



WINTER
1962/63

electronic age

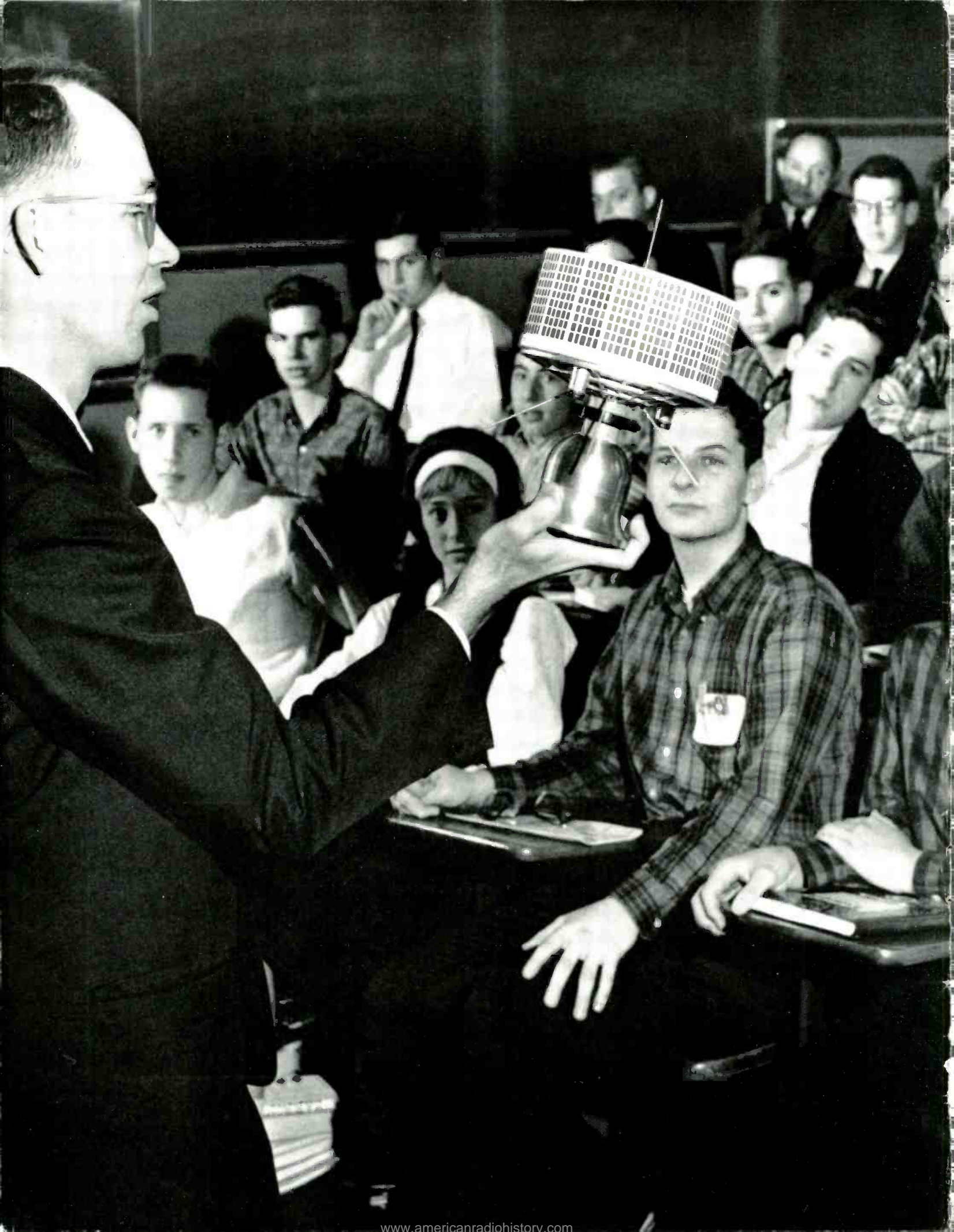
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RCA in 1962

**YEAR-END
REPORT BY
RCA CHAIRMAN
DAVID SARNOFF**





electronic age

VOL. 22/NO. 1/WINTER 1962/63



COVER: Surrounded by large glass funnels that will become RCA color television tubes an employee at RCA's new color television tube plant in Marion, Ind., applies a special black coating to the necks of the funnels in the initial production step. For a report on RCA's overall industrial expansion, see page 7.

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Dr. Gary D. Gordon from the RCA Space Center in Princeton, N. J., discusses the TIROS weather satellite before a New York high school physics class in the first session of the David Sarnoff Industry-Science Teaching Program. A detailed outline of the unique program starts on page 14.

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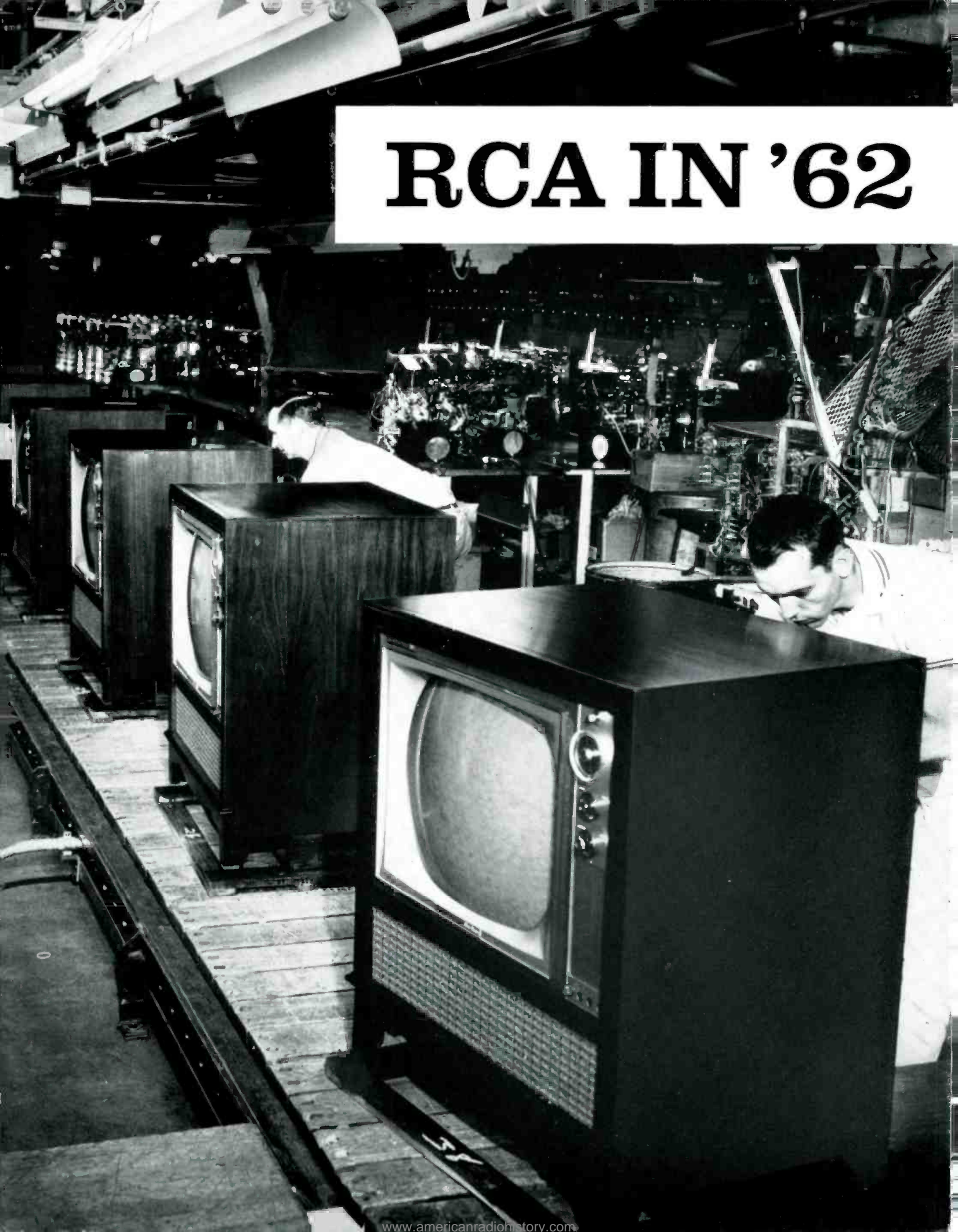
RADIO CORPORATION OF AMERICA

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RCA IN '62



More sales, more earnings, more scientific frontiers probed, mark an outstanding year in the company's 43-year history

By **DAVID SARNOFF**

*Chairman of the Board
Radio Corporation of America*

THE RADIO CORPORATION OF AMERICA sold more goods and services, earned more dollars and probed more new scientific frontiers in 1962 than ever before. Measured by most of the accepted indices of corporate health and progress, this was the best twelve-month period in RCA's forty-three-year history.

Sales for the year, in final tabulation, will approach \$1,700,000,000, exceeding by approximately 10 per cent the 1961 record of \$1,545,912,000. Operating profit after taxes will advance at least 40 per cent beyond 1961's level of \$35,511,000, and will surpass \$50,000,000. The previous RCA earnings record of \$47,525,000 was set in 1955.

In relation to the movement of the national economy as a whole, RCA stands out as an industrial pace-setter. The estimated increase in the company's sales is higher than the average sales gain of all American manufacturers in 1962; the increase in operating profits is at least double the estimated average rise in net income for all manufacturing industries.

RCA's earnings were increased further in 1962 through a capital gain of \$7,000,000 from the sale of 991,816 shares of common stock of the Whirlpool Corporation. This non-recurring income added 41 cents per share of common stock to the operating earnings in 1962.

Against this backdrop of profit improvement, the principal production, sales and administrative elements in RCA's 1962 success story can be enumerated:

1. A strong upward thrust in consumer products and services, paced by sales of more than twice as many color television sets as in 1961, and by an estimated five-fold increase during 1962 in profits on color apparatus and related services;
2. Growing strength in RCA's electronic data

processing operations, reflected in the more than doubling during 1962 of revenue from domestic and international sale and rental of commercial systems, and the continued substantial reduction of related costs;

3. Continued advances in space and defense electronics, dramatized by the unprecedented 100 per cent effectiveness of the six RCA-developed TIROS weather satellites that have so far been launched and operated by the National Aeronautics and Space Administration;

4. Record sales and profits of the National Broadcasting Company;

5. Successful implementation of an intensive company-wide program to increase operating efficiencies and reduce costs.

To direct its drive for profit improvement, RCA's management in 1962 called upon a highly skilled team of 37 principal operating division and corporate staff executives whose average age is only 51 years, but who possess an average of 20 years of experience with RCA and 27 years of experience in the electronics industry. This management group has proven increasingly effective in planning for the future and in developing the research, engineering, production and marketing techniques that can assure a substantial return to RCA from its growing investment in electronics.

CONSUMER PRODUCTS

All RCA activities concerned with home instruments and home entertainment ran well ahead of the previous year in business volume and profits.

— Total sales of all RCA Victor home instruments increased by 30 per cent over 1961 and exceeded the

previous record high of 1956, with the most substantial gains registered in radios, "Victrola" phonographs, tape recorders and color television.

— Unit sales of television sets were well in excess of 1,000,000, and rose in dollar volume beyond the previous all-time peak established in 1950.

— RCA was hard-pressed to meet the demand for color television sets, and color picture tube production facilities were expanded at Marion, Indiana, and Lancaster, Pennsylvania, to help meet the anticipated industry demand in 1963.

— RCA Victor records achieved a record sales volume and again led the industry in the list of the nation's top twenty best-selling single records.

BROADCASTING

The National Broadcasting Company had its most successful year, highlighted by record profits and advertiser investment in television.

— NBC television attracted 262 advertisers, more than on any other network, and a new high for the company.

— Twenty-five per cent of its television programming in 1962 was devoted to news and public affairs, with the largest audiences among all networks consistently attracted to these NBC presentations.

— Nearly 2,000 hours of color television were broadcast by NBC during the year, including 68 per

cent of its total nighttime schedule.

— NBC Radio maintained its position as the leading network in sponsored time, with billings and profits higher than in 1961.

ELECTRONIC DATA PROCESSING

RCA is now firmly established as one of the leading manufacturers and suppliers of electronic data processing and is proceeding toward the development of a profitable growth business in this significant new field.

