute received a $5-million grant from the Sloan Foundation for a Center for Advanced Engineering Study whose purpose is "to explore ways of increasing the effectiveness of mature engineers." It is aimed at engineers in two categories: the specialist who is interested in acquiring additional skills in a particular field, and the engineer who wants to take a fresh look at a general area.

The program is full-time and lasts for one year. A variety of courses are offered, arranged to correspond to the objectives and background of each man, for at the heart of the project is the desire to tailor each program to the special needs of each participant. In addition to the one-year students, the center also offers a series of programs of shorter duration to technical managers who need to learn how to apply new developments.

The entire offering of regular MIT undergraduate and graduate subjects, seminars, and colloquia is open to qualified engineers. In addition, participation in ongoing research work may be arranged either in the laboratories of individual professors or in the large laboratories. Following satisfactory completion of the program, each participant is granted a certificate. He may also request that he be given a grade in a regular MIT subject.

The vast majority of the nation's 800,000 engineers, however, do not have access to formal industry retraining programs, nor can they avail themselves of many of the university programs which require resident attendance for an extended period of time. The Engineers Joint Council, composed of more than half a million engineers in the nation's major engineering societies, has recently undertaken a pilot program that may help these engineers. Recognizing that engineering obsolescence is the result of many factors, the Council undertook a concentrated study that focused on the need of the practicing engineer to stay abreast of the changing technology at a time, place, and pace best suited to him.

One of the key needs, it discovered, was an information center—a clearinghouse for the collection of information regarding available educational resources, such as engineering symposia, short courses and seminars being offered by the professional societies, academic institutions, and industry. The center will also provide individuals and companies with information on where to get appropriate educational materials.

The study further indicated the need for an operational, high-quality, well-coordinated program, and the Council is therefore establishing a Continuing Engineering Studies Commission as one of its arms. The Commission's activities will include the development and offering of packaged programs in the interdisciplinary areas of high interest, such as computers and programming, that can be distributed and handled locally by the local sections of engineering societies. There will also be self-administered tests that will enable the individual engineer to determine exactly where he stands in different areas. If he is behind in one or more areas, he could then receive advice and counsel on how he should remedy his deficiencies.

Engineers have been responding to these various training programs, convinced that their professional advancement will depend largely on their ability to acquire and apply new knowledge. However, most authorities agree that the need for advanced training exceeds the programs that are available for it. They believe that many more engineers would be motivated to continue their professional development with the greater availability of programs and further encouragement from industry.

In the face of today's rapid obsolescence of theory, methods, and materials, maintaining the quality of engineering staffs, therefore, promises to present a continuing challenge to the engineering educator, the industry he serves, and the engineer himself for many years to come. ■

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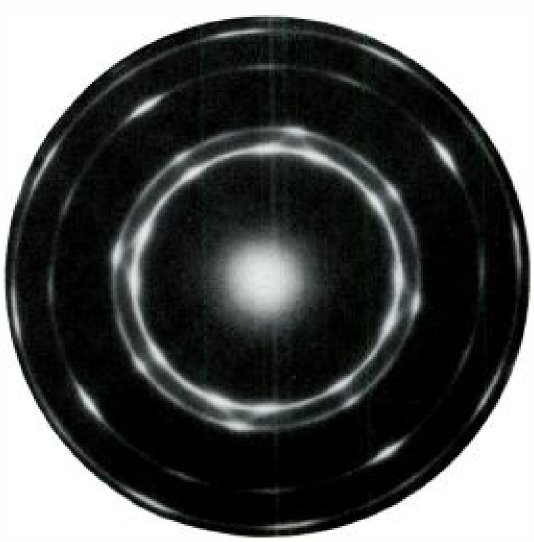
Peaceful Uses of Nuclear Radiation

Scientists are gradually taming atomic radiation, so that it someday may become as beneficial to mankind as electricity.

by Andrew Holmes-Siedle



Atomic structure of titanium (top) and nickel chromium crystals are revealed in these X-ray photographs.

Every minute, several particles traveling at very high velocity come through the ceiling, pass through our bodies, and then carry on through the floor. These "cosmic rays" from space travel so fast and are so minute that we never notice them. However, this very fact can create the uneasy feeling that they might be basically harmful.

Since the nuclear age opened with the devastation of a city, many people tend to think of nuclear radiation only as a fearsome and destructive thing. Not only does such radiation have an obvious power to harm but we are blind to it and, hence, instinctively distrustful, as of other forces that we do not adequately understand.

Yet nuclear radiation is gradually being tamed. The intensely radioactive isotopes produced by nuclear research and the high-energy accelerators used in this research are gradually finding some commonplace uses in the production of household goods and, more important, in the beneficent control of the environment. Characteristically, radiation is also performing some functions that cannot otherwise be performed, such as sending back an automatic analysis of the soil of the moon, observing the shape of a bullet as it ploughs through a sandbag, or killing a weevil hidden in many tons of flour. It is conceivable that, in time, man will grow to depend upon its use as much as that of electricity, and the effects of radiation, now defensively referred to as "radiation damage," may some time acquire a more complimentary name.

It may be useful to pause and consider what nuclear or high-energy radiation is. The term "nuclear" is used because the first high-energy particles studied came from the nucleus of decomposing radioactive atoms. Electrons, protons, neutrons, or gamma rays, each traveling at very high velocities, are produced in the decomposition. For some time, however, it has also been possible to produce particles of similar energy by accelerating them in high electric fields. For example, the author recently experimented with 10-million-volt electrons in an accelerator built by the U.S. Air Force. This means that the electrons had as much energy as if they had been repelled from a 10-million-volt electrode. At such energies, these electrons become capable of entering the nucleus of atoms in their path and causing nuclear fission. Thus, although they are not produced by radioactive decay but by an electron gun, they can be classed as "nuclear."

Similarly, X-rays, although produced by a machine and usually incapable of nuclear reactions, can be lumped with nuclear radiation because they possess the same unusual but useful properties—namely, invisibility, strong penetration of matter, and the ability to bring about biological, chemical, and physical effects. It is these effects which give radiation its potentialities for service to industry and, eventually, to the home.

X-rays are best known in the form of the familiar shadow photographs of the human frame. However, several other important uses are developing for X-rays. The ultimate in high-speed photography is performed by the "flash X-ray" machine. It is now possible to make extremely short, intense bursts of X-rays, which are more effective than light and, of course, more penetrating. With flashes lasting less than a hundred-millionth of a second, the photographer can "stop" phenomena such as bullet impacts, capturing details that would never have been possible with flashes of light.

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These short and directed bursts of energy may also be of considerable use in studying rapid chemical and physical changes in gases, liquids, and solids. X-rays may also be used in a different way to probe the basic structure of matter by using their "wave" properties. By studying the patterns produced on a photographic plate when X-rays are passed through a crystal, detailed information may be obtained about the geometrical arrangement of the crystal.

The X-ray shadowgraph is one of the cruder ways in which to employ the ability of nuclear radiation to gauge density in materials. This ability is used in industry in a much more exact manner. Even the thickness of a sheet of paper can be precisely determined by measuring the number of beta rays which are stopped by it. Thus, a small speck of radioactive isotope on one side of the paper and a Geiger counter on the other are sufficient to tell the operator of a paper-making machine whether it is producing the correct thickness of paper. The reading of the Geiger counter can even be used to control the roller pressure automatically until the correct thickness is achieved. It is, of course, even simpler to use this principle to indicate fluid levels in a container. For example, such a scheme could relieve the gasoline station attendant of the dreary task of filling a tank exactly to the brim.

Matter not only has the power to stop high-energy radiation but it can also bounce some of it back. This backscatter can be used as a simple form of radar, or ranging, although, as will be mentioned later, more subtle information is also contained in the particles thrown back. Automatic mining machines have been made which "feel" their way along a coal seam by means of backscattered gamma rays, while a whole science of detection and measurement of movement, even that as slow as the hour hand of a clock, has been built about the recently discovered Mössbauer effect, which is related to the Doppler effect in sound.

In the medical sphere, radiation, in many ways, strongly resembles a drug. In small doses, X-rays and isotopes aid in diagnosis without any harm to the patient. In larger doses, the over-all effect may be beneficial, but the doctor must now balance the benefit against the possibly serious side-effects. In still larger doses, radiation can kill since, like any drug, it is a poison.

The killing effect of radiation can be useful when the organism killed is a pest or a germ. In food, where boiling is not desirable, radiation will sometimes do the job better. It may soon be possible to store raw steak for years in plastic packages without refrigeration. The U.S. Army has preserved apples and canned bacon by this method, while strawberries have been successfully irradiated to make them keep longer in the grocery store. It is not likely that the gammacell will replace the deep-freeze in the basement very soon, since not every food takes kindly to irradiation. However, the food industry is already considering these ideas very seriously.

In the same manner, the clumsy process of sterilizing surgical apparatus by superheated steam is ready for replacement. As with strawberries, it is difficult to boil blankets and rubber gloves. The author has made good use of an extensive radiation facility which was built by a pharmaceutical firm for such a purpose. Surgical sutures and rubber gloves, already packaged, are passed through an intense electron beam of several million volts energy. This energy is within the range of energies of electrons present in space. The author was thereby able to put on the conveyor belt an unaccustomed assemblage of satellite parts, such as solar cell transistors, glass, and adhesives, and measure their degradation as it would occur in space.

Animals that have been purposefully exposed to harmful radiation tend to give birth to dead offspring, although they may also be deformed if irradiated during a certain phase of development. A subtle form of this phenomenon was recently practiced on the fast-breeding fruit fly. A fruit-growing state arranged for the breeding of many millions of flies, followed by the administration of a carefully adjusted gamma-ray dose. This gave rise to sexually vigorous but sterile males. The flies were then released from an airplane over the fruit groves, where they competed with the indigenous males for the females. Eggs begotten by the irradiated flies did not hatch and the breeding cycle was interrupted, producing a definite relief from the existing fruit fly nuisance. A less subtle use of radiation in disinfestation was the effective irradiation of weevil-infested flour in a silo by isotope gamma rays.

Much research has gone into placing inanimate materials into a hierarchy of sensitivity to radiation and into understanding why radiation can frequently change some crucial property of the materials used in electronics or optics. As a rule, metals are at the top of the hierarchy, and optical materials, electronic semiconductors, and plastics are at the bottom. Optical materials and semiconductors are usually degraded by the radiation; many plastics are improved in strength, while others may crumble. This is because the energy imparted to the polymer chains of the plastic by the radiation may either split the chain or weld several together. Thus, one of the uses of radiation which is gaining importance is the improvement of sheet plastic by passage through an electron beam. This type of irradiation is well matched to mass production. No liquids are involved, there are few by-products, and the radiation beam is otherwise very amenable to control.

