RCA

Electronic Age

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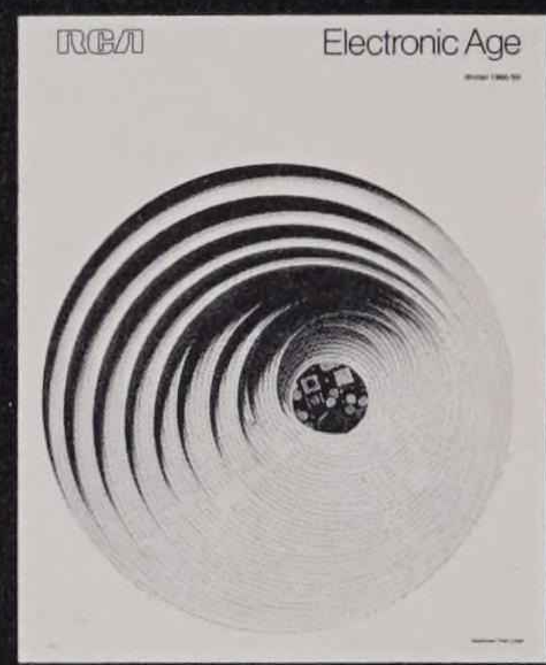
Machines That Liste



Cover: This paper sculpture of a machine "ear" is an illustrator's conception of an emerging technology—voice communication between man and machine. More and more, machines are comprehending and responding to continuous, human speech. The day may not be too far distant when a person may be able to dial a telephone or query a computer merely by speaking to it. For a report on what is being done in the field of voice recognition, turn to page 2.

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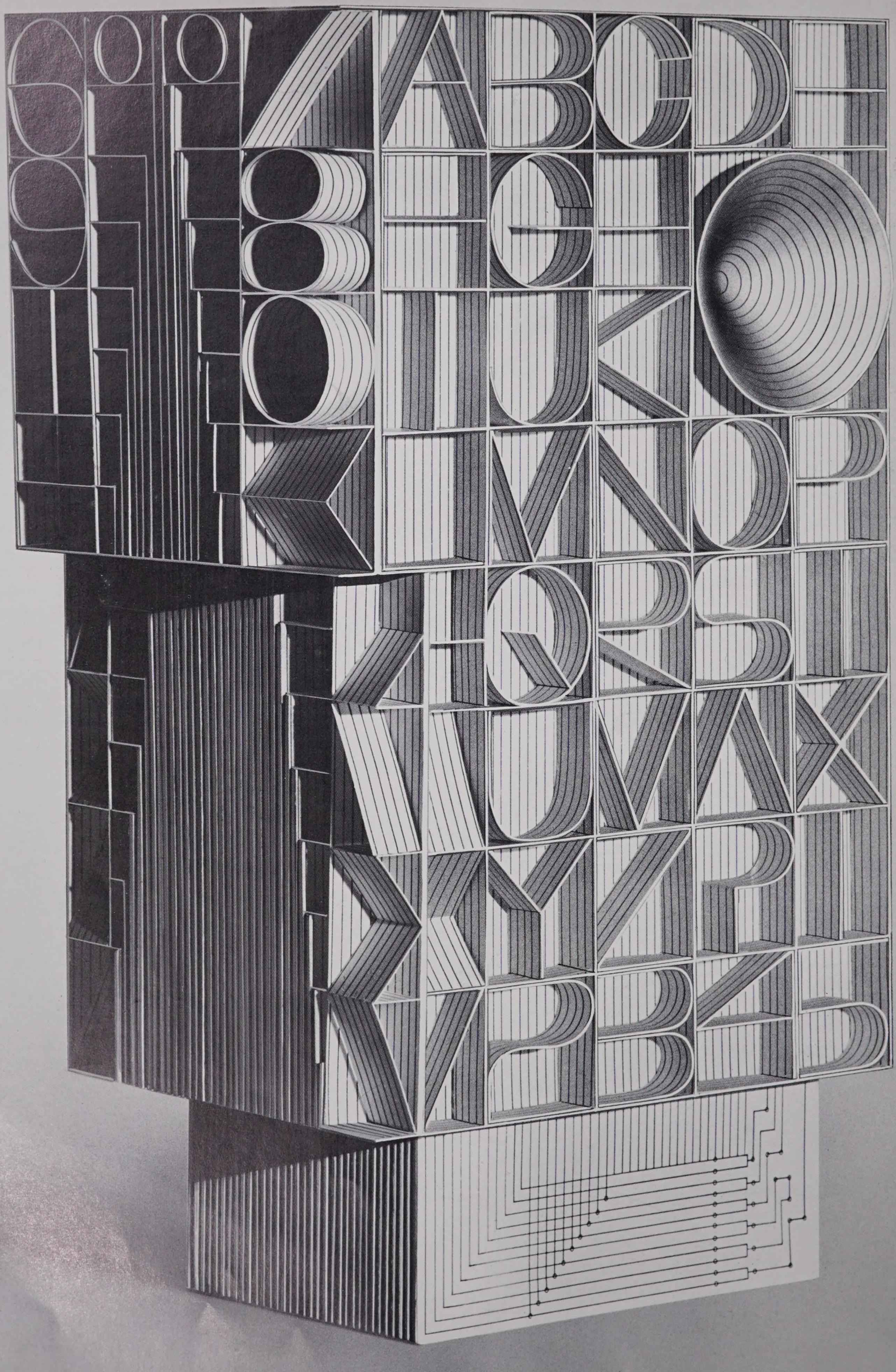


Voice Recognition: Machines That Listen

A report on machines that listen and respond to the human voice.

by Robert L. Moora and Norman H. Solon

In the near future, an American astronaut will literally be able to talk his way through outer space. Free from the confines of his capsule, he will be able to maneuver himself simply by speaking commands such as "up," "down," "yaw right," and "roll left" into a microphone enclosed in his space helmet. A voice-controlled device would respond to the order by activating a switch that would move the spaceman in the desired direction. Both of his hands would be left free for making repairs, taking photos, transferring cargo, or, perhaps, rescuing a stranded fellow astronaut.

This is one of the more dramatic examples of the potential of voice and sound in the control of operations and communications systems. For more than three decades, scientific and industrial organizations — especially electronics companies — in the United States and abroad have been experimenting in the field of voice recognition. The ultimate goal of these researchers is to build a machine that would be able to hear, understand, and act in response to the continuous spoken word. This would solve two major problems.

First, such a device would enormously simplify man's communication with machine, a process that has become increasingly cumbersome as technology has advanced. Instead of preparing an elaborate set of programmed instructions or actuating a myriad of dials, keys, switches, and levers, a man could direct a machine to perform a set of operations just by speaking to it. If he wants to dial

Robert L. Moora and Norman H. Solon are on the RCA Public Affairs staff.

a telephone, he could simply voice his own code number and a central computer system would instantly retrieve his speech profile. Then, he would speak the desired phone number and the machine would recognize the digits and automatically complete the call. Scientists at Bell Laboratories have been attempting to design such a system. In another case, a man who desires information could merely phrase a question to a computer, which would then retrieve the data and print out a reply or respond with synthesized speech constructed from some 200 to 500 prerecorded basic sounds.

Equally important, the voice-recognition device could end the pressing problem of the overcrowding of the frequency band width — vital to almost all areas of communication, from radio to telephone. For example, a police officer in a patrol car could respond to a call from headquarters by speaking into the recognition device. There, his speech would be reduced to a digital code and reconstructed at the other end of the communications system into synthesized speech. By transmitting the code, rather than human speech, the band width requirement is reduced by a ratio of 1,000 to one.

A machine that could produce an accurate printed or oral record of continuous speech is still quite far on the research horizon. However, scientists have successfully built several electronic systems that recognize limited vocabularies. One system developed by RCA that reacts to a spoken postal sorting code, and may soon be put in operation by the Post Office Department, is discussed in detail later in this article.

All speech-recognition machines — regardless of complexity — are based on identification of acoustical clues. Speech is broken down into its smallest possible component, which — depending on the sound and the sophistication of the machine — could be a syllable, syblet (phonetic syllables that are usually determined by the vocal transition from a hard to soft or soft to hard sound), or phoneme (smallest distinguishable word component). To comprehend or express ideas adequately in a language, a vocabulary of some 10,000 words is required. This can be reduced to a more wieldy 1,500 syllables, 800 syblets, or 41 phonemes. The energies of these components are electronically analyzed in three dimensions: time (duration of the sound); frequency; and amplitude (loudness). An electronic pattern of these components is thus established, and recognition consists of matching the pattern with the acoustical input.

However, recognition of continuous speech is much more complex than the simple comparison of two patterns. The individual components of speech, when strung together in words and sentences, greatly change in their acoustical values. And no two persons speak exactly alike. The optimum voice-recognition machine would have to allow for such variables as accents, speech defects — and even the physical and emotional state of the speaker. Thus, most of the research being conducted today is aimed at determining the information-bearing features and characteristics of sound within the three fundamental parameters of amplitude, frequency, and time. In other words, scientists are attempting to learn the common denominators of particular sounds that will lead to their identification no matter how they are pronounced. This is lengthy trial-and-error work, consisting of analyzing and reanalyzing sound, mostly by computer and other speech-recognition hardware.

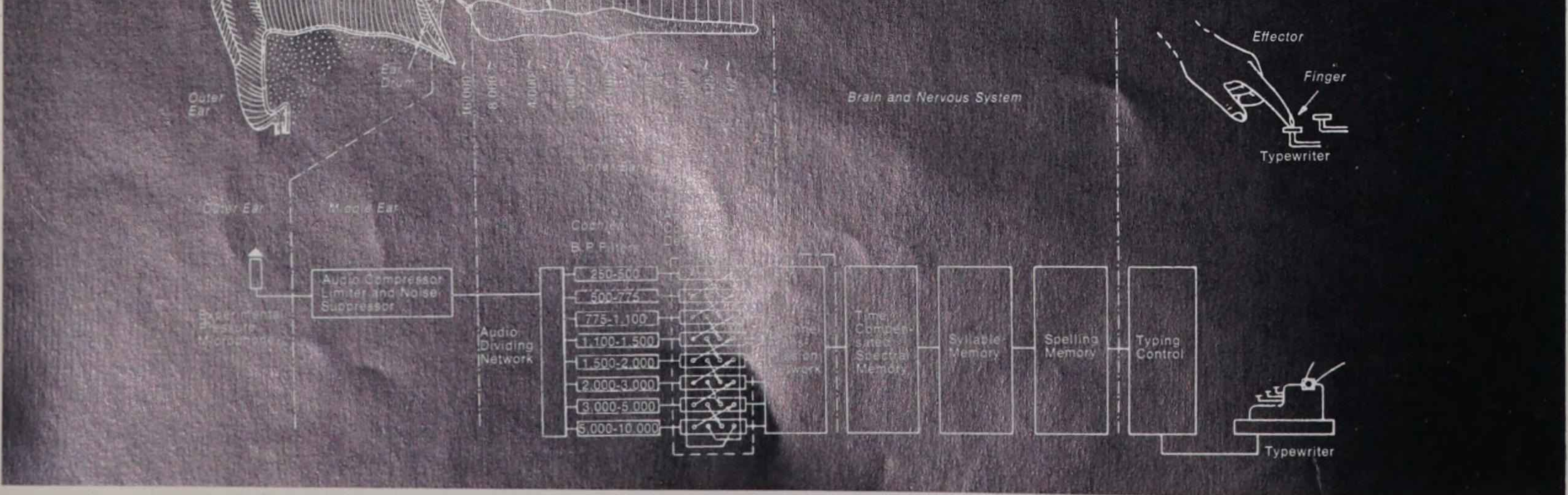
The actual dynamics of listening and reacting to speech are amazingly similar in man and machine. The human ear canal and middle ear transmit sound and also promote clarity by de-emphasizing extraneous low frequencies and compressing sound levels. These functions are duplicated in a machine by the microphone, audio amplifier, and audio compressor and limiter. (Sound levels are compressed — normalized in amplitude — to minimize the effects on the speech analysis process of the speaker's distance from the microphone and the variations of loudness in talking.)

In man, the inner ear is, in effect, a sound analyzer able to distinguish among as many as 1,500 frequencies, to measure amplitude, and feed its finding to the brain, via 4,000 nerve end fibers. In greatly simplified terms, the brain then processes the data, makes a decision, and, for example, directs a finger to type.

Although the brain is infinitely more complex than even the most sophisticated voice-recognition machine, their control processes are comparable. The frequency analyzer of the machine breaks down speech into frequency bands and an amplitude sensor compares their levels. The information is then coded and passed through a time-compensated spectral memory device where it is further subdivided in terms of time. The quantitized information, in numerical form, is then funneled into the speech element memory of the unit. There, the recognition of the correct syllable, syblet, or phoneme from the numerical code is simply a sorting-out process. When the word element is determined, a spelling or word-memory relay, associated with that element or group of elements, is activated. In the case of a phonetic (voice-operated) typewriter, this relay would be wired up to sequencing and letter-code buses in a typing control unit, which in turn operates the electric typewriter.

The one drawback to all voice-recognition units is that, unlike a brain, they cannot think and cannot be programmed with unlimited knowledge. Thus, all words have to be typed in a predetermined spelling form, based on phonetics rather than rules of English. A closer approach to conventional spelling would require a much more sophisticated memory unit — large enough to include sentence structure and grammar.

The use of sound to control inanimate objects is hardly new. Nearly a half-century ago, the toy industry put on the market a kennel with a metal dog inside. When the dog's young master commanded "Here, Fido," in a sharp tone, the door would fly open and the pup would obediently pop out. More recently, safety devices have been produced that can stop a tractor by the sound of a loud voice. The farmer could yell "stop" or give a



Schematic drawing illustrates the similar manner in which human beings and machines listen and react to an oral command; in this instance, the operation of a typewriter.

"The actual dynamics of listening and reacting to speech are amazingly similar in man and machine."

hog call, it makes no difference. Both of these applications are based simply on the physical reaction to sound vibrations and bear no more relation to sophisticated voice-recognition devices than a kite does to a jet liner.

Research in voice analysis and recognition dates back to the late 1930s, when a team headed by Dr. Homer Dudley of Bell Laboratories developed the Vocoder, a device that broke down speech into a frequency code for transmission and reconstructed it at the other end. This early attempt to prevent the present band width population explosion was only partially successful, because of comparatively small band width reduction, and the complexity and expense of the hardware.

In 1956, a team headed by Dr. Harry Olson of the RCA Laboratories in Princeton, N.J., achieved the first major breakthrough in voice recognition by building the first phonetic typewriter, with a memory unit of only seven syllables. The most advanced experimental unit at Princeton today can recognize 200 speech elements, enough to handle about one-half of the words in the average person's vocabulary.

However, only recently has voice-recognition research advanced into practical applications. The Astronaut Maneuvering Unit (AMU), developed by the Advanced Technology Laboratories of RCA, is one of the latest examples. The AMU voice controller, which can comprehend and obey 14 commands, can be "trained" to recognize any of the voices of the three-man Apollo spacecraft crew and that of a ground-control speaker. Thus, it can be operated by the astronauts, or by remote control from the spacecraft or launch command. An inexpensive set of voice-pattern cards could be prepared in advance for each probable astronaut on a projected mission, to compensate for last-minute changes in the crew. The AMU, which initially will supplement the present manually controlled unit, will not create a weight or space problem. Ultimately, it will weigh less than five pounds and fit into a package no bigger than a cigar box.

Another system currently under development may allow the Air Force to transmit voice conversations from spacecraft to ground stations with a small fraction of the power now needed. A prototype model has already been delivered to Wright-Patterson Air Force Base at Dayton, Ohio. It was purposely built large — six equipment racks, each six feet high — to provide accessibility for experimentation. But with the use of microsized integrated circuitry, it could easily be reduced to one-third the size of one of these racks. RCA engineers, who call it the most accurate voice-recognition device yet developed for electronic commands, see it as a pioneering approach to such developments as voice control of computer programming.

Voice recognition, however, is more than a space age tool. RCA scientists are applying concerted effort to one project that promises to help efficiency in the post office. It is a system to enable postal workers to distribute packages much more quickly into the proper sorting bins or sacks and speed them through many of the nation's larger post offices, which are equipped with mail-sorting machines.

In the larger post offices — such as Washington, Miami, and Philadelphia — the process of routing packages is now performed by a number of two-man teams. One man separates and directs the package onto a conveyor belt, and the second man reads the ZIP code and key-punches it on a device resembling an adding machine. The key-punch activates a parcel-sorting system that, as the package travels down a conveyor belt, kicks the parcel into the proper chute or bin to send it toward its proper destination.

With electronic speech recognition, this work can be accomplished far more efficiently. A clerk, wearing a head microphone that leaves both hands free, can speak a memorized sorting code number and place the package on the conveyor. An indication of the spoken number is instantly flashed on a monitor in front of the operator as an accuracy check. The conveyor then proceeds to feed the sorting machine automatically.

For example, if the operator speaks code number "34" after reading the address on the package, the bag will be deposited in the bin for New York State. If he speaks "35," the package will be dumped into the bin for California.

As in all speech-recognition projects, the engineers have encountered problems in implementing the sorting code recognition system. For one thing, although the sorting code requires recognition of only 11 words — "one" through "nine," "zero," and "oh" — the pronunciation of these digits, with no pauses between, introduces problems in determining when a digit begins and ends.

For another, the problem of background noise — which might automatically trigger the system with sounds that resemble the intended ones — is a formidable one, since a busy post office is an extremely noisy place. However, the noise problem probably can be solved through use of a closeup noise-canceling type microphone that hugs the speaker's cheek and cancels out irrelevant sounds.

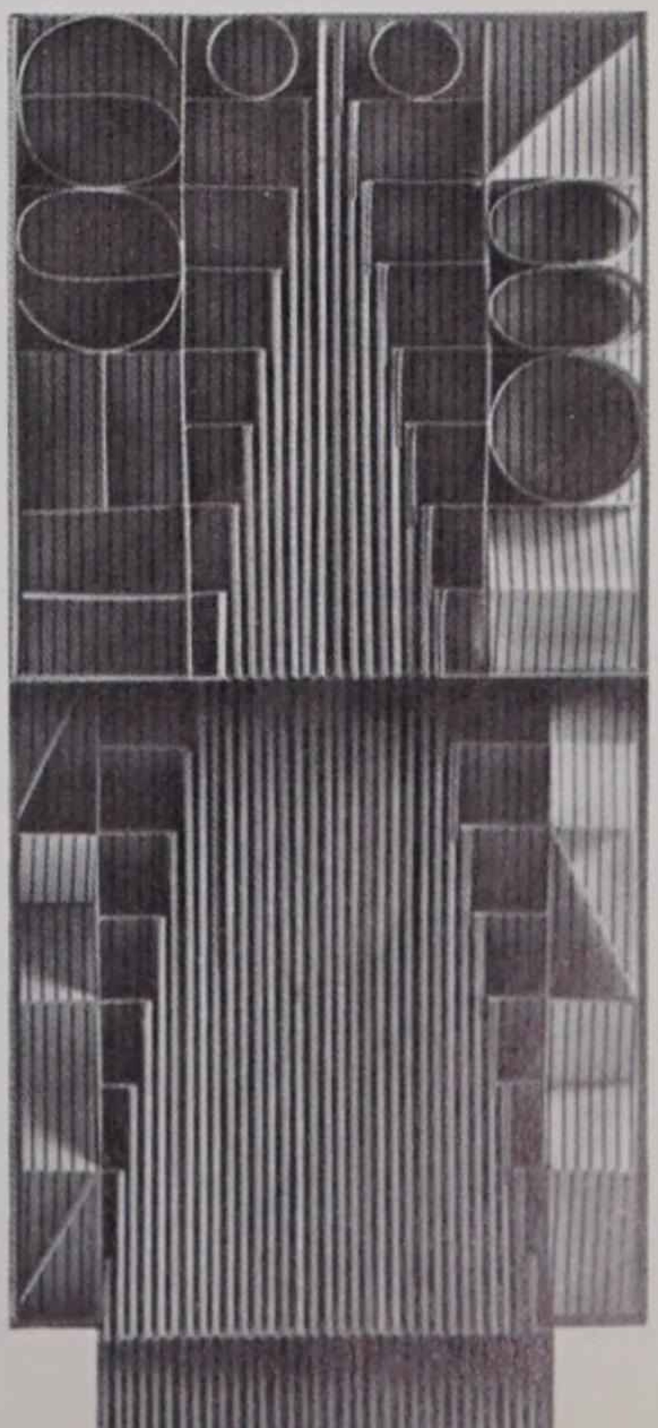
Third, there are many differences in the accents peculiar to various sections of the country. These differences must be taken into account in the design of the digit-recognition system and are creating one of the biggest headaches for engineers working on speech-recognition, or voice-controlled, electronic systems. But the problem is not insurmountable says Marvin B. Herscher, who heads pattern-recognition research for RCA's advanced technology programs. Again, it is simply a matter of isolating information-bearing features common to all speech.

Finally, any computer (and the speech-recognition system is essentially a computer) is a simple-minded creature that can "think" only in terms of absolutes, such as yes and no. Since speech is mostly "gray," methods are being found to make the system respond only to the sounds essential to form the required digit or word.

There are many other voice-recognition projects at the drawing-board stage. For example, scientists are attempting to develop a translator that, in correct sentence form, will instantly convert foreign speech into continuous English. In essence, the foreign and English word memories would be compared, the translation made, and the correct sentence structure formed by a word-sequencer device. The synthesized voice output would then be created from prerecorded speech elements. This system is still years away from development, but word-for-word translating machines have already been built.

Music, as well as speech, can be analyzed and synthesized. In fact, it is easier to control music electronically since all tones can be completely described in terms of the frequency, intensity, portamento (passage from one tone to another in a continuous glide), timbre — and duration of growth, steady state, and decay of each note. All of these properties can be coded and converted into music on the experimental Electronic Music Synthesizer developed by the RCA Laboratories in Princeton, N.J. The EMS could be a step in the development of a commercial "computer music" phonograph. According to one prominent scientist, a coded disk the size of a conventional 12-inch record could produce as many as 200 hours of music on this type of phonograph.

