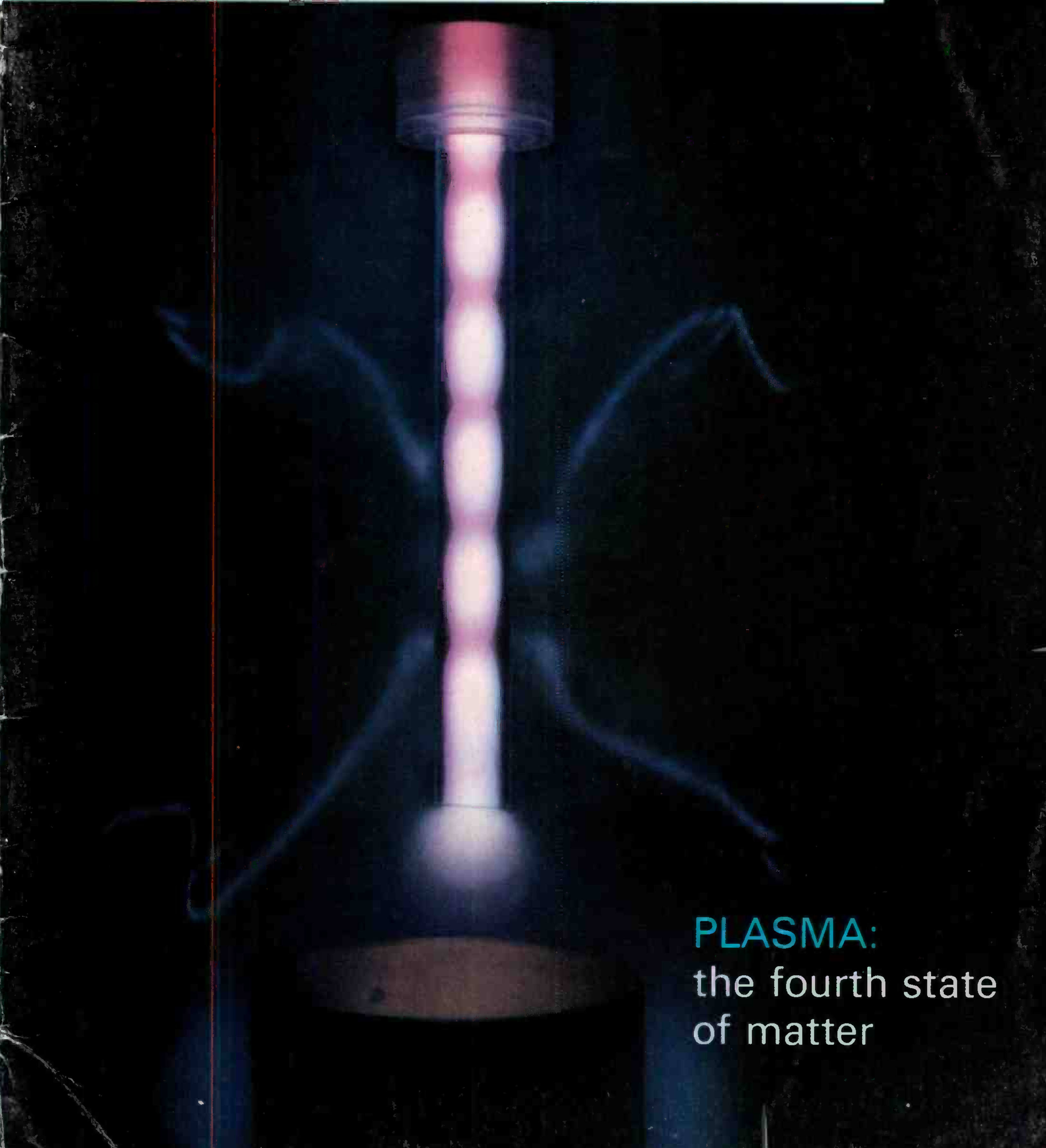
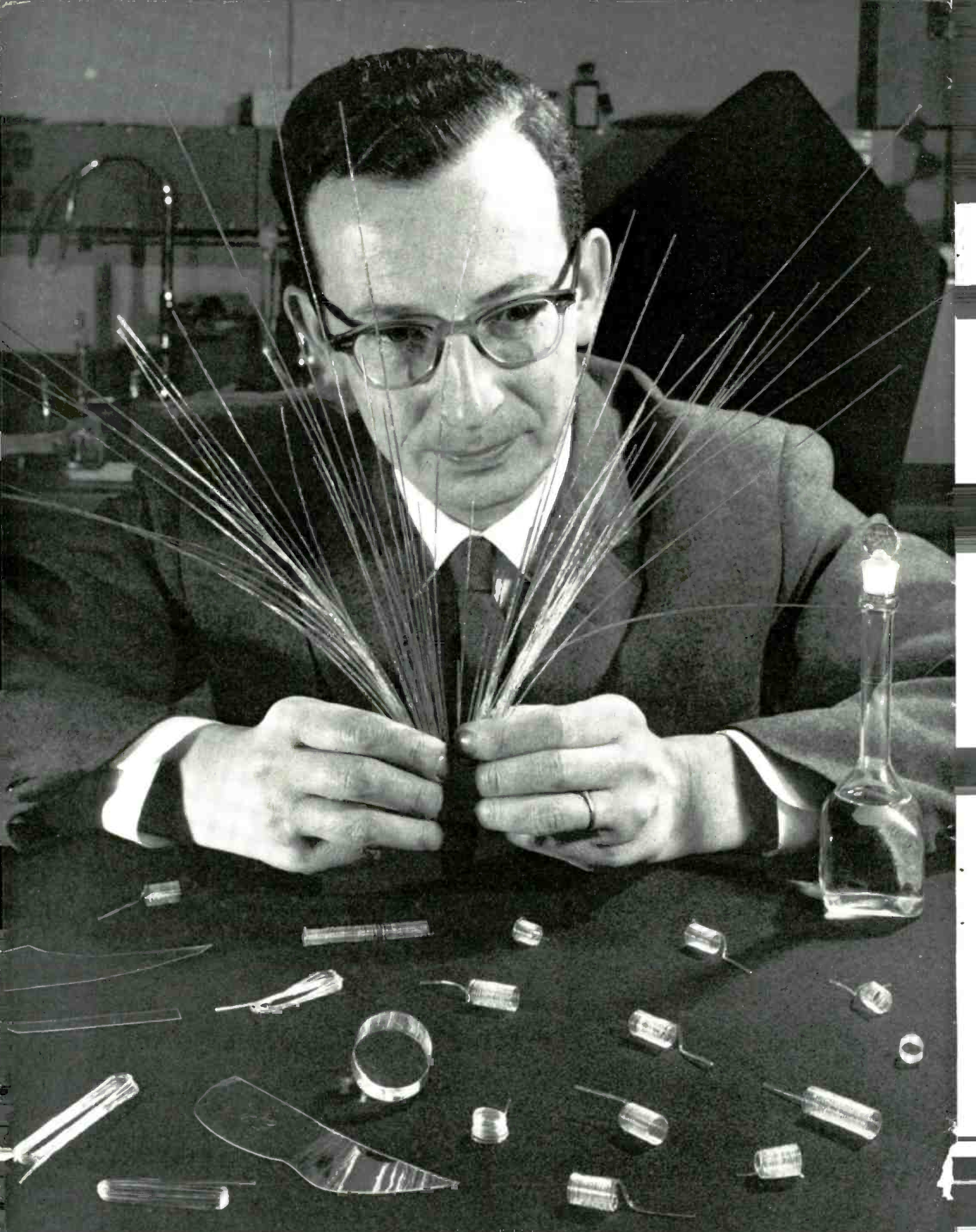
RCA

SPRING
1963

electronic age



PLASMA: the fourth state of matter



RCA electronic age

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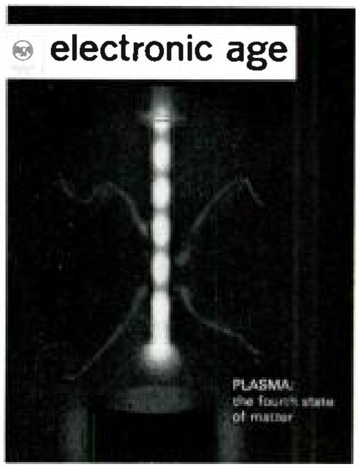


COVER: *At David Sarnoff Research Center, Princeton, N. J., an argon plasma — hot ionized gas — is generated inside a six-inch glass column by application of a radio frequency field. In this experiment, RCA scientists are attempting to simulate the plasma created around a space vehicle when it reenters the earth's atmosphere.*

Blue arcs on either side of plasma column are reflections on the glass window of the vacuum apparatus. Light globules in the plasma stream itself are, as yet, an unexplained phenomenon.

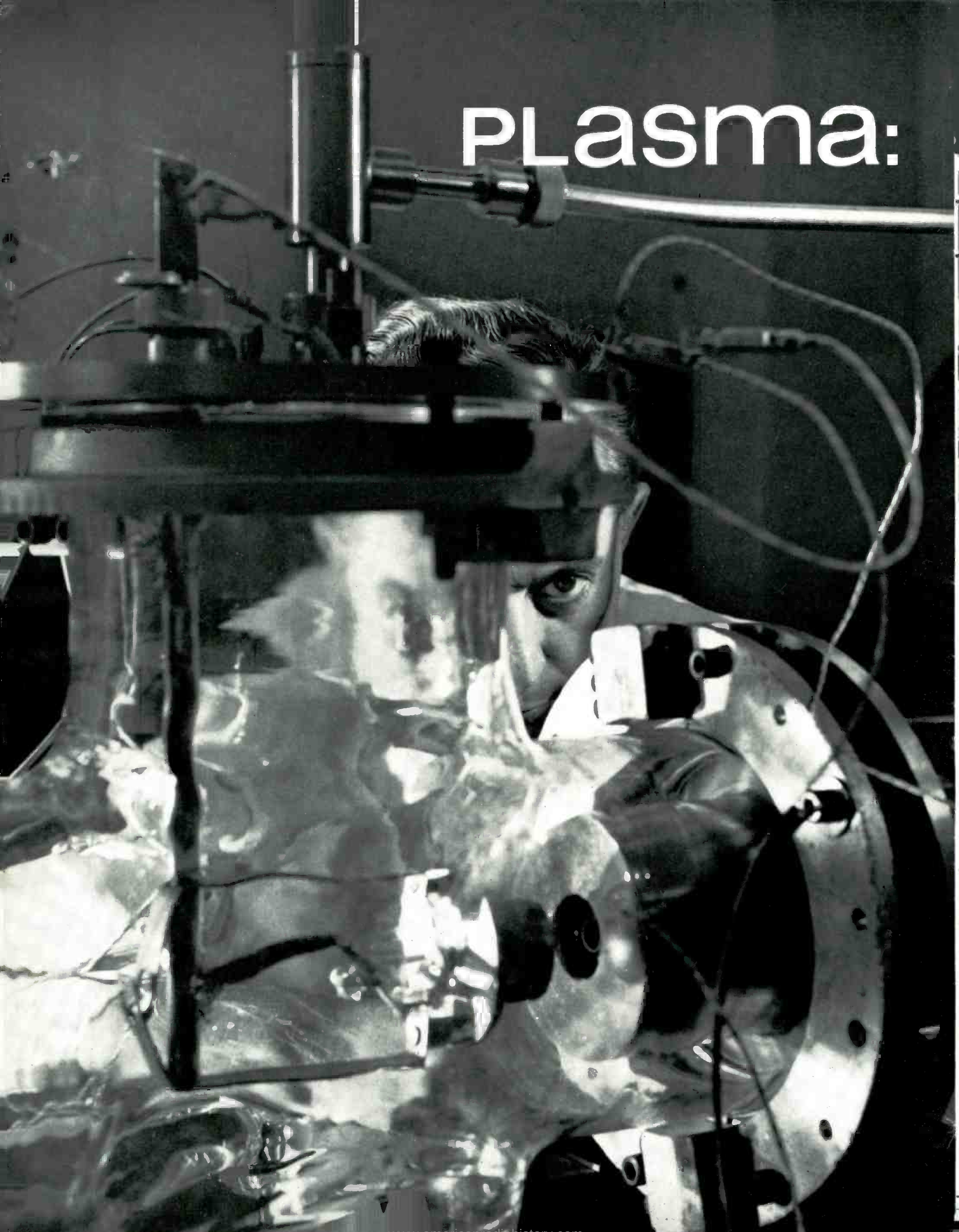
JULES KOSLOW, *Editor*
Frederick W. Roloff, *Associate Editor*

Dr. Nikolaus E. Wolff, of RCA Laboratories in Princeton, N. J., examines a spray of newly developed plastic fibers similar to those that have produced laser action. These plastic lasers may be the forerunner of a whole new family of low-cost, mass-produced lasers. In the foreground are other shapes that future plastic lasers may take.

In this issue . . .

RADIO CORPORATION OF AMERICA
30 ROCKEFELLER PLAZA, NEW YORK 20, N. Y.

PLASMA:



the fourth state of matter

Not solid, not liquid, not gas— artificially produced plasmas are providing exciting new potentials for direct energy conversion, space propulsion, communications, and basic research.

BY BRUCE SHORE

On the drawing boards or under development in the nation's bustling research laboratories is a spectacular array of new electronic products whose performance will derive from a strange, fourth state of matter known as *plasma*.

Identified and described by Dr. Lewi Tonks and Dr. Irving Langmuir in 1929, plasmas are now the basis for a gathering scientific upheaval in the fields of direct energy conversion, space propulsion, communications, weaponry, industrial processing, and basic research.

Not solid, not liquid, not gas – plasmas are a kind of "electronic jelly" composed of equal numbers of negatively charged electrons and positively charged ions held together by their own long-range electrical forces. They are generated when the atoms of a stable element, such as mercury, are excited – usually by heat or electric energy – to a point where their nuclei and some or all of their electrons dissociate.

While they are too energetic to reassemble into atoms, these "free" electrons and "free" ions (i.e., the nuclei) are not energetic enough to escape their mutual electrical attraction, and continue to swarm in each other's vicinity. Therefore, they form a seething, vibrating, electronic "Funny Putty," which is surprisingly stable, cohesive, and electrically neutral.

While plasmas have some of the character of a gas – they will diffuse to fill any container, for example – they are quite different. They can exist even in solids. Solid-state plasmas are a current focus of intense study at RCA Laboratories at Princeton, N.J., because of their ability to generate high-frequency radio waves.

Interestingly, plasmas have been an intimate part of day-to-day living from the beginning of life on earth, although they have moved to the fore of scientific research only recently.

The sun is a plasma. Racked by continuous thermonuclear explosions and multi-million-degree temperatures, squeezed by gravitational pressures that would add tons to the weight of a man on its surface, buffeted by fierce electric fields, magnetic storms, and other cosmic disturbances – the sun could not exist as anything *but* a plasma.

The ionosphere, too, is a plasma. Enveloping the earth from an altitude of 60 miles out to several hundred, it makes possible world-wide communications by reflecting short-wave and other radio frequencies back and forth to the ground until they have propagated around the world.