Optical materials can be radically changed by radiation. Glass may turn deep brown due to the formation of "color centers," while some crystals may produce a pleasant blue color. Some startling, but unofficial, improvements in the color of diamonds have been achieved by judicious irradiation. The usually adverse effect of radiation on silicon and other materials used in electronics is caused by "defect centers." In this case, these centers interfere with electrical currents in the material. There is a possibility that this effect can be used to "tailor" the properties of a transistor in the

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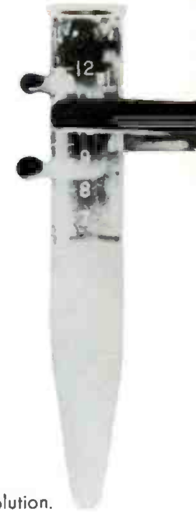
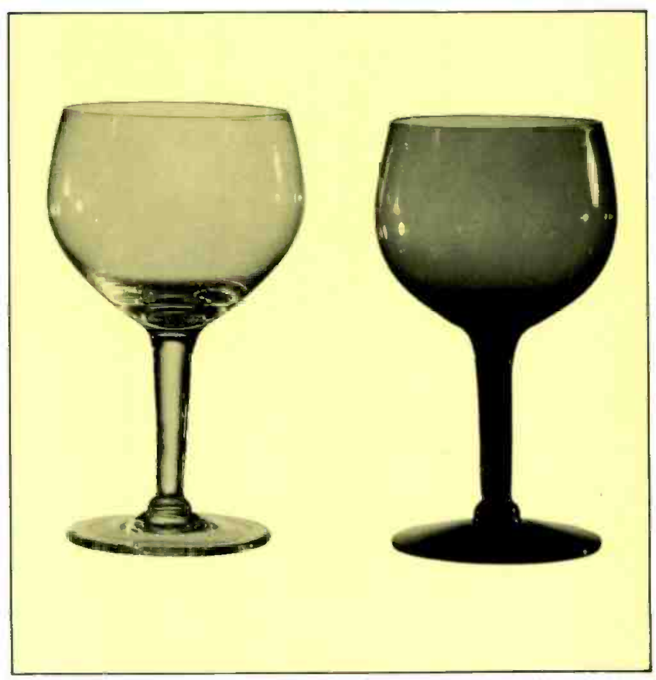
Plant mutations, such as this variegated species of white and red carnations, can be produced by irradiation.



An isotope being investigated for possible use as a power source emits a pale light in solution.

A "flash X-ray" photograph of a pistol at the moment of firing.



Glass goblet (right) changes color when exposed to radiation.

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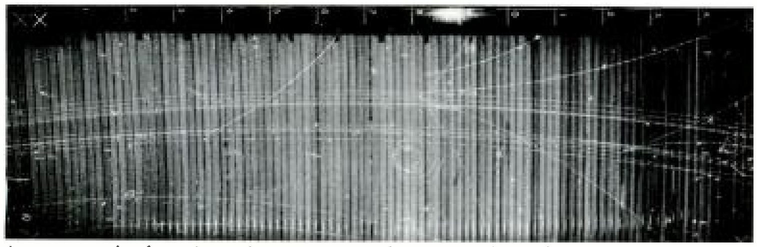
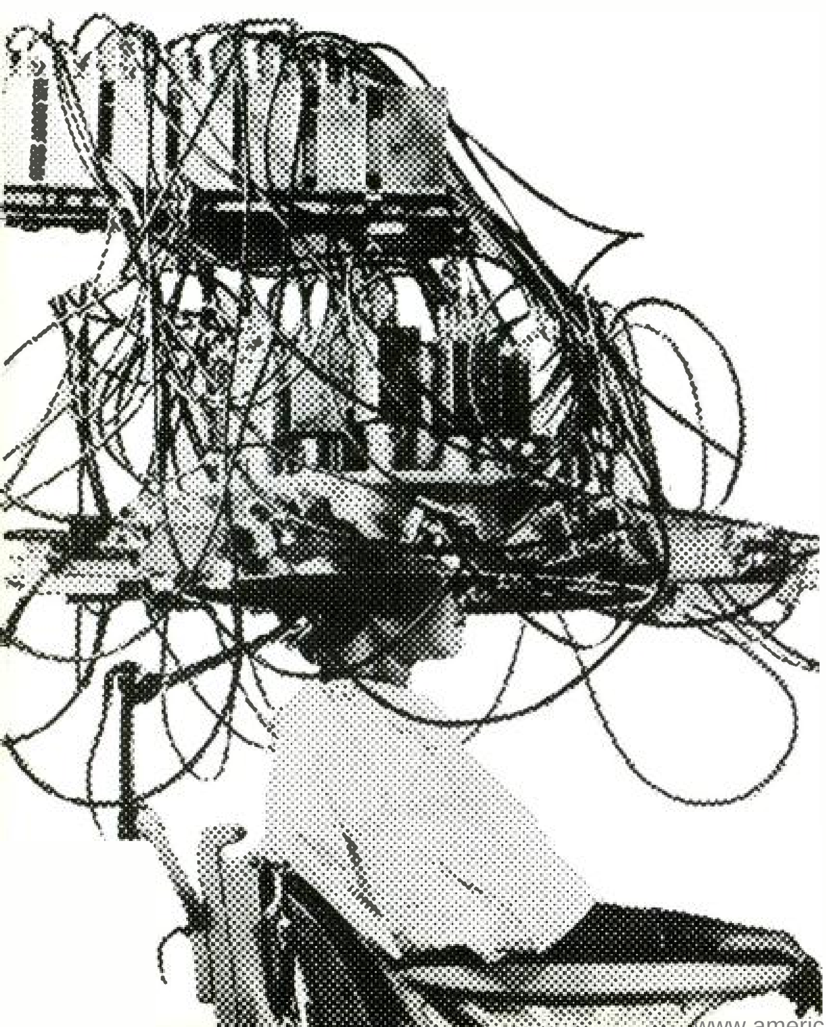


Atomic particles form these characteristic tracks in a cloud chamber.

A detector used to locate brain tumors by means of radioactive tracers.



somewhat rare cases where the device has too much amplifying power for the desired use.

Perhaps the widest use that will be made of radioactive materials is in the "tagging" of objects or chemicals. The nuclear tag is minute and harmless, yet unique and unerasable. A lighthearted example of this principle, which may yet come to pass, would be the nuclear tagging of golf balls. The interior of the ball would be made very mildly radioactive. The golfer would be armed with a Geiger counter (one of the many available devices which registers when a nuclear particle passes through it) and, by this means, could home in on the steady signal from the ball. This technique has been used to find spent shells on an artillery range. The beauty of the "tracer element" is that it is of atomic size and is, chemically, just like its nonradioactive counterpart, or isotope. Thus, the scientist can follow the telltale atoms through any chemical reaction.

The tracer technique is one of the few ways in which the path of a chemical can be easily traced through the body or through a plant. Exactly the same principle can be used to trace seashore sand, oil in pipelines, or migrating locusts. One built-in tag—radioactive carbon—is known to last in plant and animal remains for millions of years and acts as the best available indicator of age. The tagging may also be achieved by performing a nuclear transmutation, as in activation analysis. In this technique, truly minute traces of impurities can be detected if they can be irradiated in a nuclear reactor and thereby made radioactive. Their emissions, when analyzed by electronic means, are as distinctive as a fingerprint. The technique is one of the most sensitive known for chemical identification and has achieved such recent successes as measuring the excess of arsenic in a lock of Napoleon's hair, confirming a theory that he was systematically poisoned while on St. Helena. Another different, but remarkable, example of analysis by nuclear radiation was the soil analysis of the moon by the Surveyor spacecraft. Here, the backscatter from an alpha-particle beam was analyzed so as to indicate percentage proportions of about 10 lunar elements.

This account has avoided the more conventional uses of nuclear radiation for heat and power generation, but it should be noted that one of the milder forms of nuclear power, isotope heat, is already being developed in ways which might, in time, be adapted for individual household use. Weather and other ocean buoys are being equipped with power packs that will last a hundred times longer than batteries. These isotope power units generate only a few watts of power, but only the price and some not insoluble safety problems make it presently unattractive to manufacture isotope generators producing several kilowatts. Such units could be used in houses remote from main supplies.

The hints given here of the possible use of radiation and radioactivity in the future may, perhaps, give some hope that the present worldwide nuclear research effort will not begin and end solely as an expensive exercise in power politics. If popular mistrust of this medium can be decreased, and more resources made available to apply technology to the public welfare, better use can be made of the potentialities of nuclear radiation. What is now used only in a highly specialized sphere may, like electricity, develop into a beneficent influence on man's day-to-day existence. ■

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Electronic Measurement

Uniquely sensitive and flexible,
electronic measurement
has become vital
in such widely varied fields
as genetics, seismology,
and weather prediction.

by Jan Syrjala

RCA electron microscope at the U. S. Steel research laboratory in Monroeville, Pa., is used for metallurgical analysis.

Advances in today's science and technology would be impossible without corresponding advances in measurement. The steelmaker, for example, who wants to know the thickness or weight or magnetic properties of a strip of steel coming at high speed out of a rolling mill would not think of stopping the mill to make these measurements. Fairly simple electronic equipment will tell him instantaneously and continuously how his steel measures, in these and other respects, without the slightest pause in the pace of production and to any accuracy he may need.

Today's scientist or engineer looks upon the enormous sensitivity and flexibility of electronic measurement, of which the above is one example, as a simple fact of life. Indeed, electronics has virtually transformed the science of measurement.

Consider, for example, the seismologist looking for better ways to predict earthquakes. One phenomenon that he expects as a prelude to some earthquakes is a minute stretching of the surface of the earth, similar to the stretching of a filled balloon receiving an extra puff of air. The amount of the stretching may total a small fraction of an inch over a distance of 500 to 1,000 yards.

Detecting such slight changes is impossible through mechanical means. If a tape or wire were stretched over the 1,000 yards, a change in temperature of only one degree would alter the length of the tape or wire 10 to 100 times more than the fraction of an inch that the seismologist is looking for.

The solution was found in a device that combines an old, high-precision instrument with one of science's most recent wonders—the laser. Called the laser interferometer, this instrument splits a beam of laser light, sends the two beams over separate paths, and then recombines them. These recombined waves produce a pattern of light and dark bands known as the "interference fringes." Any change in the length of one path of light, down to millionths of an inch, will cause the pattern to shift measurably.

Prior to the laser, the interferometer was not adequate for precise measurement over distances longer than a few centimeters. Even using the purest light possible, the fringe pattern became too fuzzy to read because the light waves were not spaced evenly enough to remain in good step over long distances. This crucial defect was solved by the laser, with its spectacularly even or "coherent" spacing of light waves. Even over very long light paths, the fringe pattern is sharp and clear.

To study any given area, the seismologist sets up one mirror near his apparatus and another one about 1,000 yards away. The beam from the laser is split, one going to one mirror, one to the other. Reflected together again at the viewing point, they form a sharp, clear pattern that moves an easily measured amount for even the slightest change in the distance between the mirrors. The pattern motion can be automatically monitored by another electronic aid—a photocell, or photomultiplier tube, which can be connected to alarm or recording equipment.

Electronic measurement is equally important to the research scientist, who frequently needs to measure the size of objects so small that they are visible only to the scanning eye of an electron beam. In the field of genetics, for example, it is sometimes necessary to measure the diameters of

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viruses a few millionths of an inch across for a better understanding of how some characteristics are passed from one generation to the next. By photographing the viruses through an electron microscope and further enlarging the picture optically, the geneticist can use an ordinary ruler to read diameters down to a fraction of a millionth of an inch. And the photographs are of sufficient quality that he can distinguish the shape of viruses, a factor that is often important in genetic research.

