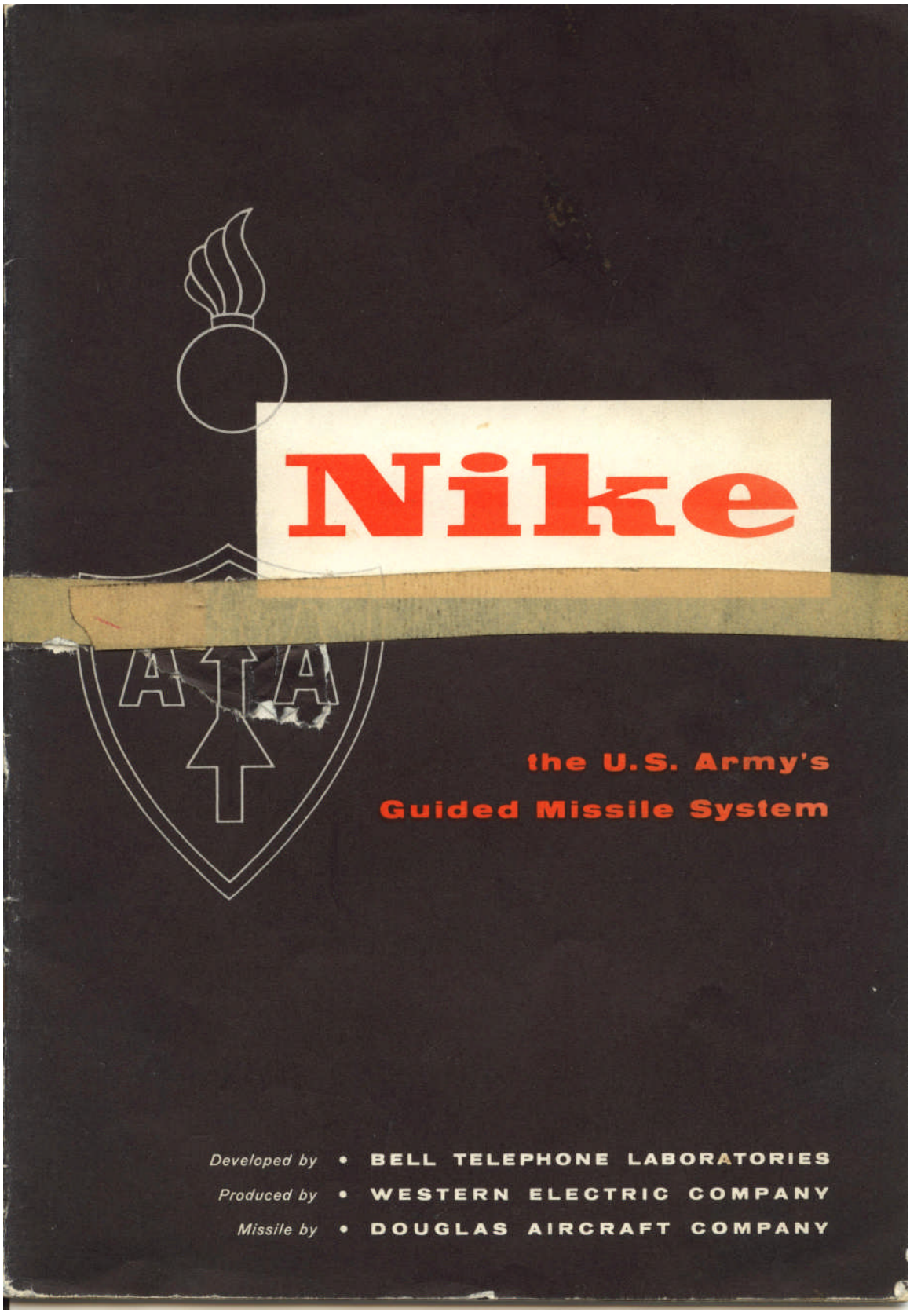
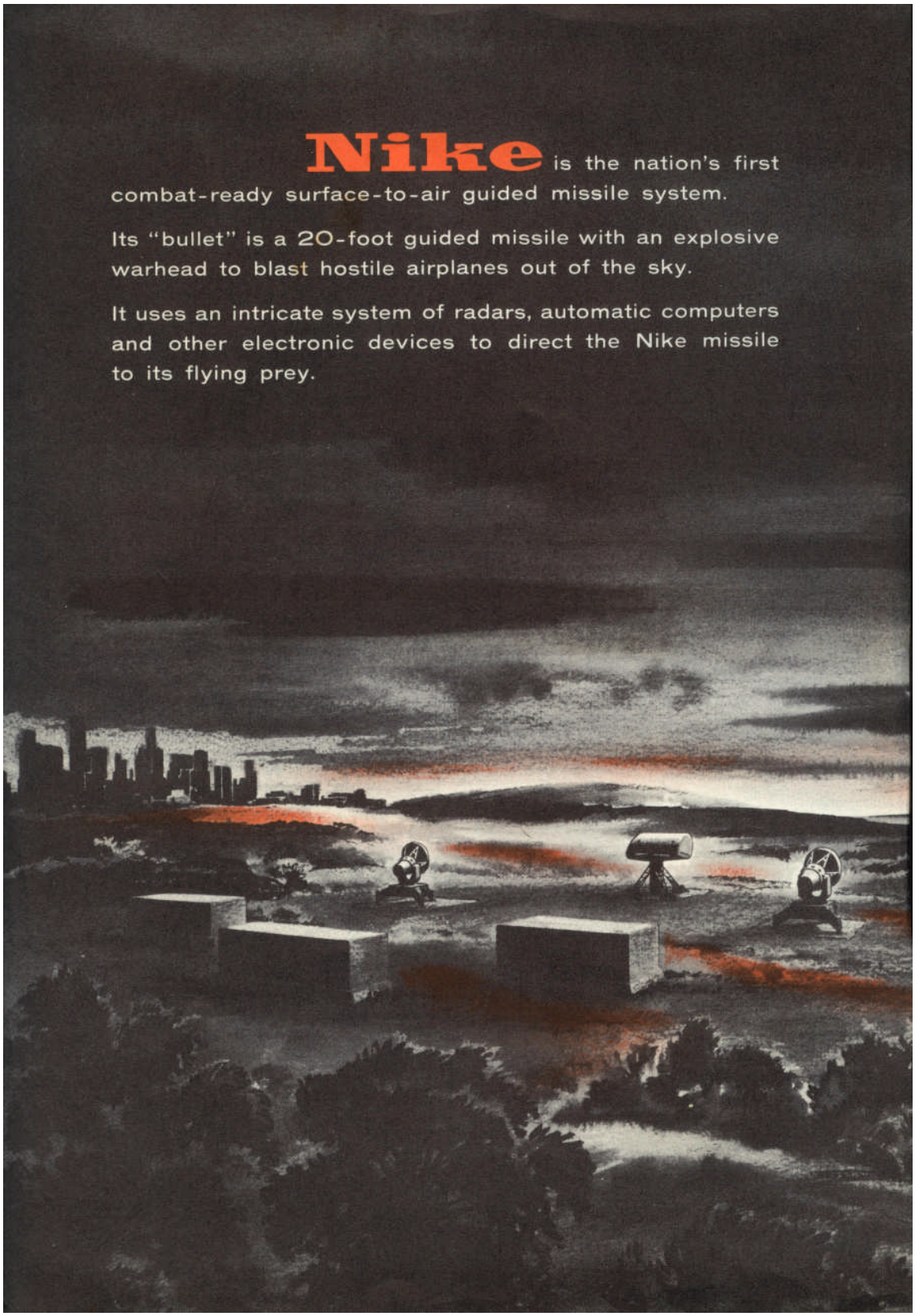
A BOOKLET ON THE CREATION OF THE NIKE AJAX