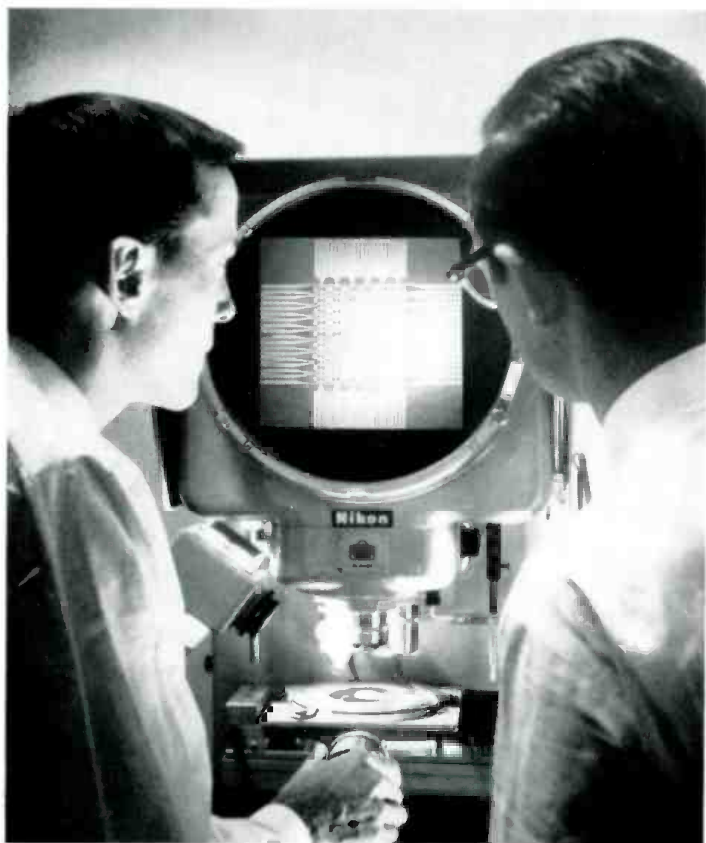
— More than 280 RCA electronic data processing systems have been shipped to government and commercial users in this country and overseas, and mounting demand has required expansion of the work force producing the versatile RCA 301 at Palm Beach Gardens, Florida.

— Foreign orders for RCA systems rose to 158, a 125 per cent increase over the 1961 year-end total, and substantial new overseas orders have been received for millions of dollars worth of components and peripheral equipment.

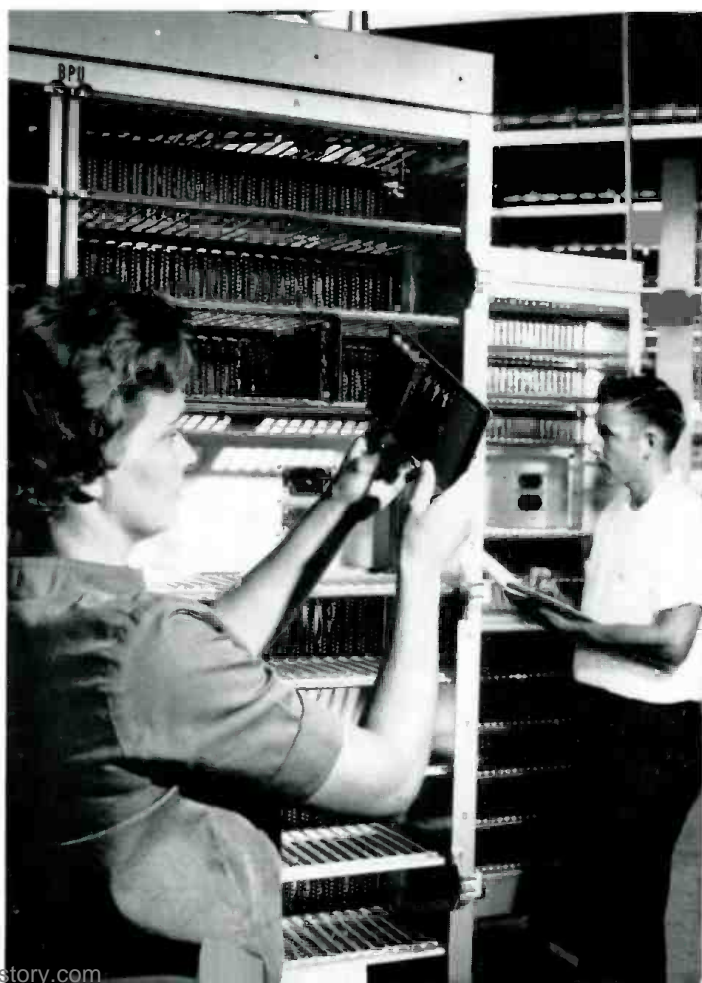
— The first RCA 601, a large new computer for industrial and scientific use, was placed in operation in December at the New Jersey Bell Telephone Co.

ELECTRONIC TECHNOLOGY

The basic research programs and the device and



A magnified projection of advanced memory plane for computers is examined (above) at RCA's Princeton laboratories. At right, technicians check high speed arithmetic circuitry for the RCA 301 computer.



circuit development activities of RCA continue to provide strong support for the advance of all electronics.

— RCA Laboratories achieved major gains in basic materials and techniques for lasers, new types of high-speed computer memories, microelectronic circuits suited to mass production, and new superconductive magnets for defense, space and computer applications.

— Sales of RCA electron tubes for industrial, broadcast and military equipment reached a new high in 1962, and important new business development programs were launched in electronic power devices such as thermoelectrics and solar cells.

— Sales of color broadcast equipment increased substantially, paced by a three-fold rise in sales of color film cameras for locally originated programming.

— RCA introduced in 1962 new packaged circuits and microferrite memory devices to increase the speed and capacity of computers, and new types of transistors gave RCA one of the broadest lines of military and industrial semiconductor devices on the market.

SPACE AND DEFENSE

RCA made notable contributions in 1962 to the advancement of space technology and to national security.

— Nearly a score of major space packages in addition to the TIROS satellites were delivered or near-

ing completion by RCA at the year's end, highlighted by the complex television payloads to be carried to the moon in 1963 in the RANGER program.

— A multitude of important defense systems and devices were provided to the armed forces, ranging from miniaturized computers for military field use to one of the largest and most precise missile tracking radars yet developed.

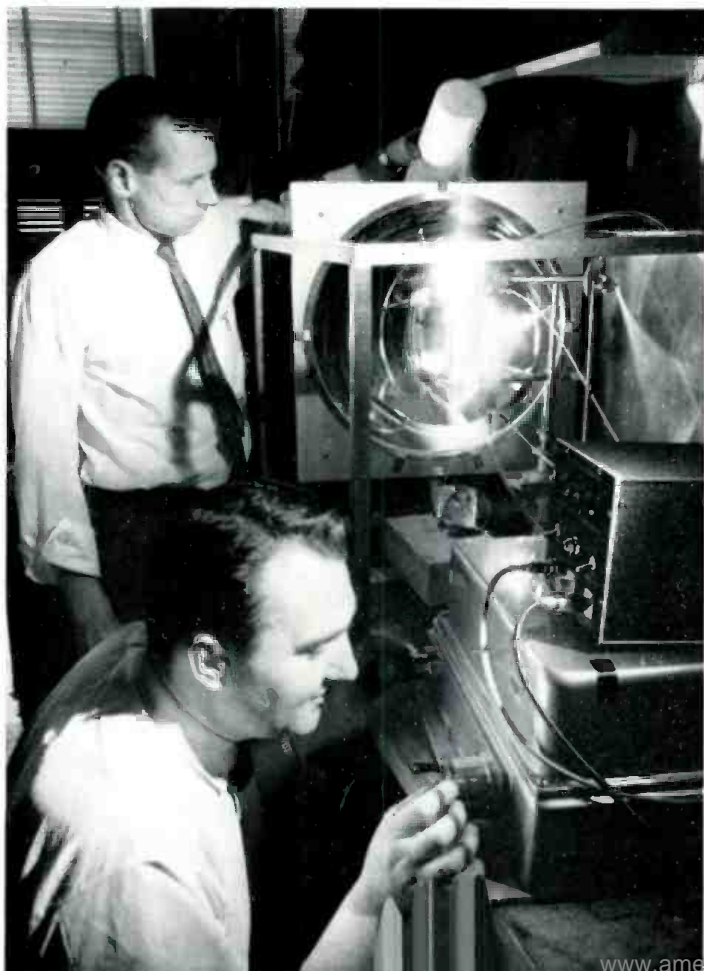
— RCA Service Company, which achieved an all-time high in sales, completed installation, checkout, and test of the ground support equipment for the Titan missile complex at Beale Air Force Base in California, and further expanded its operation and maintenance services for the Atlantic Missile Range, based on Cape Canaveral.

WORLD TRADE AND COMMUNICATIONS

Mounting prosperity and economic growth in the Free World were reflected in gains by RCA in overseas markets and in worldwide communication services.

— International sales of RCA products and services set a new record.

— RCA's international communications network handled the greatest volume of traffic in its history, and important new services were inaugurated in computer data transmission and weather facsimile broadcasting.



A new laser (left) was developed by RCA requiring 10 times less energy than present types to generate infrared beams, and (above) superconductive magnets may form an important new business for RCA.

THE OUTLOOK FOR 1963

The development of a strong profit base in 1962 has placed RCA in a position to advance to even higher levels of sales and earnings in 1963, conditioned upon the strength of the national economy as a whole.

I believe the economy this year will sustain a relatively high level of activity, buoyed by the prospect of early measures to stimulate more vigorous business investment and growth. Despite evidence of softness in a few sectors, the question is not whether, but how energetically, the economy as a whole will continue to advance.

For electronics in particular, we can anticipate continuation through 1963 of the upward trend in sales and earnings which has placed the industry ahead of all others in dynamic growth in recent years.

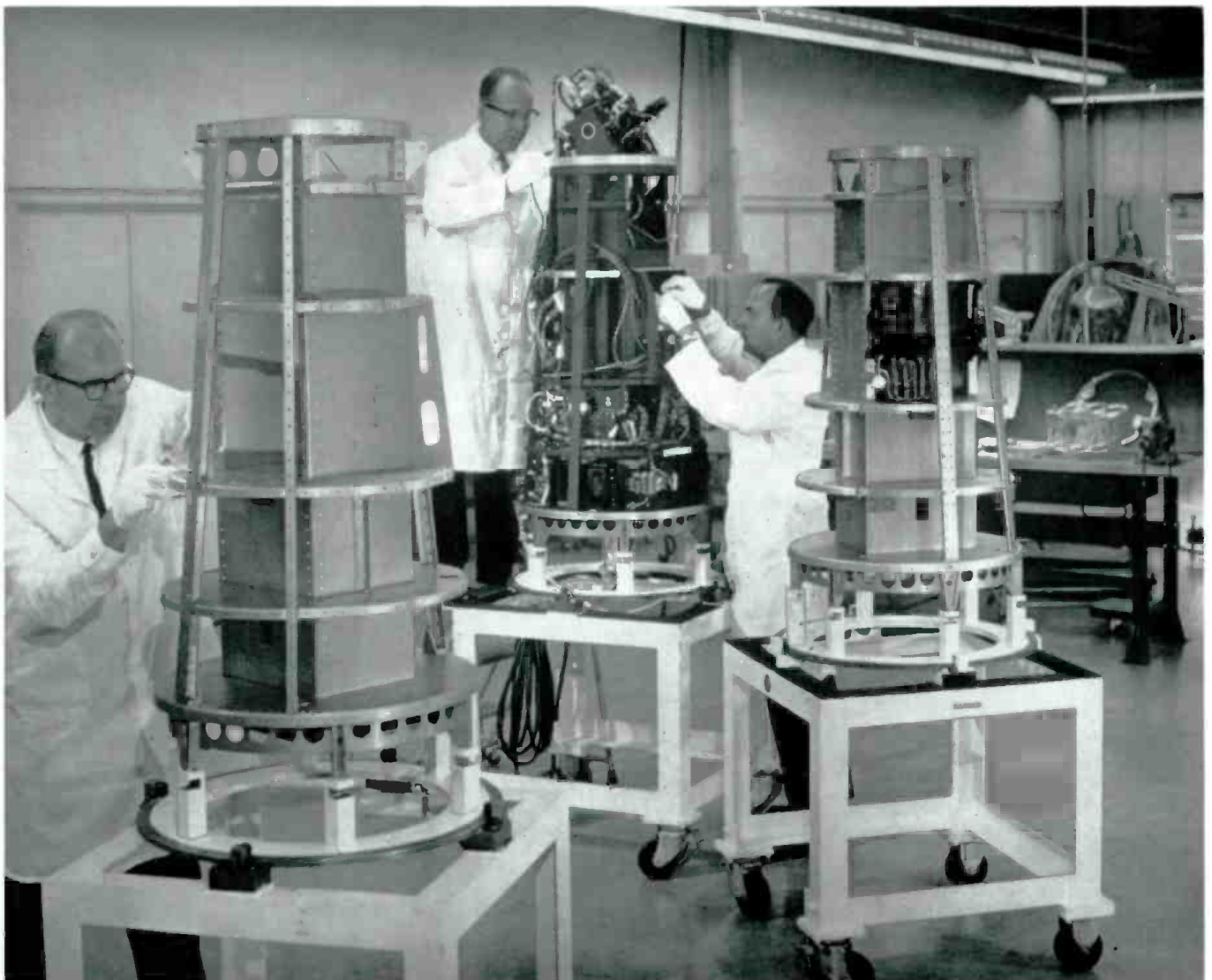
The scope of the nation's space program and the undiminished requirement for national security are expected to expand further the substantial market for

advanced electronic systems for space and defense.

In the home instruments and home entertainment market, color television has clearly entered an era of major growth and profitability. It is estimated that the market can absorb from 750,000 to 1,000,000 color sets in 1963 if picture tubes can be produced in adequate numbers.

Electronic data processing has advanced beyond its introductory threshold to become a new growth industry of infinite potential. The anticipated trend in 1963 is for substantially increased demand in the commercial and industrial markets, especially for faster and more versatile systems to assist management in business planning and the control of operations.

In all of these sectors, and in the allied fields of research and engineering, basic components, and electronic services, RCA made rewarding advances in 1962. The new year should provide further confirmation of the validity of our program for progress and profits. ■



Under almost surgically clean conditions, RCA engineers assemble a television payload for the Ranger moon vehicle.