Predicting weather conditions around the world has also been advanced through electronic measurement. The primary task of the meteorologist is to determine the patterns in the transfers of energy from sun to earth and air, from sea to air, and from air to sea, because these patterns determine the weather. Fifty years ago, the measurement of these vital energy flows was inconceivable. Today, the job has come within the realm of possibility through a vast network of electronic observing stations around the world to report air, ground, and water temperatures, wind movements, water currents, and other relevant meteorological facts.

Electronics is essential to the automatic recording of this vast flow of information and its automatic transmission to central points via "telemetering," a process of radio or TV transmission of data from the occurrence point to an analysis point. Without electronic data processing, the analysis of the huge amounts of data gathered would be impossible. When accurate long-range weather forecasting becomes a reality, as many scientists now believe it will, electronic measurement will have played a paramount role in uncovering the necessary knowledge.

But electronic measurement is even more versatile than any of the above illustrations might indicate. A few examples chosen from biological science will illustrate what might be called the "total resourcefulness" of electronic measurement—its ability to carry out almost any complex operation the laboratory worker can devise in answer to a need.

Cancer researchers at Columbia University and the Sloan-Kettering Center in New York City wanted to speed up their examination of cell tissues taken from patients in order to identify more quickly any significant concentration of cells with certain abnormal chemical characteristics. In order to do this, they built a "spectrophotometer," an instrument that analyzes the light absorption capacities of cellular tissue. High absorption at a certain wave length signals an abnormal cell.

The researchers then pumped a solution containing the cells through a microscopic channel in a block of glass on which the light was focused. From this, a photomultiplier tube, with associated electronics ending with an oscilloscope, measured the light that came through each cell and recorded the result by putting a long-persisting dot on the oscilloscope screen. The position of each dot on the screen corresponds to the light value for that cell. As many as 100,000 cells could be run through the machine in a few minutes, and the pattern left on the oscilloscope screen would tell at a glance, with reasonable accuracy, how large a fraction was abnormal. To do the job by older chemical analysis methods would take hours or days.

But the scientists were not content with this "ultrarapid scanning," as they called it, so they added an electronics-actuated system that would automatically divert abnormal

Accelerators for U. S. Steel's electron microscope drive its electron beam at nearly the speed of light.

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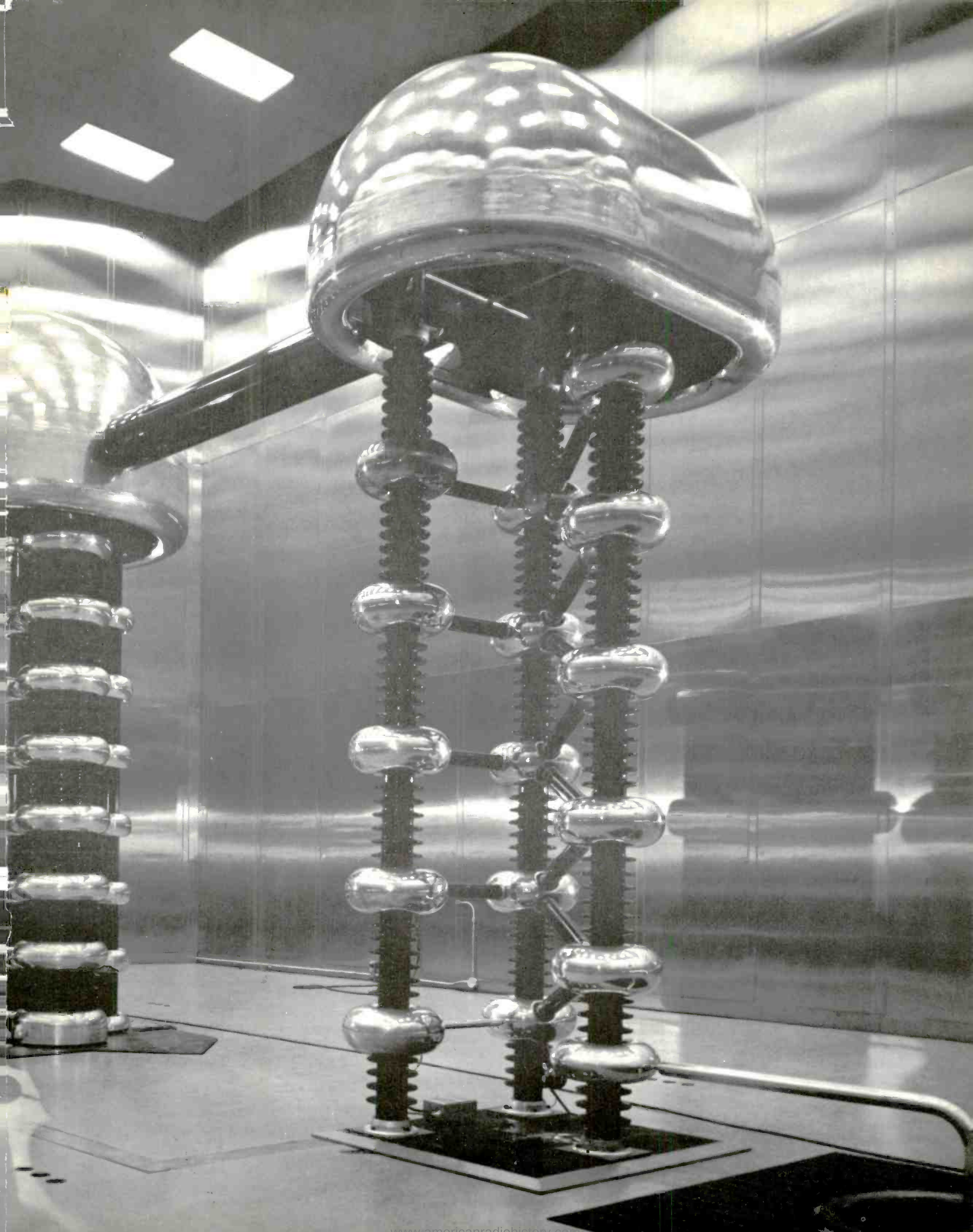

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cells from the main flow and deliver them onto a filter paper for more detailed examination. This kind of feedback arrangement, in which the operation being monitored is altered in accordance with the measurement of its results, is one of the greatest contributions of electronics to the accuracy and efficiency of both research and production. Control feedback of a kind can be accomplished in many ways—pneumatically, mechanically, with fluids—but electronics removes virtually all limitations on the speed, accuracy, and complexity that can be built into a feedback loop. The steelmaker mentioned at the beginning of this article, for example, can add to his electronic measuring equipment an electronic control system that automatically corrects the speed or pressure of the rolling mill if the dimensions of the steel drift outside the desired limits. This kind of production control is now an old story in many industries, particularly in the chemical industries.

An even more subtle kind of feedback, which helps to create an electronic measuring tool of great sophistication, is exemplified in an experiment carried out on the responses of a horseshoe crab's eye to light stimulation. This particular animal is popular in such experiments because its eyes have extremely large, separate "elements," each connected to a single nerve, which makes it easy to correlate the patterns of light striking an eye element with the resulting electrical impulses on the nerve. In this vital area of physiology, there is still much to learn, for many of the patterns of nerve action that carry a "picture" from eye to brain are so complex that they are still undeciphered.

In this experiment, the researchers not only had the usual electrodes inserted in the eye nerves and connected to amplifiers and recorders that took down all the electrical events but they also made an electronic computer a central actor in the experiment. It is often necessary to present a very great number of short stimuli in nerve studies because it is the running average of the resulting electrical waves that is important. The computer, in this case, could be programmed to produce a long series of precisely timed light flashes. The computer then timed and analyzed the results of the electrical waves on the nerves as fast as they were gathered. It could also alter the light flashes, in accordance with principles put in its memory, and even take the experiment to the next step. Thus, the researchers automated, made more precise, and greatly speeded what would have been a very laborious alternation of analysis and recasting.

The way that electronics has altered the measurement of time is another example of its powerful influence on the physical sciences. For millennia, scientists have relied upon the single rotation of the earth as the basic unit of time. Such a time standard, however, is much too variable for many purposes. The ability of electronics to measure and separate events as short as a billionth of a second has given scientists another master clock of virtually perfect accuracy.

The new master clock consists of the radiation given off by certain radioactive atoms, such as cesium, or by an energy transition in an atom, or by the waves emitted by a laser or maser. The timing and spacing of these waves—their frequency and wave lengths—are many times more even and stable than is the earth's rotation. To make such a clock, it is necessary only to count electronically the emission of these waves. Timing devices built on the cesium transition agree with each other within a few parts in 10 to the 12th power.

Even more reliable, it has been recently discovered, are timers using the waves from some masers and lasers. Hydrogen masers are being used to calibrate the cesium beam frequency standards. The National Aeronautics and Space Administration has underwritten the development of rubidium gas frequency standards that, it is hoped, will not vary more than two parts in 10 to the 12th power per year, or, in clock terms, will not gain or lose as much as a second in approximately 10,000 years.

Why do we need such precise time? NASA has found that celestial navigation and space vehicle tracking require the utmost of precision. For instance, scientists follow the path of space vehicles by noting the change in frequency, or "Doppler shift," of the signals, emitted by the vehicle as it passes overhead. To measure this change in frequency with sufficient accuracy for good position determination, it is necessary that the ground station use a highly precise frequency standard.

Another technique that needs very precise frequency standards is radar, which depends on the time it takes a radio wave to go to a target and back. The better the "clock" in the radar, the more accurate this time will be and, consequently, the ranging. Lately, various forms of laser ranging have been suggested or tried, and these, as well, need precise time standards. One such laser system measures the height of the cloud cover over airports. The laser light is projected toward the cloud in pulses about 20 billionths of a second long. If any light comes back, the time for the round trip is measured and automatically shown in terms of the distance traveled. Since it will take the light only about two millionths of a second to go to a cloud a thousand feet high and back, the "clock" in the instrument must be able to resolve, or divide, time into fractions of a millionth of a second to make the measurement.

The nuclear investigator also needs to divide his time into similar infinitesimal bits. The events that take place when an atomic nucleus is hit by a tiny projectile in an atom smasher are often measured in millionths or billionths of a second. The nuclear scientist must know not only what happened but what came first and how long each event took. Timing systems based on the radio waves emitted by one of the new master clocks enable him to work out the chronology of these almost unbelievably short events.

And, finally, there is still another field in which electronic measurement is important and will become increasingly more so as time goes on. This is the area of diagnostic medicine. One example out of hundreds is the identification of brain tumors with radioactive tracers—chemicals that, injected into the brain, tend to concentrate in tumerous tissues. The radio waves given off by the tracer can be spotted with what is, in essence, a sensitive radio receiver. To guide the diagnostician quickly to where the radioactive material is concentrated, an electronic instrument automatically scans the patient's head and presents a map showing the relative strength of the radioactivity in each part of the brain.