Although voice-recognition and synthesizing systems are just beginning to emerge from the laboratory stage, their effect on business, industry, pure science, and the military is more than a promise. As Dr. Olson puts it, "There is no doubt that these systems will become a reality since developments have advanced beyond the questioning stage." ■



The Alphabet in the Electronic Age

Is the age-old alphabet adequate to handle the demands of modern society in which machines as well as people read and write?

by Ed Campbell

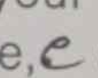
1. Letter forms change from their hieroglyphic beginnings.
2. Sumerian inscriptions on this stone describe events that occurred in Asia Minor hundreds of years before the Christian era.
3. Lettering from the German Bauhaus School, 1925.
4. Graffiti of the 1960s.
5. Baroque initials of the seventeenth century.
6. Chinese ideograms for "autumn" and "heart" combine to form the word "melancholy."
7. Egyptian hieroglyphics.
8. Caslon's Old Face, designed in 1725, is still a standard typeface.

How long has it been since you thought about the alphabet? If you are typical, not since grammar school. And why should you? After all, it has always been around, hasn't it? And it works quite adequately. Or does it?

The fact is that it has not always been around in the form that we now know it. And it doesn't do everything it should — especially in this age of information.

What is wrong with the alphabet? Many things. There is a lack of correspondence between the alphabet and the sounds it is supposed to represent. The letters themselves — the actual character shapes — introduce serious legibility problems. And today, man is not the only user of the alphabet. Electronic computers are beginning to "read and write" handwriting as well as type.

If these problems exist, why isn't society doing something about them? For one thing, 99.99 per cent of the population aren't really aware of the problem. They take the alphabet for granted because, for most purposes, the 26 letters used to form the English language suffice. And the 0.01 per cent who see the need for reform don't agree on how to do it or what should be done.

As far back as 1768, Benjamin Franklin — scientist, statesman, writer, as well as printer — looked at the deficiencies and decided a new, expanded alphabet was the answer. On the other hand, the playwright George Bernard Shaw saw the problem in a different way. He left £8,300 in his will for work on simplifying the alphabet. Reform, however, is not impossible, as your secretary may know. In her language,  stands for apple. She is privy to the closest thing in centuries to alphabet reform. Stenography, with its many systems of shorthand writing, came into being because the alphabet is just too complex a system to use for capturing speech. Here is an anomaly to ponder: words formed by the letters of the alphabet can be read at speeds up to 4,000 words a minute, but letters can't be formed fast enough to keep up with a 120-word-per-minute speaker.

There are also other built-in deficiencies that make the alphabet an eminently unwieldy instrument for many purposes. For example, the letters have to symbolize at least 44 common phonemes. (A phoneme is a basic distinguishable unit of sound that affects meaning.) When one sees the letter "A," for instance, in a totally strange word, how should it be said? Is this ā, or a̍, or â, or ă, or ä, or ȧ, or ô, or ŏ, or ĭ? Imagine a barbarian trying to pronounce "barbarian." And explain, if you can, why "wh" in "which" has an "hw" sound. Or speaking of "h" and "w," give the correct pronunciation of "You hew the hued yew, Hugh."

It seems the alphabet works better in some of its secondary uses in which it has literal as well as symbolic meaning. For instance, the familiar character forms describe everything from clothing to structures. Consider these: A-frame, C-clamp, I-beam, O-ring, S-curve, T-square, and V-neck. (The Germans go two better with *X-beine* for "knock-kneed" and *O-beine* for "bowlegged.")

Educators are beginning to overcome the handicap of a nonphonetic alphabet in the teaching of the English language. The new Initial Teaching Alphabet (ITA) — with 44 symbols, all based on specific sounds — is being used in primary grades of some schools to get young students past the initial shock of the alphabet. The students use ITA for one year and then make the transition to the normal alphabet. In the process, they learn to read and comprehend faster than students who use conventional means all the way.

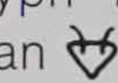
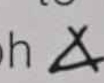
Incidentally, if anyone is worried about how people would learn to use an expanded alphabet, consider the experience of the Orientals. Japanese children learn to read their 2,000-character ideographic language faster than Americans learn their alphabet. And even the Chinese deal satisfactorily with a 30,000-ideogram language. This is because each ideogram has a separate and distinct meaning.

The alphabet is also inefficient for computers. One of the reasons they are more adept at reading holes in punched paper tape or cards, rather than standard type characters or handwritten letters, is that there is similarity in the shapes in our letter forms. An optical scanner has an extremely difficult time distinguishing among i and l, and 1, or between O and 0. Computers and first graders have one thing in common: they both start out illiterate — and have to be "programmed" to use the alphabet. For both the machine and child, the alphabet has been tried and found wanting in quality, quantity, shape, and ease of readability.

How, then, has the alphabet endured? Why is it accepted without thinking by the vast majority of its users? Can the alphabet, as it is presently constituted, endure in an electronic environment? Can it be a useful tool in an era of instant global communications and electronic computers that operate at fantastic speeds? In order to answer with any degree of certainty, society has first to look at where the alphabet came from, how it has survived, and how it has been adapted to meet change.

Symbolic letter writing began with the Sumerians in Asia Minor around 1500 B.C. Before that time, events had been recorded by the simple expedient of drawing the occurrence. Later, Egyptian hieroglyphics, which were mostly a mixture of symbols and syllabary, were developed. But there were few methods of conveying abstract ideas. The Sumerians developed a highly sophisticated cuneiform script containing all the elements necessary for script writing: ideographic forms, which represented ideas themselves (such as our punctuation marks); syllabic forms, with signs indicating open or closed symbols, diphthongs, and isolated vowels; and alphabetic forms that represented the sounds of the voice. Every element needed for all the varieties of scripts used in the world today or in the past was said to be present actually or potentially in the 300 signs of Sumerian script.

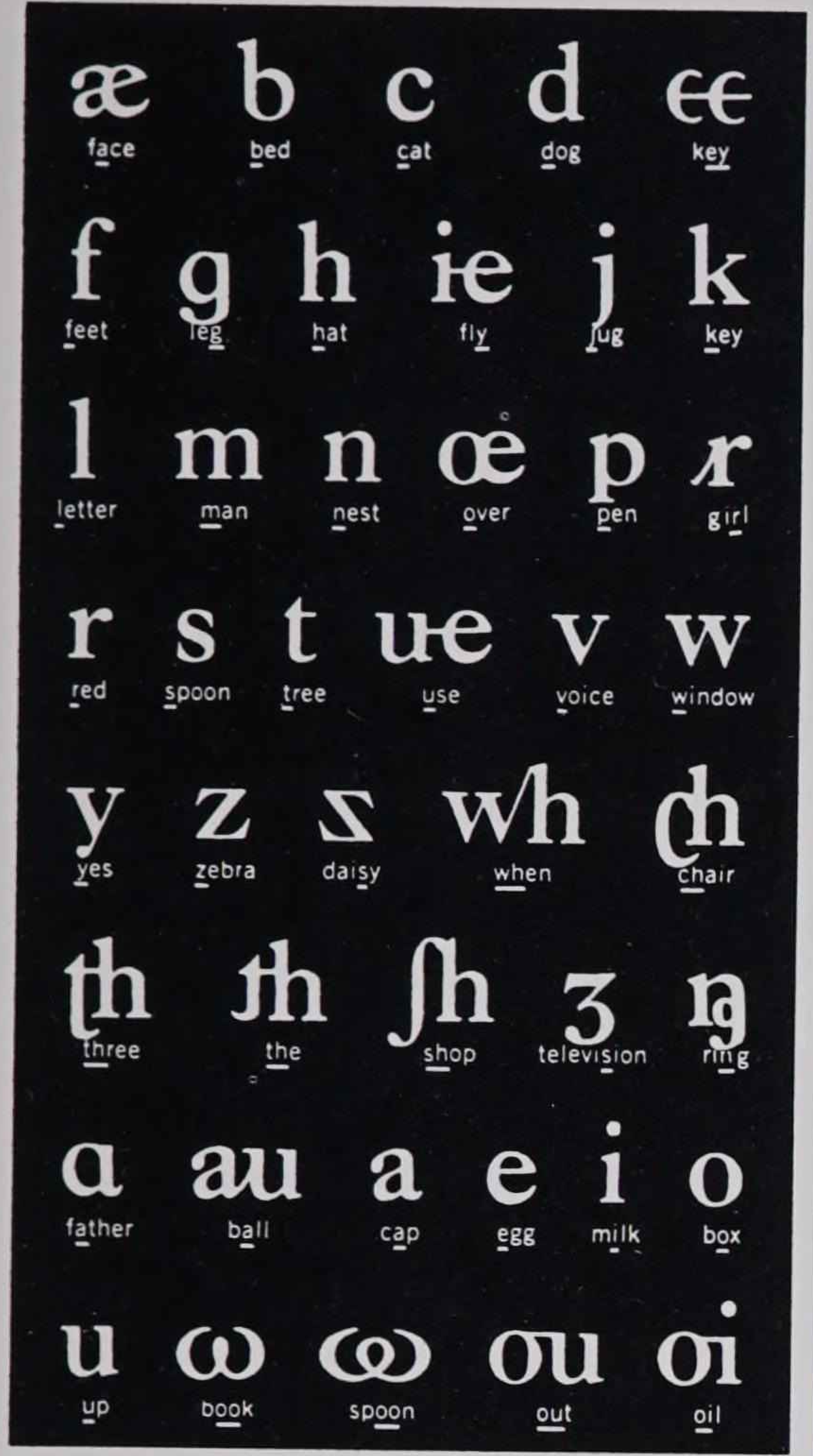
The alphabet of today comes from the Sumerians by way of the Greek and Semitic alphabets — a lineage that the word "alphabet" itself reveals. (*Aleph* and *beth* are the first two letters of the Semitic alphabet; *alpha* and *beta,* the first two of the Greek.)

The lineage is also revealed in the letters themselves. Some authorities believe that the pictographic origin of the alphabet can be seen by tracing the Egyptian hieroglyph for ox  through to the Sumerian , to the Semitic aleph , to the Greek alpha , and to the Roman A.

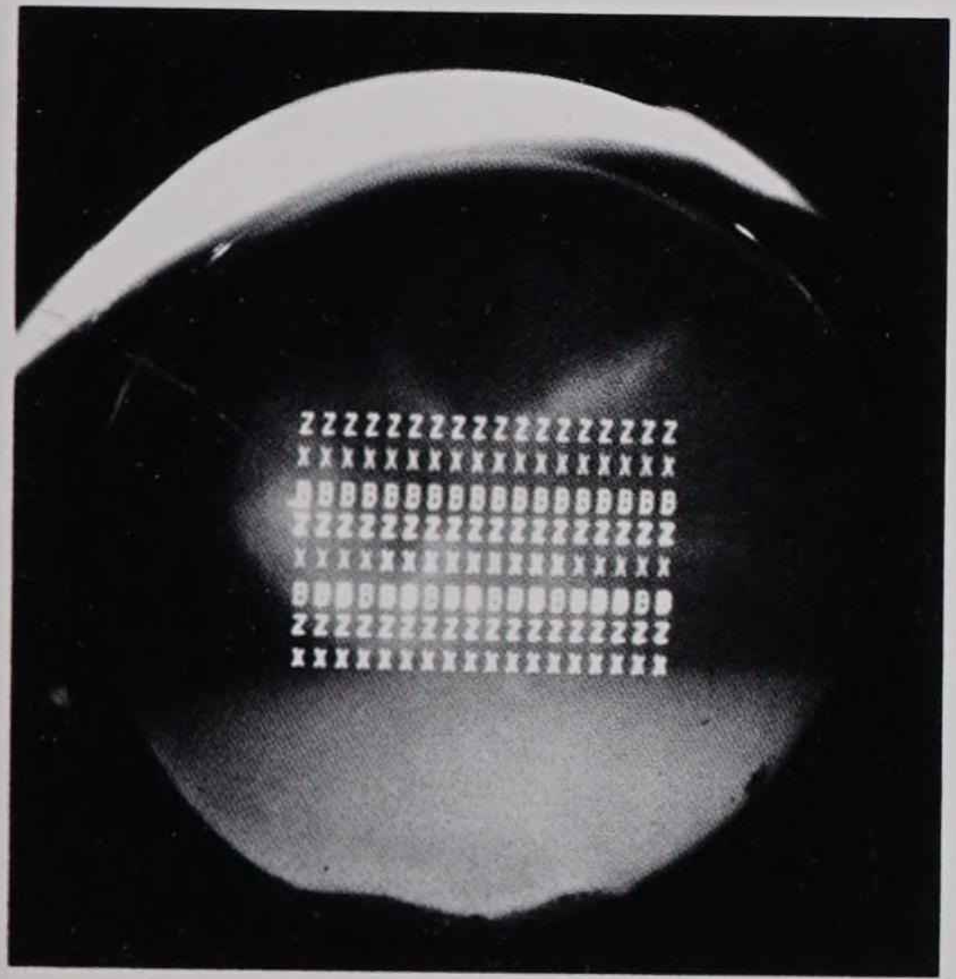
The most recent addition to the alphabet, "W," first appeared in eleventh-century England. And despite the efforts of reformers, the 26-character alphabet has endured since, partly through simple inertia. When an entire populace has learned to put up with the vagaries of a language or alphabet, it does not readily change it. Retraining and conversion are slow and extremely expensive. Then, too, a tool as basic as an alphabet tends to take on an almost religious significance. In this century, reform of the Arabic alphabet was met with a loud outcry because it was seen as man changing a way of writing that Allah himself had revealed.

It has not endured in one shape, however. Over the centuries, individual letters have been pushed around like so much Silly Putty, kneaded into one form or another, but always retaining — almost — their basic shapes.

Ed Campbell is with the RCA Graphic Systems Division.



The new Initial Teaching Alphabet has 44 symbols, all based on specific sounds.



The electronic VIDEOCOMP systems generate type at speeds up to 6,000 characters a second.

Three forces have been at work.

The first, and most important, was the tool used. Stylus, chisel, goose quill, brush, finger, crayon, nib pen, pencil, ball-point pen, felt-tip pen; type produced by hand, by machine, by camera, and now electronically on a cathode ray tube: each has had its effect on letter form. The mostly straight lines of the classic Roman, incised in granite, gave way to fluid brush strokes, which, in turn, were superseded by the thicks and thins of quills and pens. In modern times, these gave way to the execrable scribble of the ball point and, most recently, to a return to the more fluid line of the felt-tip pen.

The early imperfections of handcut type were, for the most part, eliminated by the mechanical accuracy of machine-made type. And more recently, the trend is going to the almost infinitely variable characters that can be produced electronically. The RCA VIDEOCOMP systems, for example, can turn out type at speeds of up to 6,000 characters a second—hundreds of times faster than a manual line-caster machine.

Each of these writing tools, each new technology, has had an inevitable and lasting imprint on the alphabet. In addition, man himself has willed changes in letter forms. Indeed, most of the typefaces in use today came into being because of the remaining two forces that work on type design: fashion and competition. An informed observer of type can, in fact, point out the similarities of a typeface to the furniture, architecture, and dress of the age in which it was produced.

The first typeface was J. Gutenberg's Gothic Blackletter. But in a few years, Nicolas Jenson developed the first evolved Roman face. And by 1495, Aldus Manutius built on Jenson's design and created Bembo, which noted type designer Frederic Goudy a half-century ago called "the loveliest Roman of them all." Competition between type designers and foundries has had its hand in the proliferation of typefaces.

Early typefaces usually were known by the name of the designer. For example, there is William Caslon's Old Face, designed in 1725; John Baskerville's transitional typeface, first out in 1751; and Giambattista Bodoni's modern face, a product of 1790. The contemporary Roman and sans serif faces, like Times New Roman (1932) — the most widely used typeface in the world — and Univers (1957), are modern versions of older styles.

These three forces — technology, fashion, and competition—have been responsible for virtually every curlicue added to or subtracted from the letters in the alphabet. Today, there are literally thousands of typefaces available, but all the changes have been surface changes, with little effect on the basic form of each individual letter.

At present, a curious thing is happening. A new force has gone to work on the alphabet, a force that is at once symbolized and aggravated by the demands of the age: a concern for reading.

There is no record of research into the legibility of type until the late eighteenth century, and those experiments were quite primitive. One of the early experiments conducted in the 1790s was made by setting two single-page specimens in different typefaces and comparing visibility. There was little of note done between then and 1878, when Professor Emile Javal of the University of Paris first studied the visibility of letters under dim lighting.

It was not until the 1930s and 1940s that any legibility studies of real significance were conducted by industry and educational groups. Now, there is beginning to be more definitive documentation on the effects of such factors as type size and style on legibility. Today, most of the research being conducted toward possible redesign of the alphabet is aimed at making it more compatible with electronic machines as well as man.

This is because society is just beginning to use electronics as its latest typesetting tool, with initial applications in the printing of books, directories, and manuals. Electronic composition systems are truly a product of this age of information. They combine readability with the speed of computers and the flexibility of television. The shape of each character is stored in a computer-like memory. When characters are called out, analog circuits use the signals to generate properly sized letters and position them on the face of a cathode ray tube. Then, a precision lens "picks" the images from the tube and transfers them to film. As important as speed, these new systems make it possible to change letter forms infinitely. And because characters are stored electronically, they can be changed almost at will — it's like having rubber type. Even Japanese ideographs are easy to write electronically, as are the special magnetic-ink optical-character recognition symbols used by the computer.

There is a definite need to change, or at least streamline, the alphabet. It could save man time and effort in reading at a time when his need for information is greater than ever before. And it would permit computers to recognize, more easily, type and handwriting. What is needed is an alphabet in which "p"s and "q"s don't look so much alike, "k"s and "h"s can't be confused, and there is more than a squiggle of difference between handwritten "a"s and "o"s. In fact, it would be well to design an alphabet with a closer letter/phoneme relationship, to aid in the development of voice-recognition machines. Ideally, you would be able simply to dictate into a machine and have it produce accurate typewritten or printed material.

That would be quite an accomplishment, indeed. But if the Sumerians could develop a new alphabet, who's to stop us? ■

The Rating Game

TV ratings—scientifically determined from a cross section of American homes—do not evaluate programs; they reflect the viewing habits of the public.

by Ray Kennedy

There is no denying the importance of ratings in the television industry — and elsewhere. Each season, the casts and production crews of new TV shows await their first ratings with all the nervous anticipation of a troupe of Broadway players, who stay up on opening night to read the first-edition verdicts of the newspaper critics. And newcomer or not, the suspense is always present. Even TV veterans such as Ed Sullivan admit to a slight case of the jitters each time they pick up the telephone to hear the rating results.

The difference, of course, is that, in television, unlike the theater, the critics are not a vital factor. What every TV producer seeks is public approval, expressed through actual viewing. And the first rating means very little; consistency of satisfactory audience levels is what matters.

However, ratings have become the most misunderstood and misrepresented phase of television as far as the public is concerned. The implication is that a rating is a critical evaluation or some other subjective judgment of a program. In fact, it is no such thing. A rating is merely a measurement of audience size — not a qualitative evaluation. It does not indicate whether a program is liked or disliked by its audience.

Voices from the past are heard whenever rating critics dig into their archives of quotes. One is the late Fred Allen's cutting observation: "The rating services see two children walking down the block eating oranges, so they come to the conclusion that more people are eating oranges than ever before."

The detractors are not without their own detractors, which, according to one network official, is like one man saying the world is flat and another saying it is bumpy. Mark Goodson, the producer of several network game shows, notes that the critics of the ratings could themselves be rated on an ever-changing, hot-to-cold scale. "I've never yet met a man in television," he explains, "who, on the one hand, didn't attack the ratings when he was doing poorly, and brag about his standing in the rating picture when he was doing well." More succinctly, director-writer Abe Burrows defines a rating as "a figure that tells the size of your audience, which is completely inaccurate if it is too low."

The disparate reaction to the rating system is entirely understandable. Mainly, it is due to the fact that the methods of the system are not so understandable. Based on widely used, but rather sophisticated, techniques of market research, the gathering, the tabulation, and interpretation of rating data involve the kind of statistical expertise that is beyond most laymen. These rating techniques must be complex since they involve the measurement of public or mass taste, which is as diverse as the shape of snowflakes.

The need for and the use of ratings are obvious. Ratings are to TV what circulation figures are to newspapers and magazines. For sponsors, who this year will spend $3 billion in TV advertising, the ratings are the critical marketing guide. They are used to plan advertising campaigns in much the same way that finite circulation figures are used to buy space in magazines and newspapers. "If the ratings were thrown out," says John Allen, a vice president of the McCann-Erickson advertising agency, "we would all be in the jungle for a couple of years until we figured out something else."

Even if there were no commercials on television, there undoubtedly would still be some form of ratings. Television people, like anyone else in communications, need to know the size of their audience since size is one measure of their creative efforts. It has to do with man's natural sense of curiosity as well as achievement. Plays and movies are rated at the box office in dollars and cents; telecasts, however, are free and thus, by necessity, must rely on their own unique kind of polls. That this necessity exists beyond

Ray Kennedy is an associate editor of *Time* magazine.

"TV advertisers are becoming increasingly interested in the composition of the audience of a show, rather than simply in over-all totals."

advertising is perhaps best proved by the fact that the British Broadcasting Corporation, a wholly noncommercial network, regularly conducts audience surveys nearly as elaborate as those done by U.S. rating services.

Elaborate is the word for the surveys conducted by the A. C. Nielsen Company, of Chicago, the largest and most widely known TV rating service. In 1,200 households, scrupulously selected by computer to represent a cross section of all 60-million U.S. homes with or without TV, Nielsen is a silent member of the family. Each of these "Nielsen homes," a sample that undergoes a complete turnover every five years, is equipped with an audimeter, an electronic device about the size and shape of a car battery. Wired to the TV set and hidden away in a closet or the attic, this black box records on film a minute-by-minute account of when and where the set is tuned. Every week, the family gets a new film cartridge in the mail that ejects two 25¢ pieces as it clicks into place. (As added incentives to stay in the sample, Nielsen gives long-service awards and also foots half of the family's TV repair bills. The validity of the Nielsen ratings is dependent on these households remaining in the sample.)