*RCA's facilities and services
grow and multiply to provide...*

A SUPPLY FOR THE DEMAND

FOR THE second time in a year, RCA has expanded its color television picture tube manufacturing facilities to meet the rising demand — a demand that shows signs of growing still more in 1963.

In Marion, Ind., a town of nearly 40,000 persons in the flat farmland 65 miles northeast of Indianapolis, a second color TV tube facility has gone into operation on an around-the-clock basis to help fill the rising backlog of orders from TV set makers.

It means a \$1.7 million expansion for Marion and comes on the heels of a recent \$1.5 million expansion at RCA's Lancaster, Pa., color TV picture tube plant.

A glance at the record shows why: Color TV is now a \$200 million-a-year industry — twice the volume of just two years ago. Other manufacturers have entered the color TV field and color TV program schedules have increased sharply.

"RCA's new facilities at Marion and Lancaster will significantly increase the flow of picture tubes available to the color TV industry," says D. Y. Smith, Vice President and General Manager, RCA Electron Tube Division. "This increased output should start to reduce some shortages of color picture tubes."

Establishment of the 24-hour-a-day color tube facilities in Indiana (the plant will continue to make over 100 types of black-and-white picture tubes) will help production and distribution, but it may not be enough to take care of the demand.

"For this reason," says Mr. Smith, "RCA has advised its color receiver manufacturer customers that it may be impossible to handle their total picture tube requirements during 1963."

Elsewhere in the RCA Electron Tube Division, the receiving tube engineering organization has been

realigned to meet current and future operational needs. The aim: Increased efficiency and greater emphasis on new products.

In addition, the Tube Division and RCA Laboratories have set up a new research facility at the David Sarnoff Research Center at Princeton, N.J.

The new applied research laboratory will perfect techniques for mass-producing superconductive, niobium-tin high-field magnets. Niobium-tin is a superconductive compound which can generate and sustain very strong magnetic fields without any power dissipation. Thus, magnets made with the material will continue to operate indefinitely without consuming any power — except for the small initial energy to start a current flowing.

Thanks to a new process developed by RCA Laboratories for rapid and continuous production of the new metallic compound, widespread practical applications can be foreseen for additional superconductive products. Examples: Space communications, relay satellites, radar, radio astronomy, frictionless bearings and gyroscopes in missile systems, and high-speed commercial and military computer memory systems.

But growth in the Electron Tube Division is only part of the RCA expansion story in 1962 — a story that includes a 50 per cent increase in facilities at RCA's Princeton, N.J., Space Center; a new RCA West Coast headquarters; establishment of a new Educational Services Department to make available programs for schools, industry and government; and a consolidation of advertising efforts for the RCA Service Company.

The expansion of RCA's Space Center added more than 100,000 square feet of engineering and administrative space to the facility, which was first opened in 1958 with a modest 40,000 square feet of floor space.

The Center, operating in a specially-constructed, ultra-modern building on the outskirts of Princeton, N.J., has the assignment of assuring dependable performance of vehicles and satellites in space.

It is equipped with a large and complex array of testing apparatus, from vibration and shock machines to thermal-humidity chambers, huge thermal-vacuum facilities, and rotary accelerators, among others.

The aim of the Center is to simulate all environments in which space devices and vehicles must function reliably. Ground transportation, as well as blast off and orbiting, are included in the testing. This explains the shock and vibration machines.

First indication of the important value of the Center came through its use for the engineering development and environmental testing which contributed to the outstanding reliability of the TIROS weather satellites, built under contract for the National Aeronautics and Space Administration.

Growth of the Space Center, notes Barton Kreuzer, Division Vice President and General Manager of the Astro-Electronics Division, RCA Defense Electronic Products, "has paralleled the growth of the space program of our nation. RCA feels that while we have made a significant contribution in the past, we will be called upon to provide an even greater effort in the future."

During 1962, for instance, RCA delivered more than a score of space packages, including the TIROS meteorological satellites and satellites for the Project Relay transoceanic communications experiment.

RCA's new West Coast headquarters (at 6363 Sunset Boulevard, Hollywood) is scheduled for completion in late 1963. RCA will occupy more than half the nine-story, 76,000-square-foot structure to house its West Coast corporate offices, electronic data processing sales activities, and recording studios of RCA Victor Records. The rest of the building, which will have a "floating tower" effect and which will be owned by Frank Muller, Hollywood businessman, will be leased to other tenants and will include a parking garage on the third story.

The new RCA Victor facilities will include the latest in acoustical engineering and will utilize the most modern techniques in use or in development at other RCA studios. They will include two, two-story high recording studios, one smaller studio, three control rooms, two re-recording rooms, a listening room, two cutting rooms, two editing rooms and a master test room, all featuring the latest equipment for hi-fidelity and stereo recordings.

The new building will be at Sunset Boulevard and Ivar Street, one of Southern California's busiest corners. RCA's present western headquarters are in the NBC Building at Sunset and Vine.

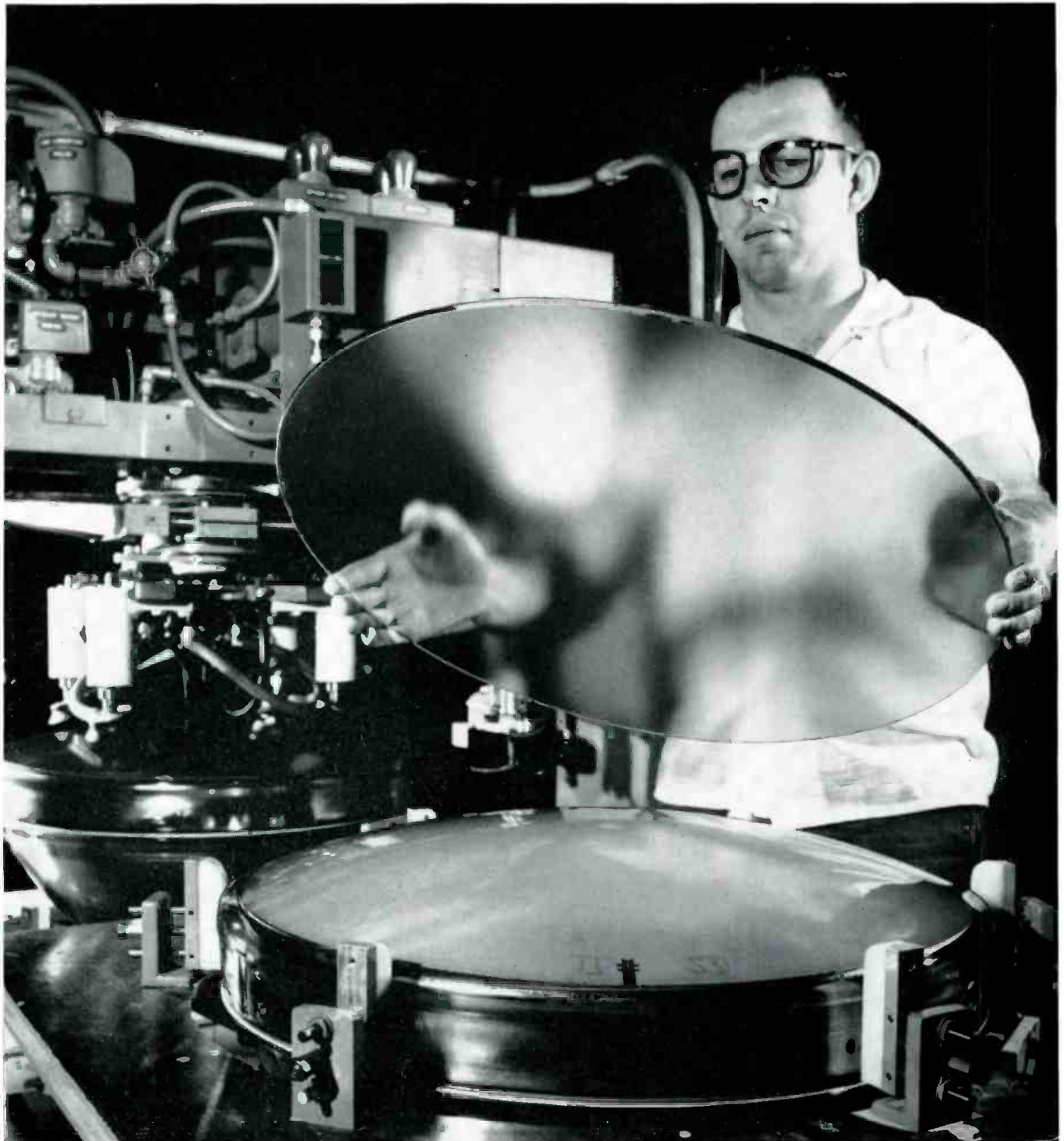
The new RCA Educational Services Department, headed by Harold Metz, Division Vice President, provides custom-designed and packaged educational programs, materials and equipment as a focal point for the company's traditional educational efforts.

"With the nation's educational and training problems continually in the spotlight, and with federal, state and local governments striving to improve this situation," says A. L. Conrad, President of RCA Service Company, "there is a need for a company with RCA's technological capabilities and broad electronics background to make major contributions to the field of education."

RCA equipment and services available to educators range from basic classroom audio-visual aids and engineering and technical courses to development, consultation and evaluation services.

As a starter, the newly established department has





An RCA employee prepares to bond a glass saucer onto color TV tube faceplate, eliminating room-light glare, separate safety glass.

undertaken the training of teachers in various school systems in the art and science of programmed instruction.

Workshops are offered to teachers to help them develop classes of students with increased enthusiasm for their school work. The workshops (conducted in an informal seminar manner at local schools) aid the teacher in writing self-instructional programs which

can be used as instructional aids to the students' advantage.

Consolidation of the product and service advertising efforts of the RCA Service Company is designed to provide better service to the distribution outlets in the promotion of the company's products.

All these programs represent RCA's increasing industrial productivity and service. ■

LONGEST HIT SHOW IN NEW YORK

For more than 15 years, RCA's Exhibition Hall has played host to millions of Americans for an introduction to electronic pleasure

AN ISLAND of promise and a magnetic attraction for millions of visitors, New York wears gracefully her crown of "America's Most Interesting City."

For the resident or the relaxed passer-by this teeming metropolis presents an almost confusing array of elements which, singly or in mixture, can satisfy nearly any hunger — work, progress, culture, education, entertainment, curiosity, beauty or just plain fun.

Like the Statue of Liberty in the harbor with her torch eternally held aloft, New York City ceaselessly makes available her heterogeneous fare for all to partake. The 8 million who permanently live here or the more than 14 million who annually visit for at least an overnight stay, find that New York's banquet table of events is always set.

Exciting Broadway hit shows, concerts by the world's finest performers, a skyline unmatched on this planet, museums to delight the eye of the old and the imagination of the young, lively night club acts, the quiet dignity of the Cloisters overlooking the Hudson River or a flea circus off Times Square. These are all part of New York City.

There's another facet of Manhattanville's multiform program, however, that residents and visitors alike have come to accept as New Yorkish as the Empire State Building, snarled traffic, the Fulton Fish Market or the Radio City Rockettes.

This is the availability of spectacular and educational exhibitions maintained by a number of organizations, a large percentage of which are private enterprises. More than anything else these popular "shows" are motivated by the desire to provide a public service, although such exhibits can be a vehicle to carry an enterprise's story to the public.

In referring to these particular exhibitions, a spokesman for the N.Y. Convention and Visitors Bureau points out that these "privately sponsored exhibitions are important to the city and are particularly valuable to school groups. The existence of such free shows is one of the many reasons why New York is such a bargain place to visit."

New York's Commerce & Industry Association also looks upon such exhibits as a valuable asset in the city's stock of attractions.

The Convention Bureau notes that one of the most popular, and certainly one of the longest-running of such exhibitions, is that provided by the Radio Corporation of America. In the famous Radio City area — a city within a city — the RCA Exhibition Hall at 40 West 49th Street has been "a hit show" since its birth on May 14, 1947.

Since that period shortly after World War II, America has come a long way. RCA has kept pace with that growth, as the more than 4,000 visitors to the company's Exhibition Hall each day can attest. Where some 15 years ago an exhibit visitor, viewing the wonders of television, stood amazed at the tiny, black and white picture winking and blinking back at him, today he can stand and watch continuous color television on a large, sharp screen, contemplating only which style cabinet would look best in his living room.

A rather amazing fact is that while some 14 million visit New York City each year for a stay of at least 24 hours, the RCA Exhibition Hall alone plays host to about 1.7 million persons annually! This is in face of such powerful competition as only this pulsating city can offer, such as: Radio City Music Hall, just a block from the Exhibition Hall, the world's largest exclusively indoor theatre and the Metropolitan Museum of Art, which draws about 3 million persons each year to one of the greatest art collections in the world.

The powerful attraction of RCA's electronic wonderland is so great it even outdraws that dear lady in the Bay, the Statue of Liberty herself! Last year, a record total of about 850,000 persons visited Liberty compared with the approximately 1,700,000 who toured the RCA Exhibition Hall in 1962.