These are but a few of the rewards gained from electronics measurement in the past. The future promises advances that we can only begin to surmise. This field has as exciting a potential as any in the rapidly expanding world of electronics, and the story has only just begun. ■

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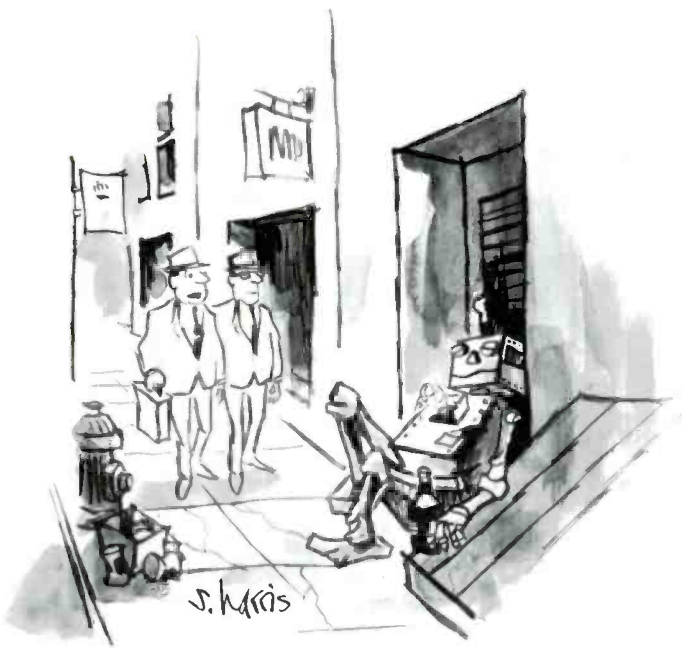
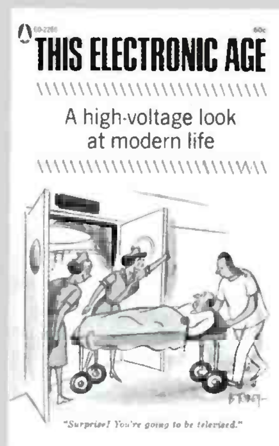
This Electronic Age...

"I guess they really are Number One."



"In a way it's encouraging, knowing they're not perfect."



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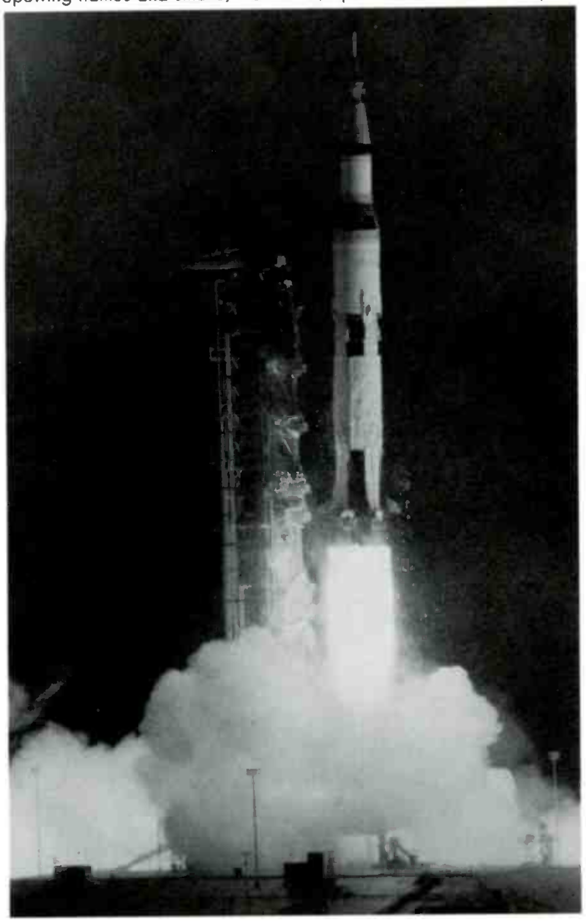
Spewing flames and smoke, the Saturn/Apollo leaves the launch pad.



Reaching for the Moon

Amidst a thunderous explosion of smoke and flame, the Apollo/ Saturn 5 moon rocket rose gently from launch pad 39A at Cape Kennedy on November 9, bound for several orbits around the earth and the first successful flight of the vehicle that is to take man to the moon. The near-perfect performance of the rocket raised hopes that the lunar expedition would be made as scheduled by 1970.

Generating 7,500,000 pounds of thrust at liftoff, the 363-foot-high, 3,000-ton vehicle rose to an altitude of 38 miles in two and one-half minutes. A second-stage rocket took over and boosted the vehicle to an altitude of 115 miles. A third stage then inserted the Apollo spacecraft, service module, and lunar module—a total of 140 tons and by far the heaviest payload ever to be placed in space—into a 117-mile orbit. The following NASA photographs depict various stages of the flight.

Gaining altitude, the rocket heads out over the South Atlantic. Two minutes after liftoff, it reached a speed of over 6,000 miles an hour.

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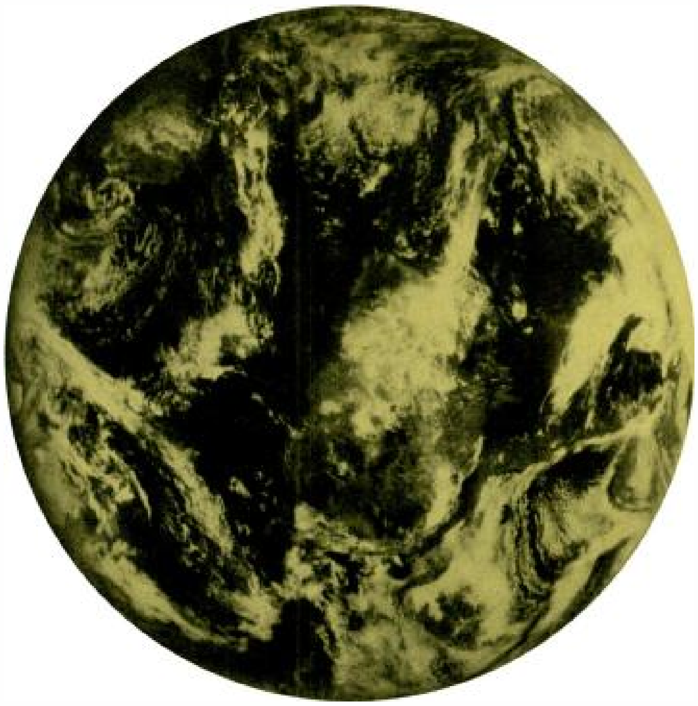

A view of the earth as photographed by NASA's ATS-III satellite the day following the Saturn launch. The satellite was the first to take color photos from a 22,300-mile synchronous orbit.

The firing room at Cape Kennedy contains display, monitoring, and control equipment. Every critical component of the rocket was automatically checked out by RCA computers during the launch sequence.

Eight hours and 37 minutes after launch, the Apollo spacecraft splashed into the Pacific.

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Electronic Innovations in the Library

The merging of computers with electronic communications is destined to transform the library's traditional role as a passive storehouse of information into one of active transmitter and distributor of knowledge.

by Joseph Becker

Strong undercurrents of technological change are running through today's libraries, and their effects will soon revise all our information habits. Electronic innovations, and particularly the computer, are responsible for the transformation. Not since A.D. 1440, when Johann Gutenberg brought together paper and the printing press, has the library world been subjected to so profound a change.

Once Gutenberg's press had been introduced, written messages could be preserved by being reproduced in multiple copies; later, courier and postal systems carried these messages over great distances. To satisfy local demands for the use of books and other printed materials, collections were established, and from these our present libraries grew.

Over the years, libraries have developed techniques for making recorded material widely available. These techniques have weathered the storm of operation: they work. Libraries, generally speaking, are effective information systems; they provide their customers with information, with reasonable speed and at minimal cost; they excel at storing information and providing easy and often open, unlimited access to printed material. Despite rich printed resources and effective organization, however, library service has always been limited by the requirement that a reader must travel to the library in order to use it. Progress in electronic communications indicates that this remaining barrier can be removed by providing alternate means for transporting printed information from the library to the individual.

By no means does this freedom to communicate imply that the book is obsolete and about to vanish from the library. Its portability, compactness, and ease of use will keep it a dominant form for many years to come. However, tomorrow's library is also expected to handle other media, such as video tapes, digital computer tapes, and microfilm.

For the first time, libraries can transmit and receive all forms of messages—oral, digital, printed, and graphic—virtually without constraints of space or time. Improved communications can extend the resources of a library far beyond its physical borders, and it can also marshal the resources of many libraries to meet a particular information need.

Projections of future demands for library service indicate that these expanded facilities will be needed. As the population grows, and as a greater proportion of the population acquires advanced education, pressures on the library to supply the reading public with more materials for recreation, research, and education will increase. The only hope that the library has of satisfying its burgeoning clientele is through these new arteries of communication.

It is the marriage of computers to electronic communications that is destined to transform the library's traditional role as a passive receiver of information into the much expanded and infinitely more useful role of an active transmitter and distributor of information. New channels of communication will connect libraries to homes enabling individuals to be in two-way remote contact with multimedia sources of information stored elsewhere.

The developments taking place in libraries that will make future knowledge incomparably accessible can be divided into four parts: (1) application of the computer to the performance of internal library functions, (2) research in information retrieval, (3) communication with multimedia files, and (4) creation of library networks.

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Until recently, the computer in the library was used mainly for housekeeping functions, such as book ordering, accounting, and the clerical processing of library records. However, another type of application has evolved, in which the computer is used not as a business data processor but as a control tool for library management. In fact, some librarians have begun to view the library as a "total system" and are employing operations research techniques to provide answers to questions about cost versus effectiveness, quality and rate of service, and so forth. Alert to this trend, schools of library science are revising their curricula in order to equip the next generation of librarians with the fundamentals of information science and thereby to accelerate progress to new systems. Professional groups, such as the American Library Association, American Documentation Institute, and the Special Libraries Association, are also establishing continuing education programs in library automation in order to raise the level of understanding among practicing librarians. As a result, computer applications are being introduced into libraries at a rapid pace. By 1970, the profession expects to reach the point where the new technology, no longer a mystery, will have become part of a new way of doing things. As with other professions, the rate of change in the library world will depend on how fast the librarian can make things happen. Although some individuals are resisting the challenge of change, most librarians have accepted library automation and are encouraging it.

Aside from these applications, research is being pursued to find ways of using the computer to answer library reference questions and for information retrieval. Until now, language subtleties have proven too fine for computer programming—but the work continues. Libraries of the future expect to have the full text of certain materials stored in a form readable by machine. However, such digital files will be of limited value unless computer programs are devised which possess intellectual concepts for retrieval that mark a significant improvement over the traditional, manual method of hierarchical subject classification. The crux of the problem is to develop computer programs that not only organize information by subject but are capable of logically reorganizing stored information to satisfy changing interests. If this can be done, it may then be possible to extract underlying patterns of meaning from a mass of digitally stored language. This is the ultimate goal.

A current trend in the library profession is to produce bibliographical data that are machine readable. Bibliographical data include the identifying elements of cataloging that describe a given book: the author's name, the title of the book, the publisher, and so forth. The retrieval process here is more manageable because the elements of catalog data are determined. Since many different libraries are required to catalog the *same* title, the Library of Congress has inaugurated a program called Project MARC (Machine Readable Catalog), which converts catalog data into machine-readable form. These data are then transferred to magnetic tape, which the Library of Congress plans to make available to any library.