Man-made electron tube devices for converting alternating to direct current, such as *thyratrons* and *ignitrons*, also employ plasmas. The mammoth, RCA-built Ballistic Missile Early Warning System (BMEWS) uses *ignitrons* to produce and shape the powerful radar pulses with which it sweeps the northern skies in search of hostile intruders.

Because of their peculiar structure, plasmas have a wealth of useful properties not found in any other form of matter. For example, they vibrate at a constant frequency that varies with their density. Scientists refer to this as their "natural" or "plasma" frequency.

Since a vibrating electric charge can emit electromagnetic radiation ranging from radio waves to light, a collection of such charges in a plasma can do the same. For this reason, plasmas are being considered for use in a whole new family of radio communications equipment.

Plasma vibrations can be a mixed blessing, however. Not only do they act as a mechanism by which to generate radio waves but they can also be used, in a different way, to suppress or reflect them. The fact is that plasmas will not allow a radio wave oscillating at less than their own natural frequency to pass through them. This explains why we lose contact with our Mercury space capsules at some point during re-entry. Their torrid plunge to earth creates around them a plasma sheath that eventually attains a natural frequency greater than that of their communications system. Communications black-out results until the plasma dissipates.

Dr. George Brucker of the David Sarnoff Research Center, Princeton, N. J., prepares to operate a charge-exchange plasma propulsion system now under development.

One solution to this problem is to design communications equipment that operates at or above the frequency of the re-entry plasma. This is presently being done at RCA's Defense Electronic Products Division in Camden, N. J.

Another idiosyncrasy of plasmas is that they are constantly rearranging their positive and negative charges so as to maintain electrical neutrality. So successful are they in this respect that a charged particle, introduced from outside, never "sees" their internal electric fields. This trait is used to great advantage in the thermionic diodes currently being built at the RCA Electron Tube Division plant in Lancaster, Pa.

Thermionic diodes are a new kind of electron tube developed to convert heat directly to electricity. Their two electrodes are housed in a vacuum tube and connected by an outside wire. If either electrode is heated sufficiently, it gives off electrons. In effect, this means the cooler electrode is losing electrons via the connecting wire to the hot electrode and acquiring a net positive charge in the bargain. The electrons freed from the hot electrode now "see" this charge and rush to it, completing the circuit. A flow of electric current results.

This works very well for low voltages and currents, but when scientists try to step these up, something unexpected happens. So many electrons collect in the gap between the electrodes that their combined negative charge — called "space charge"— begins to restrict or even curtail the flow of electrons. To obtain higher powers, therefore, the space charge must be neutralized.

This is done by filling the gap between the electrodes with a plasma. Today, thermionic diodes being built in Lancaster all employ plasmas and produce powers up to 500 watts from such heat sources as burning coal, focused sunlight, or nuclear reactors.

Plasmas can be used in yet another way to generate electric power because their free negative and positive charges create a kind of spatial storage battery. It is figuratively possible to attach terminals to them and force their electrons into an outside circuit to do work.

The best means for doing this is to drive the plasma across a magnetic field. Electrodes placed at right angles to this field then act as terminals, the electrons going to one and the ions to the other. Moreover, if these electrodes are connected by an insulated copper wire that runs through all the homes, factories, and stores of a fair-sized town, a whole community might be powered this way. This possibility is presently being explored under the formidable title of *magnetohydrodynamics* — MHD, for short.

Though such a system might generate millions of watts of power, it would be of the direct current variety, which is not as manageable as alternating current. True, it could be converted to the alternating form, but why not generate it that way in the first place?

This line of reasoning has led RCA engineers working in Moorestown, N.J., to design an experimental alternating current MHD generator. Their approach is to move an alternating electromagnetic field along a plasma chamber at a speed slower than that at which the plasma is moving inside it. This causes a string of counter-rotating loops of electric current to appear in the plasma at right angles to the field.

Inside each of these, in turn, are self-generated magnetic fields that switch their polarity, up or down, in opposition to the constant polarity changes occurring in the controlling field.

The upshot is that the magnetic fields inside the plasma gain energy and induce an electric current right back into the coils generating the controlling field. In addition to producing alternating current, this scheme provides current by induction, eliminating the need to station electrodes directly in the plasma stream where they erode rapidly.

The feasibility of this system was recently demonstrated for the first time when RCA scientists successfully measured a power flow of 10 watts from the plasma. Eventually, a full-scale version might produce as much power as Grand Coulee Dam.

Even more sensational in the field of power generation, however, is the world-wide effort to produce electricity from controlled thermonuclear fusion. C Stellarator, Zeta, OGRA, Perhapsatron, Aston — these are some of the remarkable machines built or under construction in the United States and abroad to essay the task. All will depend for their success on creating and harnessing a hydrogen plasma something like that of the sun.

In the largest of these, the C Stellarator, built by RCA and Allis-Chalmers at Princeton University for the Atomic Energy Commission, a hydrogen plasma is generated and trapped in a powerful magnetic field around whose lines of force the plasma ions and electrons spiral in opposite directions.

Accelerated steadily by strong electric fields imposed from outside, the plasma ions eventually gain so much energy that their positive electrical fields can no longer hold them apart. They begin to collide. As they do, a nuclear reaction takes place producing helium and releasing a torrent of heat, light, and other electromagnetic energy. All that remains is to collect this energy for the production of electricity either by

An RCA Laboratories scientist shapes a quartz rod in the intense heat of an argon plasma torch. Temperature at the center of the plasma stream shown exceeds 10,000°C.

Dr. George A. Swartz, RCA Laboratories, observes experimental operation of a new radio frequency technique that may be used to propel space vehicles on long interplanetary voyages.

heating water to drive a steam turbine or by some other means.

This is how it should happen in theory. In fact, however, controlled thermonuclear fusion has yet to be mastered. So far, it has proven impossible to keep the hydrogen plasma stable in the C Stellarator or in any of the other machines.

Still another facet of this magical stuff that is called plasma is its significant potential as a fuel for space vehicles.

Thus far in our nation's space program, only chemical fuels have been used for this purpose. These provide enormous thrust for short periods, but they must be used in huge volume because they leave the rocket at relatively slow speed.

Another approach is to use very little material at any given time, but to eject it at very high speed for a very long time. This is the idea behind plasma engines. Plasma engines produce too little thrust to get a rocket off the ground, but out in space they can accelerate and drive the vehicle at speeds upwards of 100,000 miles per hour.

At the Astro-Electronics Division's Applied Research Laboratory in Princeton, N.J., scientists are investigating several possible methods of plasma propulsion. Of these, the most promising at present is referred to as a cyclatron-resonance system. In brief, a magnetic field is stretched along the thrust chamber with an electric field placed at right angles to it. A neutral gas is introduced, converted to a plasma by the electric field, and immediately confined by the magnetic field.

Because of the interaction of the two fields, the plasma electrons begin to spiral down the magnetic lines of force towards the exhaust nozzle. As they do, they are given periodic kicks by the electric field (in accord with a phenomenon known as *cyclatron resonance*) until they are moving at tremendous velocity.

Plasmas being what they are, these electrons no sooner issue from the exhaust than they drag the bystanding ions along with them to maintain the cohesion and electrical neutrality of their association. A plasma jet is created and propulsion results.

Added to these plasma projects, RCA is hatching still other plasma-dependent archetypes including gas lasers, microwave switches and amplifiers, cathodes, and acetylene-like torches that generate temperatures above 10,000°C.

With all of this research and engineering activity, both in the laboratories of the Radio Corporation of America and elsewhere, it is only a matter of time until playful – but powerful – "electronic blobs" called plasmas come to live with all of us. ■

DYNAGROOVE RECORDS: An achievement in sound

RCA Victor's new Dynagroove process uses revolutionary recording techniques to produce startling clarity on all phonographs.

BY HERBERT KUPFERBERG

CERTAIN ENIGMAS probably will persist to the end of time. What is the Sphinx thinking? Why is the Mona Lisa smiling? What is the message that Nipper, the RCA Victor dog, is hearing from "His Master's Voice"?

About the Sphinx and Mona Lisa, philosophers and scientists have been able to tell us nothing. About Nipper, at least one thing is certain: he *knew* it was his master's voice. And how? Because he recognized it. In other words, even on the primitive sound box in Francis Barraud's famous picture – and RCA Victor has issued quite a few models since – the sound was identifiable and reasonably true to life. Since that time, of course, phonographic fidelity has increased, even as canine fidelity has remained constant. But to transmit sound from its source to the listener as truthfully, accurately, and realistically as possible remains the goal of engineers, technicians, and recording companies. Long-play, magnetic tape, and stereo have all played a part in the process, and have helped to build the sound we know today.

Now one further step has just been taken with the sound called Dynagroove, which has just been developed by RCA Victor and placed before the public in an initial release of five Red Seal and five popular recordings. Unlike LP or stereo, the Dynagroove process is not the kind of development that makes current equipment obsolete or entails an increase in record prices. On the contrary, part of its stated aim is to improve the quality of sound reproduction even on low-priced, or at least medium-priced equipment. It does not seek to make sounds that are different,

but sounds that are better – sounds that offer greater clarity, more brilliance, and less distortion than the general average of record releases today.

To achieve this has been neither a short nor a simple task. RCA began its endeavors some two and a half years ago, not in a casual or restricted way, but as a massive campaign. "This has been a cooperative effort of the RCA family," says George R. Marek, Vice President and General Manager of the RCA Victor Record Division. "The Record Division, the acoustic laboratories, the Artist and Repertoire people, and all others concerned have worked together on Dynagroove, which is the result of a complete restudying of sound reproduction in all its phases."

For an exact definition of the Dynagroove process, a reporter turns naturally to John F. Pfeiffer, Administrator of Red Seal Audio Coordination, who has been directing the classical phase of recording in the new process, while his colleague, Jack Somer, has been working on the popular side.

"I'd say it is an effort to produce a recorded sound that brings maximum clarity to a listener sitting at home – and let me emphasize 'sitting at home,'" says Mr. Pfeiffer. "Sometimes audio people say they're trying to reproduce the sound you would hear sitting in the concert hall. Well, of course you can't listen at home the same way you do in the hall – the sound level is different, the spatial conditions are different, your entire perception is altered. Then, too, many people like to play records at low levels, and they complain that they don't sound right – they lose texture, clarity, and the characteristic sound of an instrument. Among other things, Dynagroove records compensate for the difference between the performance level in a large enclosure and the lower normal listening level in a much smaller enclosure. Somebody in the pops division even suggested we put out a record of mood music called 'Music to Keep Your Lease By.'"

The Dynagroove process, according to Mr. Pfeiffer, represents not one or two new engineering techniques, but a link-by-link rewelding of the entire chain of sound reproduction. Before RCA Victor came to the crucial matter of cutting the finished musical performance into the disc that you play at home, it reassessed the recording process itself. Pre-session planning, studio acoustical and atmospheric conditions, positioning of performers, efficiency of microphones and other equipment, the musical content of the score itself – all these were reappraised in terms of obtaining optimum results in *recording* as distinguished from straight performing. RCA Victor feels that even before pure technology took over, a definite gain had been made by tightening up the preliminary procedures.

But obviously, Dynagroove recording isn't a matter of straightening the drapes or polishing the reflectors in the recording studio. It involves the employment of new electronic advances and techniques, achieved largely at RCA's David Sarnoff Research Laboratories in Princeton, N.J.

To appreciate what these new processes accomplish, it is necessary to remember that for nearly twenty years now, magnetic tape has become an essential intermediary in the recording process, capturing the sound of the actual performance, which is then transferred, by means of a cutting stylus, to a master disc from which the commercial recordings are eventually to be made. In this delicate cutting process, it becomes essential that the sound of the tape be transferred to the master disc, intact, unimpaired and free of distortion – and that this sound, in turn, be reproduced with maximum fidelity on the commercial disc you buy in the record shop.

But unfortunately, certain mechanical difficulties

The RCA Victor Red Seal recording team: (left to right) John F. Pfeiffer, Administrator of Red Seal Audio Coordination; George R. Marek, RCA Victor Record Division Vice President (standing); and Lewis Layton, Recording Engineer; Richard Mohr, A&R Musical Director (seated). They are supervising the recording of "Madama Butterfly" in RCA's new Rome studios. This opera is an initial Dynagroove record release.

intrude. And it is to overcome these that RCA's engineers have designed two new electronic devices which, they believe, raise reproduction quality to the highest level yet achieved. These devices — plus a third device which assures an even truer transfer from microphone to magnetic tape — are:

I. The Dynamic Stylii Correlator: This computer-type electronic instrument has been developed for a specific and sensitive job: to compensate for the difference in the shape of the cutting stylus used when sound from the tape is being engraved in the master disc, and the shape of the playback stylus with which the home phonograph is equipped. The former is chisel-shaped, the latter ball-point, and the divergency between the two opens the way for a host of difficulties to the home listener — poor tracking of the stylus, distortion in high and loud passages, and disfiguration — and sometimes disintegration — of sound in the final grooves of a record, those closest to the label.

The new RCA instrument, as its name implies, correlates the two stylii in stereo recording — that used in sound cutting and that used in sound reproduction. It does this by serving as an electronic "brain" which modifies the signal fed to the cutting stylus, so that the groove it engraves in the master actually conforms to the tracking requirements of the playback stylus. The groove-shape is altered — but, paradoxically, the sound is truer than ever.

II. The Recording Overload Indicator: This is a meter that predicts to the recording engineer by means of a swinging pointer the difficulty the stylus will have in following the groove of the record to be made from the master tape. With the Recording Overload Indicator in action, it is possible to record at maximum sound level with correct tracking.