The cartridge with the TV tuning records is mailed to Chicago, where analysts read its coded dots and streaks and feed the results into two computers that print out the ratings and estimated audience sizes. In the statistical breakdown of the "sample universe," one Nielsen family reflects the viewing habits of some 57,000 other families, and one rating point represents something over a half-million homes. Actually, no one home can represent any other home in the U.S., but, in total, a properly executed sample can reflect the behavior of the total population within certain known mathematical limits. The rating itself is an estimate, on a percentage basis, of the number of homes viewing a program. A rating of 20, for example, indicates that 20 per cent of all the American homes with TV sets tuned in the program, in a given minute.

Despite all the science involved, the viewer, who really owns the TV system in the United States, persists in asking, again and again, how can a mere 1,200 Nielsen families possibly reflect the TV tastes of some 200-million Americans? "The same way," answers A. C. Nielsen, Jr., "that you know the content of a tank car full of milk by withdrawing just one pint."

The Nielsen Company—which commands 90 per cent of all dollars spent on national TV ratings, including $1 million annually from the three networks—also sells its services to some 600 advertisers, agencies, and stations. In return, the subscribers get masses of data compiled from other supplementary services, such as the Audilog-Recordimeter (A-R).

Placed in 2,200 homes in specific market areas, the Recordimeter is a small, clocklike instrument that tallies up the numbers of hours that a TV set is on. But since it cannot record what channel the set is tuned to, every half-hour a white light flashes behind the picture tube. The signal acts as a reminder for the viewer to write down, in the Audilog, the channel he is watching and any channel changes he has made during the 30-minute period. Together with what Nielsen interviewers have already learned about the A-R families, the computers are then able to measure not only audience size but such demographic particulars as how many viewers of a certain show own sports cars.

Other Nielsen services include TV ratings for 225 local markets, which in the New York City area are compiled by Instantaneous Audimeter. This system allows "morning-after" reports by directly linking the sample TV sets to a central computer in Chicago via leased telephone lines. Every five minutes during the day and every 90 seconds at night, the computer "calls" the TV sets and takes instantaneous readings. An Instantaneous Audimeter family does not have to be aware of a meter or mail in anything. As a result, they forget that they are even members of the panel. This rapid method of tabulation is expected to replace the in-home audimeter system on a national basis. It is felt that the inception of overnight national ratings will tend to make television programming even more responsive to public demand in that the networks will be supplied with tuning behavior data in time to make fast changes.

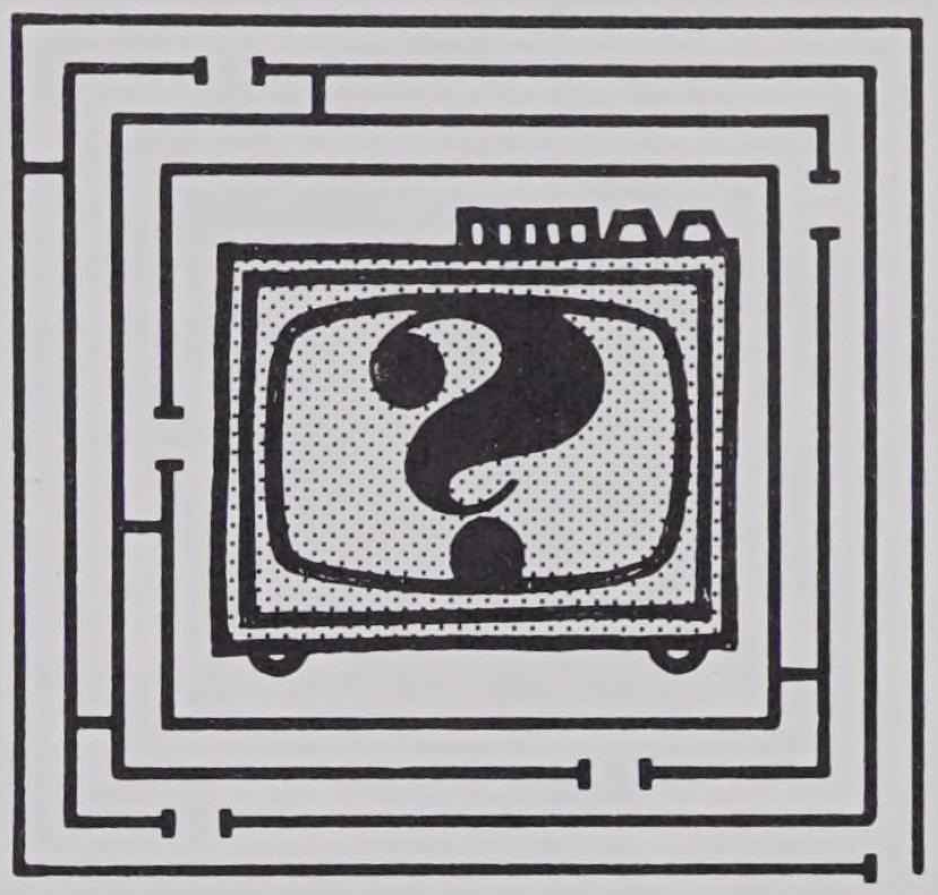
Though Nielsen is the best-known rating service, several others are also used by the TV industry. The American Research Bureau is the largest service in local audience measurement. For local ratings in 226 TV markets outside of New York City, ARB uses the diary technique, which it developed. (In New York, it also has electronic instantaneous measuring systems.)

The Pulse rating service is based on door-to-door recall surveys in which viewers are asked what they watched that afternoon or previous evening. Trendex, Inc., uses the "telephone coincidental" method. To spot check viewing habits while TV sets are on, it employs 200 women, who call from their homes in major cities where all three networks are on the air. A Trendex rating for a half-hour period is based on an average of 1,000 completed calls.

There are other rating services, but most are variations on the telephone, diary, door-to-door, or recall approaches. Among the more novel techniques is an electronic detector system that may be installed in 56 cities by the Television Audit Corporation. The system, which is still being tested in Miami, "reads" the signals emitted from oscillators on TV sets via a tower or mast. If all of its proposed 56 masts are erected, TAC claims that it will be able to monitor the channel settings of up to 50,000 sets, feed the data to a central computer, and produce minute-by-minute ratings.

The Tanner Electronic Survey Tabulator, or TEST, operates on a similar principle. Its comparator, which is mounted on panel trucks that cruise around city streets, can, according to Tanner, count channel settings at the rate of 106 TV sets a minute. A drawback, as one network researcher points out, is that "It is equally important to know how many sets are turned off as it is to know which sets are tuned in to what channels—and TEST ratings cannot tell us that."

The rating game often precedes the start of the new season. Many TV producers subject their programs to a kind of pre-rating rating test at Audience Surveys, Inc., in Los Angeles. Here, volunteer audiences sit through previews of new TV shows and play critic by twisting rheostat-like dials—left for disapproval, right for approval. Their mass reactions



are automatically plotted by a needle on a 25-inch graph, which shows precisely where the plot sags or climbs to a climax. CBS pretests its new shows in its own testing laboratory at the network's New York headquarters.

Don Durgin, President, NBC-TV Network Division, endorses the rating systems, stating: "Ratings do not measure *absolutely* the size and success of programs. But we do know that they are accurate within limits because we've tried many different services with many different methods, and they all produce almost the same results." However, some viewers invariably blame the "tyranny of the ratings" whenever there is a shift in programming that does not meet with their approval. "That," says Mort Werner, an NBC-TV Network vice president, "is like blaming bad weather on the barometer. Ratings should no more be blamed for a show's cancellation than the box-office manager of a Broadway play should be blamed when it closes because it does not attract an audience that a producer thinks is high enough."

Who then should be held responsible for TV failures? "No one," says Nielsen. "The audience has a right to vote. Reduced to its essentials, the act of tuning to a program is a vote."

But an increasing number of network and advertising agency officials are taking into consideration who is casting these "votes"—a four-year-old preschooler or a thirty-four-year-old breadwinner—and weighing them accordingly.

As a result, NBC's Werner denies that the rating system is an absolute monarch. The misconceptions about the role of ratings in programming, he says, are due to the overemphasis of their importance in the press. "Because of this emphasis, ratings come to be falsely regarded as the end-all and be-all of programming, instead of what they are—broadcasting's form of market research that must be combined with creative judgment and program experience in making program decisions." In fact, lately ratings have exerted an upgrading influence on programming. These days, TV advertisers are becoming increasingly interested in the composition of the audience of a show, rather than simply in over-all totals. The fact that Ed Sullivan, for example, may slightly outdraw Dean Martin in total audience size is not the crucial consideration for many sponsors. The deciding factor for an airline or automobile advertiser may be that Martin pulls 23.4 per cent of the families earning more than $10,000 a year, while Sullivan attracts only 16.8 per cent of that group.

As a result, the Nielsen people are now supplying their subscribers with more detailed data on demographic mix—age, sex, income, education, and rural or urban residence. "As we get better information," says Justin Gershe, Vice President of Media Research at Ted Bates and Company, "we have a better opportunity to spend money wisely. In the 1950s, we talked about reaching homes, but not about whom we reached in the homes. Since then, there has been a gradual evolution toward reaching people."

Thus, as more and more sponsors reach for higher income, better educated "target audiences," there will be more and more quality programming to meet these viewers' tastes. The upshot, says Paul L. Klein, Vice President, Audience Measurement, at NBC, is that "The old guard syndrome of 'who's winning' and 'I've got more homes than you and therefore I'm better' is no longer applicable." One network official summed up the role of ratings in these words: "When properly conceived, evaluated, and interpreted, ratings are an excellent analytical tool. That is their role in our operations."

His sentiments echo those of one eminent critic whose writings on the subject of evaluation could serve as the credo for the rating game:

"Immersion in water makes the straight seem bent; but reason, thus confused by false appearances, is beautifully restored by measuring, numbering, and weighing. Surely it is the better part of thought that relies on measurement and calculation."

The critic's name was Socrates. ■


Spacecraft Is Set for Today
Resource
Apollo
Hurricane

Apollo–

Voyage to the Moon

In the Apollo program, man is combining the accumulated knowledge of 25 centuries with the modern organizational techniques and resources of American industry.

by Robert G. Shortal

Robert G. Shortal is on the RCA Public Affairs staff.

Astronaut James Lovell, aboard the lunar-orbiting Apollo 8 spacecraft, wishes his mother a happy birthday via the 4.5-pound RCA TV camera, which brought the event live to millions of homes around the world. His fellow-astronaut Frank Borman (background) looks on.

The morning sun reflecting on the Atlantic Ocean and Gulf of Mexico is filmed from 122 miles in space.

The Bahama Islands as seen from earth orbit.

"You are go for TLI."

"Roger."

With that laconic conversation, the greatest adventure in human history began to unfold. Man was on his way to the moon in a space odyssey that would carry him across a trackless void to that desolate realm of dream and mystery.

Only a few hours earlier on that December morning, Apollo 8 astronauts Frank Borman, James Lovell, and William Anders had blasted off from launch pad 39-A at Cape Kennedy. Their giant Saturn V rocket — with its first stage building up 7.5-million pounds of thrust — hurled them into orbit some 100 miles above the earth.

During their second orbit of earth, the capsule communicator at Houston, Tex., spoke the historic words, "You are go for TLI (translunar injection)," and thus began a space adventure that visionaries for centuries could only dream about.

The incredible journey of Apollo 8 came about only 11 years after man had succeeded in orbiting the first artificial satellite and just seven years after the first man had successfully orbited the earth. It carried America — and the world — a giant step closer to the late President Kennedy's goal of landing a man on the moon before the end of this decade.

So perfect was the flight of Apollo 8 — from lift-off to splashdown — that many experts believe the United States will be ready to land a man on the moon this summer. Much remains to be done before that epochal event takes place, but Apollo 8 proved that man had the equipment and the know-how to leave his own planet, navigate tnrough the vast ocean of space, rendezvous and orbit the moon, and then find his way home to safety.

At this writing, the Apollo 9 spacecraft is being readied for a February 28 launch. This will be an earth orbit mission and will be the first manned flight of the bug-like Lunar Module (LM). The LM is the vehicle that actually will land men on the moon, permit them to explore the lunar surface, and then return them to the Command Module (CM) in orbit around the moon for the trip home. Another mission — Apollo 10 — is planned for May or June. On this flight, the LM will be tested in the vicinity of the moon, probably at an altitude of only 50,000 feet above the moon's pock-marked surface. If all goes well on these two missions, America could land two men on the moon as early as July or August.

The flight of Apollo 8 must be considered the greatest scientific, engineering, and exploratory accomplishment in history. For the first time, man ventured far from his native planet. Up to then, astronauts in earth orbit had never been more than a few minutes from re-entry into the comforting embrace of the earth's atmosphere. Out in the lunar vicinity, the crew had only their spaceship to protect them. Failure of their life-support system would have meant certain death. Once in lunar orbit, their return to earth was dependent on the firing of the service propulsion engine. If it failed to reignite, the astronauts — like the legendary Flying Dutchman — would be doomed to be in sight of land yet unable to land. For weeks or months, their ship would circle the moon in its 70-mile-high track until the orbit decayed under the moon's gravitational pull and the spaceship crashed.

But Apollo 8 was a picture mission, and astronauts Borman, Lovell, and Anders etched their names alongside history's great explorers. The three astronauts completed their half-million-mile round trip to the moon in 147 hours, and splashed down in the Pacific only 5,000 yards from the recovery aircraft carrier, the U.S.S. *Yorktown.* It is interesting to note that it took Christopher Columbus eight months to complete his round trip to the new world, and, when he returned to Spain, he really wasn't sure where he had been.

Unlike the early explorers, the Apollo 8 astronauts were in constant touch with NASA's worldwide tracking network, except for those brief periods when the spacecraft disappeared behind the moon. Even more dramatic was the fact that countless millions of television viewers occupied a "fourth" seat in the Command Module through the eyes of a 4.5-pound RCA television camera. This camera — small enough to fit in the glove compartment of a car — enabled TV viewers to monitor the three astronauts at work in their spaceship and to experience a spaceman's view of the moon and earth.

The flight of Apollo 8 was the fulfillment of an age-old dream. In the second century, A.D., Lucien of Samosata envisioned a sailing ship lifted from the sea by a violent wind and carried to the moon. Science-fiction writers—such as Savinien de Cyrano de Bergerac, Daniel Defoe, Voltaire, Edgar Allan Poe, and Jules Verne — also applied their imaginations to space travel. They used animal power, firecrackers, balloons, catapults, cannons, and supernatural means to get their fictional explorers into space.

However, it wasn't until the development of the modern reaction rocket that the key to space travel was found. Although men had used rockets for warfare for hundreds of years, the idea of applying them to space travel didn't dawn until the late nineteenth century. Some of the great pioneering work in this area was done by three scientists, all working independently of each other: Konstantin Eduardovitch Tsiolkovsky of the Soviet Union, Robert Hutchings Goddard of the United States, and Hermann Oberth of Germany. Their theories and experiments laid the groundwork for modern rocketry and permitted man for the first time to give serious consideration to space travel. Rocketry came of age during World War II and in the postwar years, which were marked by tremendous technological advances.

The Saturn V rocket, the most powerful ever to blast man into space, was developed at NASA's Marshall Space Flight Center, Huntsville, Ala., under direction of Dr. Wernher Von Braun. It is a three-stage rocket that stands 281.8 feet tall (364 feet with the Apollo spacecraft attached) and develops 8.7-million pounds of thrust, or enough energy to provide New York City with electricity for 15 minutes under peak load conditions.

The Apollo manned-flight system that rides atop this giant rocket is a cocoon that carries an artificial world capable of sustaining all the needs of three human beings for two weeks in space. It contains all of the life-supporting elements of food, air, shelter, and waste disposal, together with the navigational, propulsion, and communications equipment required for deep space travel.

The Apollo payload consists of three essential sections. The cone-shaped Command Module (CM), located at the front of the spacecraft, is the control center. Slightly larger than a station wagon, it contains living and working quarters for the crew. It is a compact — only 12 feet high by 12 feet 10 inches in diameter — yet efficiently arranged combination of office, laboratory, kitchen, bathroom, bedroom, and radio station. During blastoff, the CM is capped by a rocket device, which in case of emergency will pull the manned capsule clear of the rest of the spacecraft and the Saturn V rocket and parachute it to earth.

Attached to the rear of the CM is the Service Module (SM), which houses the electrical power system, reaction control engines, and a part of the environmental control system — all in a container 22 feet high and 12 feet 10 inches in diameter. It also contains the service-propulsion engine subsystem, including the main engine that inserts the spacecraft into and out of lunar orbit and can make mid-course corrections.

The bug-shaped Lunar Module (LM) is the "commuter" vehicle that will carry two of the Apollo's three astronauts from the CM, which will orbit around the moon, to the lunar surface. There, it will provide a base of operations for several hours of exploration (two or three days in later missions), and afterward will return the men to the CM for the trip home. During launch, the LM is stored in the Spacecraft-LM Adapter (SLA) and becomes operational only in the vacuum of space. The LM did not fly on the Apollo 8 mission, but will make its manned-flight space debut on Apollo 9.

An Apollo mission is a monument to precision. At launch, the first stage of the Saturn V propels the more than 6-million-

This spectacular view of the earth was transmitted by the RCA TV camera during the flight of Apollo 8.

The curvature of the earth is clearly defined from an altitude of 150 miles.

pound payload to an altitude of some 40 miles, and then burns out and separates. The second stage ignites and boosts the Apollo to a 100-mile-high orbital altitude, and also burns out and separates. The third stage now ignites and accelerates the spacecraft to a speed of 17,500 miles an hour and places it into orbit around the earth. There, the Apollo coasts for two or three orbits as all systems are checked out and the orbit is precisely determined.

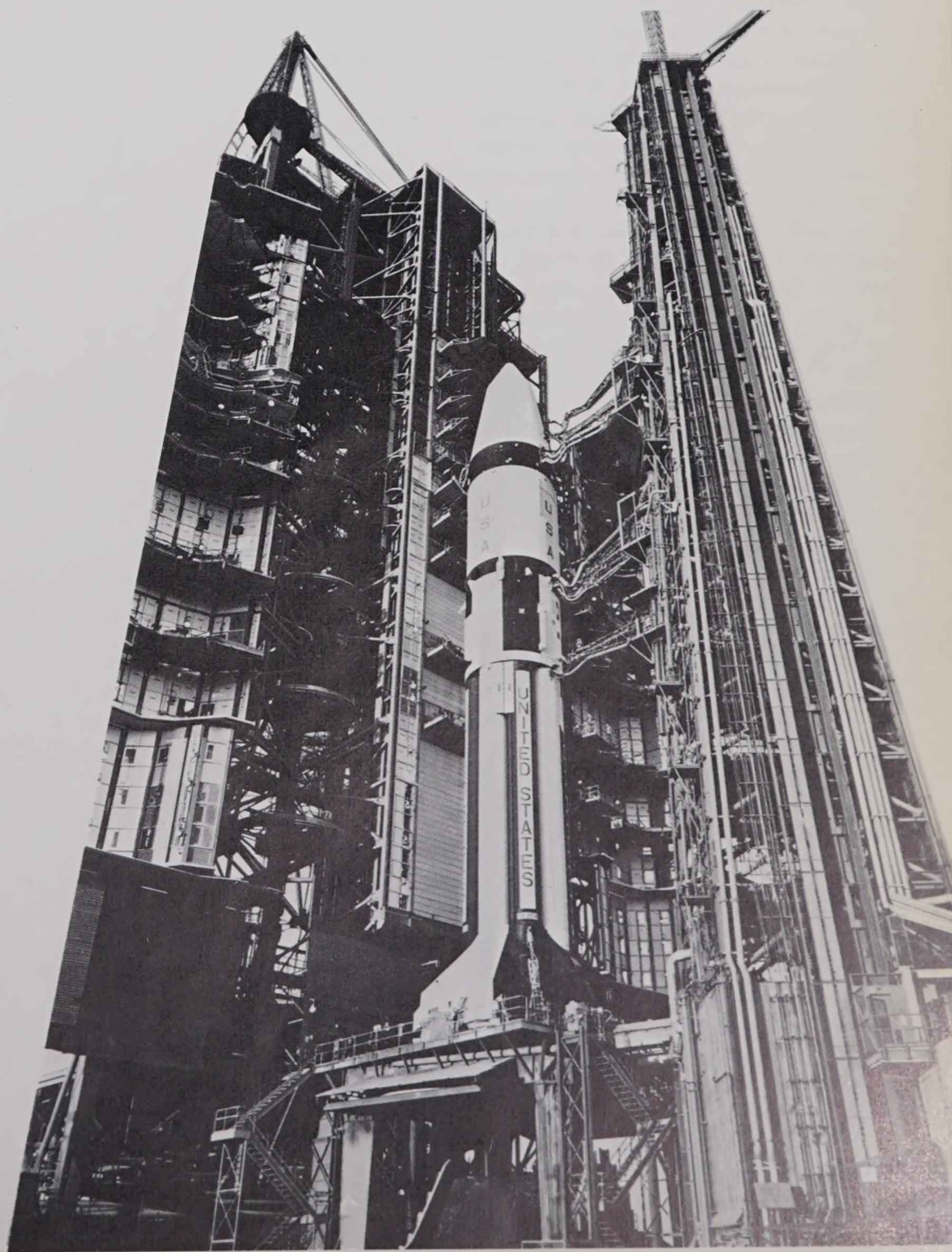
At a predetermined time and position, the crew reignites the third stage for a bull's-eye injection into translunar trajectory. Once the spacecraft reaches a speed of 25,000 miles an hour, it escapes from the grasp of the earth and begins a 66-hour glide to the moon. While the spacecraft is coasting through space, the astronauts go into their "barbecue mode," slowly rotating the spacecraft to prevent its systems from boiling under the direct rays of the sun or freezing in the airless, extreme cold of outer space.