RCA's "hit show" presents an array of radios, television sets, phonographs, tape recorders, stereophonic consoles and a host of other electronic gems that make those earlier exhibition items as obsolete as the "talking machine" which RCA Victor retains as its world-



Continuous color reception on RCA sets is just one of the many attractions for the 4,000 visitors each day to the RCA Exhibition Hall.

known trade mark.

Since its creation, the unique RCA Exhibition Hall has played host to upwards of 26 million men, women and children. In addition to the main floor attractions which can be seen from the street in most cases, the hall includes a small modern theater, seating 66, meeting room, information center, demonstration rooms, displays of the latest space achievement and an educated look into the future of electronics.

Not all those paying a call on RCA's exhibit come to ooh! and ahh! over the luxurious electronic masterpieces on display. In fact, RCA officials concede, the most popular attraction is the chance to "See yourself on television". The groups of school children touring Radio City especially feel the highlight of their trip is the sight of themselves on a television screen.

"See yourself on television" also brings out the thespian in Mr. Average Citizen, according to the staff

at RCA's Exhibition Hall. A favorite is the almost daily visitor, a dapper, elderly, wax-moustached gentleman who comes armed with champagne, wishes one and all "A Merry Christmas" no matter the season, and then steps before the camera to toast the world at large as he observes his image on the screen.

Outside the 200-foot-long glass window that encases the RCA display, friends and passersby can also watch the antics of those in front of the camera. One of the most popular "entertainers" is the youthful, frequent visitor who, dressed dramatically in black hat, black cape and sporting dark glasses becomes — depending on his mood — Zorro, Mr. X or the Bat Man.

Man's desire to see himself as others do probably is the main reason for the popularity of RCA's exhibit. According to Army Air Force veteran Roy Thyberg, assistant exhibit manager, this motivates most people to come into the RCA Exhibition Hall.

Whatever the attraction, one comes away with a better understanding of some of today's marvels in the fields of communication, space, data processing, radio and television broadcasting and numerous other 20th Century industries. Visitors also can familiarize themselves with RCA's vast variety of products and services. Available is a rundown on Victor records, the smallest transistor radio or the most expensive hi-fi set-up.

No sales transactions take place at RCA's exhibit and no one tries to sell anything. A floor staff of four men and two women are on hand between 11:00 a.m., when doors open, until closing at 8:00 p.m. to answer the thousands of varied questions tossed its way. Whether the query concerns the performance of an inexpensive table radio or the complexities of tuning in a deluxe combination color television-stereo-AM/FM radio console model worth a few thousand dollars, the answer is always polite and informative.

In addition to the well-trained floor staff, there are 14 additional experts directly involved with the smooth operation of the RCA showplace. Engineers maintain a steady flow of color television programs, thanks to a complete telecasting unit in the lower level; repair and service personnel keep in operation equipment and products damaged by over-zealous youngsters and mechanically-minded adults; a projectionist stands ready at all times to book, operate or record a program in the sound-perfect little theater.

The Exhibition Hall personnel are constantly challenged to demonstrate rare ingenuity. The RCA staff last year, for example, was called upon to place a cabin cruiser in a section of the display window that, unfortunately, measured exactly the length of the boat. After a slight remodelling job on the hall, the craft was safely installed.

RCA in the coming year will completely overhaul the entire exhibit hall, updating displays and providing for a smoother flow of visitors from one section to another. Only once before — in 1948 — was the hall completely revamped, although about four times a year it is redecorated to coincide with the seasons.

How much of a contribution to a corporation's sales does such an exhibition make? That is unanswerable, but in the opinion of dealers and the manufacturers themselves, such displays create enormous goodwill and probably are the determining factor in a number of sales. At RCA's exhibit, one of practically every company-made consumer product is shown. Often dealers refer potential customers there to see first hand the item contemplated.

In its revamping plans, RCA will strive to relate some of its exhibits more closely to current happenings, such as moon shots, new missile developments

and orbital flights. The company is aware of the public interest in the future. Even now it has a section of pictures showing the expected nature of products in the 1970s. For one, there is a color TV, AM/FM unit the size of the present day pocket transistor radio.

As a public service, RCA makes available its meeting room in the Exhibition Hall for press conferences, group meetings and for the introduction of products. The Johnny Victor Theatre, presided over by Leo Popkin, is available at a nominal fee to civic, philanthropic, business and advertising groups. Many top motion picture screenings have taken place here and it is often used as a studio to dub in sounds for television films.

Visitors to the RCA Exhibition Hall have come from every state in the union and from almost every known area of the world. The list of royalty and other celebrities who have entered these interesting portals read like a Presidential date book.

For the hi-fi enthusiast two demonstration rooms are available where a variety of records can be heard in surroundings akin to a person's own living room.

Open seven days a week with the exception of a few main holidays, RCA's Exhibition Hall has become the favorite retreat for not only foot-weary sight-seers, but of long-time New Yorkers who enjoy the inviting atmosphere of an attractive, interesting display which costs nothing but time to observe. Many office workers drop in daily on their lunch hours.

Exhibition Hall staffers have to think fast on their feet to answer unexpected questions that are not merely concerned with model numbers, equipment performance or price. Some of the answers require a combination of State Department diplomacy and scientific logic.

Recently a visitor loudly proclaimed that television set designers — and in particular RCA's set designers — didn't know what they were doing in lowering the height of sets, bringing the screens closer to the floor on many of the models.

One of the Exhibition Hall staff quietly asked him where he held a book or magazine when he read. "Down in my lap, of course" replied the man.

"Exactly," said the staff man, "looking down is the ideal angle for reading or viewing and that's why the sets are being lowered in relationship to a viewer standing or sitting in an armchair."

For close to 15 years now, RCA's exhibition has been considered among the top tourist attractions in a city where a visitor is faced with a plethora of diversions. Under the remodelling job now contemplated to be completed in time for the New York World's Fair in 1964, the Hall can only improve its position on everyone's "must see" list. ■

THE David Sarnoff Industry-Science TEACHING PROGRAM



AN IMPORTANT SIDE EFFECT of the successful launch and orbit of Sputnik I in October, 1957, by the supposedly scientifically backward Russians was to shake many Americans into awareness of shortcomings in the scientific training of our youth. Referring to "snap" courses and the lack of extensive scientific training, among other things, in our schools, Sloan Wilson, in *Life* magazine of March 24, 1958, reflecting the mood of the times, wrote: "It is time to close the carnival and go to work."

Foreboding statistics on the increasing shortage of scientists and engineers have heavily underscored the results of years of "carnival time." The National Science Foundation, for instance, estimates that by 1970 the United States will need 2,032,000 scientists and engineers to meet its minimum requirements. Today, there are only 1,100,000 such professionals.

The need is for 106,000 additional scientists and engineers each year; our colleges are graduating only about 80,000 each year.

The National Education Association estimates that there is a shortage of between 12,000 and 15,000 science and mathematics teachers in this country. The Office of Education reports that among high school students fewer than 9 per cent take chemistry and only 5 per cent take physics.

Even before Sputnik I, a few men spoke up loudly and clearly about this dangerous situation. One of these men was David Sarnoff, Board Chairman of the Radio Corporation of America.

On January 26, 1956, in Washington, D.C., General Sarnoff was presented the Forrester Memorial Award, and on that occasion suggested an exciting plan that had been maturing in his mind for many years and



which he was convinced would help to attract more youngsters in their formative years to a scientific career. The plan — like most good plans — was an uncomplicated one. Basically it consisted of having scientists and engineers from industry assist in classroom teaching in the nation's schools. The industrial employers would release some of their scientists for teaching assignments in nearby high schools. The scientists would be asked to teach on a voluntary basis, and there would be no costs involved for the schools.

On April 25, 1956, and on January 13, 1958, before Senate committees, General Sarnoff again made this proposal. The plan was greeted with enthusiasm by government officials, public-spirited citizens, and educators, but no directly related action was forthcoming from government, industry, or education.

Four years later, on January 28, 1962, General

Sarnoff again presented his plan in an article in *This Week* magazine. There was a strong and affirmative reaction in letters and comments from educators, industrialists, and scientists throughout the United States. Encouraged by the enthusiastic response, General Sarnoff decided that the time had come to show by example that the plan could be put into effect. He proposed a pilot program on a one-year basis in a local school system, pointing the way subsequently to broad, nationwide implementation.

General Sarnoff presented the idea to representatives of the New York City Board of Education, with the suggestion that outstanding scientists from his own corporation, RCA, might willingly volunteer as teachers in the first experiment, to be conducted in a group of New York schools. After many meetings and discussions between the school authorities and RCA rep-

representatives, unanimous agreement was reached that RCA and the New York City school system would formulate a comprehensive pilot program, which would be known as the David Sarnoff Industry-Science Teaching Program and which would be undertaken during the 1962-63 school year.

The Program was announced to the general public at a press conference held at the Board of Education's headquarters in Brooklyn on September 27, 1962. The first lectures were delivered at Midwood High School and Erasmus Hall High School on October 15, 1962.

For the past few months, exciting educational events such as the following have been taking place in the various schools associated with the Program:

At Midwood High School, RCA Senior Engineer Dr. Gary D. Gordon, who has been working on temperature control on satellites, explained to a group of students phenomena such as radiation belts and how the RCA-developed Tiros weather satellites are doing yeomen work in spotting storms through TV pictures sent back from satellite to earth.

At Erasmus Hall High School, as part of his classroom lecture, Dr. T. Todd Reboul, Senior Engineer with the RCA Astro-Electronics Division, demonstrated with slides and equipment the principles of space propulsion.

At Andries Hudde Junior High School, scientist Dr. Donald McCoy, with equipment used in experiments at the RCA Laboratories in Princeton, New Jersey, introduced students to the mysteries of sound waves.

And at Ditmas Junior High School, RCA scientist Benjamin Rabinovici, using demonstration aids such as liquid nitrogen, told 50 students from grades 7 through 9 how low temperatures are artificially produced, what discoveries have been made at low temperatures, and other salient features of cryogenics.

Continuing through the 1962-63 school year, 51 such lecture-demonstrations by RCA scientists will be given in these four Brooklyn schools on such up-to-the-minute scientific subjects as Electron Tubes, Television Principles, Radar and Microwaves, Communications Theory and Systems, Solid State Physics, Nuclear Physics, Energy Conversion, Computers and Data Processing, and Practical Problem Solving, in addition to Space Technology, Cryogenics, and Acoustics.

The nature and objectives of the program are to demonstrate the possibility of increasing student interest in science studies and science careers through classroom presentations and after-school demonstration lectures by scientists and engineers from industry. The role of the industrial participants is to project the present and future horizons of science and technology in their individual fields of specialization.

PRESIDENT KENNEDY

On The Need For Technical Studies

— *From President Kennedy's Press Conference, December 12, 1962*

Q — I wonder what your reaction is to a program in some of the New York City schools, where scientists from private industry, I believe at Gen. Sarnoff's suggestion, are going into classrooms and giving lectures and demonstrations with the object of encouraging scientific careers?

THE PRESIDENT: I think it would be useful, because I think motivation is one of the problems. In addition, lack of funds is the problem to which the committee just addressed itself. We are going to have a big shortage of engineers, mathematicians, scientists, and a good many of these men who would have the potential cannot afford the doctorate studies. It will require an investment by the Federal Government, but the kind of program which provides motivation you talked about will be very useful.

In one phase of the Program, these presentations are related directly to the curriculum so that they will enrich the normal teaching pattern. In another phase, they comprise a broader, more extensive series of after-school demonstration lectures so that they will create a general view of the excitement and promise of technological progress.

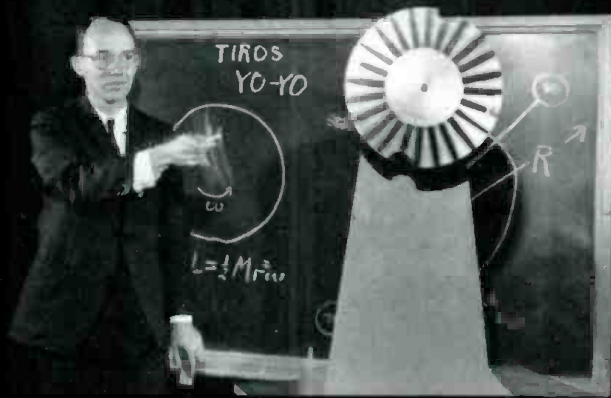
At all times, there is a close cooperation between the teachers and the industry scientists, all of whom have freely volunteered their time.

In preparation for his classroom presentation, the RCA scientist meets in advance with the classroom teacher for an exchange of ideas. This ensures a close relationship between the curriculum material and the enrichment lecture presented by the scientist.

In preparation for the after-school demonstration lectures, open to faculty as well as students, advance discussions are held by the selected representative of the school's science faculty and the RCA scientist in order to ensure that the level of the presentation is appropriate to the students attending.

In both classroom and after-school seminars, time is allowed after the presentation for questions and discussion between students and the guest scientist.

One of the attractive features of the Program is that in these times of rising school costs, the Program



RCA's Dr. Gary Gordon indicates one method of reducing the spin-rate of a satellite in space before science students.



RCA Senior Staff Scientist Benjamin Rabinovici demonstrates effects of cryogenics on various objects — in this particular case a frozen hot dog.



Illustrating the effects of artificially-produced low temperatures, Rabinovici immerses hot dog into jug of liquid nitrogen.

involves no cost to the New York City school system. The fourteen outstanding scientists and engineers from seven RCA operating divisions donate their services and provide their own demonstrations.