Nike
the U.S. Army's
Guided Missile System
Developed by • BELL TELEPHONE LABORATORIES
Produced by • WESTERN ELECTRIC COMPANY
Missile by • DOUGLAS AIRCRAFT COMPANY

Nike is the nation's first combat-ready surface-to-air guided missile system.

Its "bullet" is a 20-foot guided missile with an explosive warhead to blast hostile airplanes out of the sky.

It uses an intricate system of radars, automatic computers and other electronic devices to direct the Nike missile to its flying prey.



Named for the winged goddess of victory of ancient mythology

Nike is the United States Army's deadly guided missile anti-aircraft defense weapon – created to destroy enemy planes which might escape the nation's outer defenses and come streaking at supersonic speeds to bomb our homes and factories. On the basis of what is known of the world's aircraft today, no enemy plane can fly so high, so fast, or so evasively that it thereby could escape an intercepting Nike missile.

No longer hidden quite so deeply in the shadows by military secrecy restrictions, Nike is now hailed as one of the truly great defense weapons of all time. It is becoming familiar to more and more Americans as batteries are established on the edges of selected cities and strategic areas. Citizens in numerous localities are getting accustomed to the idea of having Nike batteries ready for action in their municipal backyards.

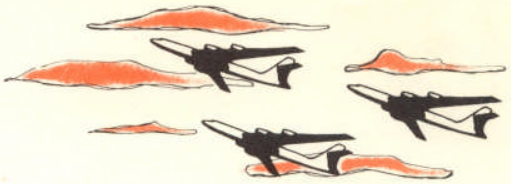
But to many Western Electric and Bell Laboratories people, Nike is not new at all. These people have had a personal interest in Nike for many years, have had a hand in the development and manufacture of the revolutionary weapon. Our close association with Nike has been due to the fact that the

Western Electric Company is now and, right from the beginning, has been prime contractor to the Army Ordnance Corps with full responsibility for development and production of Nike.

Many other organizations, of course, have helped to make Nike the amazing weapon it is today. The Nike system was developed and designed by a service-industry team composed of engineers of the Army Ordnance Corps, Bell Telephone Laboratories, Western Electric, and the Douglas Aircraft Company. In addition, hundreds of sub-contractors have assisted in the production of Nike.

A decade of guided missile research, development, engineering, and manufacturing effort has gone into making Nike an effective weapon. And because it is so much akin to a communications system, Nike is peculiarly a Bell System "baby."

The Nike story is a big one. Within the limits of security restrictions, this story is related in the following pages.



Why Nike?

At the conclusion of World War II it was plain to military experts that many of the established concepts and techniques of war had been destroyed forever in the giant atomic explosion at Hiroshima. High-speed, high altitude, long-distance bombers, then being built or projected, could annihilate distance. And in the hands of an enemy intent upon attack, these weapons – the atom bombs and the planes to carry them – conceivably could spell disaster for the United States.

Even highly perfected and effective anti-aircraft artillery weapons, automatically aimed and fired by radar and electronic control equipment, possessed certain limitations in view of the potentialities of high-flying, supersonic planes of advanced design then in the incubator.

The problem: A better anti-aircraft weapon.

The answer: A robot projectile capable of being propelled quickly into the air that could fly higher and faster than any plane and like a predatory hawk seek out an enemy in the sky and destroy it.

This imaginative solution to the problem appeared practicable for the first time in the Fall of 1944 at Frankford Arsenal when a young Bell Telephone Laboratories engineer then on active duty with Army Ordnance proposed certain extensions of the existing radar fire-control art.

And thus Nike had its beginning.

Army Ordnance Asks for Help

Early in '45, after some preliminary investigation, Army Ordnance asked Bell Laboratories and Western Electric to study the anti-aircraft guided missile problem and to prepare recommendations for a development program should a practical solution be predicted.

To make such a request of the Bell System team was logical. For the Laboratories possess a reservoir of rich experience in communications and electronics gained in designing a telephone system unmatched in the world, plus broad experience in radar and computer techniques—all solidly backed up by Western Electric's practical production skills and knowledge in the same fields. Together, Bell Laboratories and Western Electric developed and produced about half of the Armed Forces' radar requirements during World War II in addition to radar gun directors and numerous other systems employing electronic controls and computers.