An electronic "road map" aids the astronauts in steering a precise course to the moon across the uncharted sky. The "road map" is built into an onboard computer in the form of a mathematically designated ideal trajectory, based on such factors as the speed of the spacecraft in relation to the orbits, rotations, and gravity forces of the earth and moon.

Shortly after they have achieved TLI, the astronauts perform a tricky docking maneuver. This begins with the unhinging of the SLA panels by explosive charges to expose the LM. Then, the astronauts separate their Command and Service Module (CSM) from the rest of the spacecraft, propel it a short distance away, and make a 180° turn to bring it into position. The cone of the CM is then maneuvered into the rear of the SLA to dock with the LM, and the spacecraft is backed up, pulling the LM out of its protective container. Leaving the SLA and third stage of the Saturn rocket behind, the three-section Apollo continues to the moon, coasting along at almost seven miles a second.

When the spacecraft is about 30,000 miles from the moon, lunar gravity begins to exert a stronger pull than that of the earth and the spacecraft begins to pick up speed — to a peak of 5,700 miles an hour. Near the moon, the SM engine is fired again to slow the spacecraft just enough so that it will go into orbit around the moon. Once the lunar orbit has been precisely determined, two of the astronauts will crawl through the nose of the CM into the LM. There, they will check its systems, separate the LM from the CM, and fire its descent engine to establish an elliptical orbit. This orbit will take the LM to within 50,000 feet of the lunar surface, where the astronauts will reignite the engine to take the LM out of orbit for landing. The descent engine will be used as a retrobrake to slow down the LM and achieve a soft landing.

After exploring the moon, gathering soil and rock samples, and sending back live television pictures of the lunar landscape and possibly of the earth and stars as seen from that vantage point, the two astronauts will climb back into the LM and blast off from the moon. A critical rendezvous maneuver between the LM and CM



The powerful Saturn V rocket is readied for launch at Cape Kennedy.

"Apollo...is a cocoon that carries an artificial world capable of sustaining all the needs of three human beings for two weeks in space."

must take place in lunar orbit, since the LM cannot return to earth. Then, the two astronauts will crawl back into the CM, abandoning the LM. The Service Module's main engine is fired once again, pushing the CSM away from the moon at a speed of close to 6,000 miles an hour. Once free of the moon, the spacecraft takes aim on a narrow re-entry corridor — a 40-mile-wide keyhole — in the earth's atmosphere some 230,000 miles away. The return trip will take a little over two days, with the spacecraft building up to a speed of 25,000 miles an hour as it hurtles toward earth.

During the Apollo 9 mission in February, veteran astronauts James McDivitt and David Scott and space rookie Russell Schweickart will put the Lunar Module through its paces in earth orbit, practicing rendezvous, docking, and other maneuvers that must be mastered before a moon landing. The Apollo 9 mission also will include the first walk in space since Project Gemini ended in 1966. On Apollo 10, astronauts Thomas P. Stafford and Eugene A. Cernan — who flew together on Gemini 9 — will fly the Lunar Module to within 50,000 feet of the moon's surface, while astronaut John Young — another Gemini veteran — spends a lonely vigil in the Command Module. If all goes well on these two missions, Apollo 11 could be the flight that man has dreamed, speculated, and written about for centuries. The man in the moon may be human after all.

After the first successful Apollo landing, others will follow to gather data on lunar composition and history, which may contain vital clues to the very nature of the planet earth and the solar system itself. Eventually, permanent bases may be built on the moon for astronomical observation and experimentation in biology, physics, and chemistry. Using the moon as a launch base, man will explore the other planets, first sending unmanned spacecraft to provide the information required for safe manned flights.

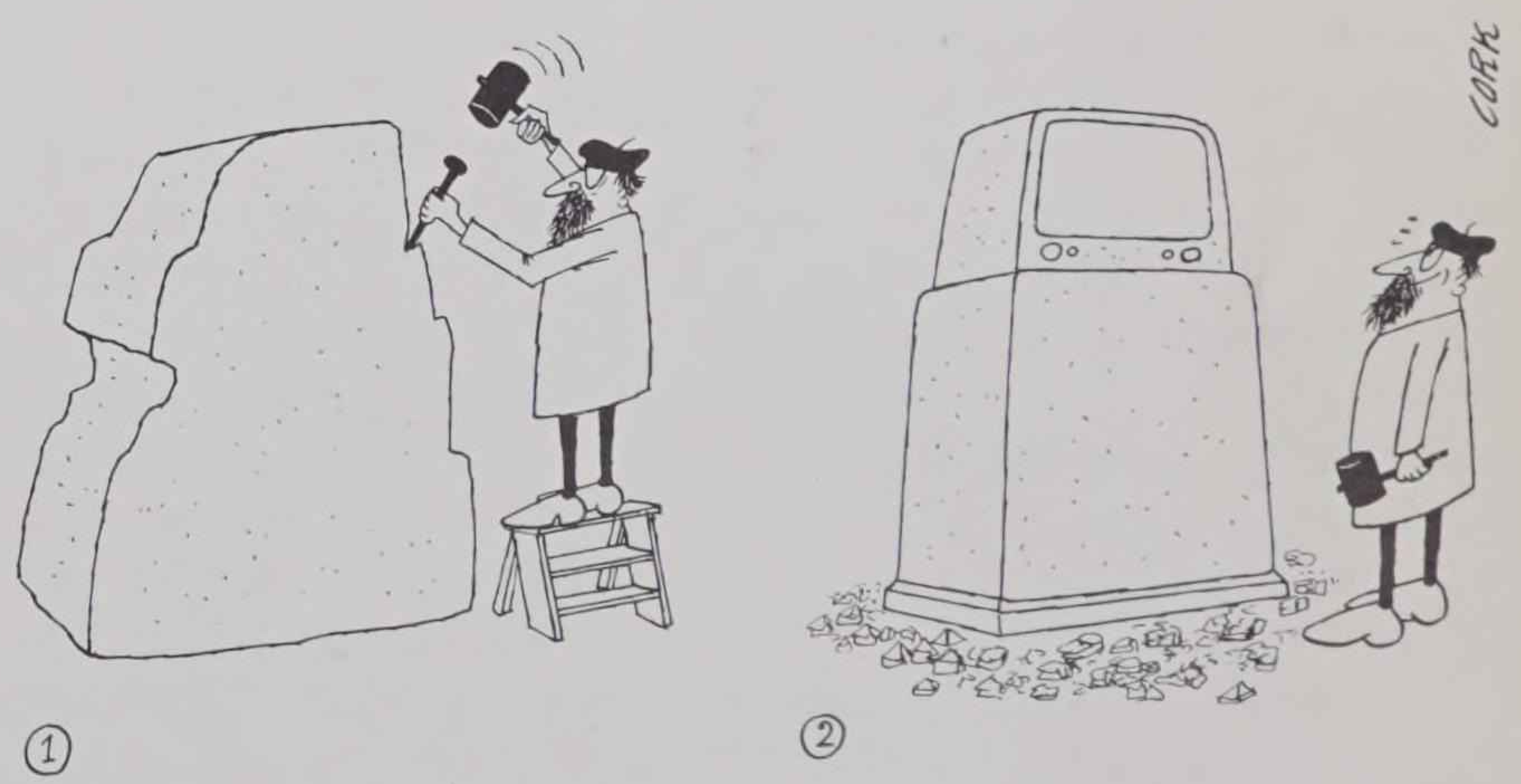
Exploring the universe staggers the imagination. But the Apollo program is testimony to what human beings can achieve when they set their minds, talents, and resources on a specific goal. In Apollo, man has combined the accumulated knowledge of 25 centuries with the modern organizational techniques and resources of American industry. It has involved amassing the skills and knowledge of 350,000 scientists, engineers, and technicians from 20,000 companies, as well as government agencies — at a cost of more than $20 billion.

Even in these sophisticated days of orbital flight, it still boggles the mind to comprehend fully what astronauts Borman, Lovell, and Anders have accomplished. It will be months before the moon trip can be completely digested, and probably years before man realizes the full extent of their achievement.

The epic of Apollo 8 heralds a new age of manned space exploration and shrinks the solar system, if ever so slightly. It was man's first step into deep space, but certainly not his last or his longest. It took America a decade to achieve this space "first," but in the decades ahead — as technology continues to accelerate at an unprecedented pace — lunar voyages may become routine. The imagination of mankind, however, will be excited anew, as men strive to reach neighboring planets and beyond — perhaps by technology as foreign to today's society as nuclear power was to Galileo. ■

This Electronic Age...

"I'm afraid this tips the balance of power in their favor."



"Oh, I think we had data when I was a child. But we just never bothered to process it."

New Sources of Electric Power

Scientists are now tapping the energy potential of radio waves, hot gases, and even nuclear heat.

by Bruce Shore

After 20 years of intensive materials research and development, the electronics industry is on the verge of revolutionizing the generation of electric power.

Under the cover of such ponderous and obfuscating terms as *magnetohydrodynamics, electrogasdynamics, photovoltaics, thermionics, thermoelectrics,* and *cryogenic chemistry,* electronics scientists are generating significant amounts of electric power directly from hot gases, radio waves, heat, light, and such chemical reactions as occur between supercold, liquefied gases. Both government and industry are beginning to find applications for these new energy sources.

In the space program, for example, all the electricity to power the instruments and life-support equipment aboard the Apollo space capsules is provided by fuel cells. The energy is derived from electrons freed during the reaction of hydrogen with oxygen to produce water. And the electric power to run the instruments of more than 200 American space satellites — from the five-watt Vanguard to the 400-watt Nimbus — has come from solar cells that convert sunlight directly to electricity by means of the photovoltaic effect. In addition, when the United States launched the first nuclear reactor into orbit in 1965, all power required on board was provided by a blanket of solid-state germanium-silicon thermocouples. These devices were developed by RCA to cover the reactor and convert its heat directly to a steady 500-watt flow of electricity.

Bruce Shore is on the staff of RCA Public Affairs.

The military is also using many of these new power-generation techniques. For instance, the Air Force powers a hypersonic wind tunnel at the Arnold Engineering Development Center in Tullahoma, Tenn., with a magnetohydrodynamic generator. This produces up to 20-million watts of electric power by driving a superhot gas across a strong magnetic field.

In other applications, both the General Electric and General Atomic companies are building nuclear reactors that incorporate thermionic diodes (vacuum tubes) to convert heat directly into electricity. In addition, the Raytheon Company is testing a robot helicopter that extracts electric power directly from a radio beam by means of microwave diodes. And a New Jersey firm, Gourdine Systems, Inc., has recently developed an experimental electrogasdynamic generator that employs a hot electrified gas moving in a narrow channel to generate electric power at levels of up to 120,000 volts.

What makes all of these systems different from most conventional sources of electric power is that the actual process by which they produce current involves no moving parts. This contrasts with motor-generator sets, such as are used in automobiles, and with dynamos typically used in steam-generating plants and hydroelectric dams. Taken together, these two items generate about 95 per cent of the world's electric power, but both depend on the motion of a mechanical armature in a magnetic field to do so.

The reason this difference is so important is that any generator that depends on mechanical motion must inevitably suffer energy losses due to inertia, friction, and heating. As a result, the very best steam-generating plants are only about 41 per cent efficient. There is also a problem of life span. Anything that rotates on an axle as fast as the armature in a dynamo does is bound to wear rapidly.

Although conventional batteries do not have moving parts and can be as much as 99 per cent efficient in converting chemical energy to electric current, they cannot achieve the powers of a dynamo and they have one fatal flaw. They consume their own electrodes, and, thus, their life is sharply limited. Further, because batteries generally employ such materials as lead and zinc, they are very heavy, especially when linked in series to gain higher outputs. In a space application, this can be a debilitating penalty.

It was just such considerations, following World War II, that led the military services and, later, NASA to seek alternatives to the dynamo and the battery. What they sought were new power sources that would be self-contained, light-weight, mobile, small, long-lived, reliable, rugged, reasonably efficient, and not too expensive. As if that were not enough, the military made quiet operation a *sine qua non* as well.

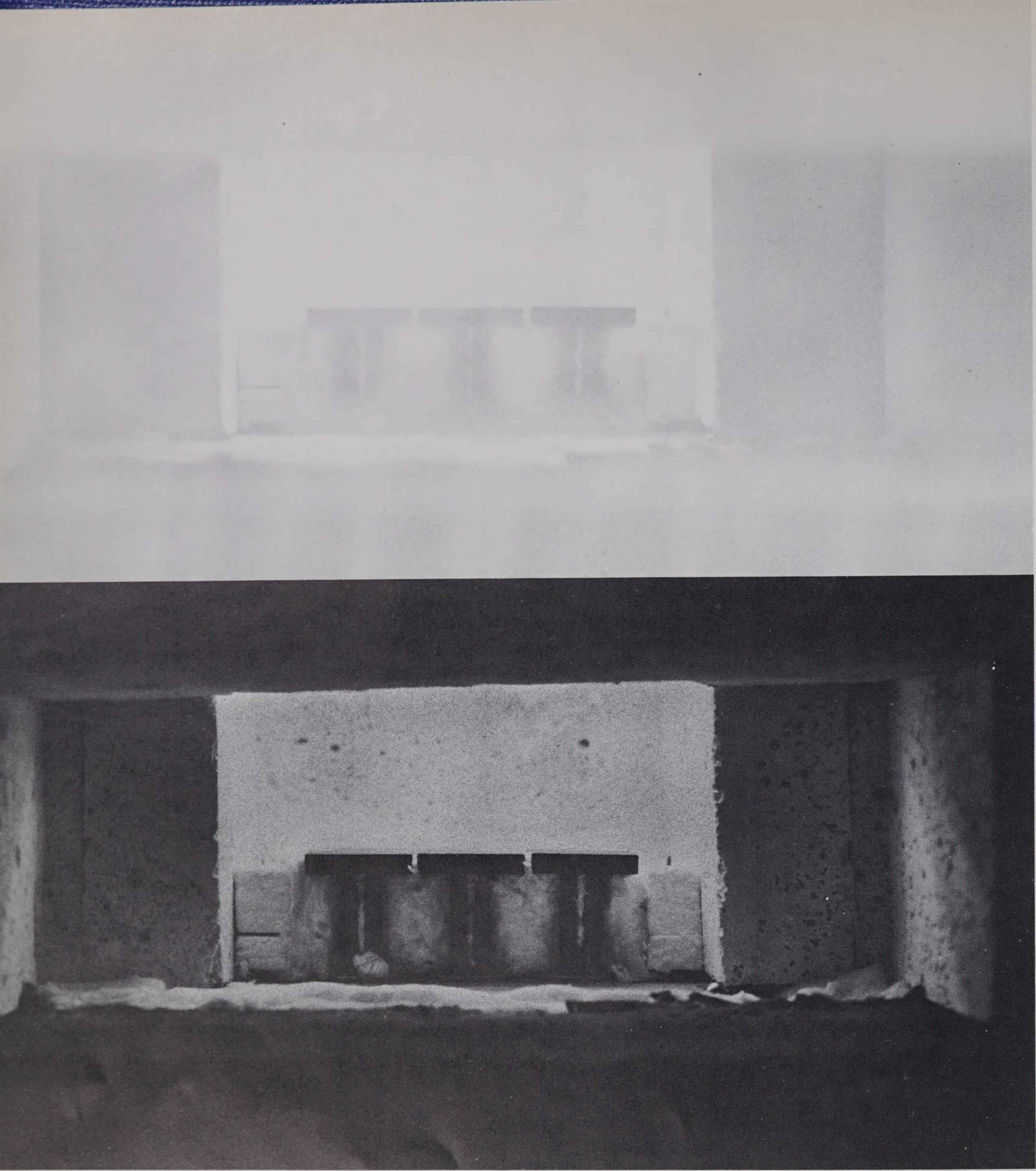
The electronics industry and others accepted the challenge. When they started, there were only three known ways to generate significant amounts of electricity: electrostatically, electrochemically, and electrodynamically. The electrostatic principle — storing electric charges on an insulator and then bringing it into contact with a conductor — was first embodied in a machine developed by Baron Otto von Guericke, of Magdeburg, Germany, in 1660. It has since found its way into certain hand-cranked generators for use in emergencies.

The electrochemical principle — involving chemical reactions that release excess electrons to a conductor in the course of their progress — was discovered in 1794 by Count Alessandro Volta, in Italy, and led him to invent the storage battery.

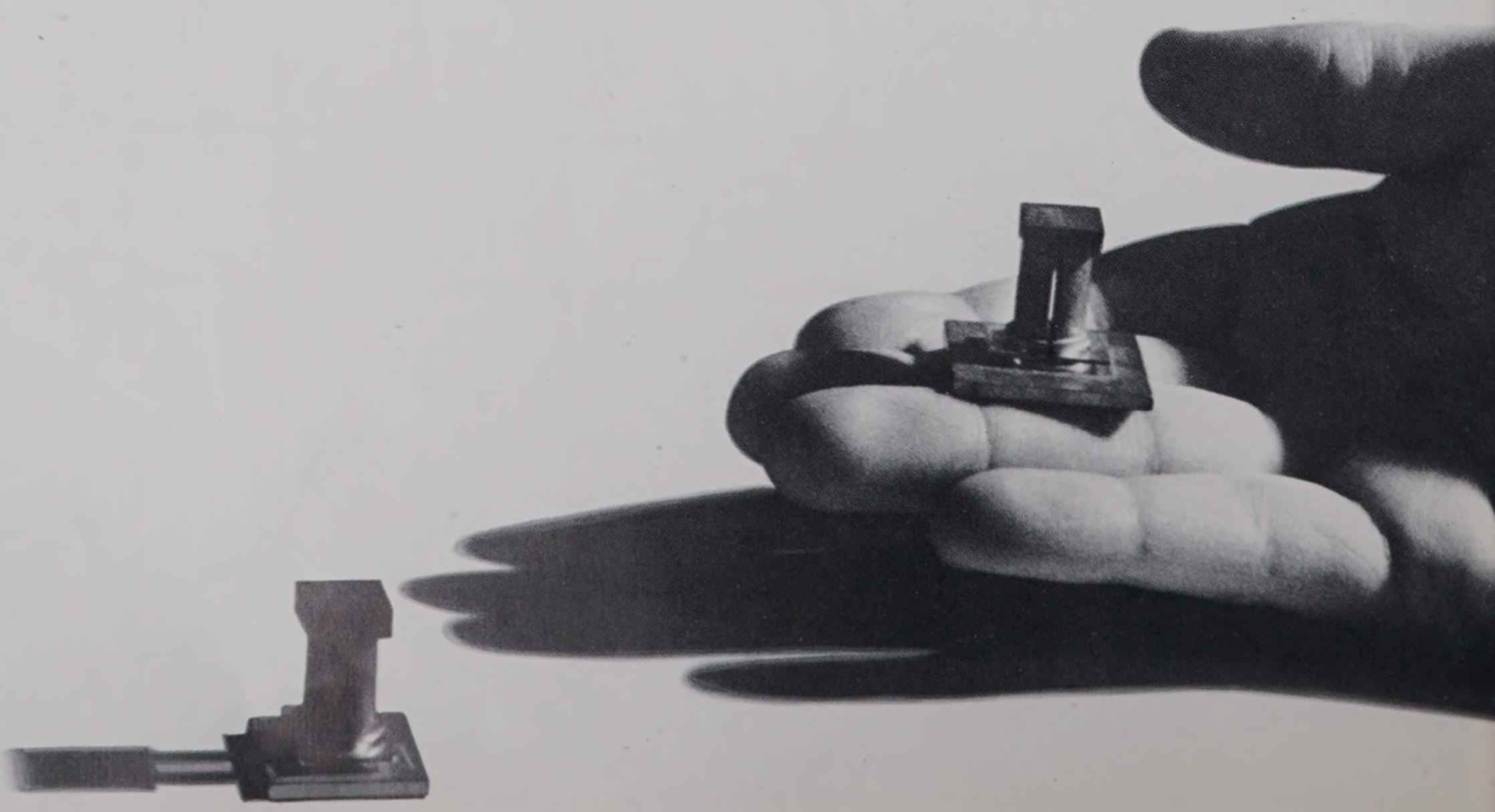
Finally, the electrodynamic principle, which entails the mechanical motion of a conductor across a magnetic field, was used in a practical machine for the first time by Antonio Pacinotti in Italy, during the early 1860s. It has since led to the creation of the dynamo.

Most of the initial research toward new power sources was directed along these three lines. For example, Gourdine Systems, an electronics firm, chose the electrostatic principle and for the past several years has been developing a family of experimental electrogasdynamic genera-

Shown at right: Part of the solar-cell array that powered the unmanned Lunar Orbiter in its moon-mapping mission, in which 96 per cent of the surface was charted. These cells directly convert sunlight to 300 watts of electricity.



Germanium-silicon thermocouples, which convert heat to electricity, are tested under extreme temperatures.



he electric power to run the
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ors. These devices heat various gases to emperatures upward of 1,500° C. and hen allow them to "blow" along a narrow channel through an electrical field that trips electrons from the gas atoms and ucks them into a nearby electrode. The momentum of the stripped atoms—now converted to positively charged ions—carries them beyond this field toward a negatively charged electrode. Since this second electrode is attached to the first by a wire running outside the machine, he ions really recombine with their own ost electrons, thus completing the circuit. Before recombining, however, the electrons can be made to do work as they run along the wire by hooking it to a motor, light bulb, or other electrical device.

The Avco Corporation, on the other hand, is using the electrodynamic approach. Since 1954, its engineers have been building experimental magnetohydrodynamic generators that are suggestive of the Gourdine approach in that they heat various gases to very high temperatures (about 2,000° C.) and blow them along a large duct. However, the gases are so hot that nearly all their atoms are broken down into constituent electrons and ions so that they form a gaseous plasma. When this plasma blows across a powerful magnetic field, set at right angles to its path, the electrons are forced up and the ions down toward electrodes protruding right into the stream. Since the electrodes are also linked by an outside wire, a current immediately flows and has the potential to do work. In effect, the Avco machine is a dynamo whose armature has been replaced by a streaming gas plasma.