The classroom enrichment program involves 15 lectures by the RCA specialists, each given at a time when the related subject is being taught in the regular curriculum. Seven of these are given in one general science class at Andries Hudde Junior High School, and eight are given in a twelfth-year physics class at Midwood High School.

The after-school "seminar" program is presented on an approximately bi-weekly schedule through the year. Eighteen are given at Erasmus Hall High School to a selected group of approximately 50 average eleventh-year chemistry students. Eighteen are also given at Ditmas Junior High School to a selected group of approximately 50 "good average" students from seventh to ninth-grade classes.

At the end of the 1962-63 school year, the results of the pilot program will be evaluated by the Office of Science Education and the Bureau of Educational Research of the New York City school system, to determine whether more students than in normal years elect to continue science studies as a result of extra stimulation provided by the Program. An evaluation will also be made of the demonstration equipment devised by the RCA participants for specific use in the program, with a view to its value for continued and more general use in schools.

Since the program was announced last autumn, there has been widespread favorable comment on the aims and objectives of the pioneering venture. The *Washington Post* called it "an industrialist's dream of taking the excitement and adventure of science from the laboratory into the classroom." The *Christian Science Monitor* noted that "without cost to the school system, since the salaries of the scientists are to be paid by industry, this pioneer project seeks to meet head-on the threatened shortage of scientists in this country by an early seeking of youthful ability and enthusiasm." The *New York Journal-American* observed that "the vast, untapped teaching potential of private industry's skilled scientists is being employed in a Brooklyn pilot project aimed at overcoming Russia's lead in scientific education."

The *New York Mirror* stated: "The program is a tribute to the civic-mindedness and farsightedness of RCA Chairman David Sarnoff who developed the plan over a six-year period. It can set a pattern of closer cooperation between the rich scientific resources of industry and the schools that could be a blueprint for educational systems in other major areas of the country." ■

Maestro Arturo Toscanini



Toscanini and Eddie Cantor were typical of 8-H's parade of artists, personalities.

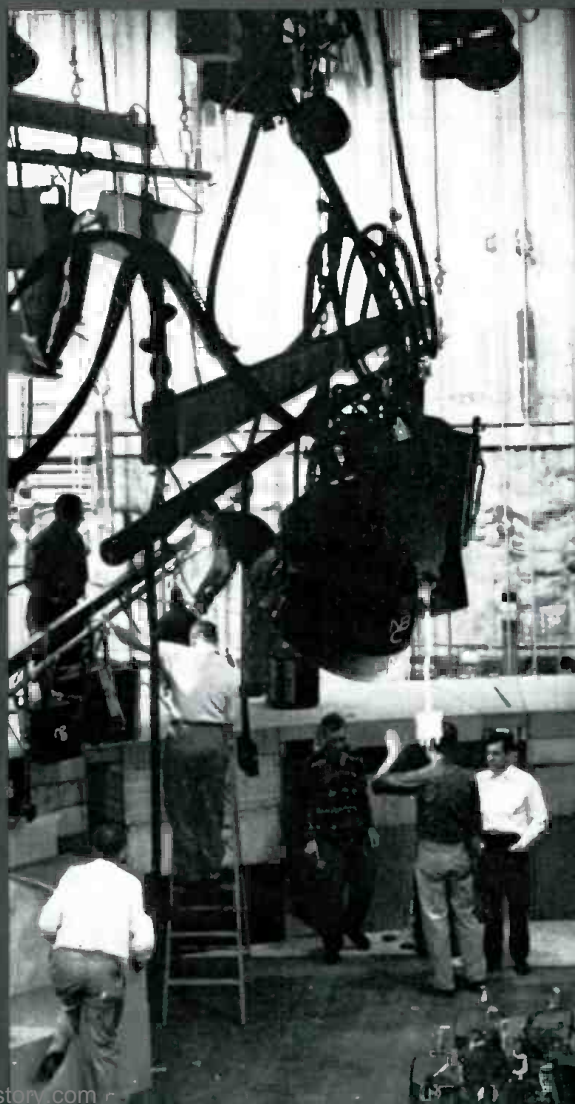
NBC's STUDIO 8-H GOES TO COLOR

WHEN THE CURTAIN went up recently in the new Peacock Theatre – the new cognomen for Studio 8-H – in NBC's New York studios in the RCA Building, the event marked another major milestone for one of the world's best-known broadcasting sites. This time the famous studio was rebuilt primarily for color TV programming. The renovation commenced last May and was completed in October, 1962.

The 29-year-old studio (10,000 square feet in area and three stories in height) had earned fame as point of origin for topflight radio shows. Now, in its latest transformation, the studio represents an ultra-modern addition to the NBC-TV Network's color facilities.

Its novel audience seating facilities accommodate several hundred people. Retractable and operated by push-button control, the ten tiers of seats can be withdrawn for programs requiring full use of the studio floor, and extended when a studio audience is required. And for the occupants of the seats, 30 loudspeakers and six 21-inch color television monitors are mechanically lowered from the ceiling. ■

Peacock Theatre lights provide better than 60 watts per square foot intensity.

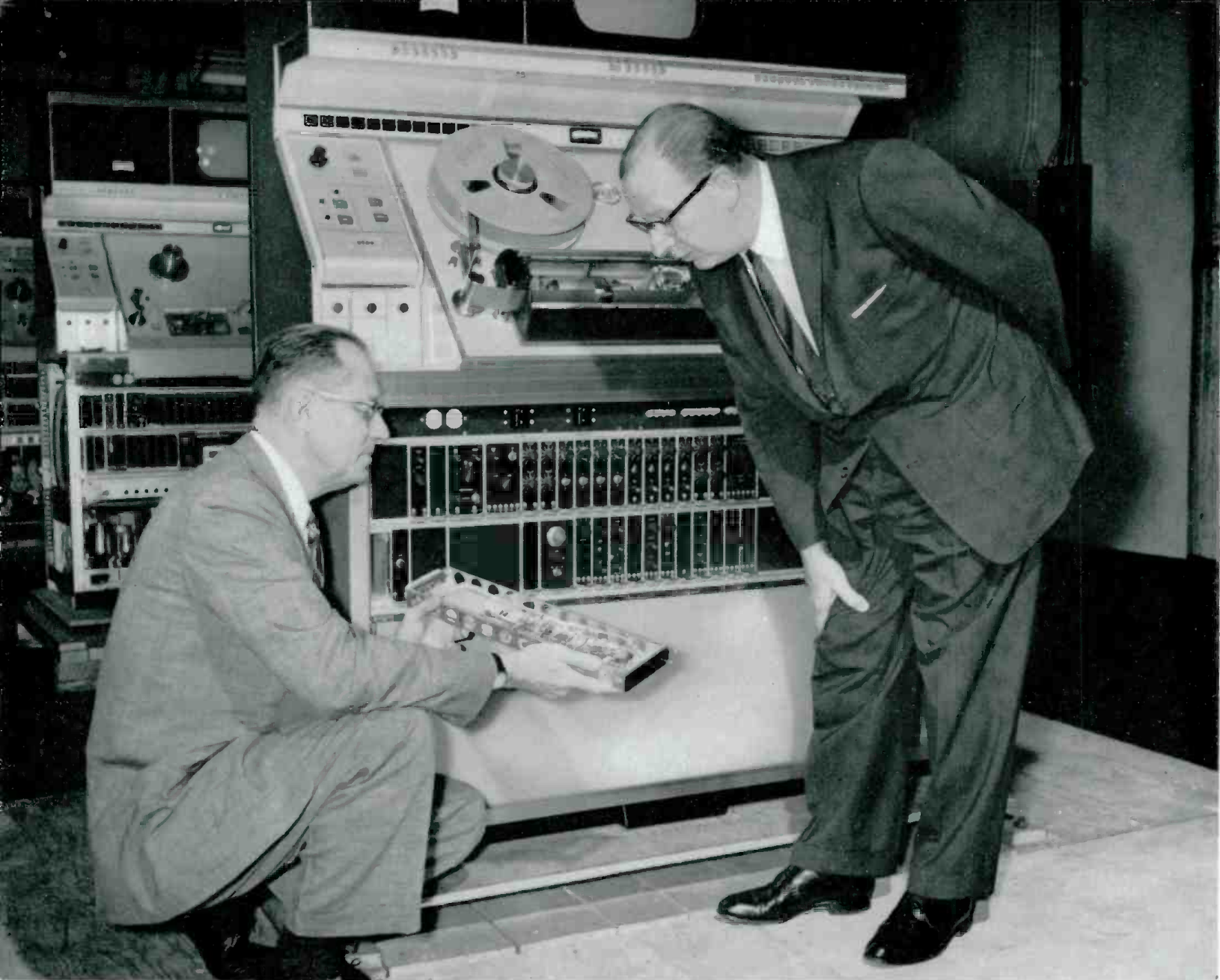


Everything from staged boxing matches (right) to last year's election returns (below) are part of the transformed studio's glamor. Commenting on the theater, William H. Trevarthen, NBC Vice President, Operations and Engineering, said "Every inch of the studio is utilized . . . Peacock Theatre will be as contemporary 10 years from now as it is today." Studio 8-H comes of age.



Control room boasts 21 television monitors.

Radio's Rudy Vallee crooned from 8-H.



Electronics' *TINY TITANS*

*Transistors and their solid-state relatives
are serving everywhere from automobiles to missiles*

IN A CAREER that has radically altered the shape and direction of a major segment of the electronics industry, the tiny transistor and its diminutive solid-state cousins are exerting ever increasing impact on America's scientific frontiers.

Satellite communications, control systems for rockets and missiles, miniature two-way radios that

can be held in one hand, electronic systems for computers, aircraft and manufacturing are some of the newer areas that owe their existence to the "little ones" of the semiconductor family.

These wonder-working devices for controlling and amplifying electrical signals supply a composite of needs — small size, high speed, dependable perform-

Frank Marx (left), President, ABC Engineers, and Charles H. Colledge, Vice President, Broadcast and Communications Products Division, RCA, examine module of RCA's TR-22 completely transistorized television tape recorder.

ance, long life, low-power requirements, cool operation and ruggedness.

Every day more and more applications can be found.

One of the latest is in consumer products, from automobiles to washing machines. Add, also, home heating and cooling systems, electronic organs, transistorized pianos, high-fidelity and stereo instruments, home lighting controls, and even wrist watches.

This inviting prospect has been anticipated by such companies as the Radio Corporation of America, which has pioneered in developing and producing transistors and other semiconductor devices, and was the first to make transistors for the home entertainment field.

RCA has contributed extensively to advances in solid-state technology, providing one of the broadest lines of military, industrial, and consumer-product type transistors, diodes and rectifiers. Its semiconductor devices are in wide use in space electronics, meeting requirements of radiation resistance, wide-temperature variation, and high-frequency operation. It has introduced tiny memory devices based on the new microferrite technology, paving the way for more economical production of high-speed computers, and its tunnel diodes have permitted a substantial increase in the speed of computer logic circuits.

Power transistors, developed and produced by RCA, have made possible the introduction of all-transistor high-fidelity phonographs with low distortion and extended frequency response.

Well over 100,000,000 consumer transistors and rectifiers made by RCA are now in field use, with unprecedented reliability evidenced by a failure rate averaging less than .01 per cent per year.

The consumer products constitute a rapidly growing market for semiconductor devices. A recent major addition is that of the automotive industry, producing new cars at the rate of some six million a year. This soon may become the largest single market for transistors.

As early as 1955, automobile manufacturers took note of the increasing use of transistors in portable radios and hearing aids. In those areas, they recognized, compactness and low operational cost more than compensated for higher initial costs. Higher initial costs, however, were considered prohibitive for automobile radios, and the introduction of transistorized radios as original equipment in new cars was accordingly postponed by Detroit.

Nevertheless, the RCA Semiconductor and Materials Division, a veteran manufacturer of transistors for consumer products, went ahead with plans to serve the automotive market.

At the Division's applications laboratory, scientists

began researching the possibilities of designing and producing low-cost transistors to meet precisely the requirements of car radios. This approach was destined to have important effects.

Transistors and other semiconductors were introduced into AM car radios literally one at a time on a stage-by-stage basis. The first step was the use of a power transistor in the output stage. Next, a semiconductor diode replaced a second-detection rectifier, and the driver stage was replaced by an audio transistor. The result was the "hybrid" set, so called because only the output and audio-driver stages were transistorized.

Detroit automobile manufacturers became one of RCA's largest markets for consumer transistors. And in 1959, the RCA Semiconductor and Materials Division opened the nation's first transistor plant devoted wholly to the manufacture of transistors for consumer applications. The plant, at Findlay, Ohio, has since increased production 650 per cent.

Fully-transistorized automobile radio receivers became practical following the development of "drift-field" transistors for the converter and RF stages. These new transistors were first commercially introduced in 1959 by RCA, together with complete design for a five-transistor AM car radio. Fully transistorized car radios were adopted by all major car manufacturers for the 1963 model year.

Among the advantages of this fully-transistorized radio are instant play; far lower power drain on the car battery; performance free of microphonics; and the greater reliability and ruggedness associated with transistor circuitry.