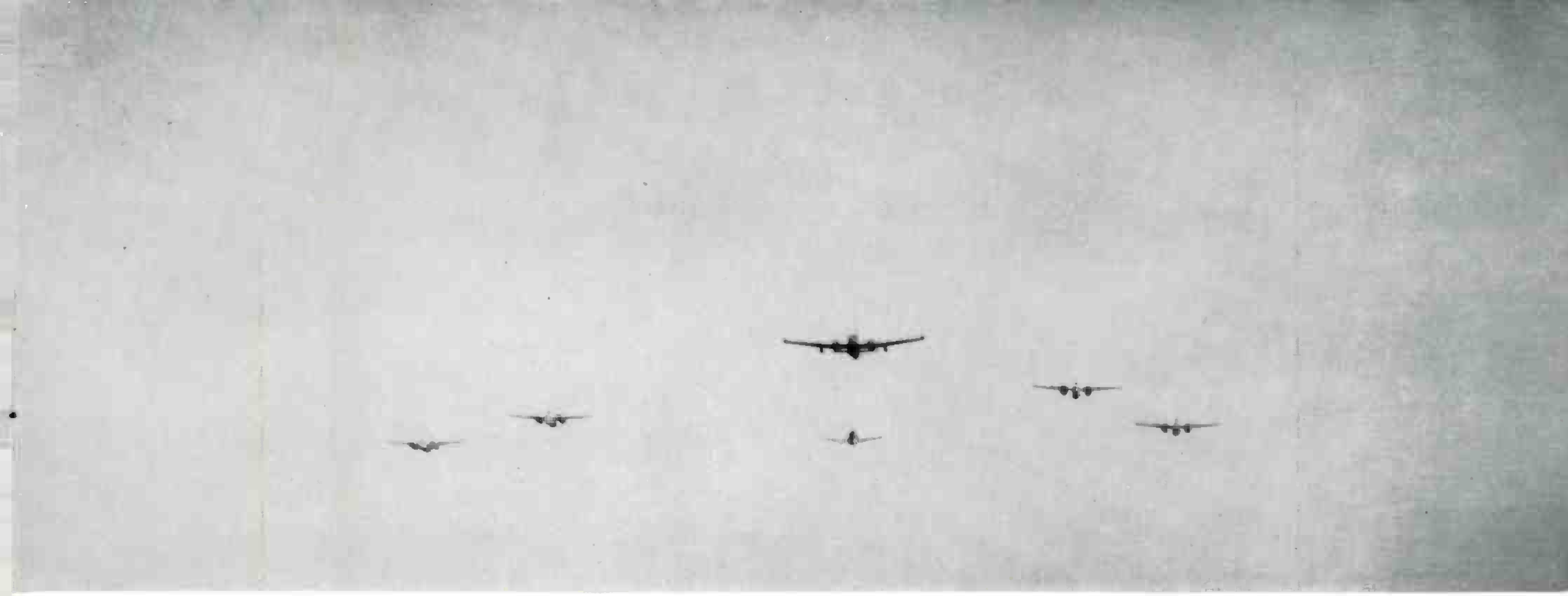
"What we'd like to stress," says Mr. Pfeiffer, "is that this is in no way an artificial or 'gimmicked' sound. We went after the musical sound — the sound that would bring out the clarity of the music — the true color of *Madama Butterfly*, or the excitement of Mahler's First Symphony, and not only in stereo, but in monaural, too."

III. The Dynamic Spectrum Equalizer: The purpose of this electronic "brain" is to see to it that musical quality is retained even when volume is reduced. Too often, characteristic tone qualities die out when the sound is diminished, leaving only a musical ghost behind. The Dynamic Spectrum Equalizer corrects this tendency to distort sound during its transmission from microphone to magnetic tape.

Mr. Pfeiffer's mention of *Madama Butterfly* and Mahler's First Symphony is by no means coincidental, for both are included among the first Dynagroove releases, with Erich Leinsdorf conducting the Boston Symphony Orchestra in the Mahler, and a cast headed by Leontyne Price in *Butterfly*. Henceforth, most RCA Victor recordings, classical and pops alike, will be issued in Dynagroove.

One more aspect of the Dynagroove process remains to be mentioned. No matter how enticing or exciting a new sound may be, it remains — or should remain — a means and not an end. The playing's the thing — as Hamlet might have said had he been a musician. To recreate the sound of music in the home remains the function and purpose of the Dynagroove system. The ultimate decision on how well it has succeeded will rest, of course, with the public, for just as visual beauty lies in the eye of the beholder, so does audio perfection lie in the ear of the hearer. But after due exposure to the clarity, brilliance, and consistency of its first releases, this slightly skeptical listener herewith casts one firm vote for Dynagroove records.

Herbert Kupferberg is Record Editor of the New York Herald Tribune.



Our Navy's expanding electronic needs

By Rear Admiral F. L. Ashworth, USN, Bureau of Naval Weapons

An expert points out the reliability and maintainability requirements for complex electronic systems used in today's naval operations.

REAR ADMIRAL FREDERICK L. ASHWORTH is Assistant Chief of the Bureau of Naval Weapons for Research, Development, Test and Evaluation.

IF WORLD WAR II had not ended when it did, the logistics of supply and maintenance could not have continued to keep the expanding electronic requirement of the U.S. Navy in a state of ready operation. The major problem facing the fleet today – one which is becoming more severe and forbidding – is associated with the increasing complexity in avionics equipment with which the fleet must operate. This problem extends to the carrier division commander, who may have a hundred strike aircraft under his command. He demands high aircraft availability, operational capability that must be available to him around the clock – not merely at periodic intervals. This means fully operational aircraft and ships, all capable of accomplishing their mission under all-weather conditions 24 hours a day.

Aircraft complexity is reflected in the tremendous growth of aircraft airframe costs from $9 a pound (several years prior to World War II) up to $120 a pound today. This is the cost for the airframe *alone*.

The complexity of avionics components and other systems has also grown. Along with this increased complexity is accompanying basic and ownership cost, as well as the increased number of maintenance manhours required to keep the aircraft in fully operational condition.

Another significant factor is the number of hours of down time for aircraft maintenance. This time is very often dictated not only by the complexity of the

These fire control radars (above) on guided missile destroyers help guide Tartar missiles despite enemy evasive tactics or jamming.

Ranges and location of high-speed aircraft are plotted on vertical plot boards (left) such as these aboard U. S. Navy cruiser.

Crewmen (right) intently scan radar scopes in electronic heart of cruiser, U.S.S. Northampton.

equipment, requiring a certain number of maintenance man-hours for its repair, but also by the number of experienced men that are actually available to work on a given system at any time.

The Navy requires that, of the total naval strength of approximately 585,000, a substantial and increasing percentage possesses sufficient ability to complete the qualification courses necessary to maintain the complex equipment which the fleet operates. This ability is found only in the upper quarter of the available manpower.

For example, the group of men who entered the naval service during World War II and who represent the hard core of experience in the technical fields will be leaving the naval service upon completion of 20 years of active duty during the next three years. This constitutes a significant percentage of the maintenance capability in Naval Aviation today. By December of 1965, the Navy will have lost approximately 50 per cent of the rated avionics electricians who are in the service today. Thus, whereas complexity and maintainability requirements for avionics equipments are increasing, the numerical strength of our experienced maintenance personnel is diminishing. This personnel limitation is fully as severe to the Navy as the dollar limit for the procurement and operation of fleet equipment.

Recapitulating the problems that bear on mission degradation, we see that aircraft readiness must be improved by reducing the total time that planes are down for avionics maintenance. To do this, two major accomplishments must be attained. First, the equipment reliability must be greatly improved. A five to 15 per cent improvement is not sufficient. Second, maintenance man-hours per flight hour must be reduced drastically. Not only must the total number of maintenance man-hours per operating hour for the equipment be brought down, but so must the level of training required by avionics maintenance people. Requirements for test equipment, support equipment, and spare parts must be reduced sharply.

The total cost of ownership for the lifetime of a piece of equipment will often far exceed the initial cost, sometimes by four to 10 times. This is the area where the major savings to the Department of Defense and to our nation can be realized through increased reliability. Total lifetime cost includes not only the initial price of the equipment but also the special training, spare parts, support equipment, technical manuals, and everything required to keep the equipment ready to go for its entire fleet life. The first three of these elements are inversely related to reliability.

In analyzing the means by which improved reliability and mission effectiveness can be introduced into the avionics equipments, we must not attempt to reduce the capability of the avionics systems in our naval aircraft. The approach to greater reliability and maintainability must be achieved through the applica-

tion of significantly improved design techniques. This involves techniques in construction, design, and assembly that are directed specifically toward producing equipments of much greater reliability as well as systems that will be more maintainable within the fleet, and cost less to own and operate.

Through major advances in electronic technology, circuit functions can now be accomplished by semiconductor devices, which otherwise would require up to 10 times the number of components and interconnections.

This is a revolution that has been achieved in electronics engineering. It has been accomplished through the efforts not only of scientists but also of physicists, chemists, ceramists, and metallurgists. Through the development of microcircuitry techniques, semiconductor microcircuits have been developed in which entire circuits, including passive and active elements, are contained in cans the same size as current transistor cans. These solid-state circuits are so small that they can be seen only under high magnification. The small size and weight of these circuits, however, are not the main goals. The absence of moving parts and the reduction of soldered connections reduces the major cause of electronic failures, and results in systems that are perhaps 10 times as reliable as their conventional counterparts.

Through a disciplined employment of standard circuits among all future avionics equipment, costs per system are expected to drop sharply.

These techniques are not in the "wish" stage. They are actually here today and are being introduced into operating equipment which is flying and which will be operational in the near future on a wide scale. These techniques have not been exploited for the purpose of reducing size and weight. Although size and weight are reduced, this is considered merely an added payoff.

The significant gain achieved through the application of these techniques is the increased reliability, and attendent to this the over-all reduction of costs.

The Bureau of Naval Weapons has initiated a program in which industry is being encouraged to substitute microcircuits on a piecemeal basis in current production equipment wherever this can be done at no increase in cost to the government. The first equipment to which microcircuitry techniques has been applied is the digital navigation computer being produced for two new Grumman-built aircraft. Electrically equivalent microcircuit boards have been developed to replace conventional circuit boards that hold conventional transistors, resistors, and capacitors.

These replacements, which are more reliable and lighter in weight, will actually cost less than their conventional counterparts and will ultimately result in substantial savings to the Navy in maintenance costs, not to mention significantly improved operational reliability.

These first steps are only the beginning of a four-phase naval avionics program, called the MEETAT program, designed to exploit fully the improvement possibilities inherent in microelectronic techniques. MEETAT stands for Major improvement in Electronic Effectiveness Through Application of Advanced Techniques. Four phases of MEETAT are:

• Development of the repairable or throwaway modules, such as the replacement plug-in boards for the A2F and W2F computers.

• Development of the maintenance module replacement. This involves the application of modular construction avionics equipment. Employing this construction design, these modules will be removable, less than 15 pounds in weight, and will provide for rapid fault location, facilitating the replacement of cards and the repair of accessible components.

• Development of functional module replacements. These are functional mission-oriented equipments. Under this phase, numerous efforts are planned, and three contracts for equipment using microelectronic and solid-state techniques have already been let. One is for an inertial guidance system to be developed by Litton Industries, which is scheduled for delivery in 1964. Another is a LORAN-C receiver to be developed by Sperry, which will weigh about 20 pounds and occupy a half cubic foot of space, a 75 per cent reduction in size and weight over its present design, using solid-state elements. The third, a high-frequency single-sideband transceiver being developed by RCA, will be all solid-state and will weigh about 30 pounds, 70 per cent less than its functional equivalent, the AN/ARC-38A. This phase also includes the requirement for visual fault location.

• Development of fully integrated avionic systems. These are to utilize modular construction, visual fault location, standard circuits, replaceable throwaway cards, all of the terms which, in the next generation aircraft, will be commonplace on the line as well as in avionic laboratories.

The major cost to the service of owning complex equipment is not in the initial cost of the equipment but in its lifetime maintenance and support. The need for cost reduction lies in this area, which is inversely proportional to reliability and maintainability. Therefore, the achievement of major gains in reliability and maintainability will mean savings to our country of hundreds of millions of dollars, not to mention improved mission effectiveness. ■

NBC Radio's advanced and compact new facilities in New York are designed to fufill the requirements of a booming U.S. radio audience that listens to more than 180,000,000 sets.

RADIO CENTRAL: Radio's Big Little World

MORE THAN 180,000,000! That's the total of radio sets in use in homes, cars, stores, gas stations, and hotels throughout the United States — approximately one radio for every man, woman, and child.

Radios in American homes alone have increased from a total of 40,000,000 in 1950 to today's total of 110,000,000.

NBC Radio has dramatically highlighted its participation in radio's growth and its confidence in radio's future by opening, in March, 1963, its totally refurbished, functionally designed Radio Central on the fifth floor of NBC's facilities in the RCA Building in New York.

Radio Central is the product of several years of planning, a year of construction, and an expenditure in excess of $500,000. Designed to house all of NBC Radio's local and network programming, Radio Central is a compact little world unto itself. It utilizes, from both an electrical and architectural standpoint, the most recent developments in radio broadcasting efficiency and effectiveness.

William K. McDaniel, Executive Vice President, NBC Radio Network, terms Radio Central's three integrated studios "the hub of our programming operation."

Studio 5B, occupying center stage, accommodates "Monitor," — a two-day weekend around-the-schedule feature embracing news and entertainment. During the week, the studio is used for recordings.

Studio 5C, from which all network broadcasts (other than "Monitor") emanate, has facilities with which to contact any of NBC's globally spaced newsmen via short-wave radio. Within seconds, the newsman's commentaries can be recorded, edited, and broadcast. The studio is manned by a newsman and two engineers who receive the overseas reports while a program is in progress. Consequently, Radio Central's Studio 5C is equipped to act as the nerve center for the world's largest news organization.

NBC's Chet Huntley gives radio news report from Studio 5C.

Studio 5A, built exactly like its sister studios, houses all local programs.

Three separate announce booths are included in Radio Central. Each one is available as an adjunct to any of the three studios or as a miniature studio in itself. The announce booth nearest the network studio (5C) can accommodate four people. Network newscasts come from this booth. Containing two microphones and seating for two persons, the other announce booths are used for local purposes and/or tapings.

There is still another studio position on the technical equipment rack behind the main studio. Here, program material can be assembled and fed to any of the other studios. Behind studios 5A, B, and C, a spacious area houses maintenance and field equipment. It is estimated that the long racks of technical apparatus to the rear of Radio Central house over 2,000,000 feet of wire with about 400,000 connections.

Radio Central is decorated in blue tones with a white vinyl floor and white leather upholstery. The colors were chosen for both decorative and psychological reasons — blue and white are known to be "restful" colors.

"To simplify broadcasting and to operate more effectively," were the reasons for creating Radio Central, according to William Trevarthen, Vice President, Operations and Engineering.

"What we have done," explains Trevarthen, "is to simplify, via operating innovations, what used to be a very complex manner of functioning. Whereas several scattered operations were once needed to air a single radio program, it is now possible, with the new facilities, for the entire controls to be centralized. The control consoles in each studio are the same. They are so versatile, you can operate any of the three studios from any of the consoles.

"Prior to the modernization," continues Trevarthen, "the switching facilities were out of line with what the current NBC Radio situation required. And, of course, prior to the sprucing up, the decor of the old Radio Central just didn't have the look that NBC Radio should have."

Until the completion of Radio Central, NBC Radio shared with NBC Television a common audio transmission area. Radio's removal from the eighth floor paved the way for constructing a scene dock for the Peacock Studio for NBC Television.

"From the start," states Trevarthen, "the concept behind Radio Central was to build a plant that befitted 1963 radio needs. We also wanted to prepare for a future rebuilding of television facilities. Since the facilities of radio and television were intertwined in some areas, they had to be separated."

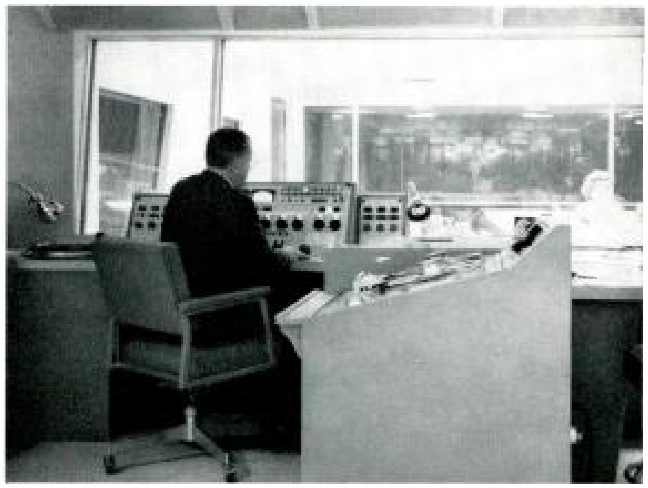
Today — except for the fifth floor's Radio Central — only the seventh floor has a connection with the broadcasting end of radio. Complete taping facilities are available there. An interview being done in advance in Radio Central's Studio B, or in one of the announce booths, is taped upstairs on the seventh floor.