Computer programs are also available that permit the recipient of a MARC tape to prepare automatically any number of useful library by-products. However, once bibliographical data are in machine-readable form, the next logical step is to store them in a direct-access memory of very large capacity and to communicate and display the data rapidly in a form suitable for use at the local library level. The addressing of a direct inquiry to such a file by a user has some interesting implications. Imagine, for example, that the Library of Congress's catalog of books and periodicals was in machine-readable storage in a national network. It would then be possible for a professor, say at the University of Alabama, to use the catalog from his office instead of having to travel to Washington. The prospect of having access to the country's most comprehensive bibliographic resource will greatly stimulate research and scholarly activity.

The idea of remote direct access to central stores of digital information is of recent origin. Computerized airline reservation systems, banking systems, and insurance systems have employed this technique for accessing files of limited size and purpose. In 1964-1965, the American Library Association featured demonstrations of remote retrieval of library information at the Library/USA exhibit in the United States Pavilion at the New York World's Fair. Any library or person with access to a teletype machine was able to interrogate a real-time computer at the Fair for selected essays, bibliographies, translations, and current periodical references by subject.

The Massachusetts Institute of Technology has an experimental system that places at a user's fingertips the terminal communications equipment needed to interrogate a large store of information under the control of a computer program while numerous other persons are simultaneously using it. This time-sharing system, called MAC (Multiple Access to Computers), led Dr. M. M. Kessler of the MIT library to develop a working model of an on-line retrieval system for selected bibliographic information in the field of physics. Interaction between man and machine is direct, and the system employs an uncomplicated inquiry language that closely resembles English and uses verbs common to bibliographic searching such as "find," "search," "print," and so forth. For example, in asking the computer to search all issues of the *Physical Review* for all titles of articles in which the words "ion collision" appear, the researcher addresses his request as follows: "Search Physical Review all, find title ion collision, output print author title identification, go."

Files of bibliographic data are not the only digital files likely to be accessible in tomorrow's libraries. Machine-readable information is beginning to be produced by some publishers and by scholars and researchers. Publishers generate full digital text as a by-product of manuscript preparation and later use it to drive automatic printing devices. In addition, certain humanistic scholars, for example those interested in comparative literary style, are painstakingly converting original material to digital form prior to computer analysis. Many of these digital sources may some day become an integral part of every library's collection and be made available through remote communications.

Although libraries have always concentrated on the collection, preservation, and organization of *printed* materials, there is a growing awareness that the newer media forms—digital, audio, film, and video—are also the library's responsibility. A wide variety of new communications equipment and techniques have been introduced by the common carriers

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for use with the newer media, and their impact on data transfer methodology is growing stronger. Dial-access systems to distant stores of information are already in use commercially, and libraries are experimenting with them as well.

For example, research programs have been devised to test the thesis that audio communications can be used effectively in libraries to supplement the printed word. A typical dial-access medical tape recording library is in operation today at the University of Wisconsin Medical School. Staff physicians record four- to six-minute commentaries on current information having to do with various medical subjects or procedures. The list of subjects is circulated by mail to physicians in the state. A practicing physician may telephone Area Code 601/262-4515 at any time of day or night and request that a particular tape be played.

Although audio communications is a slow form of information exchange, advances have been made in the production of audio tapes that permit more information to be recorded per unit of time. The President's Committee on the Employment of the Handicapped, through the Division for the Blind at the Library of Congress, is encouraging compressed speech research because it promises to provide a method for recording two to three times as much information per linear inch of tape without distortion or loss of comprehension. Direct access to stores of audio information in libraries offers an inexpensive and practical method for updating information frequently and distributing it to both the sighted and the blind over established telephone networks.

Dial-access systems to audio-visual materials can be found in many educational institutions today. An individual carrel is provided for each student from which he is able to direct-dial a language lesson or obtain audio-visual instruction on selected topics. RCA's dial-access system at Oral Roberts University in Tulsa, Okla., is a good example and even goes a step further by integrating this new learning process into the library. Carrels are located physically within the library, thus making the total multimedia resources of the institution available to the student.

Since 1950, libraries have also been experimenting with facsimile systems capable of electrically transmitting printed copy from one library to another. The facsimile system is not a new idea. The electrical transmission of pictures, maps, and other printed matter dates from the work of Alexander Bain, who in 1843 outlined such principles in a British patent. Its first application to libraries, however, was demonstrated in 1952 when RCA introduced ULTRAFAX. This system scanned a film copy of Margaret Mitchell's *Gone With the Wind* on the stage of the Coolidge Auditorium at the Library of Congress in Washington, D.C., and recorded a faithful *factum simile* on film in San Francisco moments later.

A few years ago, Xerox introduced LDX (long-distance xerography)—a high-speed facsimile system with exceptionally good resolution—and recently a number of library facsimile networks were established in Hawaii, Nevada, New York State, and California. Although the high cost and low speed of transmission over narrow-band lines are inhibiting widespread use of facsimile in libraries, the introduction of wide-band telecommunications facilities is expected to change the trend.

The next step, of course, is to develop the ability to transmit printed copy on remote command from a library file at one location to a service point at another. In this connection, RCA Laboratories in Princeton, N.J., recently announced an experimental television system that can broadcast printed pages of a book to a home TV set along with standard television programming. It works by converting the original copy into electromagnetic signals which are blended at the transmitter with those of regular television programs by means of an electronic "hitch-hiking" technique. The blended signal is then broadcast for reception by standard home antennas. This is only a step away from dialing at home for one or more pages of information in the library.

Libraries are keenly interested in systems that can provide remote access to files of video information. Systems are currently available which store individual video frames on tapes or disks. Both forms of storage can be addressed digitally. Thus, using a touch-tone telephone, it is possible to dial for a particular frame and receive it automatically for viewing on a TV monitor. Ultimately, we can expect to see information systems capable of broadcasting video frames to TV sets which can be uniquely addressed by the transmitter. This form of TV time-sharing will profoundly influence the design of library information systems.

As the tempo of library communications quickens, and as the rate of computer usage in libraries increases, the tendency among libraries will be to find new ways of sharing resources, not to compete for them. In the past, the trend was toward local self-sufficiency, but this was before electronics. Communications offers libraries their first real chance to develop the concept of information distribution. Networks of this type can turn information into a national resource readily available to every corner of the country.

At the moment, the technology of networking is better understood than are the functions it is expected to perform. Experimental communications networks, such as the one for facsimile in the New York State Library and the teletype network at Duke University for interlibrary loan with four other medical libraries, are investigating the advantages to be gained through interlibrary communications. Librarians who are aware of the potentialities of networking see it as providing two-way channels for the distribution of multimedia materials, as a system capable of improving the efficiency of clerical operations, and as an opportunity for extending library services to any person desiring information.

A nationwide network of library systems connecting local, state, and national resources is bound to involve several processing centers and many stations using combinations of leased and switched communications facilities. The design of such a system of systems is highly complex, and the introduction of broad-band transmission channels between libraries will require more than simple agreement among them on common rules of practice. Success will depend on painstaking system design, the utmost technical skill, and, above all, a sense of purpose and commitment on the part of network participants in the library community.

Yesterday's image of the library was that of an archive—a place to go where the books were kept. Tomorrow's image will more than likely be that of a communications center—an active source for information exchange and redistribution. Electronic innovations in libraries may well prove to be the catalyst that will help to bring about this change. ■

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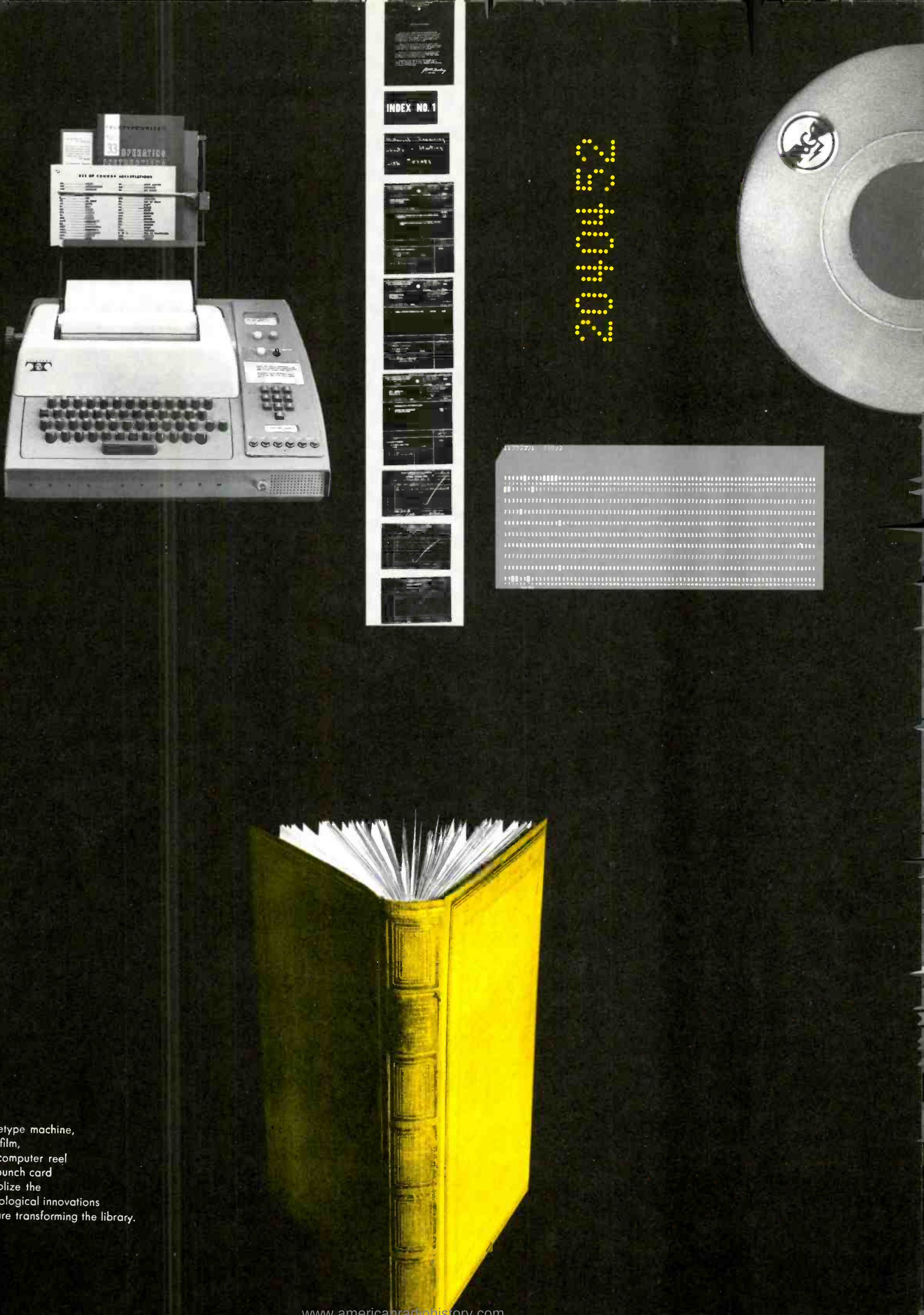

A teletype machine,
microfilm,
and computer reel
and punch card
symbolize the
technological innovations
that are transforming the library.