With the successful transistorization of the AM car radio, the automotive industry began to employ transistors and other semiconductors in other automotive equipment. Alternators, using solid-state rectifiers, are replacing generators as standard equipment on new cars. They permit a battery to keep charging even at idling speeds. And transistorized ignition is offered as an optional item in certain 1963 cars.

Within five years, a new car will employ up to 30 semiconductors, including 17 transistors, according to Dr. A. M. Glover, Vice President and General Manager of the RCA Semiconductor and Materials Division. These units will serve an AM-FM radio that will succeed the present AM set, the ignition system, the alternator, the regulator, windshield wiper controls, and automatic highway-cruising equipment.

"We expect the automotive market to be one of the largest markets for transistors specially designed for consumer application," Dr. Glover says.

In addition, there are many other growing consumer markets for transistors right now.



Musical electronic organs represent another new market for consumer transistors. This Allen home organ's circuitry uses 500 transistors.

In October, 1960, a watch company introduced the first transistorized wristwatch. More than 100,000 such movements have since been manufactured. This electronic watch employs a precision tuning fork as a time standard. A single transistor drives the tuning fork and controls the amplitude of the fork's vibrations. Power is supplied by a button-size 1.3 volt mercury cell that lasts a year.

Musical electronic organs represent another new market for consumer transistors. Size, weight, heat, and power reductions possible only with transistors are significant. Sales are now running in excess of 100,000 units annually, of which 90,000 are for family use.

One organ company began the transistorization of its high-quality organs in 1959. Today it offers five-year guarantees on all its models, ranging in price from \$1,200 to more than \$50,000. Small models employ up to 100 transistors, while the largest models, custom-built for churches, require more than 3,000 transistors each. Tone generation is 100 per cent transistorized.

In December of this year, another big company

demonstrated an automatic home washing machine, employing semiconductor controls. Used in the new washer are semiconductors that make possible an infinite number of agitation and spin speeds within the range of all laundering requirements. The tiny controls are encased in a black box that can be held in the palm of a hand.

Transistorized light dimmers are already available for home use. These permit the housewife to "Dial" the amount of light she prefers.

"Complete transistorization of all TV sets and stereo phonographs will come gradually as we find out how to do it less expensively," says W. Walter Watts, Group Executive Vice President of RCA.

Recently, transistors have moved into another home entertainment unit, the tape cartridge recorder. RCA Victor's 13-pound, all-stereo tape cartridge recorder features a transistorized amplifier.

In the years ahead, bigger and bigger roles can be anticipated for the tiny transistor and its little solid-state relatives, bringing about important improvements in products and services and opening wide new vistas for the entire electronics industry.

**A report on the development
of radar tracking**

BATS TO BMEWS

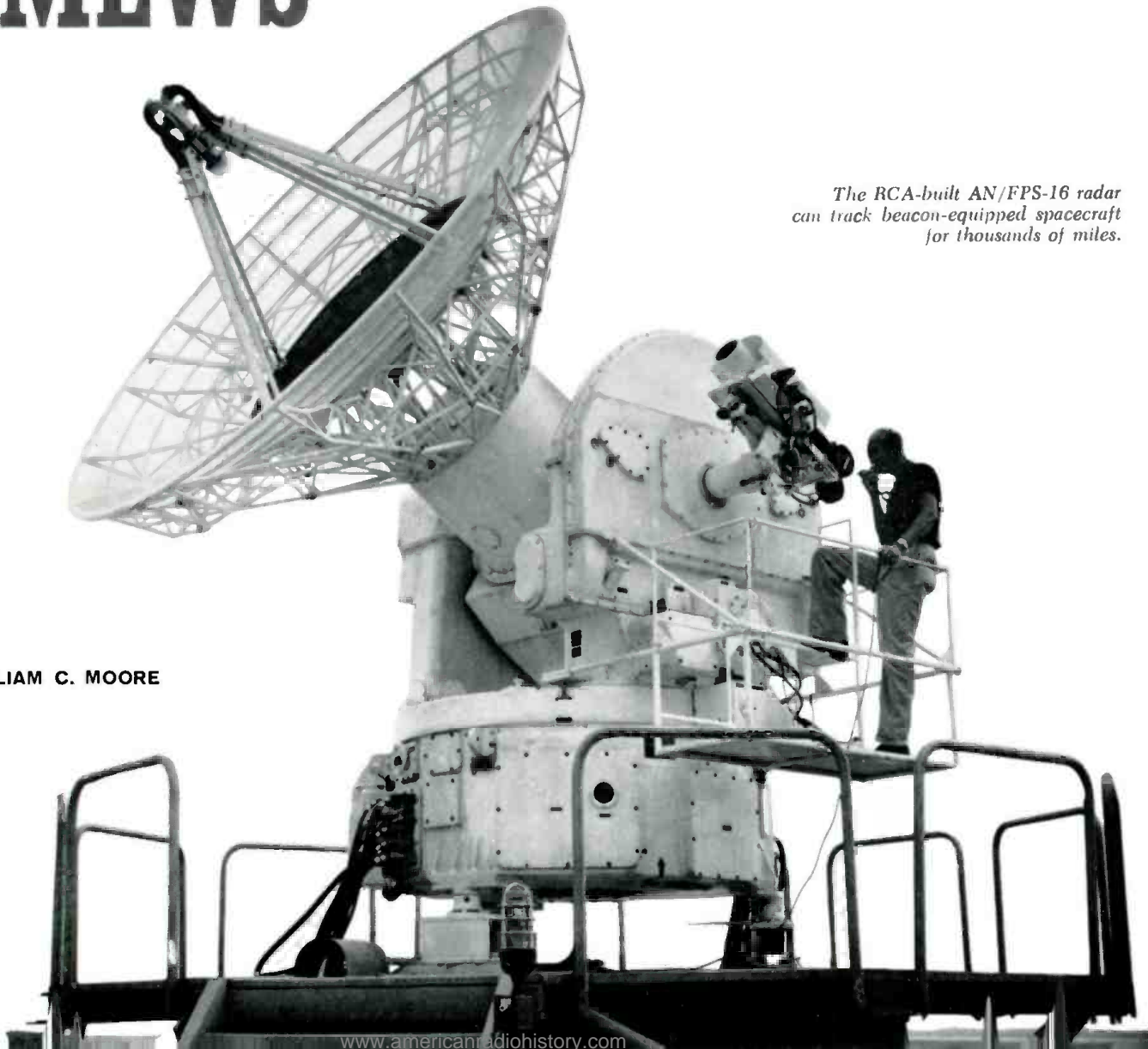
EVERY TIME an astronaut orbits the earth, an ICBM is fired on the test ranges, or a spacecraft is launched toward the moon or a planet, their exact location from the moment of launching is pinpointed by radar tracking.

Today, tracking means radar. But it wasn't always so. Until about three decades ago, tracking had to be done by means of conventional optical systems and crude sound tracking devices. In 1935, the British Air Ministry started a program that was destined, a few years later, to turn the tide of the Battle of Britain—the installation of low-frequency radars along the coast of Britain. These radars overcame the advantage of surprise traditionally belonging to the attacker and permitted the deployment to the right place at the right time of 700 British fighter aircraft in the defense of the island against 2,000 German bombers.

These CHAIN radars, as they were called, were

*The RCA-built AN/FPS-16 radar
can track beacon-equipped spacecraft
for thousands of miles.*

by **WILLIAM C. MOORE**



crude affairs that achieved bearings on their targets by triangulation between the various radar installations. The biggest drawback of the CHAIN radars was the very low frequencies in which they operated, requiring antennas so big and of such configuration that they could not be rotated to obtain target bearings.

The exigencies of war demanded better systems, and the breakthrough came with the development of the cavity magnetron, which had the then-amazing ability to put out signals of 3,000 million cycles at peak powers as high as 20 kilowatts. It had the most decisive effect on the outcome of World War II of any single scientific device evolved during the war, the atomic bomb not excluded. The magnetron, which was small in size, produced radars that could be placed in aircraft, and its microwave frequency gave radar excellent accuracy and resolution.

Microwave radar was a major contributor to Allied victory in the Battle of the Atlantic, where it effectively located submarines while they charged their batteries on the surface under cover of fog and darkness. Radar fought the V-1 "Buzz Bomb" threat by precisely directing the fire of gun batteries set up on England's coast; the first radar ballistic missile early warning system was built during World War II in Holland to track V-2 rockets in their flight to British cities, establish their trajectories, compute their launch points, and send Allied bombers to destroy these points.

While the old CHAIN radars could detect and track the attacking *Luftwaffe* with a margin of error of a few miles, today's electronic tracking looks into the far reaches of space with astonishing precision and reliability. Instrumentation radars today can track into space an object the size of a bomber 4,000 miles or better with directional accuracies of a few thousandths of a degree and range accuracy of five yards, and they can track beacon-equipped targets to planetary distances with accuracies on the order of one-half mile.

Accurate tracking of the pioneers of the space age — the captured V-2s, the WAC-Corporals, and other forerunners of today's million-pound thrust rockets — began with a leftover gun-laying radar of World War II, the Army's SCR-584, which has been described as the DC-3 of radar. The first V-2 flight in this country was faithfully tracked by a "584" as the rocket veered off course and plunged to the ground ten miles away. In modified versions, this radar became the backbone of radar range instrumentation at the Atlantic Missile Range in the early days of this complex, as well as at the White Sands Proving Ground and other missile test sites. It is still in use today.

The best modifications of the conical scanning

Locally, Nature's Still Ahead

The first tracking radar system to be developed on earth is still one of the most efficient. It is a highly sophisticated radar which has the ability both to search for targets and to track them. It employs such advanced techniques as pulses that increase in number as the target draws nearer, and it uses one type of pulse for searching and switches to another for tracking. It also features a computer that can analyze to a surprising degree the shape and composition of the target. It is the most effective very-short-range radar in existence.

Unfortunately, this tracking system belongs to the bat, and man has not been able to duplicate it.

However, while the bat still leads man in precision tracking at very short ranges, man is way ahead in long-range tracking. He is reaching to the edges of the solar system with his ability to follow and locate space probes. And he is doing it with remarkable accuracy, considering the distances involved.

SCR-584 had effective ranges of only about 200 miles, and accuracy at this range averaged 2500 feet. As missiles flew farther and faster and required greater precision to evaluate their performance, the need arose for a new radar designed specifically for such work. The radar that did the job was the famous AN/FPS-16 series, which was built by RCA's Missile and Surface Radar Division at Moorestown, N.J.

The engineers who designed and built the AN/FPS-16 say, with more truth than humor, that if a ballplayer in Yankee Stadium hit a fly ball high enough, the "16" would tell them from Moorestown — about 80 miles away — if it were fair or foul. Range accuracy of the new radar was an unheard-of five yards or less, and the accuracy of its azimuth and elevation bearings was 0.1 mile — about five thousandths of a degree. Modified versions of this radar have ranges of thousands of miles when tracking beacon-equipped spacecraft.

The one feature which more than any other earned the AN/FPS-16 the title of the world's most accurate radar was the use of monopulse techniques in place of the old conical scanning beam. The beam of the AN/FPS-16 is actually four beams slightly offset from each other emanating from the same antenna. By automatically comparing the relationship among the



Four of these giant antenna reflectors at the Thule, Greenland, BMEWS site provide data on missile speed, trajectory and impact area.

beams as they return from the target, the radar can get accurate target information from a single pulse of energy instead of the many pulses required by the conical scanning technique. Perfected by RCA in the Bumble-bee and Terrier land-based missile programs, the monopulse system is used today by most of our instrumentation radars.

Sixty AN/FPS-16 series radars have been installed in world-wide locations from Grand Bahama to Australia, but they are now being followed by an offspring: the new AN/FPQ-6 series, which has even greater accuracy and the capability of tracking to lunar distances and beyond. Known as "MIPIR," for Missile Precision Instrumentation Radar, two of these instruments have been installed at Antigua Island and Cape Canaveral and seven more are being built at RCA's Moorestown plant.

While the AN/FPS-16 was tracking missiles and satellites around the world, experiments were going on to produce radars that would reach out into space and track "non-cooperative" targets — those launched by someone else and not carrying the range-stretching beacons that emit signals to aid the trackers on the ground. To extend the radar range, engineers used the newly discovered capabilities of the power tube known as the klystron to pump millions of watts of peak power onto huge antennas. These giant "dishes,"

moving with startling smoothness and precision, make use of the fact that at any given frequency as the antenna is made bigger the radar beam becomes narrower and the available radar energy becomes more concentrated.

One of the first successful applications of this approach was a radar built by the Massachusetts Institute of Technology's Lincoln Laboratories on Millstone Hill near Boston. The Millstone radar uses a moving antenna 84 feet in diameter — the equivalent, rim to rim, of an 8-story building. It radiates two and one-half million watts of peak power at 440 megacycles and can track a sphere about three feet in diameter 3,600 miles into space. It has received radar data from such targets as Venus, 28 million miles away.

From a military standpoint, of greatest importance was Millstone's ability to track objects similar in size to missile warheads over ballistic trajectories. The knowledge gained from this radar was quickly pressed into service in the design and construction of the AN/FPS-49, the tracking radar for the Ballistic Missile Early Warning System. Also using an 84-foot antenna and a frequency similar to the Millstone radar, the AN/FPS-49 has greater power and uses monopulse techniques and other refinements to give it increased accuracy. A test model of this giant radar, covered with a 140-foot ball of fiber glass and paper capable

of withstanding 180-mile per hour winds, was installed at RCA's Moorestown facility, another is in operation in Thule, Greenland, as part of our warning system against missile attack, and three more will go into operation in Fylingdales Moor in England during 1963 to complete our northern missile warning coverage.