This knowledgeable team went to work overnight on Nike in 1945. Drawn into the project early was the Douglas Aircraft Company to study the aërodynamic problems involved in the creation of a supersonic missile. Scientists of the California Institute of Technology, the Ballistic Research Laboratories at Aberdeen Proving Ground, and the National Advisory Committee on Aëronautics, all contributed valuable services.

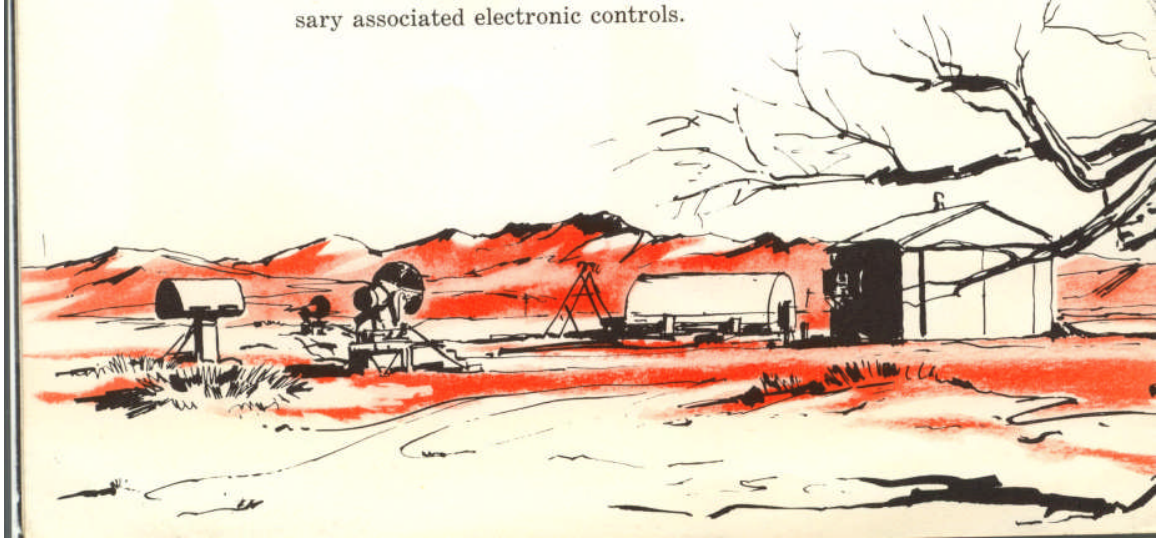
Five months after Bell Laboratories launched its study, the initial report in the form of a recommendation was forwarded to Army Ordnance by Western Electric, as contractor. It was encouraging. It described in outline today's Nike guided missile system in which a supersonic missile is controlled and guided from take-off to target by ground-based electronic equipment.

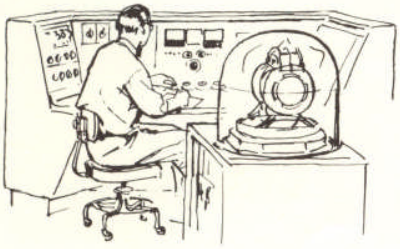
Success was assured for the Nike adventure as—in the words of a scientist-leader of the project—"the skills of military specialists and two large industrial organizations were brought to bear on the solution of one of the most complex problems in applied physics ever attempted."

Hatching the Nike "Bird"

Fast on the heels of receipt of that initial report in May '45, the Army issued a development contract to the Western Electric-Bell Laboratories team, in effect instructions to proceed full speed ahead on the guided missile project in which the guidance system was the number-one problem. At the same time the Douglas Aircraft Company was approached and asked to be responsible for the design of the missile, launcher, and handling equipment.

Rocket missiles are known as "birds" to the experts who live with them. So new and complex were the technical problems posed by the Nike system that it took nearly five years of grueling development work to hatch successfully a Nike "bird," with the necessary associated electronic controls.