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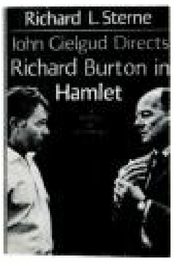
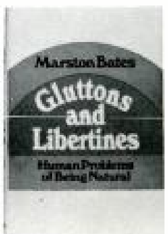
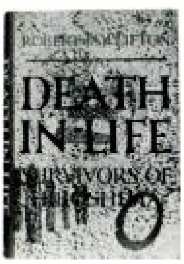
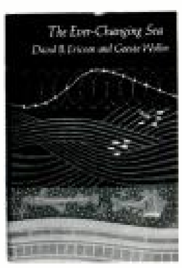
Books at Random...

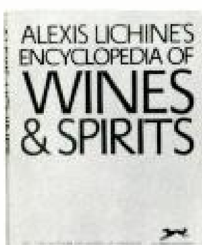
OTHER RECENT
RANDOM HOUSE BOOKS









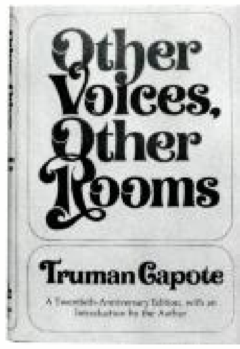


OTHER VOICES, OTHER ROOMS

by Truman Capote

(Random House)

This is a 20th-anniversary edition of Mr. Capote's first novel, with an introduction by the author in which he examines his childhood and his life as an artist. The protagonist of the book is an adolescent boy, the setting, the Deep South. When the novel first appeared in January, 1948, the *New York Herald Tribune* described Capote as "one of the most accomplished of American writers."

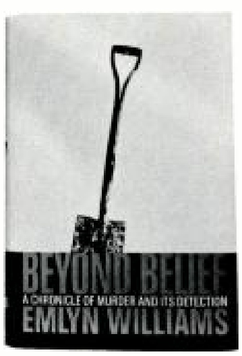


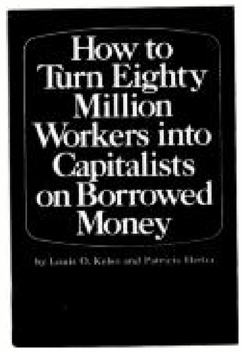
BEYOND BELIEF: A CHRONICLE OF MURDER AND ITS DETECTION

by Emlyn Williams

(Random House)

Between November 23, 1963, and October 6, 1965, three—and possibly five—of the most brutal and senseless murders (the only motive was for thrills) in the history of English crime took place in a Manchester suburb. This is the story of the Moors Murders—of the victims, of the killers themselves, and of the battle of wits between them and the police. Emlyn Williams researched this case for more than a year, interviewing almost everyone connected with it; but, since he never met the killers, all their thoughts and many of the events described are an imaginative reconstruction on his part.



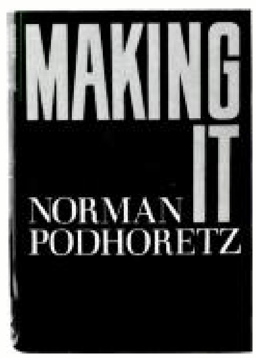


HOW TO TURN EIGHTY MILLION WORKERS INTO CAPITALISTS ON BORROWED MONEY

by Louis Kelso and Patricia Hetter

(Random House)

The authors contend that capital, not labor, is the source of affluence in an industrial society and advocate private ownership of productive capital by every American family. It proposes a Second Income Plan as the only answer to problems of underconsumption and technological change. The plan has been developed and tested by Mr. Kelso, a corporate and financial lawyer and co-author with Mortimer Adler of *The Capitalist Manifesto* and *The New Capitalists.*



MAKING IT

by Norman Podhoretz

(Random House)

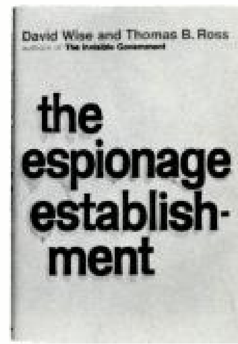
This highly personal book is an autobiography of one of the country's leading intellectuals. The author, editor of *Commentary*, is a member of the intellectual "family," which has had a vast influence on American culture. *Making It* is filled with the members of that family—Philip Rahv, Mary McCarthy, Lionel Trilling, James Baldwin, Saul Bellow, Susan Sontag, Norman Mailer, and others —their careers, and their literary and political histories.

THE ESPIONAGE ESTABLISHMENT

by David Wise and Thomas B. Ross

(Random House)

Modern espionage is examined in detail—much of it previously secret—by the authors of *The U-2 Affair* and *The Invisible Government*, the number one best seller about the CIA. This book describes the real workings of the intelligence operations of the major powers—the USSR, Great Britain, the United States, and Communist China—and the increasingly important role of espionage in international affairs.

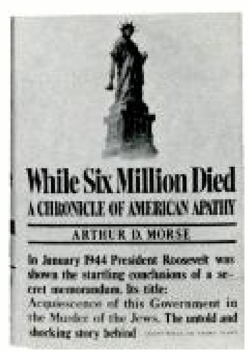


WHILE SIX MILLION DIED: A CHRONICLE OF AMERICAN APATHY

by Arthur D. Morse

(Random House)

In January, 1944, President Roosevelt was shown the startling conclusions of a secret memorandum. Its title: *Acquiescence of this Government in the Murder of the Jews.* The untold story which led to this report —never before quoted in full—is one of apathy and callousness in the face of Nazi genocide. Its thorough documentation comes from hitherto classified and unpublished official papers, worldwide interviews with participants, and research in Washington, London, Paris, Jerusalem, Geneva, Rome, and Hyde Park, N. Y.



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ON LOCATION WITH NBC

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In a constant search for
immediacy and authenticity,
NBC television this season
has ranged far and wide—
from the jungles of South Vietnam
to the blue waters
of the Mediterranean.

"Bell Telephone Hour"
in England

Julian Bream, lutanist and guitarist, was a featured soloist on "The Bell Telephone Hour" program, "Benjamin Britten and His Aldeburgh Festival."

"Jeannie"
in Hawaii

Barbara Eden and Larry Hagman, the stars of "I Dream of Jeannie," appear on the beach at Waikiki in this episode from the popular comedy serial.

NBC News
in Canada

In Ottawa, a military band marches past Parliament Hall for the daily changing of the guard in this scene from "Canada Faces the Future," an NBC News color special.

Cheetah
in Mexico

Tarzan's faithful friend and traveling companion, Cheetah, smiles for the camera. The series is filmed entirely in Mexico and features Ron Ely in the title role.

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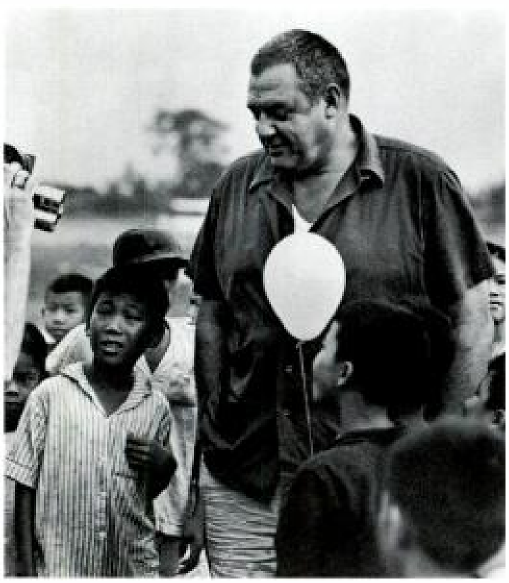
Joseph Wood Krutch in Baja California

Mexico's Baja California, one of the last wild and unsettled regions of the earth, was filmed by NBC News for the color special, "American Profile: the Forgotten Peninsula." Mr. Krutch, narrator and noted naturalist, greets a young inhabitant of the region.

"NBC Experiment in Television" in Czechoslovakia

American, French, and Czech performers will appear in a bilingual love story, "Passport to Prague," that was filmed on location by Victor Vicas for the "NBC Experiment in Television" series.



Raymond Burr in Vietnam

The star of NBC-TV's "Ironside" series, Raymond Burr, is filmed with a group of Vietnamese children for a one-hour color special on his visit to Vietnam.

"I Spy" in Greece

In an episode entitled "The Lotus Eater," Bill Cosby, who stars with Robert Culp in "I Spy," scours the islands off the coast of Greece in search for his partner. The series makes extensive use of foreign locations.

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Vietnam Calling–Via MARS

A global network made up of amateur radio operators is handling a growing volume of calls from overseas servicemen as well as providing emergency communications during disasters.

by Robert L. Moora

The two little girls, aged ten-give-or-take-a-year, stood with their mother inside a glass-enclosed room just off the main concourse on the ground floor of the Pentagon in Washington. Beyond them were half a dozen other cubicles, also glass-enclosed, where uniformed men wearing headphones were seated at big radio consoles. Behind them, the concourse itself had a Grand Central bustle, with military and civilian pedestrians streaming past.

A sergeant approached the trio: "Can I do something for you?"

"We'd like to talk to our Daddy," said the older of the two girls.

"Where *is* your Daddy?" asked the sergeant.

"He's in Vietnam," the girl replied.

The sergeant hesitated. "Well, now, we can't put a telephone call through to him right now, because we don't know just where he is and what he's doing in Vietnam. But there's one thing we *can* do. We can send him a message and ask him to telephone *you* when he gets a chance."

The message they sent was transmitted via MARS. And the phone call they subsequently received in their home in Virginia also came by MARS. Not the planet by that name, but another MARS—the Military Affiliate Radio System, a global communications network made up mostly of "ham," or amateur, radio operators and administered by the U.S. Army, Navy, and Air Force.

In "ham" circles and in amateur radio journals such as "CQ" and "QST," it is widely known. But until recently, when newspapers in increasing numbers began stumbling on the feats of individual "hams" in their localities, it has been an entity little known to the public. Today, with the fast-growing volume of Vietnam calls—as well as heroic service in hurricanes, floods, earthquakes, and other emergencies—MARS is gradually becoming better known.

The network had its origin in a loosely knit organization known as the Army Amateur Radio System formed in 1925 at the Fort Monmouth, N.J., base of the Signal Corps. By 1948, its membership and activity had spread to such a degree that it was reorganized as a joint Army-Navy-Air Force program called the Military Amateur Radio Service, or MARS. Four years later, the word "Amateur" was supplanted by "Affiliate" to describe more accurately its joint military-civilian affiliation.

There are more than 250,000 radio amateurs in the United States and its possessions today, another 10,000 in Canada, and 125,000 in other foreign countries. They use telegraphic code, voice, radio teletype, and, in a few instances, even television for their communications. Most of their conversations are within national boundaries, but many circle the globe, and some even penetrate the Iron Curtain countries where there are well over 10,000 amateurs, some of whom will talk with "hams" elsewhere—albeit "rather guardedly and briefly," as one MARS official in the Pentagon describes it. In all of these exchanges, whether domestic or international, politics and religion are avoided, and music and entertainment are legally taboo. It is all strictly business or the pursuit of a hobby toward improvement in each individual's technological capability.