Several chemically oriented companies not unexpectedly decided to try the electrochemical approach. They reasoned that, if materials lighter than zinc and lead could be used and if they could produce more free electrons while interacting, a new, high-power, light-weight battery might be developed. Further, if these chemicals consumed only each other and not their respective electrodes, a battery could be constantly replenished. The result is the fuel cell.

However, certain electronics companies, such as RCA, were not satisfied with any of these traditional approaches. They felt that, with the coming of the transistor and semiconductor technology, large amounts of electric power were no longer required to operate electronic devices and circuits. Furthermore, a hard look at the challenge given by the military services and the space agency revealed that both were primarily interested in generating power to operate control circuits, sensors, communications equipment, navigational devices, and computers. Since all of these were being rapidly transistorized, they did not need big power sources.

Though electrostatics, electrochemistry, and electrodynamics were the accepted ways to generate electricity, they were certainly not the only ones. Vacuum tubes that converted radio waves to electricity, photocells that converted light to electricity, thermionic diodes and solid-state thermocouples that converted heat to electricity: all had been made and used by the electronics industry for decades. But they produced only feeble amounts of electricity—power measured in hundredths or thousandths of a watt or less. They obviously could not be used to power even transistor circuits unless they were greatly improved. Fortunately, the means for such improvement were at hand in the same semiconductor technology that had been used to develop the transistor.

In 1954, researchers at the Bell Telephone Laboratories demonstrated what this technology could do by developing an array of 432 semiconductor devices, which they dubbed "solar cells," as a means for producing 10 watts of electricity directly from sunlight. This array was later installed atop a telephone pole in a Georgia community to power the electronic amplifiers of a rural telephone line. Each cell in the array was a flat, single crystal of silicon incorporating impurities whose atoms caused a scarcity of electrons on its top—p-side (positive)—and an excess of electrons on its bottom—n-side (negative).

At the atomic level, the condition thus created is comparable to a theater whose "seats" (atoms) possess a positive electric charge when not occupied by an electron. On the n-side, these "seats" are filled to overflowing with a crowd of electron "standees." On the p-side, just the opposite is made to occur, and a substantial number of empty "seats" is produced. Between these two sides, an electrically charged "aisle," known as a p-n junction, is formed that prevents the free n-side electrons from crossing over to occupy the empty p-side "seats."

If light is now shone on the p-side, the relatively few electrons seated there acquire sufficient energy to leave their places and cross the junction to join the electron crush on the n-side. The n-side cannot accommodate any more electrons, however, and the new arrivals are accepted only at the expense of electrons milling near the n-side "exit" (a metal contact). These are shoved, unceremoniously, into a wire that runs around to the p-side entrance (another metal contact). Once in the wire, though, these electrons "see" the empty p-side "seats" and rush to fill them, only to have the light excite them back across the junction to start the cycle all over again.

In short, when a solar cell is exposed to light, current flows out of its n-side and into its p-side through an outside conductor that can be attached to any electrical device to produce work.

In the light of this experience, semiconductor technology was next applied to thermocouples, initially by a firm that later became part of the Minnesota Mining & Manufacturing Company. Alloys of lead-telluride were "doped" with trace impurities and shaped to produce p-type and n-type legs, which were subsequently bonded to a copper crossbeam to form a U-shaped structure. Finally, a wire was attached to the ends of the legs.

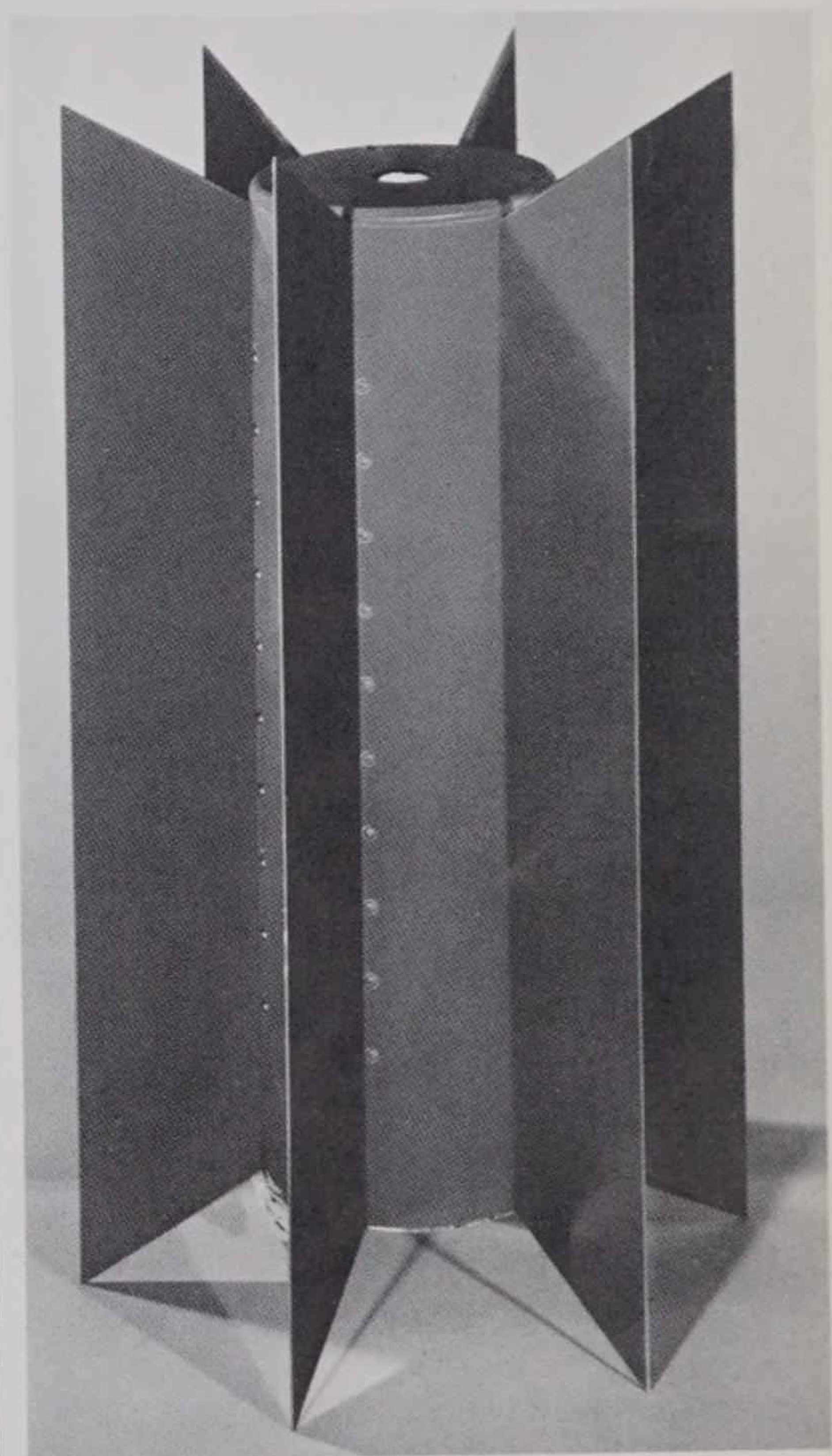
Heat applied to the copper crossbeam of such a structure immediately drives the "unseated" electrons down to the bottom of the n-leg. This causes a chain reaction of electrons moving from the copper into the n-leg and "seated" electrons moving forward from the p-leg into the copper. Once again, this latter movement produces many empty atomic "seats" near the bottom of the p-leg. The electrons, at the bottom of the n-leg, move along the wire to fill these "seats," and electric current begins to flow.

Thermoelectric arrays built from such semiconductor thermocouples now generate hundreds of watts of electricity using various heat sources, and are expected eventually to reach the 1,000-watt level.

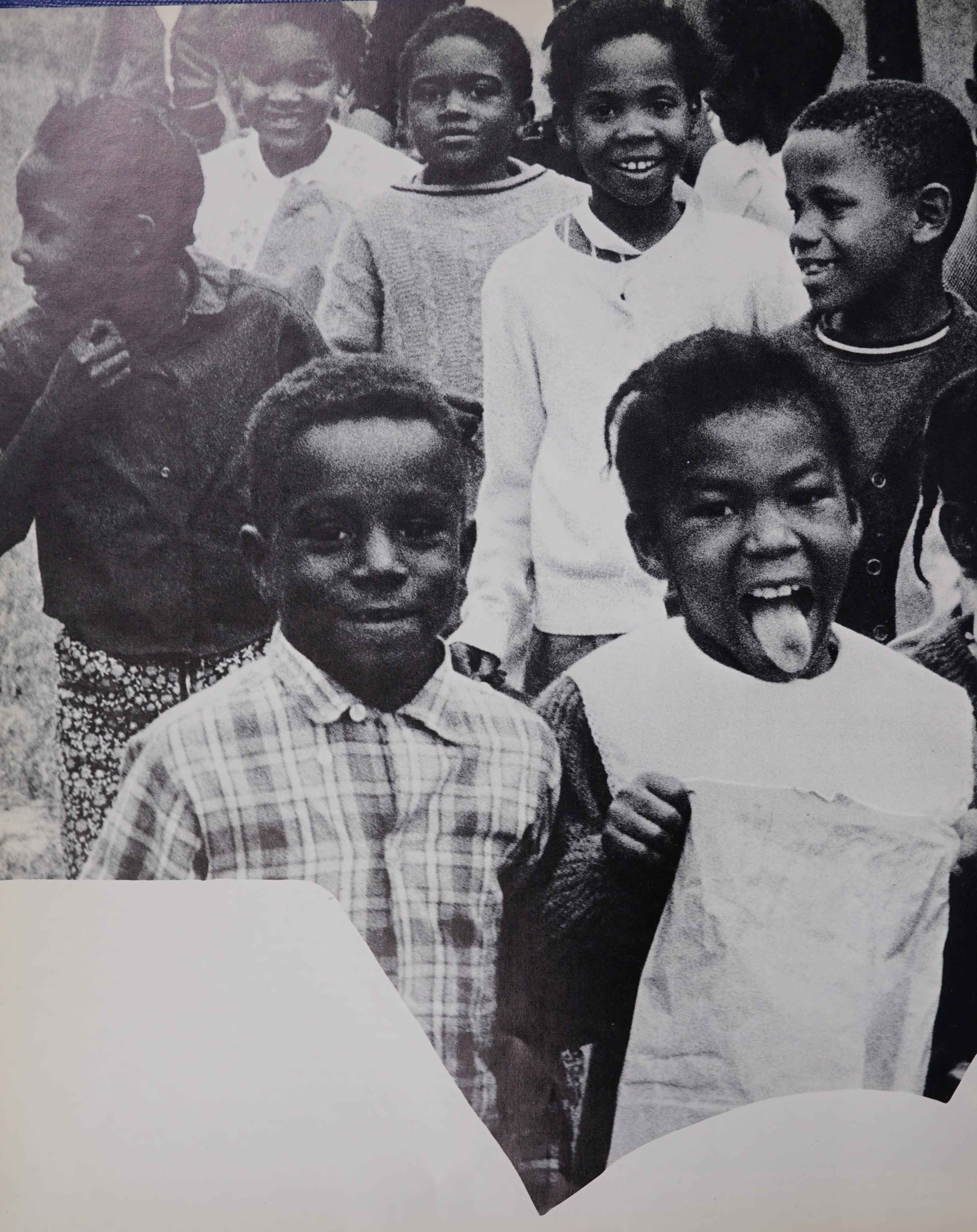
Though thermionic diodes are not semiconductors—rather, they are vacuum tubes—they deserve mention because they, too, have been transformed into significant power producers by electronics companies such as RCA. They work on the same principle as all vacuum tubes: heat applied to a metal electrode inside causes electrons to pop off into the surrounding vacuum. If this electrode is linked by an outside wire to a second electrode nearby, the latter will acquire a positive charge, since it is losing electrons to the first via the wire. It then will attract the electrons in the vacuum, thus completing the circuit.

Inherently rugged and capable of enduring high temperatures, thermionic diodes are particularly well suited for use in nuclear reactors and in association with radioisotope heat sources. They have already yielded as much as 400 watts of electric power and should be able to produce 1,000 watts before long.

A spate of recent developments in the generation of electricity is tending to erase the artificial distinction traditionally made between electronics and the electric power industry. In the process, new and more versatile ways are being found to generate the *"vis electrica,"* as Sir William Gilbert called it, that is needed to sustain and abet the commercial growth, the industrial metabolism, and the social progress of modern civilization. ■



Heat passing through the center of this experimental generator is converted directly to electrical power by solid-state thermocouples.



Hope, Skills, and Self-Respect

The Choanoke Family Development Project is helping seasonal farm workers to qualify for new jobs in today's mechanized society.

by Mary Jeanne Carlson

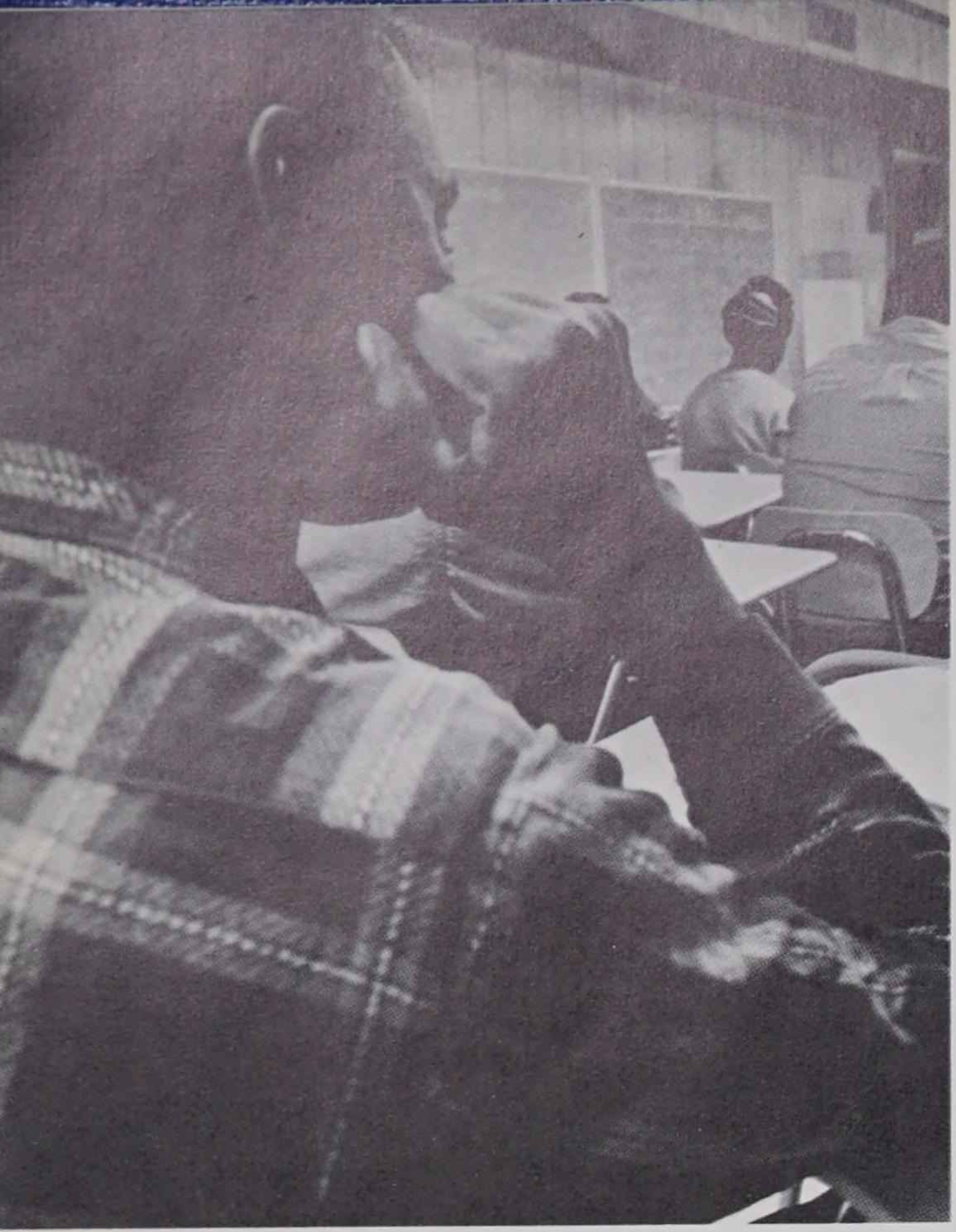
Thirty years ago, John Steinbeck wrote of the dust bowl farmers: "The men were silent and did not move often. And the women came out of the houses to stand beside their men—to feel whether this time the men would break."

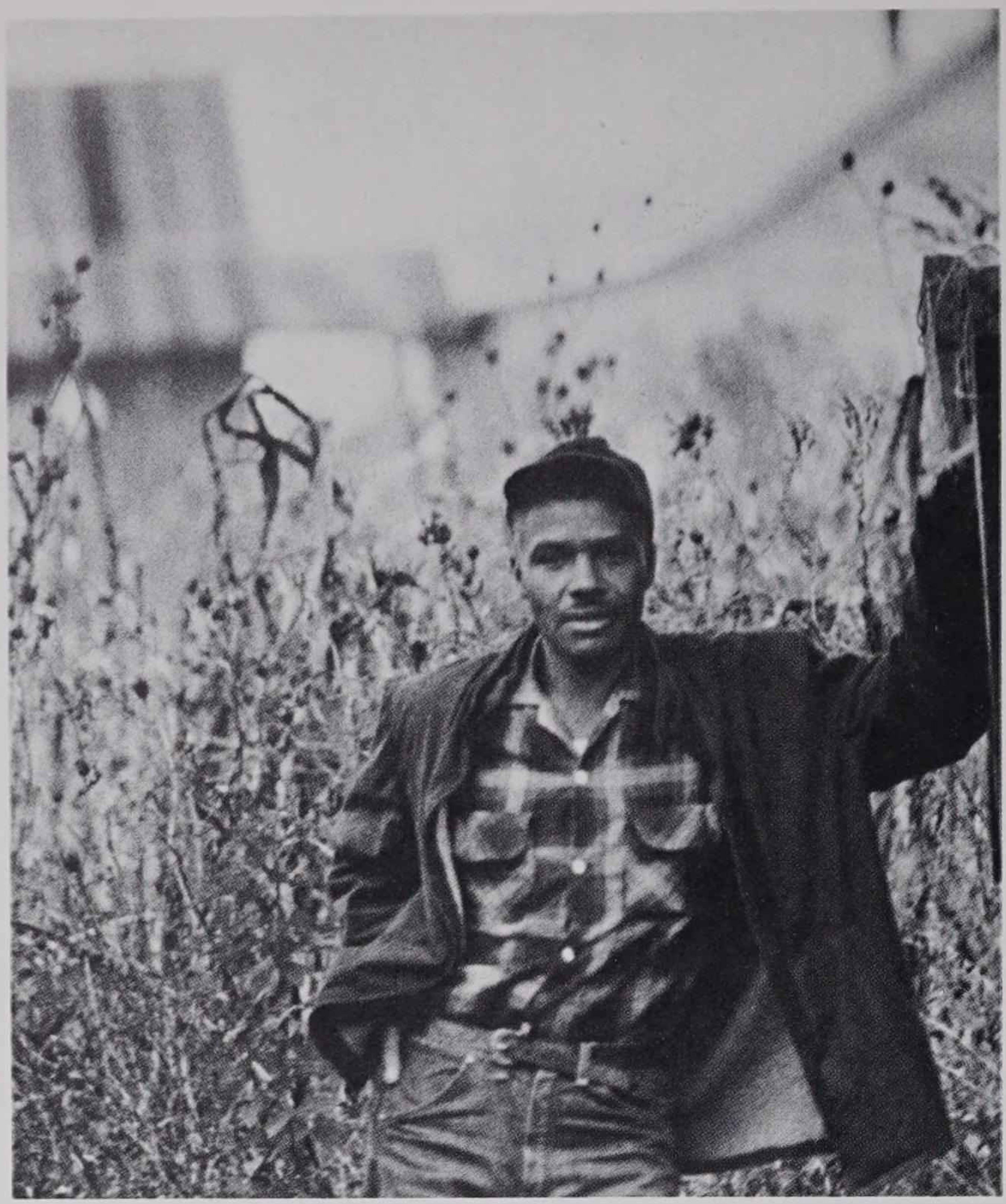
And so the Joad family, and others like them, moved to California. But the problem of the marginal tenant farmer didn't vanish into the sunset with them.

Today, some 1,065,000 of these farmers linger on, eking out an existence based either on shares of whatever crops they plant and harvest or on hourly wages that seem absurd in today's society. Their unpainted, dilapidated shacks dot the roadsides with a depressing monotony. The common denominators of their existence seem to be a hand-wringer washing machine on the front porch, a dog sleeping in the dirt, and an old, rusting automobile.

The U.S. Department of Agriculture defines these people as "seasonal farm workers," those who work less than 150 days a year. The public has been made somewhat aware of the plight of the 137,-000 migrant workers by recent efforts of

Mary Jeanne Carlson is on the staff of RCA Public Affairs.