New custom-built RCA dual channel stereo consoles were bought for Radio Central. They encompass all of the switching operations. Furthermore, prelistening facilities are available, as required, in advance of airing. Also, the consoles have the ability to pick up microphones from any studio. The discarded consoles dated back to 1932.

In addition to the above innovations, there are now separate channels in operation for AM and FM. WNBC and WNBC-FM Radio thus protect each other against possible land-line failure. Transistorized equipment, which is smaller, more stable and more reliable, is used throughout.

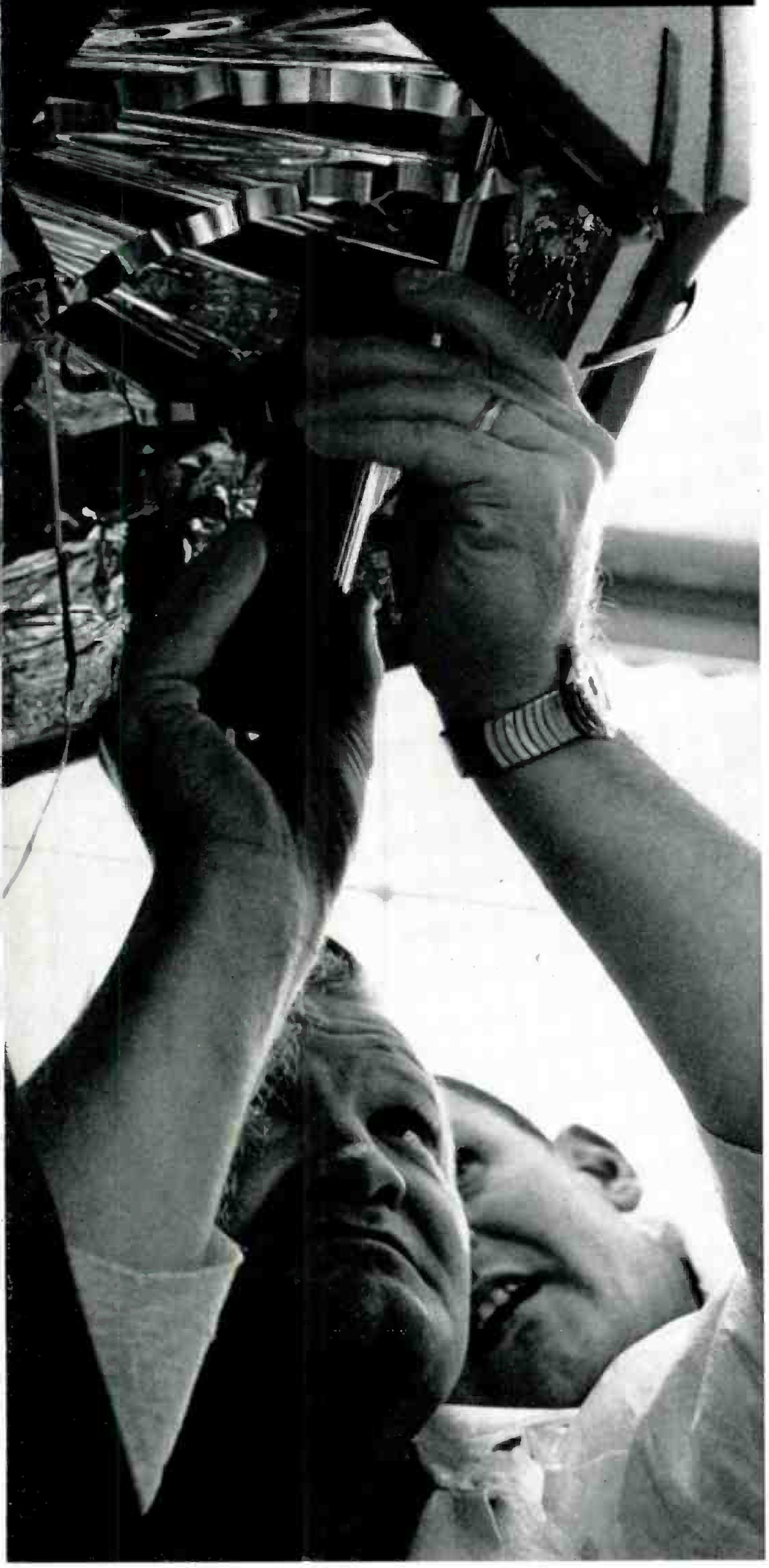
With all these improvements in the service of NBC Radio, more than 180,000,000 radio listeners never "heard" it so good. ■

Synchronized global clocks, modern decor mark Radio Central.



Engineer's view of a "Monitor" radio broadcast from Studio 5B.

A day in the life of a satellite...



With dental mirror and flashlight to aid him, Space Engineer Joseph Graham adjusts the delicate thermal controller that regulates temperatures within NASA's Relay satellite.

Here, and on the two succeeding pages, is the chronological story of 24 crucial hours in the life of the first flight model of Relay.

WHEN a new satellite or space probe is launched from Cape Canaveral these days, it's almost routine. Barring an unforeseen mishap in takeoff, the announcement probably will say simply that the spacecraft was launched successfully and attained orbit according to plan.

But to the men who designed and built "the bird," as they refer to it, and to the men who will use the spacecraft in extending the frontiers of space research, it is anything but routine. It is the culmination of many months, perhaps even years, of their own space-age equivalent of blood, tears, toil, and sweat.

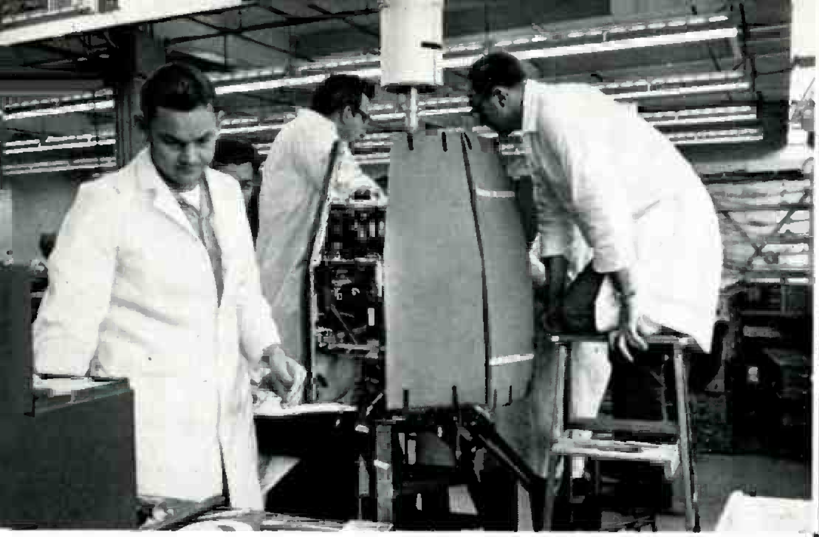
In the case of Relay, the low-altitude experimental communications satellite of the National Aeronautics and Space Administration, the story began with an idea put forward in 1957 in a theoretical paper prepared by Sidney Metzger, a research scientist of the Radio Corporation of America. Before the project attained its objective in more than 500 successful communications experiments with Relay I, it involved 58 full-time RCA engineers, 44 technicians, and all the facilities of the RCA Space Center at Princeton, N.J., plus part-time assistance of 44 technicians such as model-makers and test personnel. Many more scientists of the Goddard Space Flight Center were involved after launch, carrying out tests of voice communications, facsimile, teletype, and television experiments.

After many months of painstaking work, all of its systems and subsystems were tested repeatedly, by themselves and together. Now, for the first time, the entire flight model was assembled for its most punishing ordeal – six hours on a "shake table." The full range of vibration cycles, from 20 to 3,000 per second, and all of the gravity forces, from zero to 14 Gs, had to be tried in simulation of any stress and strain Relay might be called on to endure when launched.

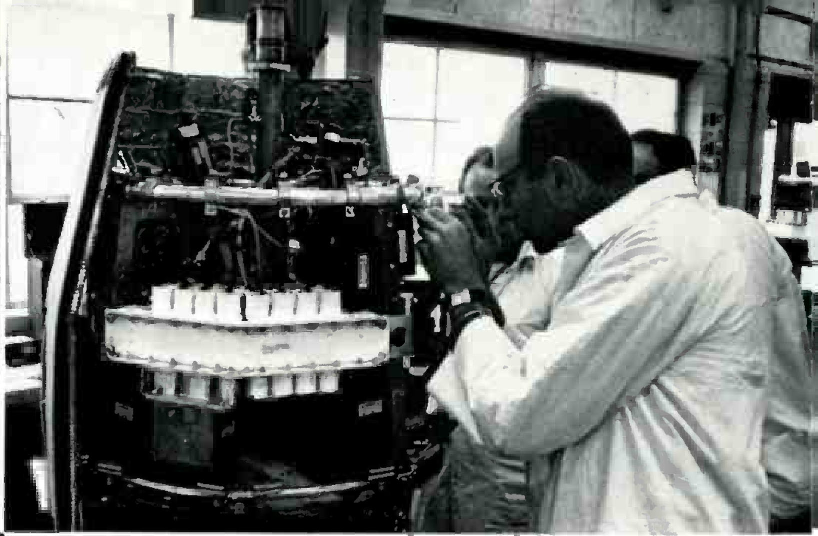
Over and over again, before the test, engineers had to remove the delicate solar panels that provide power for all of Relay's communications and sensing systems. Each panel takes about two hours of exacting work to put back in place. At 6 A.M., Sunday, the engineers were ready for a final reliability test.

However, deep inside the satellite, an electrical connector gave an uncertain response. It worked, but it might break down in vibration. Decision: Remove the six solar panels and replace the connector.

At 8:30 P.M., replacement was completed. Then followed three hours of setting up and wiring the satellite for its test. At 11:30 P.M., the vibration began, continued without letup until 6:30 A.M., Monday. The pictures on the following pages tell the story of these anxious hours.



Technicians make final adjustments on Relay Flight Model No. 1, preparatory to vibration test, only to discover that the solar panels must come off yet again to correct a suspected malfunction.



With a magnifying glass, Space Engineer Max Gittler adjusts the space between two critical parts before replacing the solar panels.

The test begins. In "box seat" are NASA Project Manager Robert Pickard (white shirt) and RCA's Associate Project Manager, Richard Dunphy. As vibrations increase, a moaning sound mounts to a roar and finally becomes a high, penetrating wail.

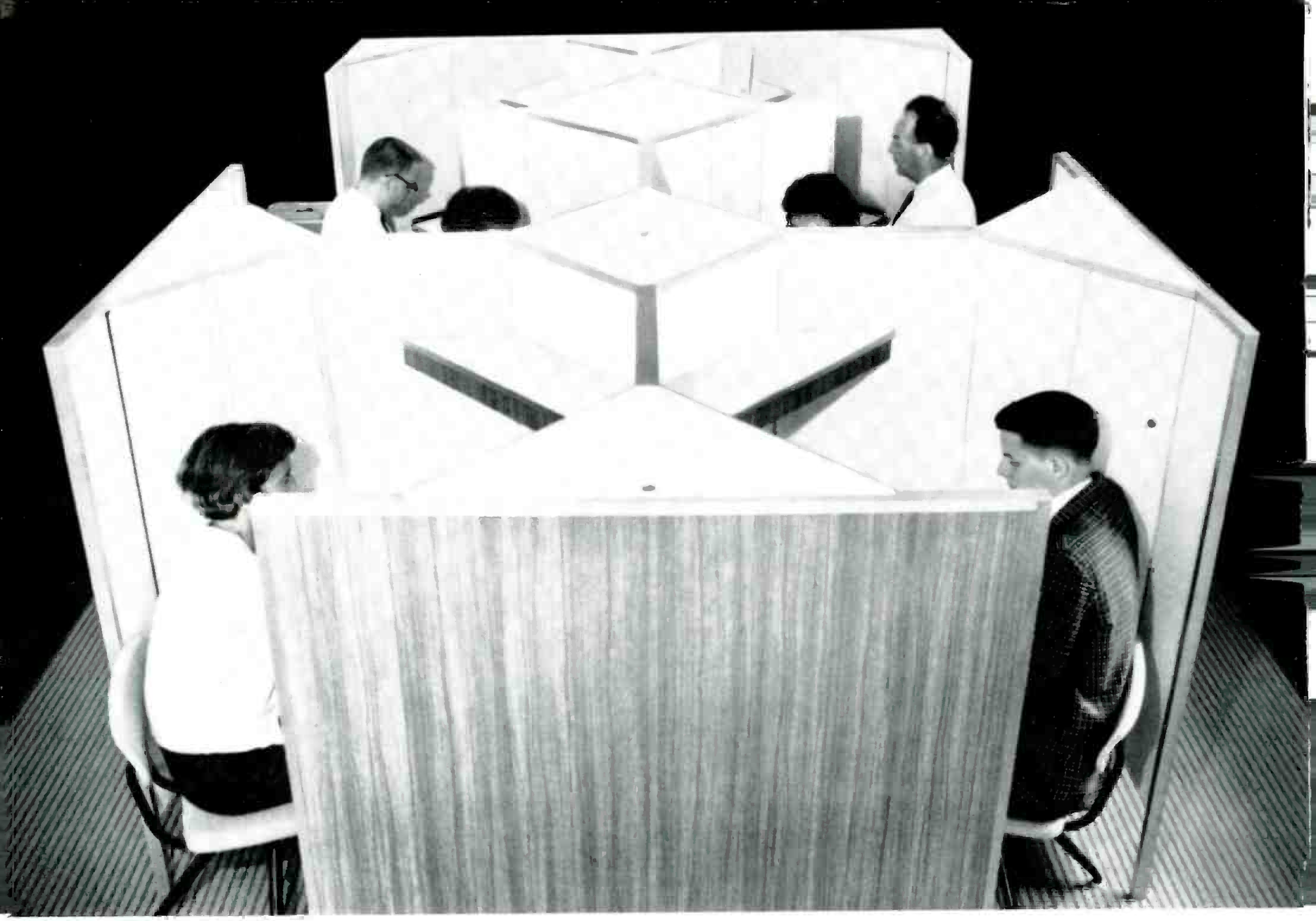
The hours drag on. Testing takes time, and time takes its toll in fatigue and anxiety. At least a dozen experts in the various systems stand by to watch the performance of the satellite as it withstands the punishing vibration.

Solar panels back in place, the six-man technical crew makes a final visual check of the assembly. The delicate solar cells — 8,215 of them costing $10 apiece — are covered with foam "blankets" for protection.

Fully reassembled, the satellite's electrical systems are checked out with high-powered lights focused on each solar panel in turn. Black velvet cloth is used to shield the other panels while test takes place.