From a military viewpoint, there is urgent need for ever-broader radar capability to permit not only the precise locating and tracking of a ballistic object so that its launch and impact points may be predicted, but accurate information on the details about the shape of the object, its size, what it is made of, its attitude, and — most important — if the object is a true warhead or a decoy. All this information about the object is wanted at the same time. A new radar, called TRADEX for Target Resolution and Discrimination Experiments, has been built by RCA and installed on Roi-Namur in Kwajalein Atoll to tackle the demanding task of giving radar this capability.

The ultra-sophisticated TRADEX, in essence a huge laboratory instrument, is looking at radar echoes from a variety of objects in ballistic and orbital trajectories to determine those echo characteristics which will reveal the desired facts about the object. To do this, it performs such ingenious operations as transmitting on two frequencies a thousand megacycles apart using the same 84-foot antenna at the same time, ranging on multiple targets at the same time, and recording its radar returns on magnetic tape which zips through the recorder at sixty miles per hour. To ensure its precision, 2,000 tons of concrete were poured into the coral island in order to build a stable platform for the antenna pedestal.

While this subtlety and sophistication is essential to the success of today's tracking systems, which must follow basketball-size objects traveling through near space at thousands of miles per hour while figuring out what the objects are made of, it does not answer the problem of tracking spacecraft to the far reaches of the solar system. To do this, science has again called on a simple radar axiom. Increased range and sensitivity are obtained — for example, by the Millstone and AN/FPS-49 radars — by higher power and by increasing antenna size for a given frequency. But another feature is equally important in radar gain. As frequency for a given antenna size is increased, the range is also increased. And if the power, antenna size, and frequency are increased, the radar begins to reach far out to the edges of this solar system into which we are effectively walled for the time being by the sun's gravity.

Radars capable of using this technique had to wait, however, for sources of higher power at higher radar frequencies. These sources are now becoming avail-

able in amazingly small packages. Today, it is possible to get fifty thousand watts of power continuously — as much as the highest powered broadcast stations — from klystron tubes small enough to hold in one hand. Moreover, this power is being obtained at frequencies twenty-five times those used by Millstone and the AN/FPS-49. Klystrons producing twice again this power are a year or less away, and by paralleling these, radar power thought impossible a few years ago can be achieved.

A radar that will make use of these techniques and take the first long leap toward Pluto's orbit is now under construction half a mile from the famous Millstone installation. It is the Haystack Hill radar, being built by MIT's Lincoln Laboratories. This monster-size radar has a moveable antenna 120 feet in diameter — over a quarter of an acre — and the frequency of its beam will be on the order of ten thousand million cycles. Considering the use of a klystron producing only 20 kilowatts of average power and peak power of three million watts, this radar would be able to track a one-square-meter target (about the equivalent of a three-foot diameter sphere) 28,000 miles. It could track a corner reflector with one-square-meter sides 220,000 miles, and if the spacecraft carried a beacon, Haystack would follow it for 2.6 billion miles — to the orbit of Neptune.

Is man approaching the limit of electronic tracking using radar techniques? Many scientists feel that while we may be approaching the limit, we have not yet reached it. They point out that in the seventeen years since the SCR-584 first began tracking missiles, science has increased the sensitivity of tracking radars by a factor of 100 million. Using current knowledge, it is now possible to build a 400-foot diameter radar dish, reflect two million watts of average power from it at a frequency of about 3,000 million cycles, and get an increase in system sensitivity one million times greater than the Haystack radar. But this road leads only so far, because every time science tries to reach the requirement of ranges ten times farther than its last best effort, it must increase the radar system's sensitivity ten thousand times.

However, there are other forks in the road that can be taken to stretch radar's capability even further. Those plots of earth paved with electronics called phased arrays — with their 10,000 tubes and transistors and ten million total parts — may eliminate the problem of designing and moving huge bulks of radar antenna.

All this adds up to the fact that the day is not too far distant when radar tracking, now only one order of magnitude away from the resolution of the eye, will see the periphery of the solar system. ■

Electromechanics Multilingual Typesetter

*Gutenberg's invention
has evolved
into a computer system
that can set type
electronically
in every language
including Chinese*



JOHANN GUTENBERG'S monumental invention in the mid-1400s might have elicited an Oriental sort of ho-hum from a knowledgeable citizen of China.

Any Western schoolboy could describe the impetus that Gutenberg's invention of movable type gave to mass literacy for half the world. But the idea was already ancient in China when Gutenberg introduced it in Germany. The history books say that printing with movable, re-usable type was known in China as early as 1041.

Its Oriental impact, however, was minimal. The Chinese simply couldn't see much good in the idea; what was the advantage of a separate bit of metal for each character in a language that had thousands of characters? Applied to the limited alphabet of the West, of course, movable type — as distinguished from its predecessor block prints — permitted swift and economical printing.

It was not until the 19th century that the Chinese, employing a simplified set of ideographs, commenced any extensive use of movable type. And by that time the West was ready with another giant typographical stride — the invention of the linotype.

Now, half a century later, the ease that the linotype provided in printing Western languages is being duplicated for the Chinese tongue. And not only that — in the printing of Western languages modern technology is moving forward into an era of automatic typesetting systems built around electronic computers to speed the production of newspapers. One such system, using an RCA 301, has just gone into operation at the *Los Angeles Times*, and another is beginning to function at the *Palm Beach (Florida) Post-Times*.

The program will be made available through RCA to other newspapers in the United States and overseas. Otis Booth, Operating Director of the *Los Angeles Times*, predicted that the computer "would become as necessary a piece of equipment in tomorrow's newspaper offices as the typewriter and rotary press are today." At the *Palm Beach Post-Times*, 150 newspaper executives attended a two-day seminar on computerized typesetting.

No longer do such technological advances come from one curious man pattering around a shop. Today the source is a research and engineering team. In the case of the Chinese printer, for example, it is a Radio Corporation of America group operating under a U.S. Army contract. The team is well on its way to perfecting the world's first practical typesetting machine for the Chinese language.

Let your mind make a brief visit to two American print shops to visualize the impact this device might have:

- The first is the kind of place Mark Twain might

have worked in. A man, a small metal tray in his hand, stands before a drawer opened out from a large chest. The drawer is divided into compartments, each containing a pile of letters, numbers or punctuation marks. Deftly, the man picks out the sliver of metal he wants, one after another until he has filled out a line of pre-determined width. He goes on to the next line. His fingers dart swiftly, but the pieces of type are tiny and all too susceptible to a jumbling slip.

• The second print shop is in a modern newspaper. Linotype machines, each with a curved metal arm that has a grotesquely alive appearance, stand in rows. In front of each sits a man, his fingers lightly stroking a typewriter-like keyboard. Each stroke drops a tiny metal mold into a line in front of him and, when the line is completed, a molten metal alloy from a bubbling cauldron at the machine's side is squeezed into the string of molds. So, when the process is completed, there is a piece of metal for each line (rather than for each letter as in Mark Twain's shop) and the molds, plucked aloft by that odd-looking arm, are returned once again to the "magazine" in the top of the machine for use again and again.

The second, modern, process is faster and less prone to accident. No longer must a hand pick up each letter. Letters now drop into place as fast as fingers can flick over a keyboard.

But the complex Chinese system of ideographs has resisted this typographical advance, introduced in the West in the decade ending in 1886 by the single-minded endeavors of a brilliant technician named Ottmar Mergenthaler.

By the 19th century, a system was devised to fit the Chinese language into a set of movable type. But there were some 5,000 characters in the typecase of a typical Chinese newspaper, 8,500 or more in a place where more literary documents would be produced.

A far cry from the Western type case of 100 characters or so. And far too many to be crammed as bits of metal into the "magazine" of a linotype.

So the RCA team has gotten away from the mechanical system utilized by Mergenthaler. According to Dr. H. J. Woll, Manager of Applied Research for RCA's Defense Electronic Products, the Chinese language device is, instead, "an electronic system utilizing fiber optics and television techniques."

While pioneering in typesetting of a tongue that has resisted such a technique for thousands of years, the device the RCA team is perfecting will be the beneficiary of dramatic strides that have been made since Mergenthaler in refinement of the linotype.

Mergenthaler's device, it is true, eliminated the tedious process of a hand reaching, one by one, for each letter. But as a keyboard-operated machine it

remained limited to the pace of its human operator. In recent years a step was intruded between operator and machine, permitting the machine to operate at its own optimum pace, utilizing the keyboard talents of any number of vari-paced humans.

Now the operator never saw the linotype. His keyboard instead punched a tape, and the linotype was altered so that it would be activated by the punched tape — at a pre-set pace that bore no relationship to the pace of the man cutting the tape. As a practical matter, a linotype can run consistently at a swifter rate than even the fastest of operators — and so Mergenthaler was gone one better.

And he is now about to be gone one better still. RCA has hooked a 301 computer into the tape punching process. The result is the first successful high-speed use of a computer in setting newspaper type, now in operation at the *Los Angeles Times*. The system saves the tape-cutting human being the time-consuming process of "justifying" lines (making sure that they even up at both ends). The editorial or advertising copy, with all editing changes, is fed into the RCA 301 on a punched tape produced by the human operator as rapidly as he can hit the keys. The computer justifies the lines, hyphenates where necessary, and produces the final tape to insert in the typesetting machine. The result: a 40 to 50 per cent saving in tape-cutting time. A similar system, with some variations, is being put into effect at the *Palm Beach (Fla.) Post-Times*.

The end result, after the tape has activated the linotype, is still a line of metal, of course — which will not be the case in the Chinese typesetting machine. Rather, according to Woll, the device will be capable of reproducing some 10,000 Chinese characters on film. This will be transferred to lithographic plates for offset printing, rather than the letterpress process from a metal plate, that still predominates in the West.

The RCA-developed equipment, Woll explained, will be capable of setting 100 characters a minute — each character representing a word, a phrase or a complete sentence. The device will work from an electronic storage bank rather than the heavy, metal-filled "magazine" of the conventional linotype. Its keyboard will have 41 basic symbols and 11 punctuation marks.

The Army contract calls for delivery of several of these machines, known technically as Ideographic Composing Machines. The machine is being developed at the RCA Applied Research laboratories at Camden, N.J., under the direction of W. R. Isom, Manager of Electromechanics, by a project team headed by Fred E. Shashoua, who already speaks Persian, Arabic and French, besides English, and now is finding it necessary to learn a lot of Chinese. He has



History's first Chinese typesetting machine uses only a 41 symbol keyboard to produce the 10,000 characters of Chinese for printing.

10 men working with him and Chinese linguists as consultants.

"The machine will be operated either manually, by keyboard, or automatically by means of paper tape punched in advance," Shashoua said. "To achieve the 10,000 characters, we have chosen 21 basic strokes — horizontal, vertical, curved, etc. — and 20 complete symbols such as circles, squares and triangles, which in various combinations make up virtually all Chinese characters, just as various combinations of our 26 Arabic letters make up our English words. These basic strokes and symbols, plus 11 punctuation marks, are represented on the keyboard of the machine.

"By a complex arrangement of electronic devices and techniques — including an optical tunnel, fiber optics and television techniques — these codes are transmitted from the keyboard onto a film, from which a lithographic plate is made for offset printing."

An extra advantage: The machine can set the

characters from top to bottom, as employed in the old-style Chinese printing, or from left to right, the more modern format.

The device is the outgrowth of an earlier electro-mechanical model built in 1959 by the Graphic Arts Foundation, Cambridge, Mass., under contract with the Army Quartermaster Corps and the Air Force to determine the practicability of a Chinese language printer.

After engineering tests by the Army at its Quartermaster Research and Engineering Command center, Natick, Mass., and at Fort Bragg, N.C., which confirmed the machine's utility, the Army moved to develop a more refined and faster version of a machine based on electronic principles.

And so the typesetting process that China invented — and rejected — 1,000 years ago is about to come back in a modern, and this time most practical, electronic dress. ■

Combat by Computer



HIGH IN THE BARREN NORTH, in the remote solitude of the polar wastes, invisible radar fans probe the Arctic sky. Back-and-forth with unceasing repetition, they weave their electronic patterns in search of far-distant echoes.

Behind the great radar antennae, each bigger than a football field, broods a fantastic electronic brain. It is an intricate complex of giant computers, designed to snatch any echo from the sky and translate it instantly into a meaningful bit of information.

What caused the echo? Was it an orbiting satellite, passing across the horizon? Was it merely some space debris, left over from a recent launch? Or was it, perhaps, something more sinister . . . ?

Suddenly, the clicking of computers becomes an angry chatter. Not one, or two, but many radar blips are showing on the screen. More and more appear, rising in menacing arcs over the North Pole.

In seconds, the whole defensive intelligence is focussed on what is happening beyond the horizon. These are no errant satellites, or bits of space junk. This is an attack!

Defending forces spring into action at the radar sites of the Ballistic Missile Early Warning System, at headquarters of the North American Air Defense Command at Colorado Springs and of the Strategic Air Command at Omaha. Air crews scramble to put bombers and interceptors in the air. At missile bases, crews with automatic check-out equipment begin the count-down for a retaliatory second strike. In Washington, the Pentagon responds with counter-moves that swiftly would deploy far-flung units of the Army, Navy and Air Force. Everything gears to instant reaction to the approaching threat of annihilation moving across the Arctic wastes.