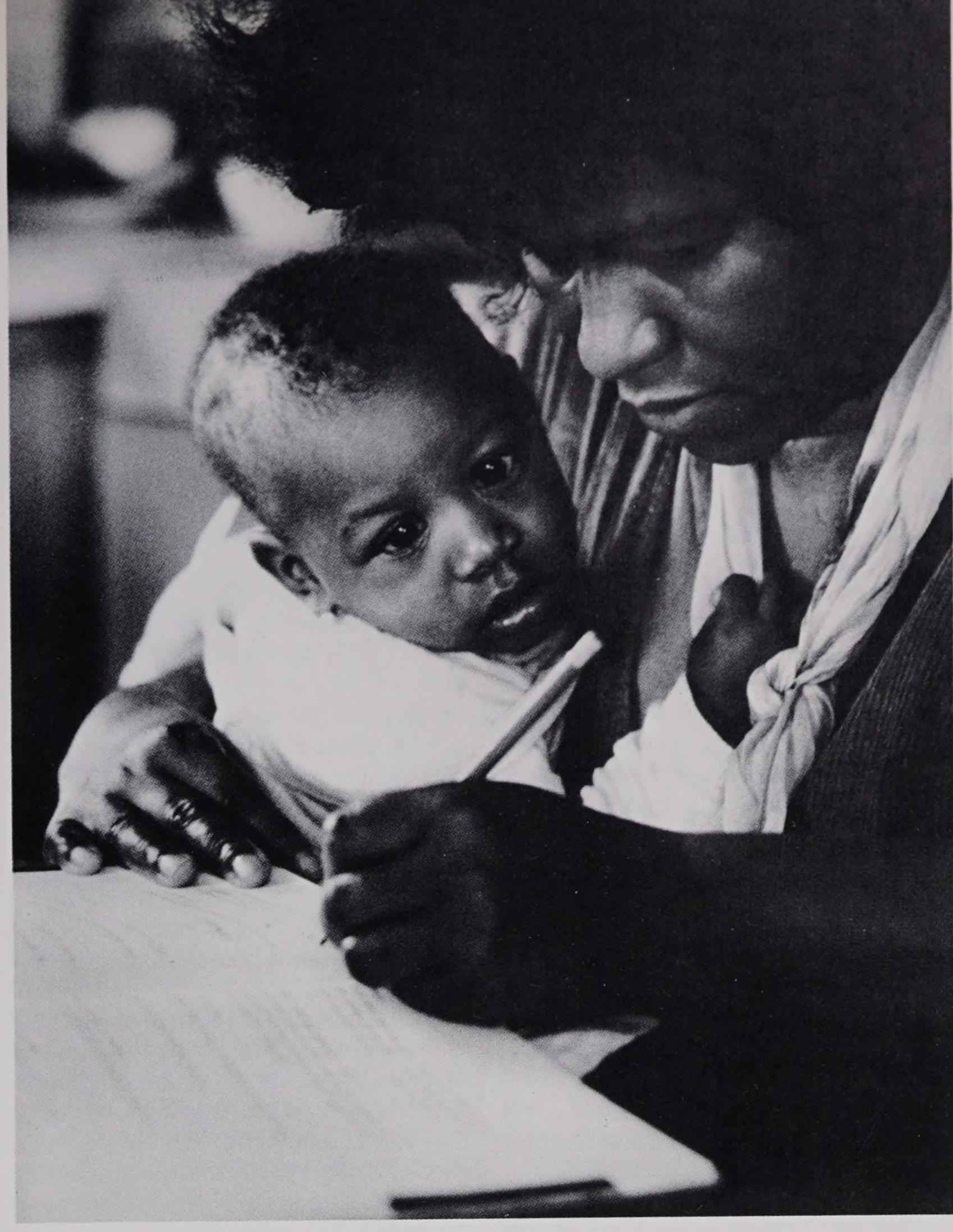


some to form unions and by reports of their social and economic conditions by the news media. But the 928,000 farmers who are tied to the land and who stand silent go virtually unnoticed. While the country worries almost exclusively about urban poverty, these people slip further away from the world of today.

Basically the victims of increasing farm technology and mechanization, they cling to what has been, for generations, their only frame of reference — the land. Some have moved to the cities where, if they are sufficiently literate and have some marketable skill, they can escape this cycle and eke out another form of livelihood. In fact, since 1960, more than 650,000 such workers have left the farms. But many still remain tied to the soil.

Bertie, Halifax, Hertford, and Northampton counties, in northeastern North Carolina, have been especially hard hit by this problem. For centuries, this rich agricultural area has been a major producer of tobacco, cotton, and peanuts. However, within the past 15 to 20 years, both planting and harvesting have become increasingly mechanized. Today, estimates of the extent of mechanization in the area range as high as 95 per cent.

Where once a farmer might have needed 15 tenant families to handle his crops, one man and a machine now do the work. As a result, nearly 8,000 farm workers in the four counties — 87 per cent of whom are Negro — are unemployed or underemployed. They continue to live in shacks on the farms they once worked, paying a minimal rent to the owner, growing enough vegetables to feed their families, and doing what little manual labor the owner may require. There are few, if any, alternatives open to them in terms of earning a living. Very little industry exists in the area, aside from some small sewing factories (each employing a dozen or more women) and



The Choanoke project is an effort at "...total family reorientation: industrial training for the men, home management education and acclimatization for the wives, and specialized services for the children."

some lumbering and paper box manufacturing. Two of the four counties are classed among the 100 poorest in the United States. And nearly 57 per cent of the families in the area have incomes below the federally defined poverty level of $3,000.

In many respects, the terrain of the area has as bleak an outlook as the economy. The counties are isolated from the western part of the state by a lack of major highways and from the Norfolk-Portsmouth industrial area by the Great Dismal Swamp, and literally lie in a tidal backwater. The small towns have the look of certain other parts of rural America: abandoned storefronts, boarded-up railroad stations, and old men sitting in the sun or lounging against buildings. The countryside is low and rolling, with stands of pine interrupting what seem to be endless fields of tobacco and cotton.

In an effort to solve at least a part of the problems of the area, the Choanoke Area Development Association (CADA) — the area community action agency — opened four Adult Basic Education Centers in August, 1967, funded by the Office of Economic Opportunity.

These ABE Centers, one in each of the counties, offer basic literacy courses, prevocational instruction, and citizenship and job attitude training to area farm workers. Their goals are to place enrollees in at least entry-level jobs in local businesses and to provide those who are qualified with further opportunities for education and advancement. At present, the total enrollment is 120 heads of households — both male and female.

Enrollees are being trained to the limit of their abilities. The courses are geared to a low level of education — first through third grades — and include such fundamentals as how to use a ruler, handle a saw, or thread a sewing machine. One man, who was taught to read and write at one of the Centers, sacks grain in a local feed mill where his new-found literacy enables him to read labels — something he couldn't do a year ago.

As of last August, the best of the enrollees have had an unusual chance at further training — through a new residential program at the Choanoke Family Development Project at Rich Square, a small town in Northampton County.

The Project, which is operated for CADA by the RCA Service Company, is the second of its kind in the nation. (The first — a Choctaw Indian retraining program on a reservation near Philadelphia, Miss. — is also managed by RCA.) Both are efforts at total family reorientation: industrial training for the men, home management education and acclimatization for the wives, and specialized services for the children such as day care and remedial tutoring.

"No one learns any surplus words here. It's 'cam,' 'piston,' and 'friction.' Only what it takes to get a job and hold onto it."

There are 21 Negro families and one white family now living at the Project. They are young — ranging in age from 21 to the mid-30s — and semiliterate. Most of the men have a third-grade reading level, although their wives tend to have completed more years of school. In the past, their average annual income has been between $600 and $1,000. They, and their families for generations before them, have known no life other than the farm life of the rural south. They know little about social security cards, lunch hours, and the other trappings of the industrial society of today.

This first group of trainees was recruited primarily from outside the ABE Centers by CADA staff workers since many ABE enrollees were either too old or ill-equipped to adapt to the new program and to the eventual reorientation to an urban, industrial way of life.

Applicants were given standard aptitude, vocational preference, and intelligence tests, and were interviewed by RCA staff personnel. Those who were accepted literally picked up and left home. Many of the residents arrived with only the clothes on their backs. Furniture and whatever miscellaneous personal possessions they may have had were put into storage.

While leaving a tenant farmer's shack would seem to be an easy decision to make, it is a difficult one for many of the workers. As Fred Cooper, CADA's Executive Director, explains: "Even if a person has nothing and lives in a shack, he knows he has this — and this is all he knows." Project officials are convinced, however, that when the first group graduates and jobs have been found for them much of the reluctance to leave the farms will be overcome.

Home at Rich Square is a far cry from anything these families have known in the past. Aluminum trailers, ranging in size from two to four bedrooms, have been installed at the site. The trailers are completely furnished and heated and are equipped with modern kitchens. The high point of the new homes seems to be the bathroom. One woman cried upon seeing the bathroom in her trailer, and another quietly said, "I could spend a week looking at it. I've never had one before." Landscaping is under way, and the 25-acre site is slowly taking on an air of permanence as play and recreation areas are bulldozed into existence and clay and mud covered with topsoil — and eventually grass. It is a self-contained community, with a dispensary, administration offices, workshops, classrooms, and day care center all housed in other trailers.

The process of education here is a highly realistic one. The men spend their mornings in vocational training classes. At present, welding, carpentry, and mechanics are being taught — simply because jobs exist in these fields in the four counties. The carpentry class has prefabricated and assembled a three-bedroom house — designed by a member of the class — and then torn it down, just for practice. The welding class is learning foundry and construction welding techniques that can command starting salaries of up to $2.75 an hour in nearby cities.

Afternoons are spent in basic education classes where the men learn to read instructions and blueprints, calculate the number of square feet in a piece of lumber, and master the language they will encounter in the working world. As one instructor remarked: "No one learns any surplus words here. It's 'cam,' 'piston,' and 'friction.' Only what it takes to get a job and hold onto it." In addition, instructors are using specialized materials that emphasize job attitudes, phonics, and mathematics. These range from simple workbooks for those with less than a third-grade education to more advanced texts, which present in simplified form some of the problems a worker might encounter on the job.

Originally, these afternoon sessions were designed to supplement those skills already acquired at the ABE Centers. But as Project manager David Goehring explains, "We had to sacrifice the higher educational levels the men would have attained at the Centers in order to get younger people. We wanted to have a related basic education program, but it has turned out — at least for the present group — to be very basic." However, RCA has taken over the operation of the ABE Centers as a part of its $380,000 contract, and it is expected that future groups of trainees will be drawn almost exclusively from these Centers.

Punching a time clock has made the training even more realistic and familiarizes the men with at least one aspect of the world they'll be entering. Each man punches in and out daily and is "docked" for time missed from classes. Trainees are paid a basic weekly stipend of $28, plus $2 for each child, up to a maximum of $38 per family. Since absenteeism results in a smaller pay envelope, the men have been very quick to adapt to the conformity of the time clock. Enrollees at the ABE Centers also receive a weekly stipend of $28, plus mileage should their training entail travel to a nearby technical institute that offers courses in welding and mechanics.

Mr. Goehring is quick to point out that this weekly stipend is not a welfare check but rather "a sort of GI Bill." The trainees are being introduced to the realities of a regular income and regular expenditures. Each family pays $2 a week for rent and utilities — a sum roughly equivalent to the rents they used to pay for their farm shacks. This $2 is being held in escrow and will be returned when they leave, providing a small nest egg to tide the family over until their first real pay check.

While the men are learning the practical skills that will provide a living for their families, the wives are also attending classes. Home management courses focus on nutrition, hygiene, sewing, housekeeping, and family budgeting. The women learn such practical things as how to use federal surplus foods — mostly oatmeal, beans, and other dried or canned foods — in an appealing way and how to remodel used clothing. But more important, they are being taught the attitudes that will be required of them in their new surroundings: the fact that their husbands have to get up in the morning and report for work at a specified hour and that their children have to be clean and washed before they are sent to school.

But life at Rich Square is not overly scheduled and confining. A women's dramatic group has been organized, and arts and crafts and recreation activities are available. The residents have even organized a community council, whose president is a sixth-grade dropout. The council has committees that work actively with the Project staff on the format and content of the training program, making recommendations and airing grievances.

Although the formal training program did not get under way until late September, the trainees have made swift progress. In less than four weeks, one young man who had only a third-grade level of literacy has been transformed into an apprentice draftsman. By using craft manuals as primers and by drawing designs to scale, he has learned reading, writing, and arithmetic at a high school level. Now, most of the group are ready for job placement.

Since most of the wives have completed more years of school than their husbands, their classroom progress has been somewhat less dramatic. Some find the home economics material repetitive and the routine of having to attend classes while running a household at times difficult to cope with. But as one woman observed: "It's only for a while and if it means that my husband will really get a job, then I guess I can go to school and put up with it."

Interest and enthusiasm can be gauged by the fact that no one has given any indication of wanting to leave the Project, although two couples, both in their mid-50s, did drop out shortly after the training program began. The trainees and their wives have adjusted to most aspects of the Project, such as the strange sensation of having to sit in a classroom at their age and having to conform to an hour-by-hour schedule for the first time in their lives. As one man remarked as he hurried to an arithmetic class, "They work me so hard it's almost worse than picking cotton. But I'd rather be here, warm, than back in that cold shack." By and large, they realize these few months are a means to an end.

And their future does seem bright. Last May, RCA conducted a job market survey in the four counties, and 30 companies indicated their willingness to cooperate with the Project's efforts to place trainees. Both Mr. Goehring and his public relations director, Robert Chapman, spend a large portion of their time speaking to area chambers of commerce and community organizations, seeking their support. They also maintain the initial contacts made last May and will continue to work with both the employer and the trainee after placement.

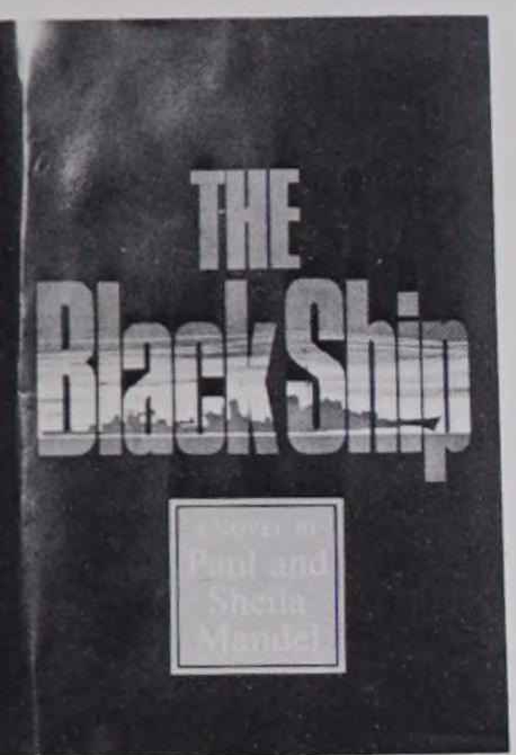
The carpentry instructor, a former contractor in the area, estimates that the construction industry in the state is "at least 30 per cent understaffed and our graduates, as journeymen carpenters, can earn a union scale of $4 an hour." Locally, they can expect to earn approximately $2.50 an hour, which is not bad, he added, "when you realize none of these people has even worked at minimum wage scales in his entire life."

Andy Anderson, the welding instructor, expects that most of the men in his class will ultimately commute, or move, to either Raleigh or Norfolk. In either city they can earn from $2.25 to $2.75 an hour.

One of the main reasons for the rapid progress of this group of trainees lies with the attitude of the Project staff and instructors, all of whom are intensely involved and optimistic. Mr. Anderson, who worked as a welder for 20 years before coming to the Project, sees his job as one of "boosting egos. These men have been stepped on for years and told they're no good and can't work — or won't work. So I say to them, 'Now you're doing something that the man in the shipyard can do. Now you can put your chest out.' "

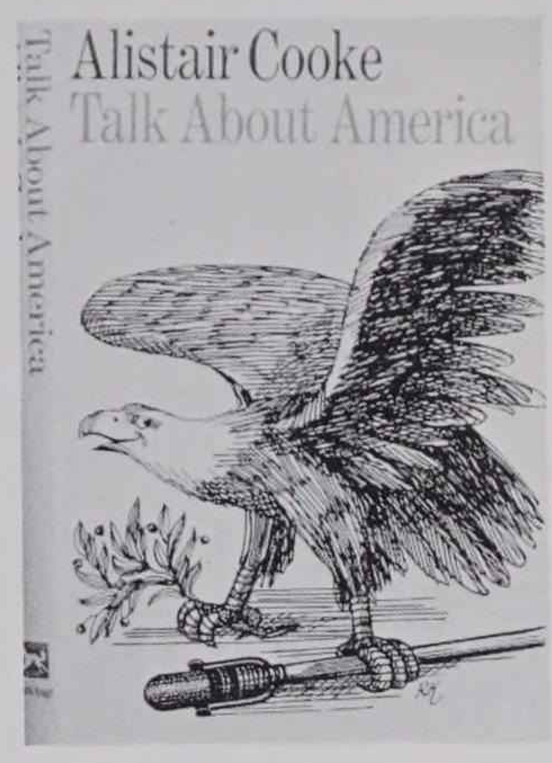
His motivation for joining the staff is personal — and explicit. "It's up to some of us to do something to help them. It's not up to us to give them something, but it is up to us to pass on what knowledge we've gained through the years. After all, somebody gave it to me." ■

Books at Random...



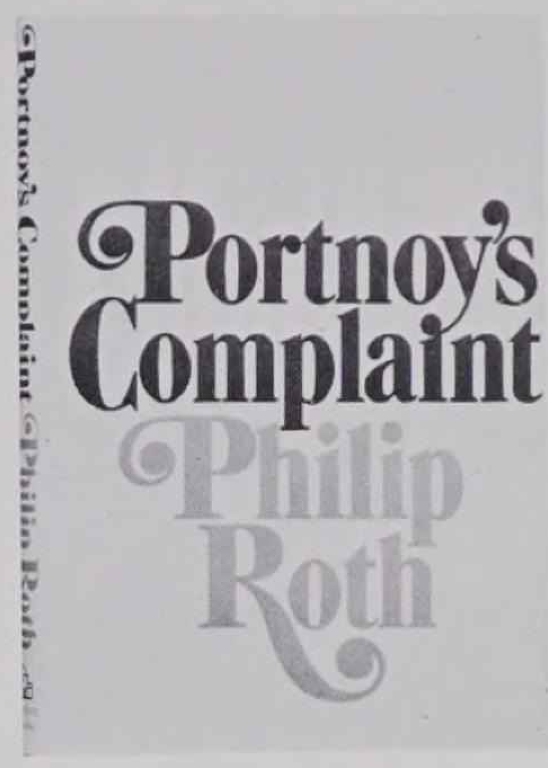
The Black Ship
by Paul and Sheila Mandel
(Random House)

The narrator of this remarkable adventure is an eager but untried American naval officer named Craig, part of a PT boat force that is based in England during World War II. On his very first mission, however, his boat is blown out of the water by the *Black Ship,* an elusive and menacing destroyer manned by the SS. Rescued and hidden by the Dutch underground, Craig finds the *Black Ship* — now wounded and tied up to shore for repairs. Joined by some English shipmates and a determined group from the Dutch underground, he decides to destroy the *Black Ship* and the evil she stands for.



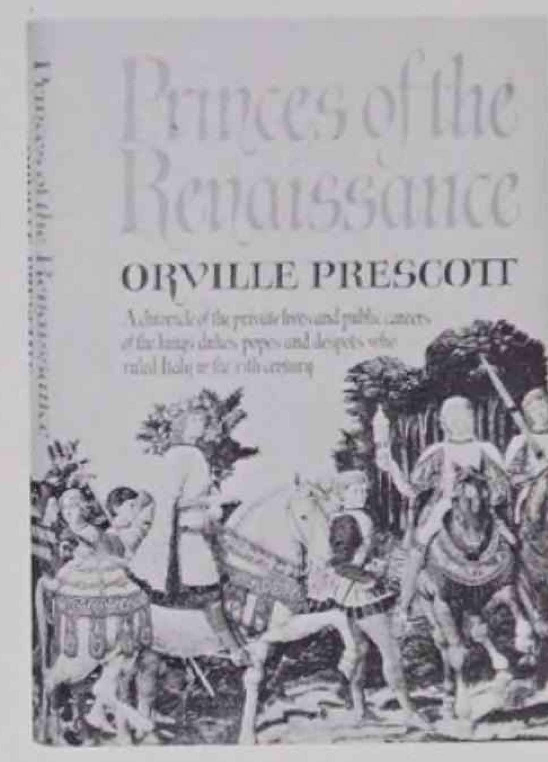
Talk About America
by Alistair Cooke (Alfred A. Knopf)

For more than 20 years, Alistair Cooke has been talking about Americans to BBC listeners around the world, speaking some of the most refreshing comments ever made about this country and its people. From his more than 1,000 broadcasts, Mr. Cooke has selected 41 of his most trenchant and entertaining observations for inclusion in this volume. Here are our manners, morals, paradoxes, peculiarities, institutions, and personalities. Here is America caught in the act of being American.



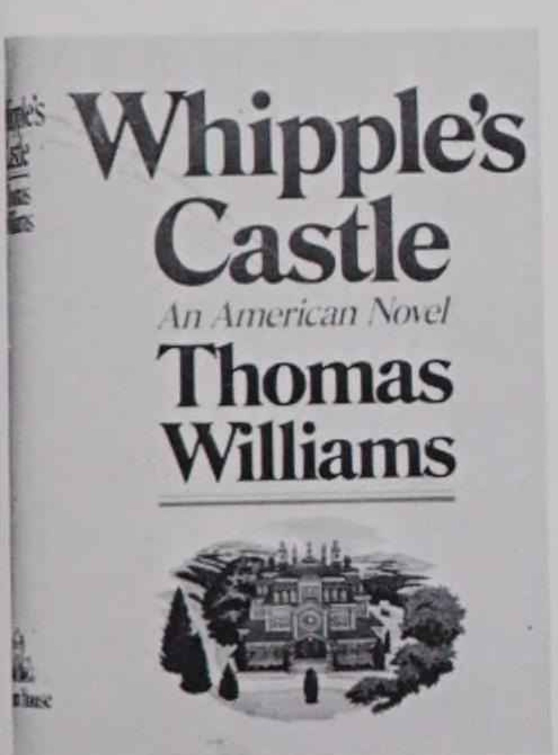
Portnoy's Complaint
by Philip Roth (Random House)

Alexander Portnoy is the Huck Finn of Newark, N.J. — a representative man of his age who grew up in the '40s, came of age in the '50s, and came apart in the '60s. Roth has taken the familiar materials of the Jewish family novel and forced them to their ultimate destination in outrage and wild humor. The source of this humor is the honest obscenity and bitterness of Portnoy's fantasies and their overt expression in his everyday life, particularly in his unmanageable, but painfully human, sexual obsessions. Roth's latest book should prove to be one of the most talked-about novels of 1969.