At last, the test is ended. Kenneth Mercy, NASA's test and evaluation engineer, gets down on hands and knees, circling the "bird" to see if the shake test has loosened any nuts, bolts, slivers of metal, or bits of solar cells. He moistens his middle finger to pick up and examine suspected particles, but none is found.

As the evaluation engineer finishes his circuit of Relay I, finding no trace of trouble, an RCA technician tosses a small nut under the satellite, bringing a laugh that breaks the tension. Relay I, has passed the test, and is ready for shipment to Cape Canaveral. The wide grin belongs to RCA technician Paul Done.



THE ELECTRONIC CLASSROOM

BY SOL CORNBERG

How electronic aids can provide students anywhere and anytime with educational material.

THE EDUCATIONAL PROBLEM in the United States can be stated simply. We are producing students faster than we are producing schoolrooms and qualified instructors. And we are racing toward the critical year – 1965 – when the so-called "war babies" will begin to flood the colleges.

What are we going to do about it? Do we go into double sessions, triple sessions? How do we increase our ability to transmit information from a limited number of instructors to an increasingly large number of students? Are there devices with which we can multiply the effectiveness of our available teachers?

There are some persons who believe the cure-all is educational television. They say: "This is simple. All you have to do is throw a signal out into the air, give the kids a television receiver, and you have it licked."

Unfortunately, the problem of the broadcast signal is that it must be used at the time it is broadcast. It presupposes that every class interested in this given piece of information is ready for it, let us say, at 10 A.M., that the content is needed at this particular moment in this particular class, and that it will be

Geometric structure of carrels provides several students with "use-attitude" educational material. Each carrel slightly exceeds conventional classroom equipment costs.

used. Moreover, at 10:30 A.M., or at whatever time the broadcast ends, this program is finished. It cannot be recalled except by broadcasting the same program again at considerable cost to other students who may not want or need to have it repeated.

Obviously, then, despite the usefulness and value of broadcast educational television, it is not the complete answer to the problem. To be truly useful, our audio-visual information must be available quickly, easily, and when and where the instructor or the students need it. More exactly, it must be stored in a "use-attitude." Push a button, and it starts to do its job.

There is no mystery or difficulty in doing this. Dial seven digits on your telephone, and you get the recorded weather forecast. Dial another seven digits, and you get the correct time. Dial yet again, and in New York City, for instance, you can get up-to-the-minute traffic information. All this is information stored in a use-attitude. It is available on a random access basis.

What can be done with recorded audio tape can also be done with video recordings, film, slides, microfilmed books, or with any other means of storing information. A student has only to dial a sequence of numbers, as indicated in a list of program availabilities, and he's in business. By the simple addition of a microphone, he can also communicate directly with his instructor to ask a question or obtain clarification.

What does this mean in terms of education? It means efficiency, for one thing. It means that an instructor can put his time "in the bank." He need not deliver the same routine lecture again and again. He can record it – visually and aurally – complete with visual aids, and in the meantime he can be doing something else, in another place, while that lecture is repeated to various groups of students. Moreover, he is free to deal with two levels of students that present educational difficulties – those who are very bright and those who are laggard.

The middle group, numbering about 80 per cent, is not the greatest problem. It is the top and bottom 10 per cent that demand an excessive amount of the teacher's time. And, as classes become larger, these demands will become more difficult to meet.

It is frightening, in this context, to observe certain classrooms. For example, at the University of the State of New York at Albany there are about 15 lecture halls planned, each seating about 425 students. What is one instructor supposed to do with 425 students. Inspire them? Even Billy Sunday couldn't do it! And yet an instructor is expected to be inspirational, hour after hour, day in and day out.

It is also frightening to realize that there are books being used in some of our schools that have not been updated in 10, 15, or even 30 years. In one case, the history book being used in the elementary schools of a great city on the East Coast of the United States carries a copyright date of 1934. Everyone will agree that some interesting and important things have happened since 1934, yet all examinations are based on this book.

In contrast, the use of modern means of communication, such as the art of television, can present the news almost as soon as it happens, and in some cases while it is taking place. In updating the news, we are updating history. This flexibility must become part of our educational scheme.

Interior of carrel shows unique features, including soundproof panels, television screen, selective dialing system, and earphones for audio instruction.

Fortunately, there is a movement in modern education to permit the child to advance at his own pace, so that he won't be held back as a member of a group. This is very similar to the old tutorial systems. It is a one-to-one relationship; the student to the teacher.

My organization serves as consultant to many educational institutions. Our business is communications. And when we design a communications center, we are concerned with ready access to information. In one central location, we provide a bank of information, stored in films, slides, audio tape, video recordings, and so on. The bank is linked with as many as several hundred student learning stations – we call them "self-paced study stations" – where each student has access to this bank of stored information. Another term for the study station is "carrel." It is designed to exclude outside noises and to permit the student to concentrate on the instructional information. The student does not wear headphones, unless his hearing is impaired, because small loudspeakers are built into the soundproofed wall on each side of him.

Audio-visual aids to education are not new. They have existed in one form or another since candlelight projectors were introduced in 1889. But up to now, we have been transporting equipment to the classroom. Often, we succeeded mainly in creating a third-person side-show situation.

Another approach is to use a room — perhaps an auditorium or assembly hall — that has a film projector, and then transport students to the hall and show them a film. But now the whole thing tends to become non-educational because of the excessive amount of time and effort necessary to carry out this cumbersome procedure.

What we have been doing is either transporting equipment or transporting people. I submit that all we really want to do is to transport information, and it is completely feasible to do this.

The equipment exists. There are audio recorders, video recorders, closed-circuit television, film projectors, and facilities for rapid access to microfilmed books or slides. By assembling them in a practical, economical manner, information can be readily available to the individual student — as he needs it and when he needs it — by storing it in a use-attitude for random access.

Each carrel has a directory, which tells the student what is available. Whether he is a slow, average, or an exceptional student, he is able to advance at the pace best suited to his own ability. Moreover, if the student wants to ask questions or check out his preliminary work with his instructor, he can reach him easily and quickly by dialing him in his office, or wherever he may be.

This is not pie-in-the-sky. Right now, there are 4,500 individual student study stations — carrels — either in construction or on the drafting boards.

At Bassett School, outside Los Angeles, 1,800 carrels are being built to serve 1,800 students. They will be mostly in groups of five, six, and eight, with no group larger than 12.

At Grand Valley State College in Michigan, now under construction, buildings literally were designed around the requirements of audio-visual presentation. There, we are starting with 256 individual student carrels on one floor, in four groups of 64 each. The four groups surround what will be known as a "resource area."

However, individual carrels are not the whole story. At Grand Valley, there are two lecture halls that seat 90 students each. Here, there will be a group relationship with the instructor. He, in turn, will have excellent audio-visual aids at his disposal, including a magnification of his lecture table so that students can see experiments or demonstrations projected on large-screen TV. This procedure does not mean that every student will leave this lecture hall with good notes, but he now can refer back to the lecture or the demonstration because it has been recorded. It is available whenever the student selects it.

Other schools are going in this direction. At Broward Junior College, Fort Lauderdale, Fla., the community acquired an old Navy airport. On this acreage, it is building a four-year college, two junior colleges, two senior high schools, two junior-senior high schools, and four elementary schools. Our organization has designed carrel systems for the first two buildings, one of which eventually will become a junior-senior high school complex of eight buildings and the other a junior college with 11 buildings.

Elsewhere, pilot programs are being installed at La Junta School, in Colorado; at Nova Junior-Senior High School in Florida; at Mount Kisco, N.Y.; and at San Marco, near San Diego, Calif.

What about costs? Well, the woodwork that goes into a carrel can be related to the cost of the desk that is normally provided for the student. The hardware that goes into selection and display includes visual display, audio playback, loudspeaker, and facilities to talk back into the system. All of this equipment at the student location — even at retail prices — amounts to less than $200.

The greater cost comes in backup equipment. How much information can be stored? If a school can afford only ten audio-tape playback devices, then it can purchase cartridge-load audio tape capable of being changed every hour, half-hour, or 15 minutes. The point is, even with limited funds, the system can be started. And the system is always open-end. It can be added to indefinitely.

Wide educational possibilities exist at the college level. For instance, College A may be better qualified to deal with a subject than College B. Then why not make the information at College A easily available to College B, and even to College C, and so on? Moreover, outstanding instructors can give their talents to presenting courses of exceptional merit. We may then also find it possible to supplement the education of many thousands of students by added access to the relatively small number of truly great teachers. And we shall have done so by a one-to-one relationship most suited to the needs of the individual student. ■

The author, president of Sol Cornberg Associates, is a designer of communications facilities, many of them involving education.

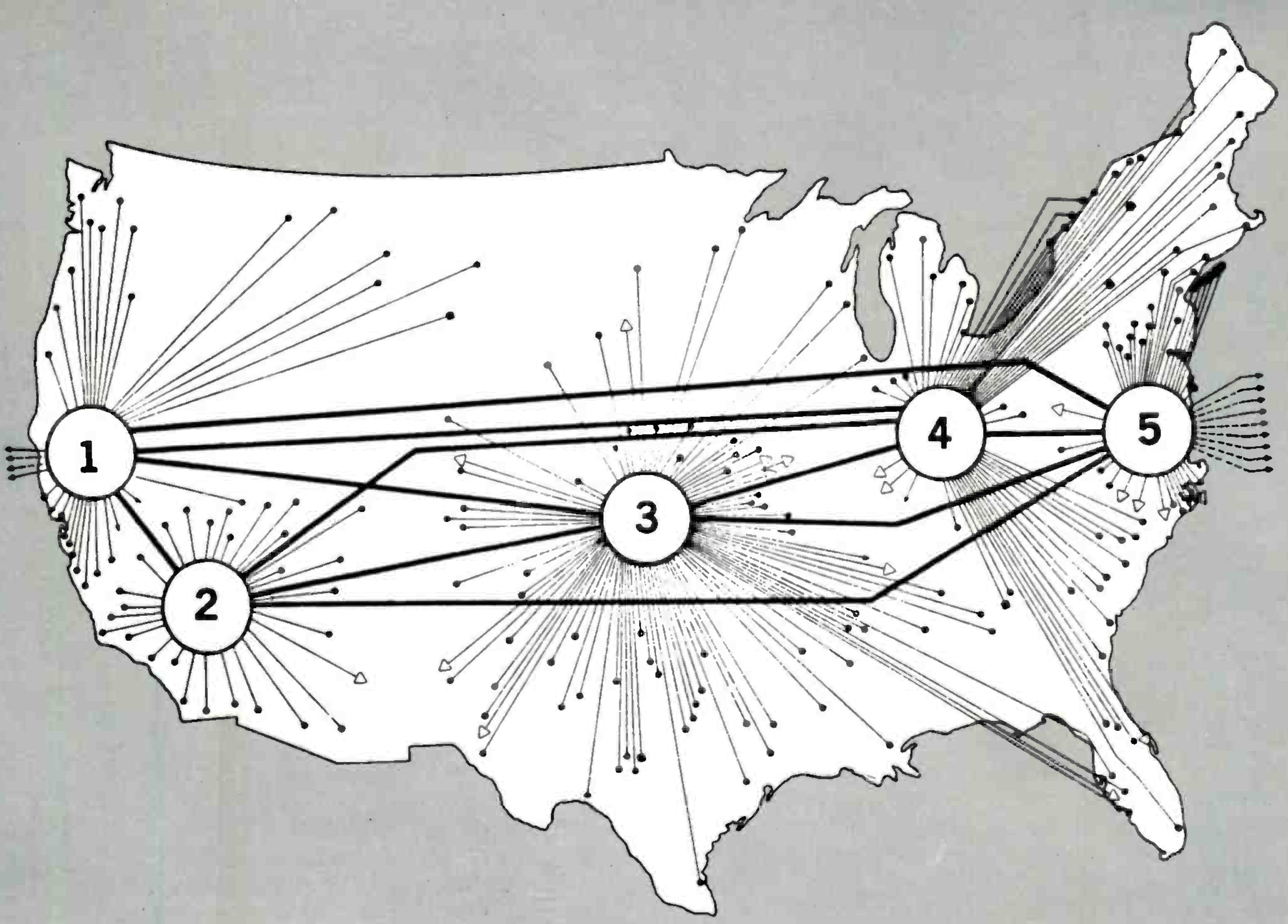


Chart illustrates U. S. Air Force network using DATACOM/AUTODIN. Switching centers are: (1) McClellan AFB, Sacramento, Calif.; (2) Norton AFB, San Bernardino, Calif.; (3) Tinker AFB, Oklahoma City, Okla.; (4) Gentile AFB, Dayton, Ohio; (5) Andrews AFB, Washington, D. C.

The 100,000,000 word messenger

BY THOMAS I. BRADSHAW

DATACOM, the Air Force Data Communications Network, is the computerized nerve center for the Department of Defense worldwide communications web.

WITH THE PUSH OF A BUTTON, the world's largest and most advanced data communications system recently came to life – a computerized U.S. Air Force network capable of relaying automatically 100,000,000 words a day between 300 strategic points across the entire country.

Designated AF DATACOM (for Air Force Data Communications Network), the highly sophisticated system represents the keystone in the Department of Defense worldwide communications web known as AUTODIN (Automatic Digital Network).

The first official message was transmitted from Andrews Air Force Base, near Washington, D.C., to four other system switching centers and their satellites, including Air Force installations and industrial suppliers. The message from the Air Force Chief of Staff, General Curtis E. LeMay, read in part:

"The activation of this new data communications system may not be so spectacular as the launching of

This automatic electronic DATACOM/AUTODIN switching center at Andrews AFB relays data electronically at speeds of from 100 to 3,000 words per minute between more than 300 Air Force, Department of Defense, and defense industry tributary stations. This center acts as a "gateway" station for data traffic entering the United States from European activities.

an ICBM; however, it is every bit as important to our security."

AF DATACOM originally was conceived as a communications answer to the logistics problem of supporting an Air Force that had become global in its operating capability and responsibility. Although designed initially to expedite the relay of more than 19,000,000 supply requisitions annually, the system's flexibility earned it other "customers" and a host of additional uses, even before the first automatic switching center was installed.

Stations linked to the network can interchange information between punched card, teletype, and magnetic tape devices at speeds ranging up to 3,000 words a minute. The network is designed to employ speeds 20 times that rate to satisfy future requirements.

Major Gen. Kenneth P. Bergquist, Commander, Air Force Communications Service, described the system as "the first of its kind, a unique marriage between data processing devices and communications facilities in a computer-controlled system. Its capability will pave the way for important defense management improvements."

One of the prime movers in the development of AF DATACOM was Lt. Col. Frederick W. Schultz, Air Force Communications Service project officer, who lived, breathed, studied, and worked on the program since it was first conceived.

Colonel Schultz points out that in the past there were systems in which teletype machines could talk to teletype machines, data card transmitters could send to data card receivers, and magnetic tape devices could transmit to magnetic tape receivers.

"DATACOM gives us a common electronic language so that now all these communications media can be used simultaneously within the same network, freely interchanging information between unlike devices," Colonel Schultz said. "This entirely new way of handling communications became a reality with the ability of technology to produce it. It would not have been possible even a few years ago."