The program was big, complicated, imaginative. Douglas in California, Bell Laboratories in New York and New Jersey, were separated by thousands of miles; but the airplane and telephone, peace-time products of these two organizations, reduced distance to a matter of little consequence. All parts of the program moved forward together as the participants demonstrated that the basic concepts of the Nike system were sound and that a practical weapon could be built to destroy high-speed maneuvering aircraft.

It was a great day in November, 1951, when in the first overall system trial, a Nike "bird" roared from its nest among the sagebrush and tumbleweed of the Army's White Sands Proving Ground in New Mexico and rocketed under electronic control through the sky to make a successful "intercept" of a drone aircraft on the very first attempt!

This and many subsequent tests proved beyond a shadow of a doubt the practicability of the Nike guided missile system as an anti-aircraft weapon.

ACQUISITION RADAR

What had been Created?

What manner of bird and system was this—which the Army now wanted designed for production and manufactured in quantity as soon as possible—and asked Western Electric to make?

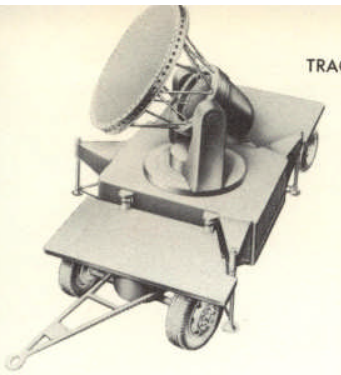
Nike was and is mostly brain, mostly wire, cable, vacuum tubes, and innumerable electrical devices. The relationship between "bird" and control equipment and launching apparatus is about the same as between an artillery shell and the gun which fires it

The missile is 20 feet long, one foot in diameter, with two sets of fins to guide and steer it. It weighs slightly more than one-half ton. Within its tubular body is the explosive warhead, an electronic brain, and a liquid-fuel power plant that propels the bird on its fiery journey with the power of thousands of horses. When a missile takes off, its first few seconds of flight straight up are powered by a booster rocket half its length to which it is attached; the booster pushes the "bird" to supersonic speed and then drops off shortly before the missile turns toward the target and the missile's rocket motor takes over.

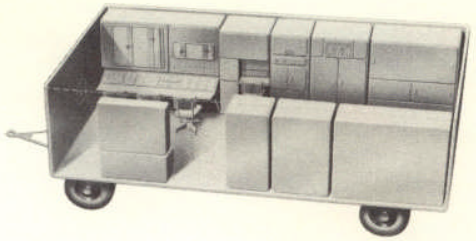
On the ground is the "bird's" intelligence, its major thinking apparatus, its eyes and most of its senses—the ground guidance system: three radars, computers, automatic plotting boards, power generators, and other equipment.

One of the radars, known as an acquisition radar, reaches out into space with its invisible fingers of energy and first detects the approach of distant aircraft.

A second radar is directed to pick up the oncoming target and follow it relentlessly, tracking it across the sky with its radar



TRACKING RADAR



CONTROL EQUIPMENT

beam. Information concerning the course of the approaching plane is fed into the computer. In the meantime, the third radar is trained on a Nike missile poised in its launching rack.

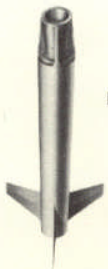
While the target is still miles away, the missile takes off and roars up out of sight under the constant surveillance of its radar. The electronic computer receives a steady stream of information from the missile-tracking radar and from the target-tracking radar. Flight instructions are transmitted to the bird as it screams to its destructive rendezvous with the target at supersonic speed. Any evasive action by the target plane is futile, for it is detected instantaneously and the missile's course is changed accordingly.

All of which happens automatically. Calculations are made, decisions are reached electronically, instructions are given with a rapidity and accuracy no human brain could hope to match. Nike's guidance equipment is an intellectual prodigy among today's electronic robots.