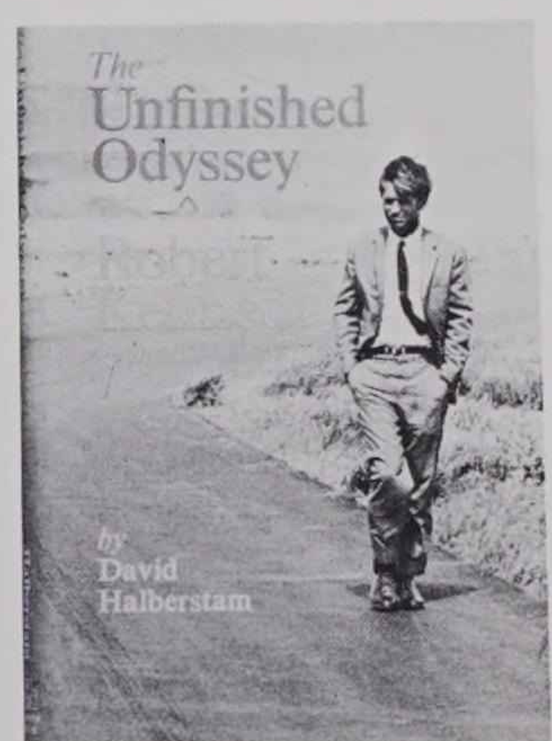
Princes of the Renaissance
by Orville Prescott (Random House)

Much has been written about the Italian Renaissance, the great cultural revolution that transformed European civilization and the minds of men. But the society that nurtured these painters, sculptors, writers, and architects was dominated by the princes of Italy, who ruled the many independent states. This book is a chronicle of the private lives and public careers of the kings, dukes, popes, and despots who ruled Italy in the fifteenth century.



Whipple's Castle
by Thomas Williams (Random House)

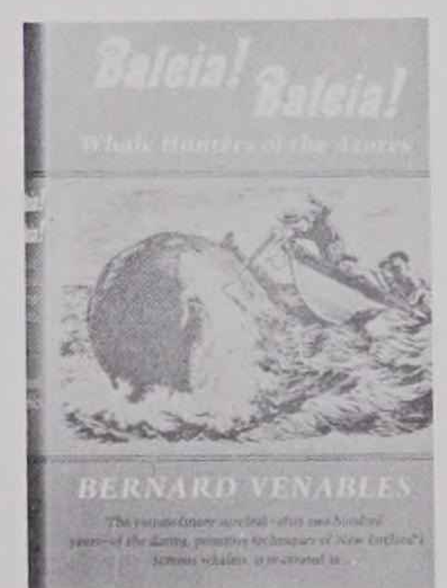
Through this novel, set in New England in the 1940s, the reader comes to know the Whipple family as he knows himself. The mother, Henrietta, bore her children in love and raised them in confusion. Harvey, the father, is endowed with strength of purpose but has a hunger for money that has no limits. Wood, the handsome eldest son, is loved by women but unable to love. David is a superb athlete who grows to use his mind as well as his body. Kate, their beautiful daughter, fears she will never be loved for her brains. And Horace, the youngest son, is tormented by nightmare demons that give him no peace.

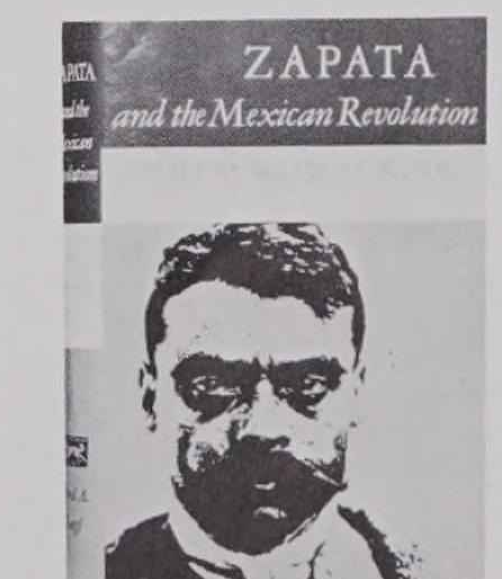


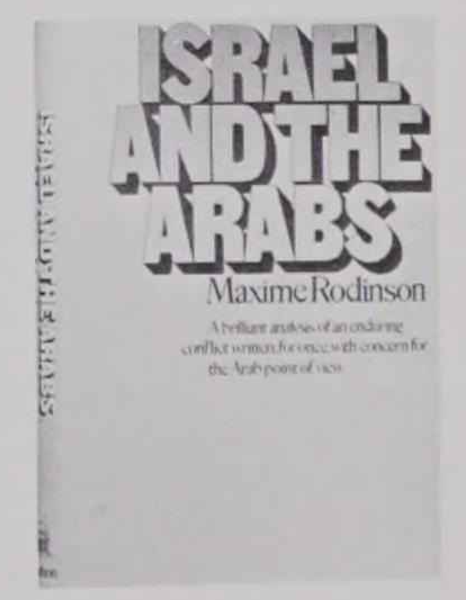
The Unfinished Odyssey of Robert Kennedy
by David Halberstam (Random House)

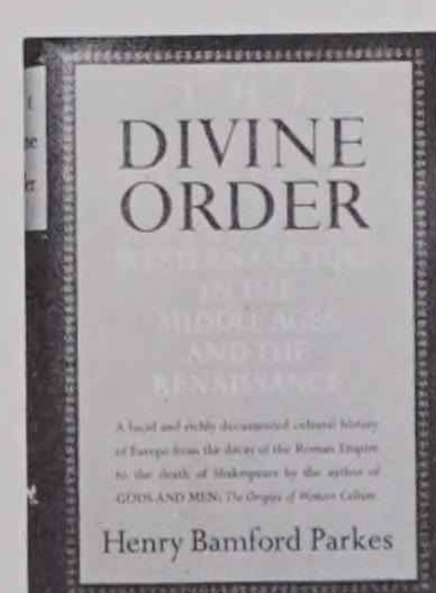
This book is not only a sympathetic and selective account of the last eight months of Robert Kennedy's life but is also an original and observant look at the new politics and the American people themselves: their social pecking order, prejudices, strengths, foibles, and, above all, their reaction to the democratic process and the American politician. It is filled with humorous anecdotes and character sketches of the men around the candidate. The author has provided a study, at once objective and fond, of the growth of the late Senator as a politician and as a human being.

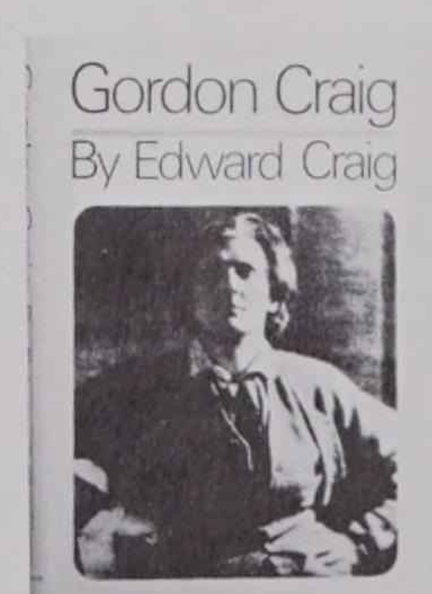
Other Recent Random House Books

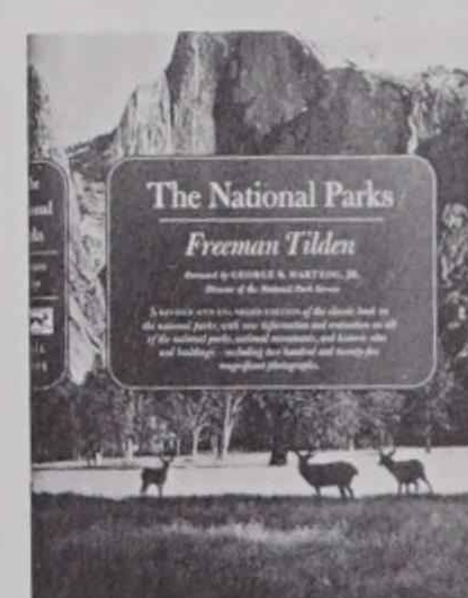












Coming:

A Cashless Society?

The day may be fast approaching when cash and checks will be obsolete—replaced by electronic money.

by Thomas J. Gradel

Like it or not, the day is quickly approaching when the average American will use a computer to keep track of almost every cent he spends. He will do this without ever touching cash except for small change to tip the shoeshine boy or bellhop. In fact, the nature of his money will change from folding paper to electronic bleeps — or no bleeps — in the memory of a computer.

Life in this "cashless society" will be easier in many ways. However, the individual will be relieved of details but not of responsibility. He will not have to scurry to his bank, withdrawing cash for a weekend trip to the shore or depositing money to cover his wife's check written yesterday. Checks will be as obsolete as cash. His salary will automatically be deposited in his account, and he will be notified that he can begin using it at 9 a.m. Friday. Upon his authorization, all of his regular bills, such as mortgage payments, will be transferred to the accounts of his creditors.

Throughout the week, he will use an all-purpose identification and credit card to make food, entertainment, gasoline, and many other purchases. (In the earlier years of the "cashless society," he would have utilized a change machine to obtain silver and small bills for vending machines and small merchants. But even that need will be eliminated.) Eventually, every financial transaction will be initiated by the identification card and every vendor, except the shoeshine boy, will have a credit card terminal, linked to a nationwide computer system, that will instantly record all financial transactions.

Thomas J. Gradel is on the staff of the RCA Information Systems Division.

The system most likely will include personal computers, neighborhood time-sharing electronic data processing centers, and gigantic processors operated by banks and leading retailers.

Such a network will help eliminate a variety of financial headaches, ranging from the familiar backlogs on Wall Street to the annoying delays in receiving receipts and canceled checks. And with terminals in the home, it will be possible for computers to report on the financial status of individuals as well as businesses. The computer will display on a screen the balance in an account, payments due in the near future, and the number of loans outstanding, including the various interest rates on each. There will be no need to wait until the end of the month to find out exactly how much money is in an account. There will be electronic safeguards against unauthorized persons gaining access to the data, to protect the individual's right to privacy.

Many payments will be made immediately, by instructing the computer to subtract a charge from a consumer's account and add it to the grocer's account. Any deferred payment will become a charge account sale and, after a certain period of time, will incur interest.

The average man's life will be simpler because he will have access to a computer to keep track of these financial transactions. It will be more complicated because virtually an unlimited number of opportunities to make loans or to borrow money will be open to him.

Despite objections from some quarters, there are definite signs that the coming of the "cashless society" is simply a matter of time. One authority points out that most of the technology needed to operate an "electronic" monetary system is already available. He further states that, if the needed technology is available but not economically feasible today, it soon will be. Yet, even today, there are holdouts against modern fiscal methods. Some people refuse to use banks, checks, or money orders. Instead, they hide huge sums in the mattress, send hundreds of dollars in cash through the mails, and consider it both sinful and foolish to borrow money or purchase goods with a credit card. Nevertheless, statistics are proving the popularity of credit cards and the coming of the "cashless society."

In the first half of 1968, the use of credit cards by national banks expanded by 15 per cent over use in the first six months of 1967. The amount of credit outstanding under credit card and revolving charge plans reached $1.13 billion at the end of June, 1968, compared with $985 million a year earlier. Credit cards alone accounted for $724 million of the mid-year totals, and the number of national banks using credit card plans increased from 187 to 217 in that six-month period. And that's just national banks. This autumn, the Federal Reserve Board (FRB) reported that 416 commercial banks were operating credit card programs, many with tie-ins with other banks.

Under most plans, cardholders can obtain merchandise or services on credit from local retail outlets and are billed through their banks. Interest on unpaid balances ranges from 1 to 1.5 per cent a month, or up to 18 per cent a year, depending on local usury laws. The average credit limit, according to the FRB, is $350.

Many of the nation's large retailers also have charge card and credit card plans. People also carry travel, entertainment, and airline cards, and at least two banks, located in Miami and New York, even issue a card that triggers a money-dispensing machine. In addition, one of the nation's largest supermarket chains recently began an experimental credit card program. The A&P, traditionally a cash-and-carry firm, introduced the program in six stores in Ohio and West Virginia.

Credit card plans are considered the first step toward the "cashless society," and their rapid proliferation is an indication that, some day, checks and paper money will not be able to compete with efficient "electronic" money. Other fiscal innovations in many industries are leading to the establishment of a national network for checking the credit and verifying the identity of the cardholder.

In an effort to reduce frequent holdups of bus drivers, the Philadelphia Transportation Company recently inaugurated an "exact fare" plan. Under this plan, passengers who do not have the exact fare deposit more than the cost of the ride in a locked box and receive a certificate. This entitles them to a refund for the difference, obtainable at centrally located refund centers. It is expected that, within a few years, buses in many metropolitan areas will carry devices that can read credit cards. Fares charged against these cards will be recorded on magnetic tape or miniaturized magnetic disks. These records will be processed by computers and, once a month, the passenger will receive a bill for all his bus and subway rides. Adapting to the exact fare plan will help Philadelphians adjust to any computerized billing that might be introduced. A credit card system would eliminate more fully the handling of money by the driver, while doing away with trips to collect the refund.

In another case, the Ripley Company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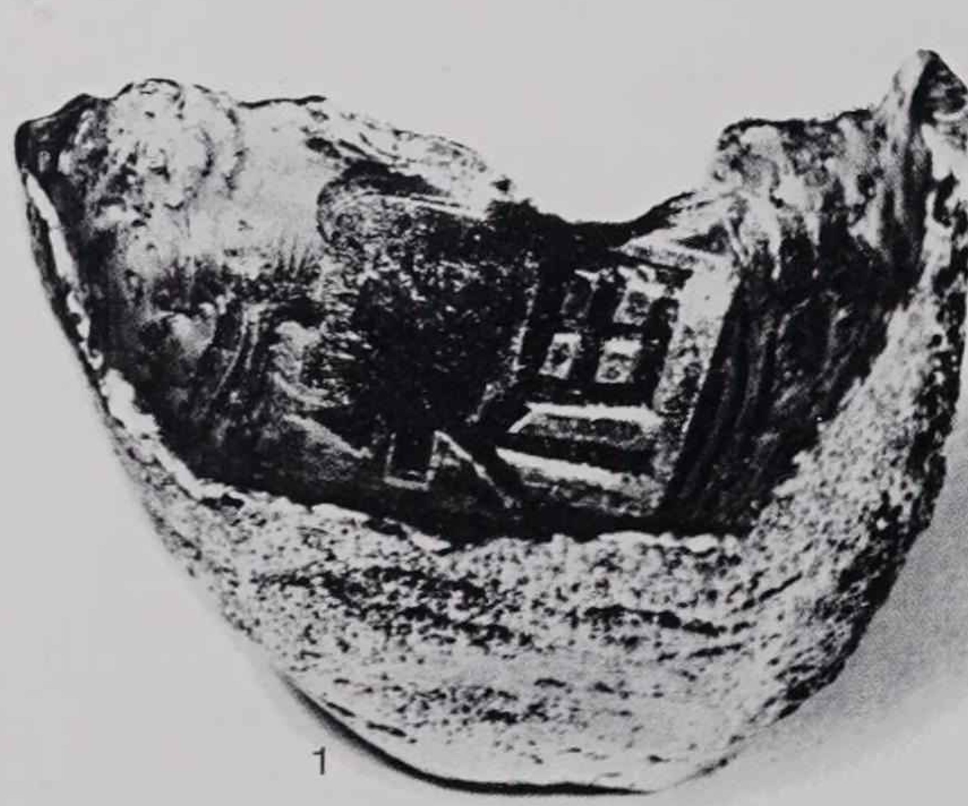
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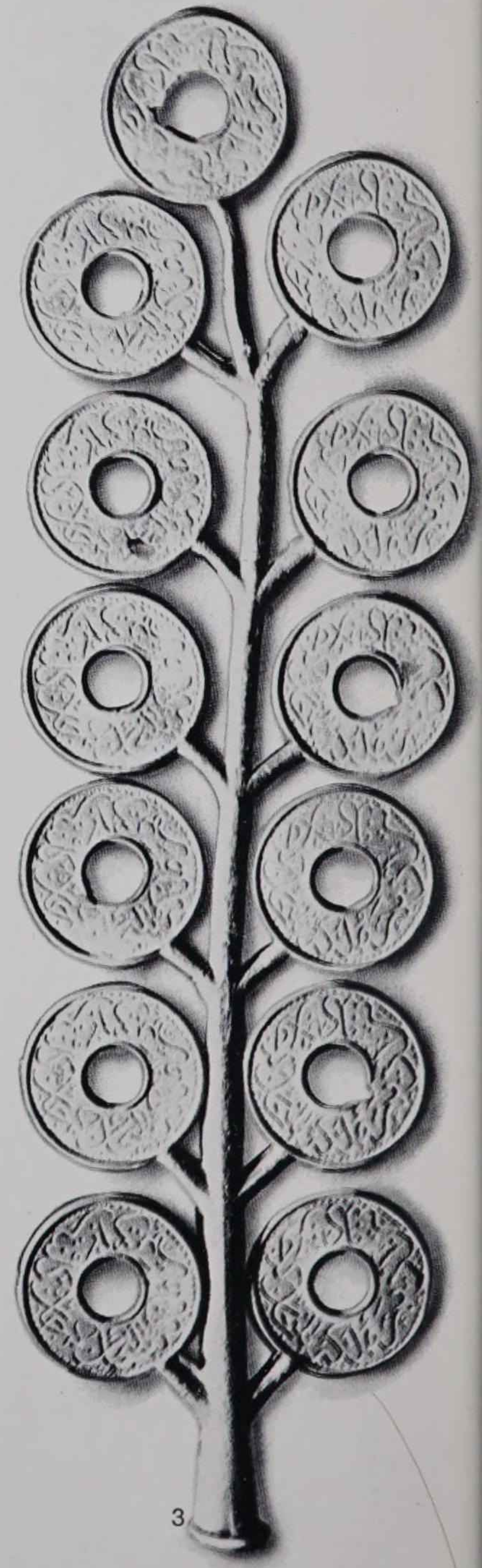
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1. Chinese shoe money.
2. Algerian currency.
3. Nineteenth-century money tree of the East Indies.
4. Weapons used as money in the Congo.
5. Alaskan copper-plate money of the nineteenth century.
6. Money stone of Yap Island.
7. Dog-teeth currency of the Solomon Islands.

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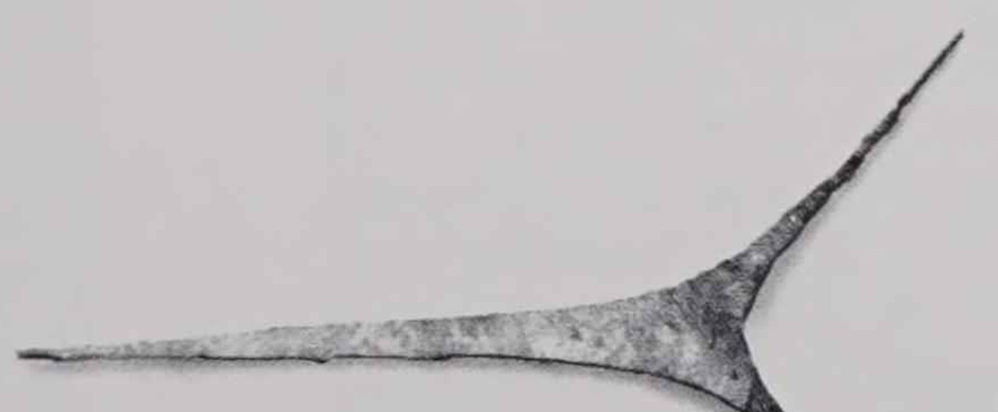

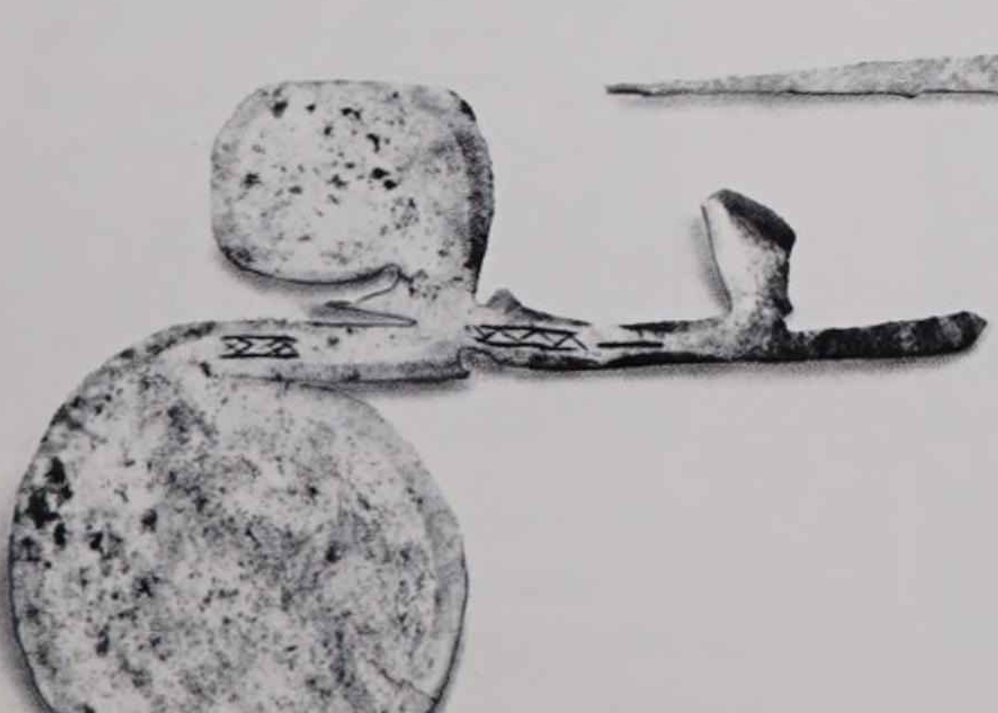

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"Most of the technology needed to operate an 'electronic' monetary system is already available."

will soon run tests to prove the feasibility of automatic utility meter reading via public telephone lines. A spokesman claims that, when such a system is operable, a computer would be programmed to interrogate the meters for each billing period and prepare the bill from the figures. With the customer's permission, the system could be tied to bank computers for automatic payment of utility bills.