The Western Union Telegraph Co. served as prime contractor to the Air Force in the mammoth project. Western Union – working with the Air Force – developed the over-all system design and called on the Radio Corporation of America to engineer and produce the bulk of the highly specialized electronic gear for the five switching centers, with computers forming the heart of the "hardware" complement.

Data transmission terminals were developed by

Units of a DATACOM switching center undergo final testing at RCA's Camden, N. J., manufacturing plant. An entirely new concept in communications handling, DATACOM/AUTODIN is now installed in key Air Force centers.

P. T. O'Neil, RCA's Manager of Customer Relations for Data Communications and Customer Projects, Electronic Data Processing, describes plug-in board from DATACOM circuitry to Western Union executive A. E. Frost.

the International Business Machines Corp. as the nerve ends of the far-flung network, while more than 200 other subcontractors and suppliers took part in producing and installing the new communications system.

The backbone of AF DATACOM consists of five automatic electronic switching or message relay centers at Norton and McClellan Air Force Bases in California; Tinker AFB, Okla.; Gentile AFB in Ohio; and Andrews AFB. Each of these serves a radiating network of satellite points.

In addition to the stateside complex of stations, key overseas bases presently served include Kindley Air Base, Bermuda; Ramey AFB, Puerto Rico; Goose AB, Labrador; Harmon AB, Newfoundland; Eielson and Elmendorf AFB's in Alaska; and Hickam AFB, Hawaii. Plans call for the gradual addition of other overseas locations to the AUTODIN network.

While there are 300 tributary stations now a part of the network within the continental U.S., the five centers as they are presently equipped can take care of an additional 150 "customers," and the five are constructed on a modular basis so each easily can be expanded beyond that point.

Completion of AF DATACOM paved the way for implementation of an Air Force plan for redesign of its personnel management process. Steps are under way to establish an Air Force Personnel Center at Randolph Air Force Base in Texas during 1963 and next year.

Consolidated base personnel centers, major command headquarters, and the new Personnel Center will be linked by means of the new data communications system. The personnel picture will be updated weekly at the Randolph Center as major air commands transmit complete reports over AF DATACOM.

Using message switching and circuit switching devices, the centers automatically relay traffic to the proper addressee. "Store and forward" memory drum units regulate the flow of traffic. High priority messages are rushed through immediately while lower precedence traffic may be held temporarily until circuits are clear.

Each center — large enough to accommodate a basketball court — is almost totally taken up by equipment of various sizes and shapes.

A technical control facility provides a means of monitoring the quality of lines and signals flowing in and out of the center. Next is the Accumulation Distribution Unit. This actually is a computer, and its function is to receive a message from the customer, hold it until the Communications Data Processor is ready to take action on it, receive the message back when properly processed, and distribute it to the addressee or addressees.

The Communications Data Processor, also a computer, examines the routing instructions contained in the message heading, stores the message until completely received, and lines it up for transmission.

There are two Accumulation Distribution Units in a center, working as a team. There also are two Communications Data Processors, with one serving as a standby to assure continued operation.

A special circuit switching unit permits customers to establish direct connection between like terminal devices. Through this portion of the system, a customer with low-speed terminal equipment can communicate directly with another point similarly equipped.

In effect, the circuit switching feature provides a service comparable to the direct distance telephone dialing service.

The security classification of a message is spotted by the electronic equipment on receipt. Any message, intended for a point without cryptographic gear automatically is rejected to prevent the transmission of such information "in the clear" or uncoded.

One of the more unusual devices at each switching center examines the contents of a longer message, and – to spread the work load – delivers portions or segments to two or more tape units. Each segment is identified with the original message, and this process is known as categorization. Each message long enough to require categorization is called a "Cat," and each segmented portion is referred to as a "Kitten."

"The DATACOM system is one of the greatest developments in the field of communications since the invention of radio 63 years ago," Colonel Schultz said. "It can provide not only much needed communications support for today but can be adapted to future Department of Defense needs.

"It is a concept which will be adapted to many future communications needs, not only within the military framework but also in industry."

Implementation of the five switching centers involved a monumental team effort by RCA planners, engineers, and production workers.

More than 1,500 RCA specialists contributed to the over-all effort, backed by the Corporation's broad electronics background.

RCA Electronic Data Processing marshaled the resources under its direction and integrated into the master plan the contributions of other divisions. EDP's engineering group provided basic circuit design, the special computers and associated equipment design, integration of this equipment into the system, and the equipment packaging concepts. The RCA plant at Camden, N.J., carried out a major portion of the manufacturing.

From RCA's Defense Electronic Products came the transistorized circuit plug-in units. DEP also developed the intricate circuit switching systems for DATACOM.

The Semiconductor and Materials Division provided most of the transistors and specially designed encapsulated circuit modules. From the same Division's Needham, Mass., plant came many of the DATACOM memory devices and memory components.

RCA Electronic Data Processing and the RCA Service Company cooperated in the programming job.

The RCA Service Company assumed responsibility for installation, and is assisting in providing support to Western Union in the maintenance of the system.

AUTODIN posed unique problems, calling for "tailor-made" equipment and new data communication concepts.

Among the more notable achievements:

1. Direct connection between general purpose computers and between a general purpose data processing system and a special purpose computer.

2. A large and highly complex, real-time, on-line program to do a job never before carried out by computer techniques.

3. The first two of the AUTODIN Centers were activated within a single month, and all five centers were placed on the air within a three-month period.

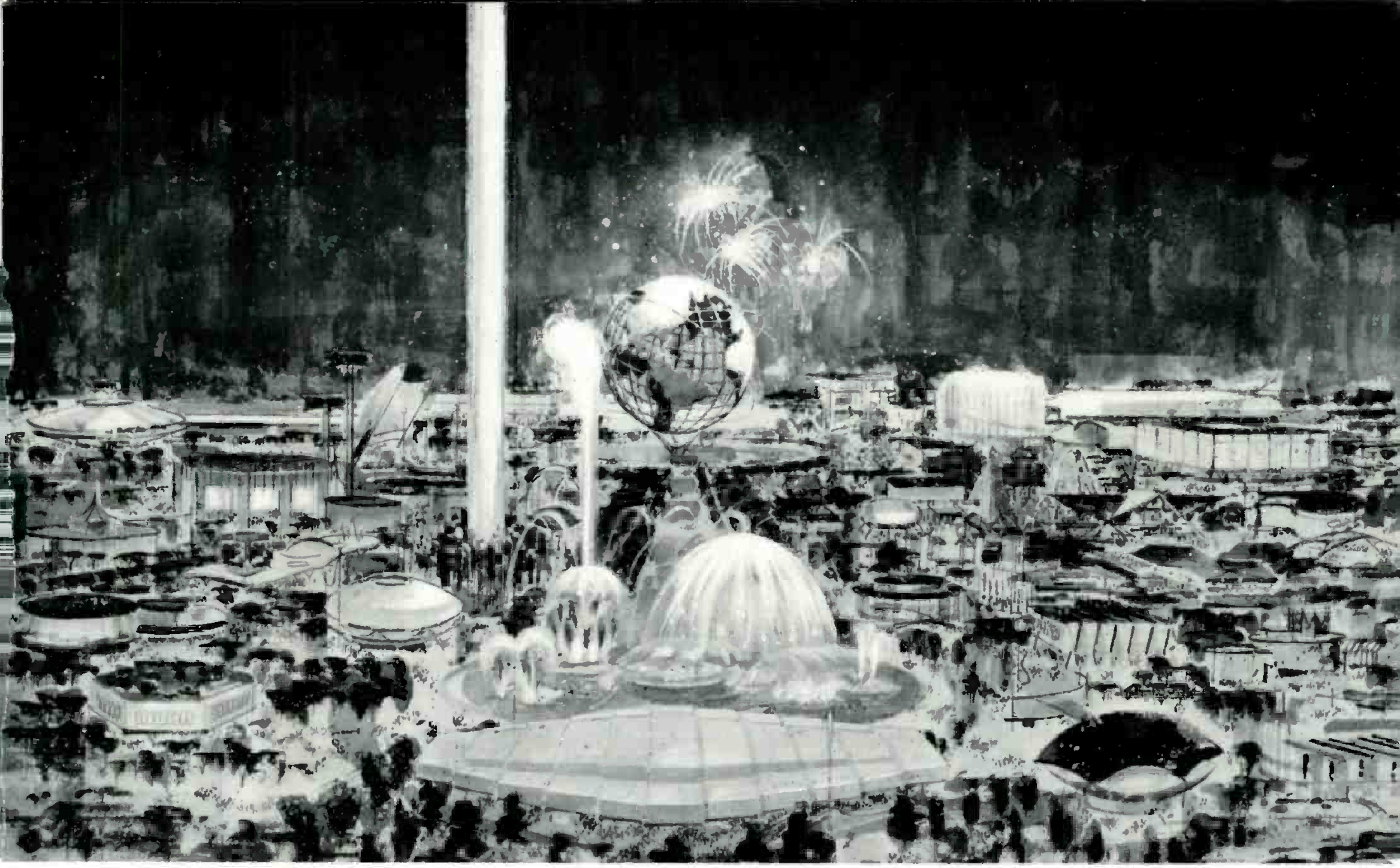
4. The basic system concept was as valid in the final stages of installation as when the project got under way.

At the recent DATACOM activation ceremony, the guest of honor was a man with an unmistakable military bearing despite his civilian attire and advancing years.

The presence of Maj. Gen. Benjamin D. Foulois, USAF (Ret.) was particularly fitting. Nearly 52 years earlier, this same officer – then a lieutenant in the infant Air Service – conducted the first successful air-to-ground wireless communications experiments.

The 1911 tests were held at College Park, Md., near the present site of Andrews AF Base and at that time the home nest for Army Aircraft No. 1, the biplane Foulois learned to fly through correspondence with Wilbur and Orville Wright.

With General Foulois, first chief of the Air Corps watching with obvious interest, Colonel Schultz pushed the button sending General LeMay's message to 300 Air Force installations and industrial concerns as much as 3,000 miles away. ■



Artist's conception of the 1964 New York World's Fair.

RCA "COLORS" THE NEW YORK WORLD'S FAIR

Operating color facility and other equipment will provide New York World's Fair visitors with a variety of color broadcasting programs.

BY KEN McKENNA

THE SPLASHIEST COLOR TELEVISION SHOW of 1964 and 1965 will originate at the New York World's Fair where a Radio Corporation of America TV Communications Center will operate from a color facility showcase on a 30,000-square-foot plot.

During the two six-month periods of Fair operation, the RCA color facility will be programming daily during those hours the industrial exhibits are open, covering news events of the Fair and broadcasting a variety of special shows. This adds up to a total of more than 4,000 hours of color programming.

Fair visitors — 75,000,000 are expected — can see the color shows on about 200 color receivers spotted in restaurants, lounges, and other locations where Fair goers might enjoy such a program service.

But one of the prime purposes of the RCA exhibit is to show the behind-the-scenes working of a color television facility. Visitors to the RCA TV Communications Center will not only be able to see themselves in living color but also to watch both rehearsals and programs in progress. In addition, they will be able to see these colorful productions on a variety of new TV receivers spaced throughout the RCA building. They can also follow the intricate teamwork of directors and technicians in a control room.

This communications activity will emanate from a building of circles and curves that looks like a careful arrangement of giant drums with white alabaster tops and copper sides.

Designated as the Fair's Official Color TV Communications Center, the exhibit is fittingly located at the heaviest traffic point of the exposition. Near its corner site is the Long Island Rail Road station where more than 50 per cent of the visitors will receive their first look at the Fair, and, incidentally, at the RCA exhibit, the first building in view.

To enter the RCA building, the visitor walks across a broad promenade of circular red brick into the reception room, a large rounding area dominated by a gracefully rising ramp. Here the visitor may see what he looks like on color television, or study small displays of the latest RCA products.

Moving up the ramp to the color facility, the visitor becomes aware of the interior's delicate decorative scheme. Varying shades of gray-blue in each room give a feeling of coolness, a happy result since the Fair is open only in the warm months. More important, the gray-blues will not conflict with the sharp rainbow colors on the 30 television monitors located throughout the exhibit.

From the gallery that winds over the circular production room, the bustle of a TV show in the midst of production will be easily visible through slanted glass windows. The control room juts over the exhibit from one wall so that the visitor can watch both the production floor and control room activity from a single vantage point.

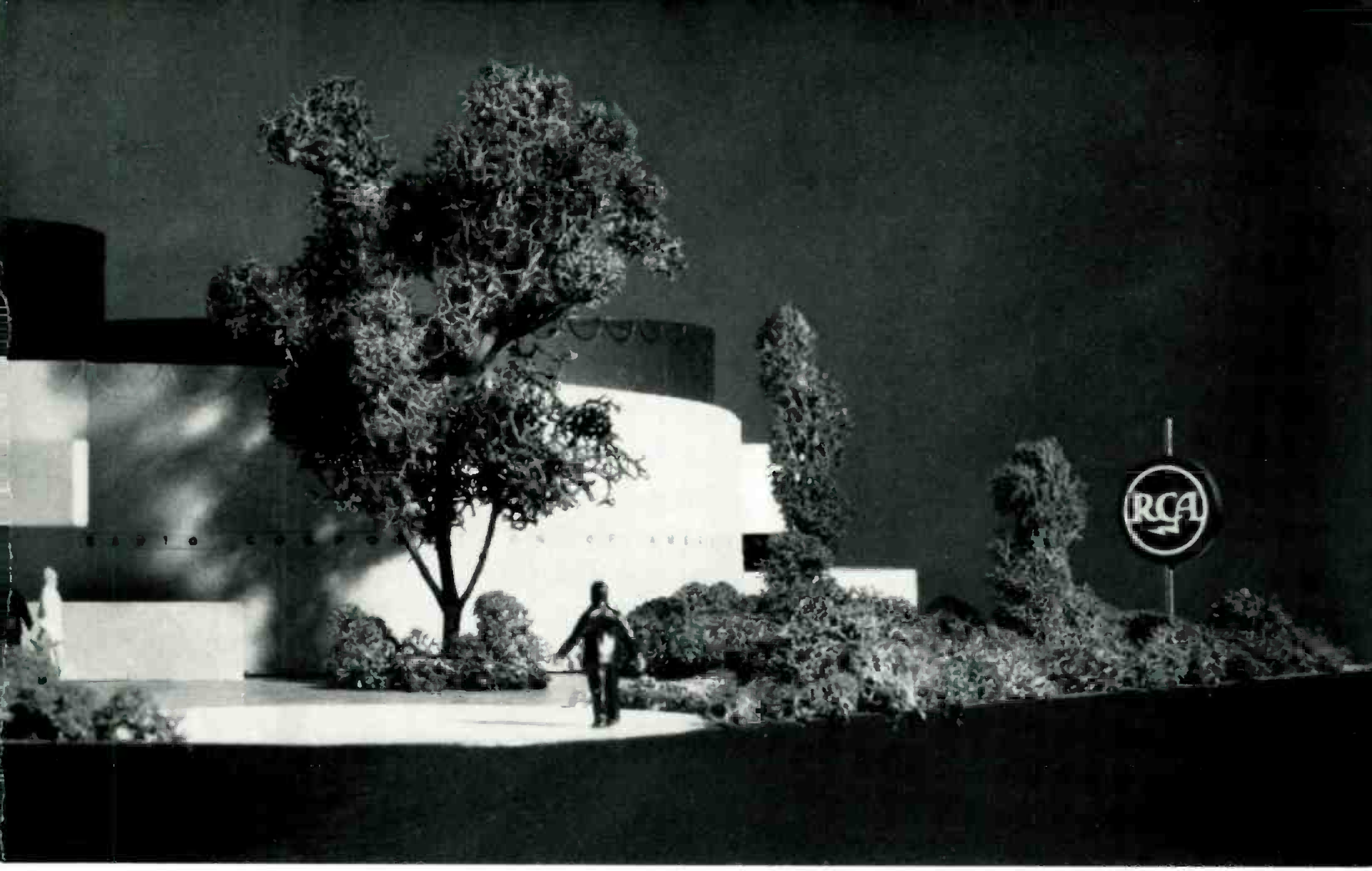
RCA plans to keep the operation in constant use with rehearsals or actual telecasts to make certain that each visitor can follow the proceedings on the floor while he studies the results on the color TV monitors. This means that even if a particular show is not being piped out over the closed-circuit network, the visitor will be able to see a TV program in actual production.