"Hams" have been dot-dashing and chattering on the wave lengths almost from the inception of wireless. But never, according to the nation's topmost amateurs, has there

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been an organized service among them to match the present MARS program handling "phone patches" and messages to and from Vietnam. Here is the way it works:

Starting in December of 1965, the three services began setting up MARS stations in the embattled Far East country. Using equipment purchased with nonappropriated funds, other gear from surplus stores, and still more devised by "hams" in uniform with typical American ingenuity, they now have about 50 MARS stations scattered through Vietnam from the delta to the highlands. Simultaneously in the United States—including Alaska and Hawaii—MARS member amateur radio stations on military bases and in private homes were appointed and authorized to handle "phone patches" from the MARS stations in Vietnam.

A GI wishing to call home seeks out a MARS station in Vietnam which endeavors to place his call through one of the MARS stations in the United States as close as possible to the caller's home town. Such a station might be at an Army, Navy, or Air Force base or in the home of a "ham" member of MARS. When contact is made, the "ham" or military operator of the stateside station telephones the caller's wife, family, or other destinee and then flicks a switch that puts the radio signal into the telephone line, thus effecting a direct radio-telephone connection or "phone patch."

More often than not the connection is reasonably clear—and the only charge is the telephone call from the stateside MARS station to the recipient, usually on a collect basis. MARS officials give much credit to the telephone company long-distance operators who do their utmost to assist the stateside stations in getting the Vietnam calls through. Connections are not always easy to make. Time differences pose problems. So do atmospherics. And locating a strategic MARS station is sometimes difficult.

MARS radio traffic to and from Vietnam has built up in the last two years at a pace far exceeding the build-up of American forces there. In January, 1966, for example, the network handled 1,100 "phone patches"...by December, 1966, the number had reached 10,000...by July, 1967, it exceeded 30,000. In the first half of 1967, the 50 MARS stations in the Vietnam organization had handled 222,000 "phone patches" and 320,000 other messages, some administrative but most of them personal.

Military commanders in Vietnam consider the MARS network a big contributor to morale, for, just as the Bell System back home advertises that one is as close to home as the nearest telephone, so is the GI fairly close even though he is 12,000 miles away—although getting through is a bit more complicated than dialing an area code and a number.

The same is true for Americans stationed elsewhere around the world, sometimes in remote locations such as the radar bases in Thule, Greenland, and Clear, Alaska, or in far-away outposts in Turkey, the Middle East, Africa, or even the Antarctic. At the bleak Arctic outposts of the Ballistic Missile Early Warning System, personnel of the RCA Service Company—which operates the radar net for the Air Force—regularly man the MARS stations for calls through the network back home.

Although military personnel reap the greatest benefit of MARS service on a regular basis, there are hundreds of thousands of other Americans who owe much to the network—in some cases their lives. MARS today is a regularly

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organized communications net not only for the military but for federal and state civil defense organizations in times of emergency. At times, it has been the only communications network left in service when the conventional channels went out—as in the Alaska earthquake of 1964, when it handled more than 10,000 distress calls in the span of a few weeks... as in the disastrous Minnesota–Wisconsin floods of April, 1965...as in Hurricane Carla in 1961, when 200 MARS members provided a communications network for the military, the Red Cross, and Civil Defense...and as in the more recent disastrous hurricane called Beulah, which hit Texas and Louisiana in the fall of 1967.

By the time Beulah came along, MARS had a prearranged plan of operation. For days in mid-September, Roland Belk, 4th Army MARS director stationed at Fort Sam Houston in Texas, had followed the Weather Bureau's hurricane warnings. At 7:15 P.M. on September 18, using every available means of communications including his own, he requested all other radio traffic to relinquish the 4020- and 4030-kilocycle frequencies for emergency use, and simultaneously he established liaison with state and local authorities. Fifty or more MARS "hams" pitched in; so did another 100 operators in RACES (Radio Amateur Civil Emergency Service); and before the crisis was over they were responsible for assisting in the evacuation of thousands of disaster-threatened residents, including 170 patients in a hospital in Hollingen, Tex., who might well have perished were it not for a quickly established MARS station at the Air Force base nearby. As MARS Director Belk remarked on October 3, after he had restored the two frequencies to normal use: "Well, they know MARS is here to stay now; I couldn't have said that two weeks ago."

Although a "ham" who joins MARS operates on military frequencies and uses a MARS radio call sign, MARS administrators at the Pentagon emphasize that the network's members are not a group apart from the amateur fraternity. As Edward S. Liscombe (call letters K4KNV), chief of the Army branch of MARS, puts it: "Each civilian MARS member is an amateur first and a MARS member second. His talents are voluntarily devoted to serving the public interest through his affiliation with the MARS program."

In its relationship with the "hams" of the country, the network reflects the fervent interest of amateurs throughout the world in maintaining communication with one another and in providing public service where possible. Personnel of many large companies, especially those in communications and electronics—Collins Radio, Hughes Aircraft, Minneapolis Honeywell, Westinghouse, RCA, to name a few—have networks of their own.

RCA is by far the largest, with members scattered throughout the United States and in several foreign countries. Each Monday night, they hold a meeting—on the air, of course—for their members in the United States and twice each Saturday morning an international session. Anywhere from 20 to 50 operators will chime in to chat with one another or to relay messages, sometimes pressing ones, from other "hams." Happily, "hams" usually use only their first names plus their call letters, for the RCA personnel who chat together range from top vice presidents to junior engineers and technicians. No other identification is needed.

One of the best known amateurs in the country, Stanley Wolff (H2HIQ), is the moderator of these meetings from his home station at Crosswicks, N.J., near McGuire Air Force Base. Wolff is now a marketing executive with RCA's Communications Systems Division at Camden, N.J. Introduced to wireless in 1927 as a National Guard horse cavalryman, he attended RCA Institutes in New York, received both his commercial and amateur licenses in 1931, spent three years as a shipboard operator at sea, then supervised wireless communications at various times for Hearst Radio at Carlstadt, N.J., for the *New York Herald Tribune*, and finally The Associated Press. In those jobs, he had more than his share of exciting adventures.

On August 27, 1939, he intercepted an urgent message from Adolf Hitler ordering all German ships at sea to return to home port. It gave a long list of ships and locations, which Wolff immediately relayed to the U.S. Naval Commandant. The story made page one of the *Herald Tribune* and was picked up, with due credit, by the wire services for worldwide distribution. It was a forewarning of World War II, which started the following week.

With The Associated Press during the war, Wolff was instrumental in setting up a high-powered receiving station outside New York City which intercepted "pool" press transcriptions abroad many minutes and sometimes hours before they reached their destinations via regular communications facilities, thus getting the copy on the AP wire well in advance of other services. And before Japan got into the war, Wolff astutely managed to get the frequencies on which Domei (Japanese) News Service transmitted its news; this gave the AP a big news break when, even before the United States received official word from Tokyo, Emperor Hirohito announced his country's surrender.

And in 1956, now no longer connected with the press but again a "ham" operator, he heard the SOS following the *Andrea Doria–Stockholm* collision off Nantucket, switched to the frequency being used for emergency transmission, and, out of old loyalty to the *Herald Tribune*, provided that paper with a seven-hour "phone patch" in which reporters were able to hear all developments—the "abandon ship" order, rescue efforts, and other ships' communications.

Many of the "hams" in the RCA group, and in other companies as well, are active in the MARS network, hooking up phone connections between men in Vietnam and their families at home. The system has grown to the point where, as Army MARS Chief Liscombe declares, "there is no doubt that, along with the amateurs in the military service, the civilian members of MARS are making the greatest single public service contribution in the history of amateur radio." ■

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For the Records...

OTHER CURRENT RCA RELEASES

PANDEMONIUM SHADOW SHOW

Nilsson

(RCA LPM/LSP 3874)

Today's music is written and performed by and for today's generation, and Nilsson, the singer/composer who has been generating an undercurrent of excitement in the world of music, is one of the foremost representatives of that generation. He is an unorthodox artist, attuned to the contemporary music scene. Ingredients of "Pandemonium Shadow Show" include six Nilsson originals: "Cuddly Toy," "It's Been So Long," "Ten Little Indians," "1941," "Without Her," and "Sleep Late, My Lady Friend." Also featured is an ingenious Nilsson-conceived Beatle medley, "You Can't Do That," incorporating 11 songs from the Lennon–McCartney songbook.

WITHOUT HER

Jack Jones

(RCA LPM/LSP 3911)

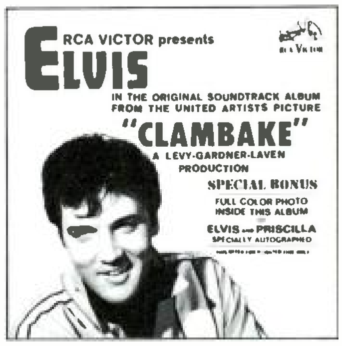
Jack Jones' initial RCA album reflects full well the talent that has made him one of the foremost singers in the popular music field today. Backed by Marty Paich and 11 dynamic arrangements, Jack enters his second decade in show business with a half-dozen contemporary tunes, including the title song, a new movie song called "Live For Life" from the forthcoming Claude LaLouche film, and the Simon and Garfunkle ballad, "Homeward Bound." Included also are five standard hits, among them "I Can't Get Started" and "You and the Night and the Music."

CLAMBAKE

Elvis Presley Original Soundtrack Recording

(RCA LPM/LSP 3893)

Elvis Presley's 26th film, "Clambake," provides him with a showcase for seven numbers—six songs written especially for the film and one popular country favorite, "You Don't Know Me." As a special bonus, there are five newly recorded songs by Elvis in this RCA original soundtrack recording, which also includes as a premium feature a full-color autographed picture of the singing star with his bride, Priscilla.



HAIR

The Original Cast Recording

(RCA LOC/LSO 1143)

"Could be that the score of 'Hair' will shape up as an authentic voice of the popular culture of 1967," wrote critic Howard Taubman of *The New York Times*. Clive Barnes, in his opening-night review in the same paper, described it as "an honest attempt to jolt the American musical into the 1960s, and a musical that is trying to relate to something other than Sigmund Romberg." "Hair" was chosen by producer Joseph Papp to open New York's Public Theater, the new permanent home of the New York Shakespeare Festival. Written by two actors in their 20s, James Rado and Gerome Ragni, it deals with the contemporary generation, their thoughts on war and interracialism, and the gulf that separates them from their elders.

HANDEL: JULIUS CAESAR

Norman Treigle, Beverly Sills, Maureen Forrester, Beverly Wolff, New York City Opera Orchestra and Chorus, Julius Rudel, Conductor

(RCA LM/LSC 6182)

Handel's "Julius Caesar" may not have been his musical masterpiece, but critics are agreed that it ranks among his best. Its performance by the New York City Opera Company in the fall of 1966 was greeted by unusual critical acclaim. Harold Schonberg, *The New York Times* critic, described it as "a stunning, creative production." This RCA Dynagroove album marks the first time "Julius Caesar" has been recorded by the original cast of a complete stage production and the first stereo recording of the Handel work.