The military is already using "cashless" money and computers to help curb black market activities in Vietnam. The U.S. military command has issued plastic currency control cards that must be used when a serviceman converts his military scrip into cash or when he spends it on certain higher priced post exchange goods. Data from these cards give officials a constant watch on the volume of converted scrip as well as on PX purchases. If, for example, a man should convert more than the authorized amount of scrip, the computer "kicks" out a card identifying him and showing all his recent transactions.

A major factor in speeding the establishment of the "cashless society" is the continuing decline in data processing costs and in the cost of transmitting information over telephone lines. In the late 1950s, it cost $1.35 to perform 100,000 multiplications on the most efficient computer available, according to a data processing consultant. Today, the same function costs less than three cents.

Dr. James Hillier, RCA Executive Vice President, Research and Engineering, frequently has stated that the "cashless society" is inevitable. In fact, he points out that, by reflecting on past economic and technological development, society might even be able to determine when it will be a reality.

A certain concept of this development, which he calls "the tyranny of numbers versus the constancy of humans," may hold the answer. This is explained by the fact that a department store clerk is essentially a constant in regard to her ability to generate bills, manually verify credit authorization, or handle the transactions of the people who line up at her counter. On the other hand, the number of credit cards, volume of financial transactions, and degree to which individuals depend on others to produce food, clothing, and personal protection are expanding at a rate faster than that of the population. If this continues, there will not be enough people in the world to handle the financial transactions — buying, selling, and billing — generated by the people of the United States.

In the past, when the constancy of humans was violently coupled with the tyranny of numbers, the resulting explosions gave birth to technological breakthroughs and important innovations. An example can be found in the history of the telephone industry. The rapid increase in the use of telephones, combined with the geometric expansion in the number of possible connections that could be made by the operators, eventually produced direct dialing and computerized switching. If switchboards were still operated manually, there would not be enough girls in the world to handle all the calls made today. Thus, according to Dr. Hillier, it is only a matter of time before the number and complexity of financial transactions make it economically necessary to convert to "electronic" money. The reduced cost of communications and data processing, the public's growing familiarity with credit cards, computerized billing, and automatic meter reading, and the more efficient manufacture of computer terminals will combine to force the conversion.

Despite these forces, there are still a few technological hang-ups that the nation's scientists and engineers have not completely solved. One is the need for a foolproof inexpensive method of verifying the identity of the cardholder. No one looks forward to an "electronic" money system if it means that a thief will have unlimited access to all his financial accounts. A lost wallet containing a code number could lead to total financial ruin. This is such a problem today that at least one company has sprung up to help protect consumers against lost or stolen credit cards. The company claims that, within 30 seconds after notification, it can put a computer to work detailing the cards owned by a subscriber. Then, the issuing companies are notified by telegram that the cards are missing and credit privileges should be canceled. Although this is a partial solution to the problem, it still puts the burden on the owners of cards to notify the firms. Any purchases charged on those cards are still their liabilities. What is really needed is a system that would deny credit privileges to the cardholder unless he could positively identify himself as the rightful owner.

Dr. Donald S. McCoy of the RCA Laboratories has suggested a speech-recognition system that employs both code words and voice-signature prints to positively identify cardholders. A person would voice an assigned code phrase of easily identified sounds — "This is six one one tango" — and then speak his name. By means of the code phrase, the computer would be directed immediately to the place in its memory where that person's voice-signature file is stored. These voice-signature prints have been demonstrated to be as efficient and forgery-proof as are fingerprints. This speaker-identification system is already possible with the speech technology of today. The cost is still high, but it is rapidly approaching economic feasibility.

One of the first developments that must take place is the establishment of a large, computerized credit card system. At the present time, one of the primary obstacles to such a pilot project is the high cost of terminals capable of reading credit cards. To attract widespread use, the terminals for the remote interrogation of credit files and the collection of credit transactions must be small and inexpensive. A credit card system will not function properly unless a remote credit card terminal is located wherever a charge can be made. Every hardware store, jewelry shop, grocery store, gasoline station, and restaurant must have at least one. These terminals must be small and easy to operate because they will be handled by proprietors and clerks who currently operate machines no more sophisticated than a cash register. The main function of these devices is to read and transmit the credit account number and to accept variable data, like the dollar amount of the transaction. Also, these devices must have the capability of tactfully signaling the terminal operator that the sale has been approved and recorded or that it has been rejected and not recorded.

One of the chief factors that will contribute to the practicality of on-line credit card networks is the development of internal computer systems. Banks, like the Marine Midland Grace Trust Company of New York, are developing computerized information networks linking all of their branches to a centralized computer. If banks develop central information files containing information on all their customers, it will become a relatively simple matter to add an automatic credit card system. Actually, credit card validation and purchase authorization require a very small fraction of computer time. Banks can continue to do batch processing and handle the credit card system through the use of multi-programming and time-sharing techniques. It is then possible for credit card terminals to interrupt the processor, request information, and receive it in only a fraction of a second. These techniques permit the processor to handle bulk processing and on-line communications at the same time.

However, many other problems must be worked out before the "cashless society" becomes a reality. For example, the competitive struggles between the banking industry, large retailers, the telephone companies, and the federal government must be resolved. The lines separating the proper fields of activities for these industries begin to fuzz when their operations project into the age of "electronic" money. Many state and federal laws will have to be modified to permit banks to engage in merchandising and also to allow retailers to perform some typical banking functions.

This would be only one of a variety of changes in the economic life of the nation. With the advent of the "cashless society," many new jobs will be created, while some pedestrian ones will be eliminated. It may even be a built-in answer to the problem of crime in the streets. Armed robbery would be obsolete if nobody carried money and a voice check was needed to use a credit card. A new breed of criminal would probably be developed, electronic embezzlers who could tamper with computer systems to inflate their accounts. Computer experts are already working on methods to foil this. In addition, federal investigators would merely have to check employers' computers to discover the honest income of a suspect.

One thing is certain. A nationwide "cashless society" would provide everyone with his own electronic accountant: a computer that can handle almost all financial details but makes none of the critical decisions. ■

For the Records...

Bruckner: Symphony No. 7 in E
Eugene Ormandy conducting The Philadelphia Orchestra LSC-3059

This recording marks the return of Eugene Ormandy and The Philadelphia Orchestra to the RCA label after an absence of a quarter-century. This massive work was written in 1880, when Bruckner was 56, and was first performed in Leipzig in December, 1884. Although he was one of the most revolutionary of the nineteenth-century symphonists, his works were thought to have been too difficult for contemporary audiences to comprehend, and worldwide recognition of his ability has come about primarily through twentieth-century recordings.

Mozart: Cosi fan tutte
Leontyne Price, Tatiana Troyanos, Judith Raskin, Sherrill Milnes, George Shirley, and Ezio Flagello.
Erich Leinsdorf conducting the New Philharmonia Orchestra LSC-6416

In 1910, Richard Strauss observed that "Not only is *Cosi fan tutte* unique amongst Mozart's dramatic masterpieces, it is also one of the gems of the whole of operatic comedy prior to Wagner's *Meistersinger.*" Since then, few critics have disagreed with his remark. This four-album set is the first complete recording of the work on RCA Red Seal, with all the recitatives intact and the customarily deleted music for baritone, soprano, and tenor restored.

Ives: Symphony No. 3
Schuman: New England Triptych
Eugene Ormandy conducting The Philadelphia Orchestra LSC-3060

Ormandy selected these works to represent the contemporary movement in serious music. The Pulitzer Prize-winning Ives Symphony was given its world premiere in New York in 1946, 42 years after it was written. Called "The Camp Meeting," it uses three hymn tunes as the source material for its movements: "Old Folks' Gatherin'," "Children's Day," and "Communion." The Schuman work is based on three pieces by William Billings, an eighteenth-century amateur composer who lived in Boston, and was commissioned by Andre Kostelanetz.

Chopin: Sonata No. 2 in B-Flat Minor, Op. 35 ("Funeral March") and Sonata No. 3 in B-Minor, Op. 58
Van Cliburn LSC-3053

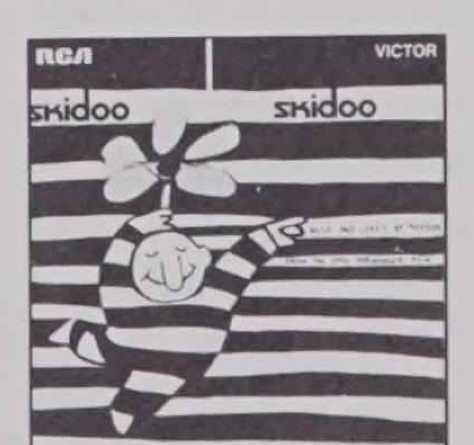
A decade has passed since Van Cliburn achieved international fame after being declared the grand prize winner of the first Tchaikovsky competition in Moscow. Today, he stands as one of the great pianists of the age, and mere announcement of his name sells out concert halls around the world. In his first recording for RCA Red Seal in two years, Cliburn performs two of the most popular major works in the piano repertoire — Chopin's Second and Third Sonatas — in an album that is a companion piece to his earlier collection of smaller Chopin works.

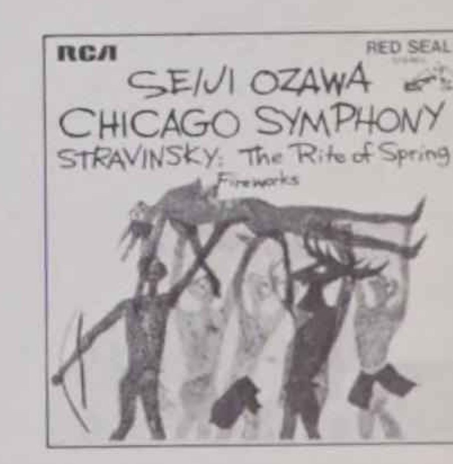
Tchaikovsky: 1812 Overture, Op. 49
Rachmaninoff: Three Russian Folk Songs, Op. 41 and Spring, Cantata, Op. 20
Igor Buketoff conducting the New Philharmonia Orchestra, the Cathedral Choir and Children's Choir of St. Ambrose, Central Band of the Royal Air Force, Guns of the King's Troop, Royal Horse Artillery, and Russian Church Bells LSC-3051

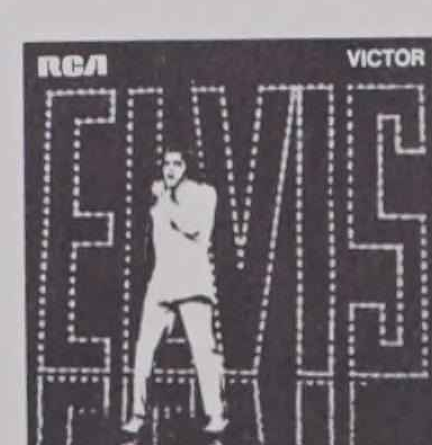
A new dimension has been added to this recording of the *1812 Overture*. The church hymn, "Save, O God, Thy People," is performed in Russian by a 90-voice *a cappella* chorus. The Russian national anthem is sung by the Cathedral Choir, and the Children's Choir performs the folk song included in the work.

Weber: Concerto No. 1 in F-Minor, Op. 73 and Concerto No. 2 in E-Flat, Op. 74
Benny Goodman, clarinetist
Jean Martinon conducting the Chicago Symphony Orchestra LSC-3052

Although Benny Goodman is best known as "The King of Swing," his first love has always been more serious music, and his background, although not generally publicized, is steeped in the classical repertoire. In this, his second recording with the Chicago Symphony Orchestra, Mr. Goodman plays two of the six works Weber wrote for the clarinet. The album is also the first stereo recording of the Concertos.







Other Current RCA Releases

Electronically Speaking...

News in Brief
of Current Developments
in Electronics

Improved Photomultiplier May Throw New Light on Scientific Mysteries

A new light detector that could revolutionize efforts to map the structure of the DNA molecule, to detect light from the mysterious radio stars known as "pulsars," to see more deeply into the atom, and to learn how green plants convert sunlight into food has been developed. The key to the radically improved photomultiplier is a new "dynode" or amplifying stage that is 10 times more efficient than those presently in use.

The emission of light can be a by-product of many natural events from the birth of a star to the fission of an atom or a chemical change in a human cell. Unfortunately, such light is often too weak or occurs in flashes too brief to be seen by the human eye or an unaided optical instrument. Therefore, scientists frequently use a photomultiplier in association with their microscopes, telescopes, scintillation counters, or similar equipment. It is in these areas that the RCA photomultiplier is expected to have its greatest immediate impact. Eventually, it may also find important use in optical receivers for laser communications systems, when these become practical.

Computerized Crime-Fighting System Established in California

California law enforcement agencies are getting a $5-million battery of high-speed electronic weapons to help in their war on crime.

Built around four RCA Spectra 70/45 computers, the new system will link some 450 police departments and law enforcement agencies throughout the state to computerized criminal information files in Sacramento, Calif., and Washington, D.C. Called the California Law Enforcement Telecommunications System (CLETS), the high-speed message-switching system will enable metropolitan precinct dispatchers and rural police chiefs and sheriffs to obtain instantaneously information on wanted persons and stolen or lost property, firearms, and vehicles.

When the CLETS system is completed in October, it will be the largest, most advanced, state-wide computerized criminal information system in the nation, employing more than 900 terminals plus communications links between every county in California. It will also utilize such modern techniques as multi-programming, emergency backup, multiple addressed messages, group coded messages, and direct access to data banks.

When the system is operational, a patrolman can spot a suspicious auto and radio the description to his dispatcher. The dispatcher will type a coded description on a computer terminal or teletypewriter and transmit the message to a CLETS computer, which automatically asks the computer at the California Department of Justice if a car fitting this description is listed in the stolen auto or wanted auto files.

The scofflaw list at the State Department of Motor Vehicles and the files at the National Crime Information Center also will be checked automatically. Any information on that auto will be instantaneously displayed on the dispatcher's terminal. Thus, in a matter of seconds, a patrolman can determine how to approach the auto or whether to call ahead for a road block. The new system also will permit local law enforcement agencies to determine immediately the first owner of a registered firearm and other important information.

New Satellite Communications Circuit Links Hawaii and the Mainland

A new overseas communications circuit links California and Hawaii through the Intelsat 2 satellite, in orbit 22,300 miles above the Pacific Ocean. The circuit is able to carry 12 two-way voice conversations or data produced by computers at approximately 50,000 words a minute.

Developed by RCA Global Communications for the Department of Defense, the facility is capable of handling voice, record, facsimile, and computer-to-computer communications. It is the first of its kind to go into operation between the U.S. mainland and an overseas point and is also the first to use a 48-kilohertz band width.

In its broadband form, this circuit can handle computer-produced data at high speeds. The Department of Defense has the option of using the broadband circuit, with special terminal equipment, to derive 12 individual high-quality channels for the transmission of intelligence by voice or the transmission of data at speeds of up to 4,500 words a minute per channel. These same 12 circuits can be used to transmit material by facsimile if required. The circuit can also be subdivided into 288 separate standard teletypewriter speed channels.

Giant Gauge Checks Crankshafts

The world's largest automatic gauge—tall as a two-story house—is being used to check 57 critical dimensions of automotive crankshafts and pinpoint flaws to tolerances as small as plus or minus .0005 inch.

The RCA machine, which has been put into operation by a major automobile manufacturer, can handle 200 crankshafts an hour and is capable of being incorporated into computer-controlled, fully automated production systems that the industry might develop in the future. It will accept either of two sizes of crankshafts, which are fed automatically to it at random. The gauge automatically color codes each measuring point to indicate whether the dimension is acceptable, oversize, or undersize.

Computer System Goes to College

A time-sharing computer system is performing administrative as well as academic duties at Shippensburg (Pa.) State College. It is being used to help solve difficult mathematics and chemical problems, forecast economic growth, figure payroll, talk to students in several classrooms at the same time, and provide instant access to administrative files.

The time-sharing system enables several users to obtain immediate and simultaneous access to the computer, via remote video data terminals and teletypewriter units located in classrooms, laboratories, and offices. It can accommodate simultaneously up to 16 of these remote terminals. Students use the computer for help in science and business courses, as well as for data processing and computer programming courses, and the system also affords many time-saving advantages to the faculty and administration.

For example, the dean of academic affairs will be able to use the system to retrieve instantly the record of any of the College's 4,400 students. A student's record will be displayed on a Video Data Terminal, permitting the dean to make decisions based on the information without a tedious search of file cabinets. He will be able to examine a different record every few seconds, or as fast as he needs them. Moreover, the same records could be retrieved simultaneously by the dean of men or other authorized officers of the College, an impossibility when records are handled physically. However, confidential files such as student records are electronically locked, prohibiting access by unauthorized persons.

The RCA Spectra 70/45 computer also will be used to forecast the long-range manpower requirements for faculty and administration, and eventually it may be employed as an on-line library information retrieval system.

Computer Matches Workers With Jobs

A computerized job bank is helping workers in Utah find employment. Details on some 80,000 job seekers, registered with the Utah Department of Employment Security, are stored electronically for matchups along with complete data on 50,000 nonfarm openings.

The federally funded job-matching system works in this manner. An employer with an opening phones an Employment Security Office. His specifications are transmitted from a Video Data Terminal over telephone lines to the central RCA Spectra 70/45 computer, which then searches through its random access files for persons whose job skills match. This takes only seconds.

The same process occurs when a job seeker registers. The file is sifted to see if his qualifications can be matched to a vacancy. If not, they are stored electronically for later matches. If he secures a job, his name is removed from the rolls of the unemployed. The result is that people may now receive job referrals in minutes rather than days.

In addition to job matching, Utah uses the computer for general administration of unemployment insurance—including claim payments.

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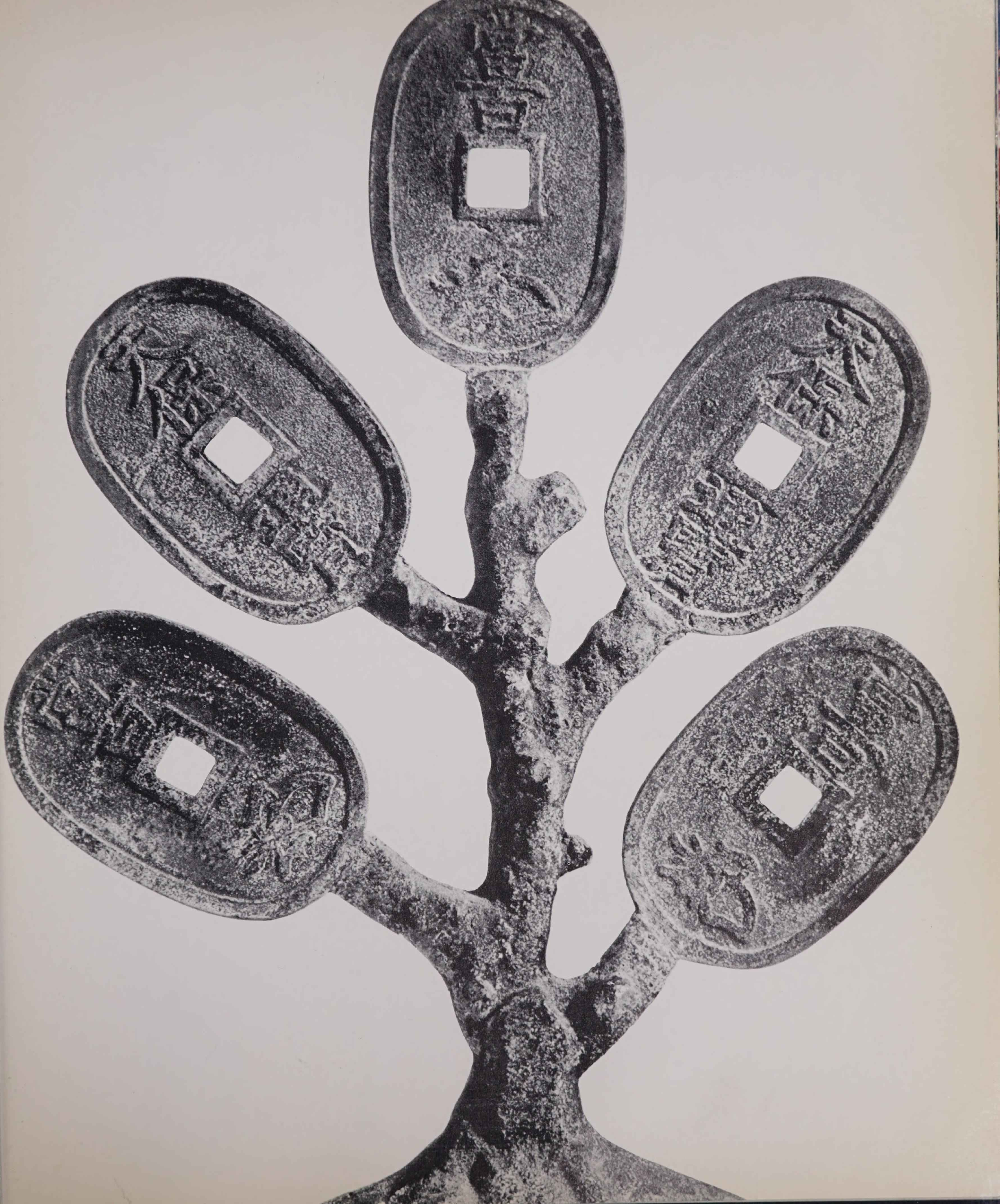
Money of all types some day may become as obsolete as this old Chinese money tree.
For an article on the cashless society, turn to page 30.



RCA

Electronic Age

Winter 1968/69

Machines That Listen