Leading off the ramp, overlooking the production facilities, the visitor will find two listening rooms, one circular and one rectangular, where stereophonic sound demonstrations will be presented regularly. A wall covered with 177 RCA album covers will be one of the most zestful decorative touches in the exhibit. The rooms will seat a total of from 80 to 100 persons.

For RCA, probably the most demanding aspect of the RCA display will be the production of enough color shows to fill 2,000 hours a season. According to J. M. Toney, Director, RCA World's Fair Exhibit, programming will have the twin purpose of entertainment and instruction.

"The emphasis will be on short segments," Mr. Toney said. "Things about the Fair that people would not normally know about. Odd facts, odd jobs, even films on the building of the Fair. We'll also get program material from other exhibits when the subject is of genuine public interest.

"After all, many persons who come to the Fair will not have anything like the three weeks that it takes to see all the displays. The closed-circuit television network will help them see things they might otherwise have missed."



RCA's TV Communications Center is located on a 30,000-square-foot plot at main entrance to the Fair. Center will feature color television facilities.

On the sheer entertainment side, there will be fashion shows and programs for children. Plans call for programs of this type to be aired both on the network and on the RCA exhibit's monitors. There is a likelihood that some regularly scheduled shows will originate at the Fair and be sent over the NBC-TV network.

Five minutes of every broadcasting hour will be set aside for the New York World's Fair Corporation's general reports on Fair activities. Fair executives are considering the closed-circuit network as a handy device for the solving of a standard exposition problem – the linking of lost children with frantic parents.

As the official closed-circuit TV network at the Fair, the RCA display will be the mecca for all VIPs arriving there. Most of them are expected to make the trip to the color cameras for an appearance on the network, the only way they can be seen simultaneously by most visitors.

If a newsworthy visitor cannot find the time to visit the RCA Communications Center while at the Fair, or an important event takes place elsewhere at the Fair, RCA will have a fully-equipped, three-camera mobile unit to handle the situation. The unit will be available to outside firms as well as to all exhibitors when feasible.

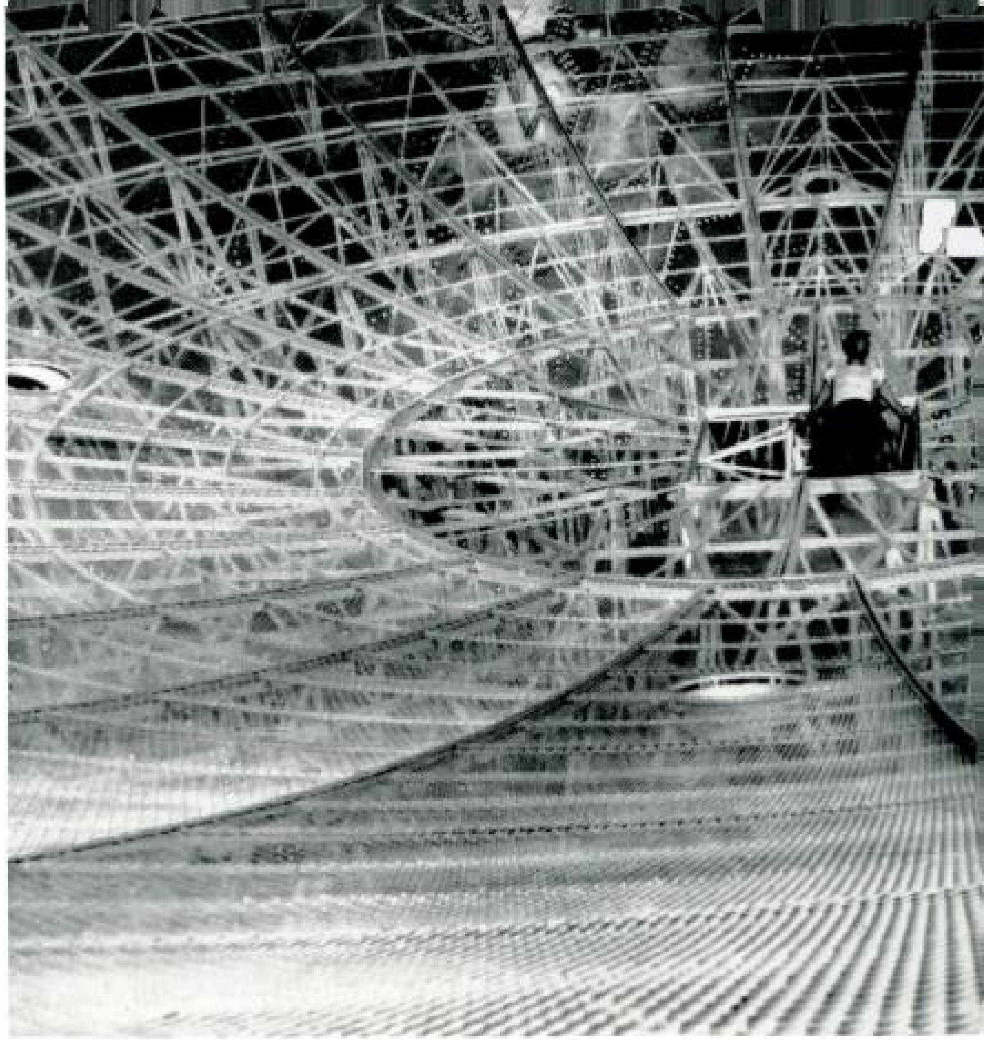
At last year's fair in Seattle, RCA also showed a color TV broadcasting facility, but the New York exhibit will be four times larger and, unlike Seattle, will be housed in a specially designed building. The television equipment, of course, will be two years ahead in development. The expected 75,000,000 attendance in New York contrasts with Seattle's 10,000,000 total.

The unique circular design of the New York building results from functional demands; a circular gallery was decided on to speed traffic and to enhance visibility. In other words, the building was designed from the inside out. Construction is already under way.

Malcolm B. Wells is the architect. He also designed RCA's Electronic Data Processing Center in Cherry Hill, N.J., and other corporation buildings in Palm Beach, Fla., and Hightstown and Somerville, N.J. John Vassos, a long-time design consultant for RCA, is the industrial designer for the project.

With the New York Fair's theme of "Peace Through Understanding," RCA's emphasis on communications through the media of television makes an apt exhibit for the exposition.

The New York World's Fair will open on April 22, 1964, and remain open daily and Sunday for the next six months. In 1965, it will open on April 21 and shut down on Sunday, Oct. 17, 1965. ■



Like a human spider in the middle of a steel web, an RCA workman at Moorestown, N. J., stands in the center of a huge BMEWS radar antenna. This particular antenna is used to train personnel and to test equipment.

At the headquarters of Radio Corporation of America's Government Services organization in Cherry Hill, N.J., employees are always getting ahead of themselves. They have no alternative. They have to keep ahead of the United States Government, their principal client, whose longing for more reliable electronic systems is near insatiable.

As the largest segment of the RCA Service Company division, Government Services performs a far more esoteric function than the manufacturing of a product. It supplies the knowledge, skills, and techniques for a diversity of complex scientific projects.

One Government Services unit installs radar stations to search for missiles through thousands of miles of space. Another operates a microwave communications network over the barrens of Alaska. A third provides the scientists for experimentation in the development of space simulation systems.

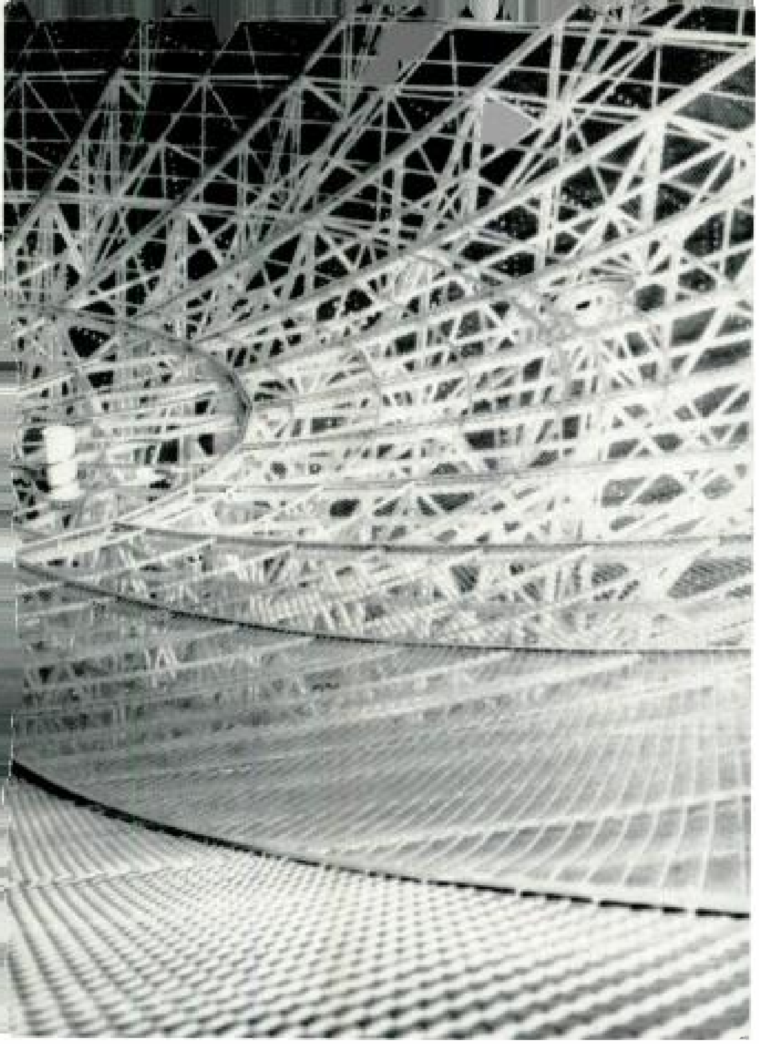
Much of the organization's work falls in the military defense and space exploration areas. And the drive to improve continually the nation's tools of defense, coupled with the inexorable changes in electronic and electromechanical systems, results in a business that is more future than present.

"We have to think of the future problems and needs of our potential customers," Stephen D. Heller, Division Vice President, Government Services, points out, "and there's little repetition in an advancing technology like defense. We have to anticipate what the government will need two to five years from now, and make sure our people will know how to handle it."

The headquarters building at Cherry Hill, where all this forward thinking is concentrated, is an impressively neat and modern structure, with an atmosphere of unhurried efficiency. But for an organization with $150 million in annual business, the size of its headquarters is disconcertingly small.

In this case, size cannot be equated with accomplishment. Few of the organization's 11,000 scientists, engineers, technicians, and training specialists spend time there. For Government Services is a vast reservoir of scientific and engineering know-how that spreads out from Cherry Hill through North America and over most of the Free World.

Its function is to supply services that can most efficiently be handled by technical specialists, by men who have acquired knowledge through practical experience. In electronics, it is no longer practical to



Service for the Space Age

RCA Service Company's Government Services organization provides scientific knowledge, skill, and experience in maintaining such diverse government operations as communications, radar tracking, and missile sites.

assemble a mass of unrelated devices and expect performance to match that of an integrated system.

With modern weapon systems, for example, the manufacturing and engineering experience going into design and fabrication, merely marks the beginning of the job. Afterwards, the equipment must be installed at the site and tested in the field to prove its acceptability. When it is ready for use, proper "documentation" and personnel trained in the operation and maintenance of the equipment must be available immediately.

"Today's electronic and electromechanical systems are designed to perform specific functions. They must do more, do it better and faster than ever before. Success depends upon the proper operation of integrated components, each contributing no more or no less than intended by the systems designer," Mr. Heller notes.

The importance of systems integration is emphasized by the fact that satisfactory operation of each component on the test bench will not necessarily assure satisfactory system performance in the field. The proper functioning of a single part depends on its relation to the entire system.

Therefore, RCA systems engineers are concerned primarily with over-all characteristics and the interrelation of the components, rather than with the detailed theory of component design. They know the potential contribution that can be made by each element of the system. They have the specialized talents required to operate and maintain sophisticated electronic systems.

Government Services engineers and scientists have been demonstrating their abilities in one vital area of supporting the weapon systems art since 1958 – the defense against enemy missiles. The organization was a member of the RCA Defense Electronic Products team, which was prime contractor for the Ballistic Missile Early Warning System (BMEWS). Today, RCA Government Services operates and maintains the BMEWS system under a prime contract with the United States Air Force.

In Thule, Greenland; Clear, Alaska; and in the United Kingdom, the steel skeletons of massive long-range radar antennas form a protective warning network in the North. They scan the air space above the Eurasian land mass for thousands of miles, prepared to alert the United States to a missile strike over the top of the world.

As the first and only defense system of its kind, BMEWS has been described as adding a new dimension to advanced warning against missile attack. Two types of radar are used in the U.S. Air Force projects — wide beam detection radars, each with antennas as large as football fields, and precise tracking radar, capable of following a metal object the size of a grapefruit across the skies.

Some 1,700 RCA personnel, members of the Company's BMEWS Service Project, have been responsible for installation, field engineering, and for preparation of detailed operating instructions and maintenance procedures. When BMEWS became operational, Company personnel, all thoroughly trained in the details of the equipment and system, were immediately available to assume operation and maintenance.

A more impressive example, even than the mighty BMEWS, can be found to illustrate the steady growth in size and technological complexity of Government Services. In 1952, Mr. Heller led a group of RCA field engineers to a minor military installation at Cape Canaveral. From this simple beginning, the RCA Service Company became a subcontractor to Pan American for the planning, systems engineering, operation, and maintenance of the vast complex instrumentation systems that constitute the Atlantic Missile Range.

In those days of lackadaisical American space efforts, the Missile Range reached only 200 miles into the South Atlantic. Today, the Range extends southeastward from the Cape over many land and sea tracking stations some 9,000 miles to the Indian Ocean. With the acceleration of the space program, RCA personnel at Patrick Air Force Base, Fla., multiplied monthly and continually assisted in improving the planning, maintenance, and operation of the Atlantic Range. Presently, more than 3,000 RCA physicists, engineers, technicians, and supporting personnel are stationed in Florida and down range.