VERDI: LA TRAVIATA

Montserrat Caballé, RCA Italiana Opera Orchestra and Chorus, Georges Prêtre, Conductor

(RCA LM/LSC 6180)

On the third Monday in September, the Metropolitan Opera commenced its 83rd season—the second in its new home—with "La Traviata" and the widely anticipated appearance of RCA's soprano from Barcelona, Montserrat Caballé. In advance of the new opera season, RCA Red Seal recorded the Verdi opera with Madame Caballé in the role of the courtesan, Violetta Valery, with tenor Carlo Bergonzi singing the role of Alfredo Germont, her lover, and Sherrill Milnes, one of the Met's brightest young baritones, as Alfredo's father, Giorgio. A complete performance is offered in this recorded production of the work, with all cuts restored.

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Electronically Speaking...

NEWS IN BRIEF
OF CURRENT DEVELOPMENTS
IN ELECTRONICS

PORTABLE COLOR CAMERA HAS MANY APPLICATIONS

A broadcast-quality color television camera, small enough to be carried by an astronaut on a manned lunar exploration mission, may also find use in a number of industrial and broadcast television applications.

The camera, its portable power supply, and receiving and transmitting radio equipment weigh a total of 56 pounds, as contrasted to an average of 200 pounds for comparable color TV cameras, not including power supply. It was developed at RCA's Astro-Electronics Division in Princeton, N.J.

The camera was designed to be carried and operated by one man, making it suitable for use in manned lunar exploration. It could be carried on the moon by an exploring astronaut to provide scientists with color views of the lunar environment. The pictures could be viewed instantly on earth TV receivers and could also be stored on conventional video tape to provide a record of the scenery for later detailed analysis.

In industry, the camera could send color views from inside test chambers and similar facilities where limited space dictates the use of lightweight, compact equipment. The camera's portability also would allow it to be carried to widely separated locations within a plant area to provide "on-the-spot" surveillance or to link management personnel via a closed-circuit network.

The versatility of the camera and its resulting wide potential applications are made possible by its compatibility with commercial TV broadcast standards. This allows it to work in conjunction with existing equipment, such as video tape recorders, without modifications. In addition, the pictures can be broadcast directly to TV networks without being changed to commercial standards by a scan converter.

PHOTO SYSTEM COMBINES TV AND LASER TECHNOLOGY

Television and laser technology are combined for the first time in a revolutionary system that transmits and records photographic images 10 times sharper than those seen on a conventional television screen.

Designed by RCA's Astro-Electronics Division for use in an earth resources observation satellite, the system uses a new TV camera tube that sends its pictures to a gas laser whose beam traces them on photographic film at the rate of 1,200 lines per second. The system might also find use in earth-based industries where it could replace many standard photographic processes used in the manufacture of integrated microelectronic circuits and the preparation of graphic arts materials.

The camera system is capable of 5,000 TV lines resolution. Home television pictures, by contrast, contain about 525 lines, and the highest resolution yet used in space is about 800 lines.

The camera's high resolution is made possible by an electron tube known as a "return beam vidicon." Electronic signals from the vidicon are converted into photographic quality pictures by a "laser beam image reproducer" that scans conventional photographic film with an intense, narrow beam of laser light.

Carried in the Department of the Interior's proposed earth resources satellite, the camera could identify and provide data on terrestrial features with a ground resolution of 100 feet. Several of the cameras could sample different areas of the light spectrum and thus provide precise information on such things as crop health, forest and mineral resources, and data for such activities as land mapping, oceanographic surveys, and urban planning.

INSTANT TRANSLATION OF VIETNAMESE DOCUMENTS

A system for immediately translating captured Viet Cong documents has been developed for use by the military. It consists of a model dictionary, programmed into about 1,000 discrete Vietnamese words and phrases, and an RCA Spectra 70/45 time-sharing computer.

Data may be sent via communications lines or radio to the computer, permitting military officials to obtain immediate intelligence prior to sending captured documents to a central location for tedious manual translation, a procedure which currently consumes many days, sometimes months, of valuable time.

The computer enables linguists to translate foreign documents very quickly, because as much as 80 per cent of a translator's time is spent looking up words in a dictionary. With computerized dictionaries performing this function, the human translator is able to make more effective use of his time and improve his accuracy.

The computer performs a word-for-word and, in some cases, phrase-for-phrase search in the Vietnamese–English dictionary stored in its memory and supplies the English equivalent of the input sentences. The system was developed by Computing Technology Inc., of Paramus, N.J.

CHINESE IDEOGRAPHS COMPOSED BY MACHINE

Undergoing test at the U.S. Army's Natick Laboratories in Natick, Mass., is a machine that allows an operator seated at its keyboard to set type in Chinese, Japanese, or Korean ideographs. By striking the keys in order, he adds each stroke until a character has been completed.

Three of the machines, two designed to handle Chinese and the third all three languages, have been delivered to the Army. They were developed by three RCA engineers at the Applied Research Laboratory in Camden, N.J.

The typesetter can be used for a newspaper or even a book. The output is photographic film, which can be used in offset or letterpress printing. The Army plans to use the machines for training publications, orientation literature, information leaflets, and other printed material.

The model used for Chinese characters has a board of 41 symbols and 11 punctuation marks. Twenty-one keys represent the basic strokes that form the ideographs, and 20 identify "phrases" or groups of strokes.

As the operator strikes the key, the machine consults its memory containing 10,000 words identifying ideographs and then presents a character to the operator's view. If it is correct, he then presses a button and the character is exposed on the film.

SPACE TV SYSTEM FOR ASTRONOMY SATELLITE

A spacecraft television system that enables observers on the ground to "watch" the movement of two 750-foot-long antennas as they wave about in space will be a vital component of NASA's Radio Astronomy Experiment Satellite, scheduled for launch this spring.

The satellite will study space radio signals in wave-length regions that are absorbed by the atmosphere and thus cannot be received on earth. It will be equipped with a pair of "V" antennas—one pointed toward outer space and the other toward earth. Each leg of each "V" will unfold in space to a length of 750 feet—the longest ever for any satellite.

The task of the RCA-built television system will be to record movement of the flexible antennas under the stress of space environment forces. Three-inch-diameter spheres, much like oversized ping-pong balls, will be affixed to the ends of the antennas to serve as visual targets for the cameras.

The measurement data acquired by the cameras will be converted to digital form and beamed to earth for instant processing by computers. The cameras' output also can be displayed on a television monitor to provide a visual record of antenna movements.

Determination of this movement is vital to the mission since the data gathered by the spacecraft can be correlated against antenna position to determine the source of radio emissions received by the satellite.

MASSACHUSETTS AUTOMATES ITS UNEMPLOYMENT SERVICE

An automated unemployment benefits system that identifies the claimant, verifies his claim, and prints his check in less than 30 seconds has been instituted by the Massachusetts Division of Employment Security.

The system went into operation with a pilot program that links an RCA computer in Boston to a remote terminal in a Worcester unemployment office. Eventually, it will be expanded to transmit information on 300,000 claims to any of Massachusetts' 43 local unemployment offices.

When a claimant enters a local office to collect an unemployment check, he simply presents an identification card, containing his name and social security number, and a ledger card to the terminal operator. Both cards are placed into the terminal—the identification card in a special reader slot and the ledger card in a device which holds the check. The information on the identification card is transmitted electronically over the telephone lines to the Boston computer, which verifies the claimant's record and eligibility and tabulates his benefits.

At the same time, the computer updates the ledger card with the date, amount of payment, and the claimant's balance. At the end of the day, all claimants' records for that period are updated and recorded in an RCA random-access memory file.

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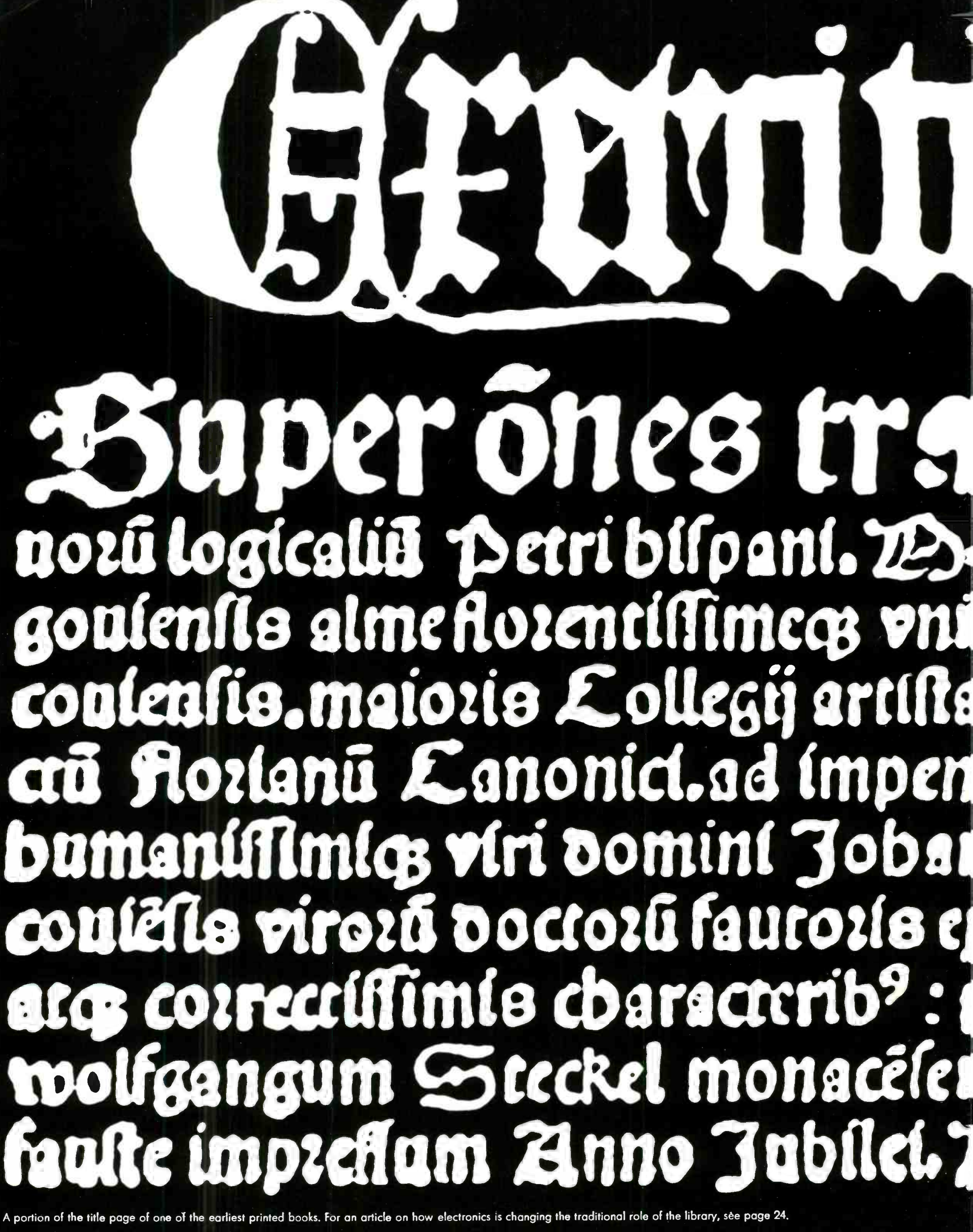

A portion of the title page of one of the earliest printed books. For an article on how electronics is changing the traditional role of the library, see page 24.

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