Everything, that is, except the final action of picking up the red telephone to the White House. For

this is not war. It is not even the beginning of a sneak attack over the North Pole. It is a test raid. Yet only a handful of umpires — and a few electronics engineers with rolls of magnetic tape — know this for sure. They, and they alone, know it is a simulated attack, carefully planned to look like a true combat situation. The defensive forces must presume — until they are told otherwise — that it is the real thing . . . and act accordingly.

This battle will be fought, as others like it are being fought nearly every day, with devastating realism. Day after day, week after week, nameless programmers devise combat situations of diabolical ingenuity and record them on electronic tapes. Any plan of attack which conceivably might occur to an enemy High Command almost certainly has been dreamed up and programmed for computers by the engineers responsible for what they call “evaluation of the Ballistic Missile Early Warning System.”

In each case, a complete sequence of battle is programmed on the tape. So many missiles . . . so many launching sites . . . so many points of converging attack . . . so many targets for the nuclear-tipped warheads presumed to be winging toward the great population centers of Canada and the United States . . . and so many manned aircraft mounting diversionary attacks. High-level missiles are picked up by the BMEWS network, lower-level aircraft by the Air Force Semi-Automatic Ground Environment system called SAGE. Both flash their warnings through separate systems to headquarters of the North American Air Defense Command.

Reduced to electronic impulses, the spurious missile information is fed directly into the forward radar screens at Clear, Alaska, and Thule, Greenland. These, with other radar installations now being built on the Yorkshire moors of England, take the information

and pass it swiftly through the BMEWS complex of computers. If the simulated raid includes enemy aircraft, separate magnetic tapes are fed into the radar screens of the Distant Early Warning Line.

At the BMEWS sites, themselves, the first battery of computers are Radar Data Converters, called RADCON for short. These identify the fictitious missiles, establish their apparent course and velocity, and indicate the magnitude of the presumed threat. In seconds, this information has been passed onward to another BMEWS computer called MIP, for Missile Impact Predictor. MIP calculates rapidly where each enemy missile may be expected to impact, and adds this to the information on numbers and locations of the approaching missiles.

Now the whole package of information is flashed from the advanced radar sites to NORAD headquarters where a Display Information Processor, called DIP, evaluates the missile threat, analyzes the attack, and plots it instantly on a huge translucent map. Bright circles appear on the screen, indicating with terrifying precision the anticipated points of nuclear impact for scores of onrushing rockets.

All of this has taken less than a minute, starting with interception of the first spurious echoes generated by the Checkout Target Simulator.

The battle may end swiftly, or it may go on for hours. In either case, the defensive forces must make quick decisions, and take bold and decisive actions. There is no room for second-guessing. Each time the men and machines must play for keeps, for the contrived situation – however unlikely – is a simulation of what *could* happen if an enemy decided to embark on nuclear war. Moves and counter-moves, actions and counter-actions by each side are noted with icy logic by the computers, which then assess the casualties and evaluate the triumphs – or the goofs – of the defenders.

Although details of the missile test raids are, for obvious reasons, regarded as classified information, it can be said that they represent the combined skills of Air Force tacticians and electronic engineers of the Radio Corporation of America, who service the BMEWS network. The Air Force determines the situation, the RCA engineers reduce it to many thousands of electronic impulses recorded on magnetic tape. Any threat can be simulated, ranging from a modest test of missile or satellite sightings to a full-scale nuclear attack.

When completed, the magnetic tape is fed into the BMEWS radars by an ingenious Checkout Data Processor, also developed by RCA. This flashes the warning signals directly into the radar network, where it appears precisely like an actual raid on this country.

Nevertheless, it is not in war games, alone, that computers play their major role in modern warfare. They have become a vital part of both offensive and defensive weaponry. Indeed, it may be said that warfare, and the defenses against it, have altered so drastically since World War II and the Korean War that the difference between weapons then, and weapons now, is almost as vast as the difference between the long-bow of Agincourt and Crecy and the modern rifle. In the last dozen years, conventional weapons have given way to complex instruments whose capacity to deter attack, or to destroy an enemy, is based on lightning calculations of an electronic 'brain.' As a result, modern warfare – at least, warfare above the scale of jungle patrols and guerilla fighting – has become warfare by computer.

The vast installations of BMEWS and SAGE, each for its separate purpose, are applications of computers intended for defense. Offensive weapons, however, also depend on electronic intelligence. For example, when an inter-continental ballistic missile lifts into space and speeds toward a test target, a miniaturized computer holds it on course with inertial guidance.



Satellites, space junk, or missiles? Computers must decide!

Right now, the rapid acceleration in military uses of electronic computers is indicated by the fact that approximately one-sixth of all expenditures for defense electronics in the coming fiscal year will be for electronic data processing equipment. In terms of money, this means something on the order of \$1.37 billion dollars, up 37% from the previous year. ■



ELECTRONICALLY SPEAKING

VICTORY OVER THE SNIVET

Three new novar type beam power tubes for use in high-efficiency horizontal-deflection amplifier circuits for both VHF and UHF television receivers have signed the death warrant for the "snivet." The "snivet" — one of television's worst villains — is actually the engineers' term for "tearing" of a TV picture.

The new tubes, developed by the RCA Electron Tube Division, have a separate base-pin connection to grid No. 3 to which positive voltage can be applied to minimize interference from "snivets."

In addition, the novar construction of the new tubes, assures exceptionally strong mount support and relatively cool operation.

All this plus the featuring of the RCA-developed "Dark Heater" in the three tubes is more than enough to handle any television "snivet."

DENMARKS "TINY TEN"

A self-contained air-cooled 10 KW amplifier — dubbed the "Tiny Ten" because of its size will be built by RCA's Surface Communications Division for the Royal Danish Air Force.

The nine compact, high-power UHF transmitters on order from Denmark, have a modular design that requires only 18 square feet of floor space and 72 inches of height.

QUIET PLEASE, SUBS AT WORK

Since operational noise is almost as deadly an enemy of a submerged submarine as a depth-charge, the U.S. Navy is constantly seeking to

reduce operational noise in its atomic submarines.

To this end, RCA Surface Communications Division is developing an electronic system to reduce operational noise in submarines.

The project was initiated by the Navy's Bureau of Ships specifically to reduce noise of sea-connected pumps in the power plant of the submarines to decrease the possibility of detection and improve its own listening capability. This is a trick because a submerged submarine is practically one big pump or collection of pumps.

Nevertheless, RCA engineers state the all-electronic noise reduction system reduces submarine pump noise more than 50 per cent.

ELECTRONIC MONEY MACHINE

Two RCA 301 electronic data processing systems are speeding up the handling of claims and printing of checks for the Ohio Bureau of Unemployment Compensation (Columbus, Ohio). In addition, the leasing of the two systems will save the state an estimated \$200,000 in supplies, equipment and personnel. Also, despite the savings in personnel costs, studies have shown that the installation of the computer equipment should not cut down or displace personnel.

TOM THUMB'S TUBES

The latest exciting addition to the growing nuvistor family of Tom Thumb-scale RCA electron tubes is a high-multriode for booster amplifiers of antenna systems.

The tiny, thimble-sized tube (RCA-13CW4), RCA's twelfth commercial nuvistor, features exceptionally high reliability and uniformity of characteristics, very small size, low plate-power requirements and all-metal-and-ceramic construction — all contributing to long and dependable performance.

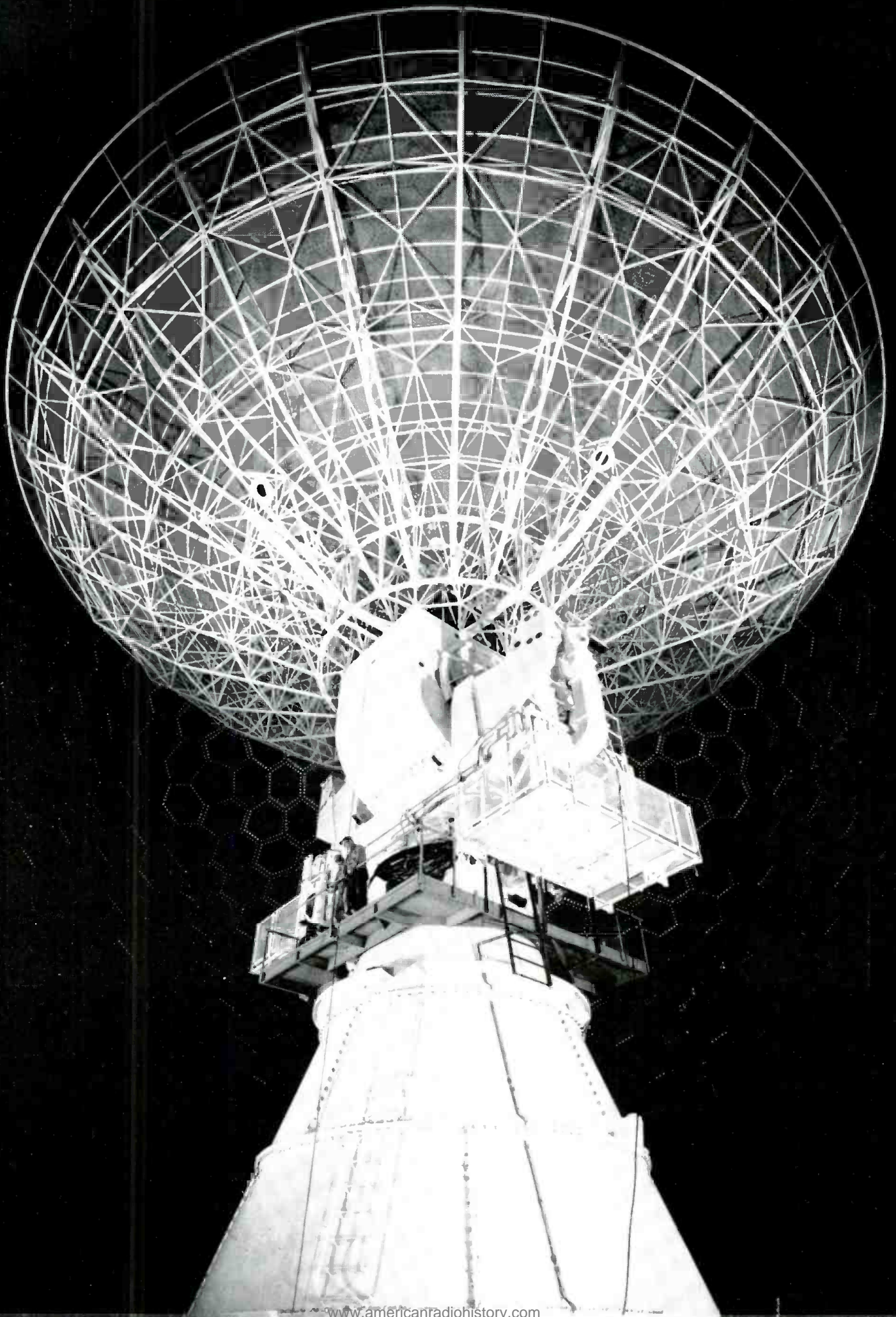
RCA'S SALUDOS AMIGOS

A raft of RCA transmitters, microwave relays and other equipment will be installed soon in Venezuela, giving that South American country the largest inter-connected television network in Latin America and placing 97.5% of Venezuela's population within range of TV signals.

When completed in mid-1963, the network will include 600 miles of inter-connected microwave relays and 900 miles of off-the-air pickups. Altogether, 15 transmitters will be used to blanket all population areas of Venezuela from east to west with television.

In addition to the transmitting stations, microwave systems, and other equipment, Radio Caracas will install its own separate communications system utilizing RCA single sideband and VHF relay equipment.

Studio facilities in Caracas, where all programming will originate, are being expanded by the addition of two large new studios. Right now, Radio Caracas TV broadcasts 15 hours a day with about two-thirds of the program schedule live, the rest on film.



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Total Sound Stereo from a travel case 9 inches thin!



Here comes the band! An exciting concept in compact portables with big, big sound and elegant styling! Lets you take true hi-fi stereo wherever you go!



Floats gently down! New Studiomatic record changer protects your records two ways—on the spindle, in the groove. After 3,000 playings, records still sound fresh and vibrant!



Spreads its "wings"! Four speakers! Two 6½" high diffusion woofers and two 3½" tweeters. You get dramatic bass tones, thrilling highs, tremendous clarity!



Sing along with your favorite records! Now add a professional touch to your parties with this new plug-in microphone that lets you sing along with your records!

and just listen—it's really RCA VICTOR Stereo High-Fidelity!

Never before an RCA Victor portable with so many big-unit features! It has the new RCA Studiomatic four-speed record changer! The identical changer used on the most expensive RCA Victor consoles. It has the same True-Track tone arm, the same "Living Stereo" ceramic pickup with synthetic sap-

phire and diamond styli! Result? Sound that thrills. And gentle changer action that safeguards each subtle nuance of your most loved "classicals" ... and helps them last.

The Mark I, shown above, is priced at \$149.95—manufacturer's nationally advertised price, optional with

dealer. Slightly higher some areas West, South. Prices, specifications subject to change.

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