Basically, Government Services is responsible for instrumentation of the Range, along with photography and data acquisition, processing, and reduction. This is far more demanding than might appear. Missile test-range instrumention has developed into a new technology. It molds the latest advances in optics and electronics into a composite system capable of measuring and recording every aspect of missile performance.

While missiles and space account for two of the outstanding capabilities of Government Services, there is a third broad management activity that developed from RCA's reputation in the communications field. RCA was called in by the Air Force to operate and maintain an Alaskan communications system known as "White Alice." The network spans the length and breadth of the sparsely settled state and forms a link between the Far North and the Air Defense Command Headquarters in Colorado Springs.

Several hundred RCA management, technical, and engineering personnel run the 80 control stations that make up White Alice, the country's largest over-the-horizon communications system. The stations, mostly on mountaintops, employ two types of antennas — one a 30-foot, disc-shaped structure and the other a 100-ton scoop-shaped unit 60 feet tall. The antennas relay signals from one to the other, sometimes over distances up to 170 miles.

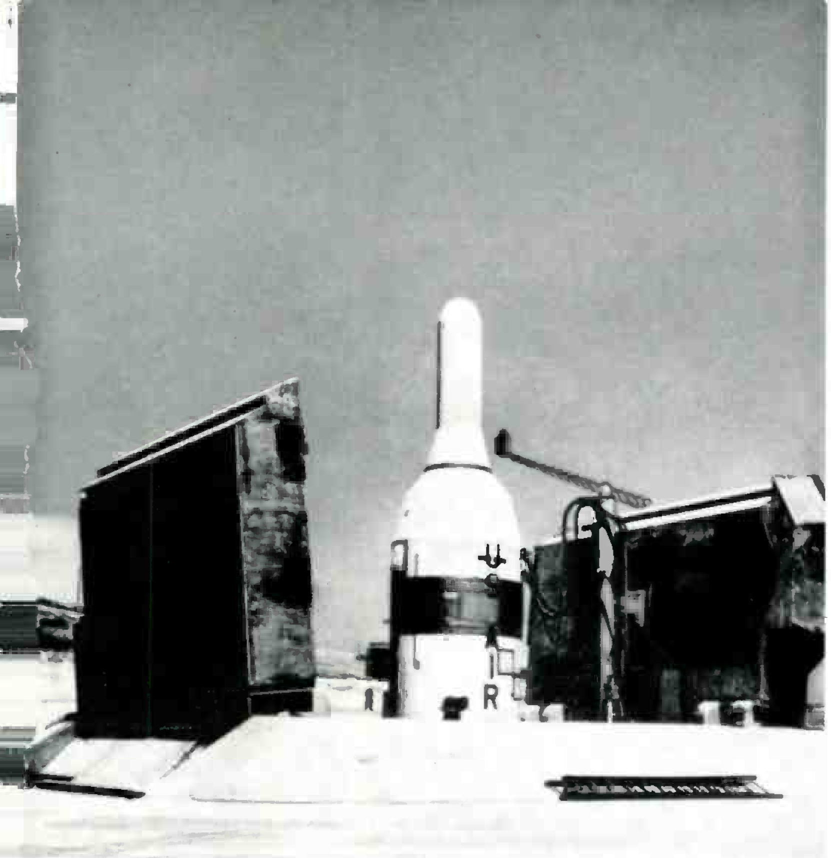
The White Alice System is essential for operations of the military and other government agencies in Alaska. Moreover, in one of the instances where defense spending directly aids peacetime pursuits, the communications network provides Alaska's civilian population with the only efficient means of connecting one end of the new state with another.

Actually, Government Services' work for White Alice, the Great Atlantic Missile Range, and BMEWS grew out of RCA's field engineering programs, one of the group's basic functions. Field engineering activities for the Armed Forces, civilian agencies, and industry are broad and diversified, ranging from systems planning, installation, maintenance, operation, and training to a complete "turnkey" mission. A single program may include several or all of these services.

Certainly, the strongest aspect of the Government Services group has been the unmatched backlog of experience gained on many makes and types of complex military electronic equipment. RCA field engineers have serviced virtually every U.S. military command, service, organization, and agency. As a result, RCA field engineering programs comprise one of the largest organizations of technical manpower available anywhere in the Free World.

An indication of the breadth of these programs can be seen by a few examples. RCA engineers and technicians augment Air Force personnel in operation and maintenance of Aircraft Control and Warning Sites within the Central Air Defense Force. Company engineers provide technical assistance to the Naval Engineering Service Unit of the Bureau of Naval Weapons. RCA engineers planned and installed a mammoth communications system in the Philippines. And on and on.

In contrast to the far-reaching mobility of the field engineers, Government Services' RCA Systems Engineering Facilities maintains units in key defense areas throughout the United States and Europe. Permanently staffed with engineers and technicians, these modern facilities develop technical programs needed to meet RCA requirements under government contracts. All phases of work are encompassed from



Two-hundred-ton steel doors (above) guard a 98-foot Titan ICBM at Beale AFB. Missile silo is serviced by RCA Service Company.

As the towering gantry (right) moves away from an Atlas ICBM at Cape Canaveral, Fla., an RCA Government Services photography crew closes in for coverage.

computer programming to equipment siting and preparation of installation and test procedures. Other groups of RCA Government Services' specialists install equipment, make field reliability surveys, prepare technical publications, and conduct training programs for military personnel.

Field engineering remains the core of Government Services. After all, the organization itself grew up from field engineering programs of two decades ago. And the Government Services unit emerged from the ever-increasing assignments given to RCA by the United States Government.

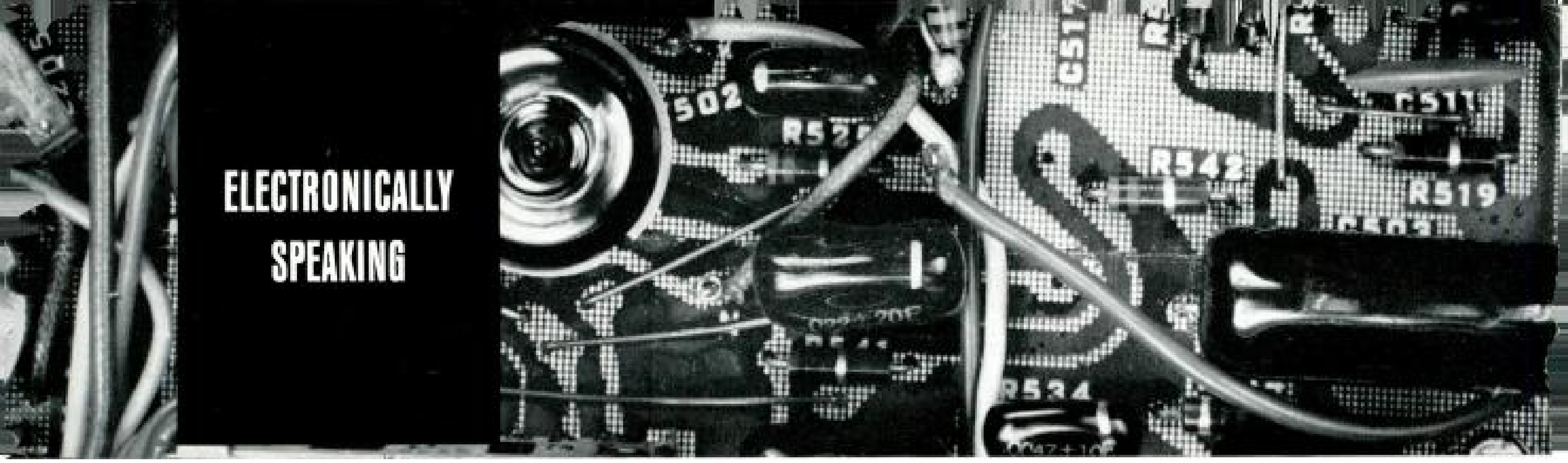
It was in 1938 that RCA first supplied technical help to the Navy for the operation and installation of radio and communications equipment aboard a Navy ship. By 1943, when RCA Service Company, Inc., was established as an RCA subsidiary, RCA field engineers were performing installation, maintenance, operation, and training services at military establishments throughout the United States and in almost every theater of war.

The business of the Government Services group declined after World War II, but the Korean conflict brought on a sudden demand for electronic equipment, and the organization caught a second breath of growth. The international situation has kept Government Services on an upward curve ever since.

The makeup of the organization's service activities has shifted drastically since the 1940s. One Government Services official pointed up the changes by contrasting the development of electronic equipment it services with other types of electronic units. "Today, our equipment is always new. In fact, 10 years ago we couldn't dream that some of the devices we service would even exist. On the other hand, take a TV repairman. He's doing basically the same work now that he was doing 10 years ago," he said.

The effort to keep apace of the expanding electronic technology has paid off for Government Services. In 1949, it was a relatively small part of the RCA Service Company. Today it is the Service Company's largest organization. In the last four years, in fact, its annual volume has doubled. While it normally is not safe to predict what the future holds for Government Services, few persons will argue with the statement that the group will continue to grow while contributing to the advancing art of technical support services. ■

ELECTRONICALLY SPEAKING



GOULD ON COLOR TV

Jack Gould, radio and television editor of the New York *Times*, stated in a recent radio broadcast, "it is now certain" that RCA Board Chairman David Sarnoff "has won out in one of the toughest and most costly battles of his career — color television."

Mr. Gould pointed out that General Sarnoff's conviction of the superiority of the compatible color television system over other methods back in the late 1940s had produced a system "that won out" over the Columbia Broadcasting System's method of color television.

Mr. Gould observed that the RCA financial report for the last quarter of 1962 showed that color TV "was now the single most profitable product" made by RCA.

In addition, he said that by the end of this year "color TV probably will be a $400,000,000 industry." Mr. Gould predicted that the number of sets of all makes is expected to rise to 2,000,000.

The N. Y. *Times* radio and television critic concluded that "General Sarnoff's steady nerves in the face of opposition or indifference to color from practically everyone else in TV have come through once again.

"That NBC Peacock may be a most ungainly bird but it symbolizes quite a chapter in contemporary industrial pioneering."

ELECTRONIC "FOREMAN"

By using impulses beamed by RCA microwave, the St. Louis headquarters of the Union Electric Company will control the power output of a new hydroelectric plant 100 miles away at Taum Sauk, Mo.

Water flowing through a 7,000-foot tunnel from a mountaintop reservoir will turn the plant's two turbines. When the generating cycle is completed, the turbines will be reversed to return the water from a lower reservoir up to the one on the mountaintop.

Once the plant is in service, its output will be controlled remotely by load dispatchers in St. Louis using microwave equipment.

THE 1,157-DAY WONDER

More than 203,000 television pictures of the earth's cloud cover were transmitted by the reliable TIROS meteorological system through the end of 1962. The TIROS satellites were developed and produced by RCA for the National Aeronautical and Space Administration.

Since April, 1960, six TIROS satellites have been launched and have logged a spectacular total of 1,157 days of useful life.

PROMETHEUS OF LIGHT

A new electron tube converting light to electricity has been developed by RCA. The tube, called the Lasecon, derives its name from "laser" and "conversion" and is expected to help advance the use of laser light beams in space communications and other areas of electronics.

At the Lasecon demonstration before the annual convention of the Institute of Electrical and Electronics Engineers in March, a light beam with intensity varying at the rate of 1,000 megacycles per second was directed at the Lasecon. The 18-inch, five-pound tube detected the changing light intensity and converted it into a 1,000 megacycle electrical signal displayed on an output meter.

Since the frequency bandwidth of the Lasecon exceeds 1,000 megacycles and a single TV channel requires only a frequency range of four, the Lasecon could handle several hundred television channels carried simultaneously over a single laser light beam.

VIDEOSCAN: ELECTRONIC READER

Combining the scanning ability of the vidicon television pickup tube with the data-handling capacity of the RCA 301 computer, RCA's new VIDEOSCAN optical character reader can process hourly up to 90,000 printed documents.

The electronic reader examines the data on documents somewhat in the way that a television camera scans a studio scene for broadcasting. In the case of VIDEOSCAN, the television signals are converted into RCA 301 code and fed into the computer.

VIDEOSCAN's simplicity, accuracy, and speed make it especially applicable to processing "turn-around" statements such as utility bills, insurance premiums, tax notices, and magazine subscription forms.

TWO HISTORIC TELEVISION EVENTS VIA RELAY

On Tuesday, April 9, 1963, as Big Ben struck the hour of 9 P.M., Sir Winston Churchill sat before a television set in his home at Hyde Park Gate in London. For the next 15 minutes, he and Lady Churchill watched – along with millions of other persons in Britain and on the European continent – as President Kennedy conferred honorary citizenship of the United States on the great wartime leader.

The ceremony in the White House rose garden was televised "live" in steady, crystal-clear pictures and sound via Relay I, the versatile communications satellite of the National Aeronautics and Space Administration. Viewers in the United States, watching the telecast on the NBC Television Network, also saw the program via Relay I, since the signals were "looped back" after passing through the satellite.

After the historic telecast, a spokesman for the Churchill family said Sir Winston had been deeply moved by the event. Press comment in Britain and on the Continent described Relay's performance as the best reception of any program thus far received in Europe via a communications satellite.

For Relay I, designed and built for NASA by the Radio Corporation of America, it was the second spectacular achievement in only three weeks.

On Sunday evening, March 24, millions of Americans saw for the first time in their homes a network color television program sent and received via a communications satellite in outer space.

It was a quarter-hour segment of the concluding episode in Robert Louis Stevenson's classic adventure story, "Kidnapped," broadcast by the National Broadcasting Company on Walt Disney's "Wonderful World of Color" after an historic experiment with Relay I.

The experiment was carried out on the night of March 19 by NASA's Goddard Space Flight Center, with the cooperation of RCA and NBC.

Millions in Britain and in Europe, as well as in the U.S., saw this TV picture transmitted from Relay in outer space as Sir Winston Churchill's son, Randolph, responded to President Kennedy on behalf of the former British Prime Minister, who had been proclaimed an honorary citizen of the United States.

The program was sent from NBC's technical center in New York to the American Telephone and Telegraph Company ground station at Andover, Me., and thence to the Relay satellite orbiting some 4,000 miles in space. Relay retransmitted the color signals back to the Andover station, which returned them by conventional video circuits to NBC's tape center in New York to be recorded on magnetic tape.

The program segment seen by the television audience was, in fact, only part of the experiment. Engineers participating in the test transmitted two complete segments of the Disney film, each 12 minutes and 21 seconds in duration, preceded and followed by color-bar tests of exceptional quality.

The film segment selected for the experiment involved especially severe color contrasts, ranging from dreary storm scenes on the windswept moors of Scotland to action of British "Redcoats" in bright sunlight, and finally back to a night scene at a bridge in which the principal characters, David Balfour and Alan Breck Stewart, make their escape to safety.

Three photographs, taken directly from the viewing screens of NBC's color monitors during the experiment, are reproduced below.