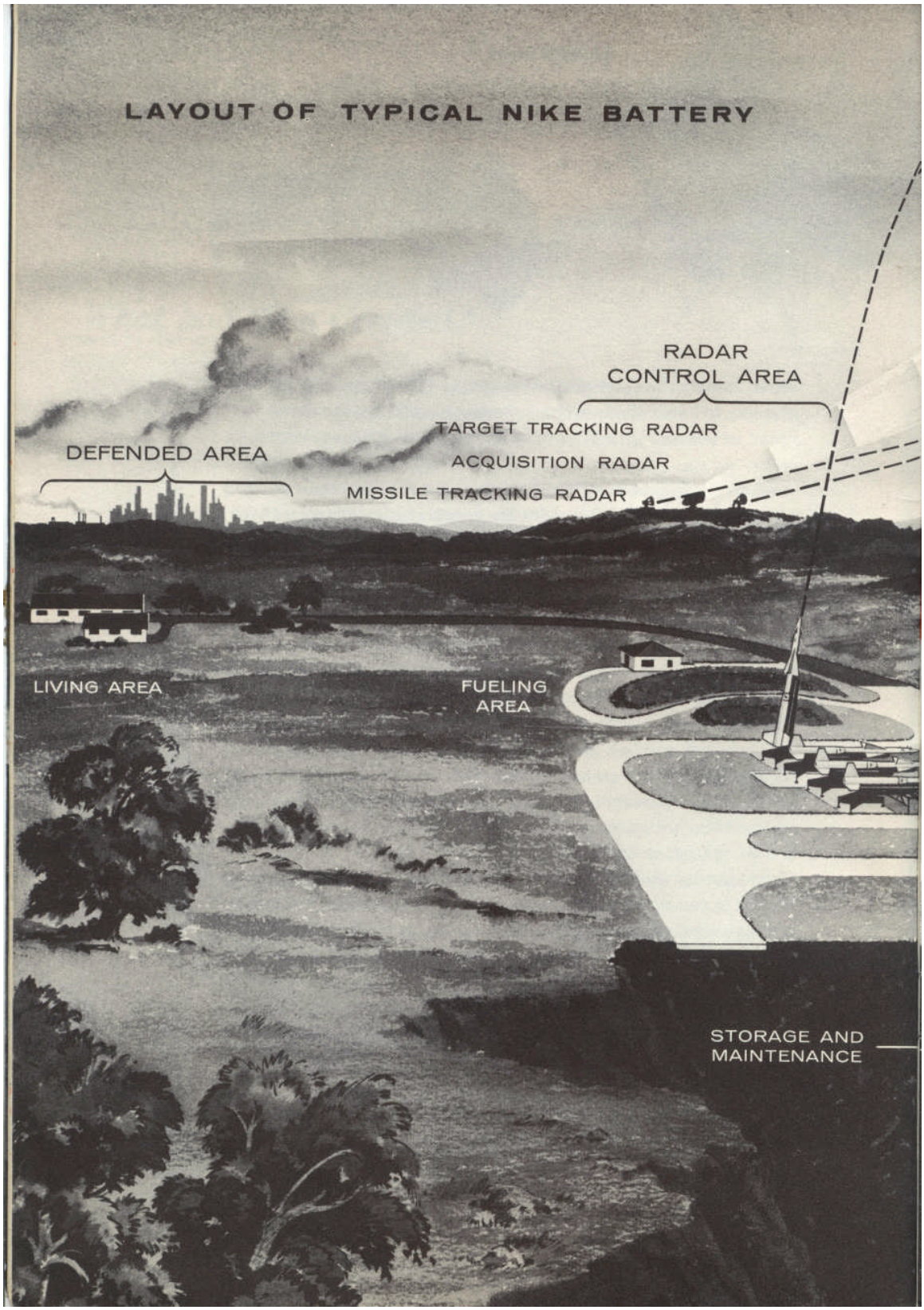
And the whole system is portable, is a tactical weapon which can be used by specially trained troops in the field. Packed in van-type trailers, mounted on wheels, made of lightweight alloys, weatherproof, a Nike battery with all its many elements can be carried by airplane and deployed almost anywhere.

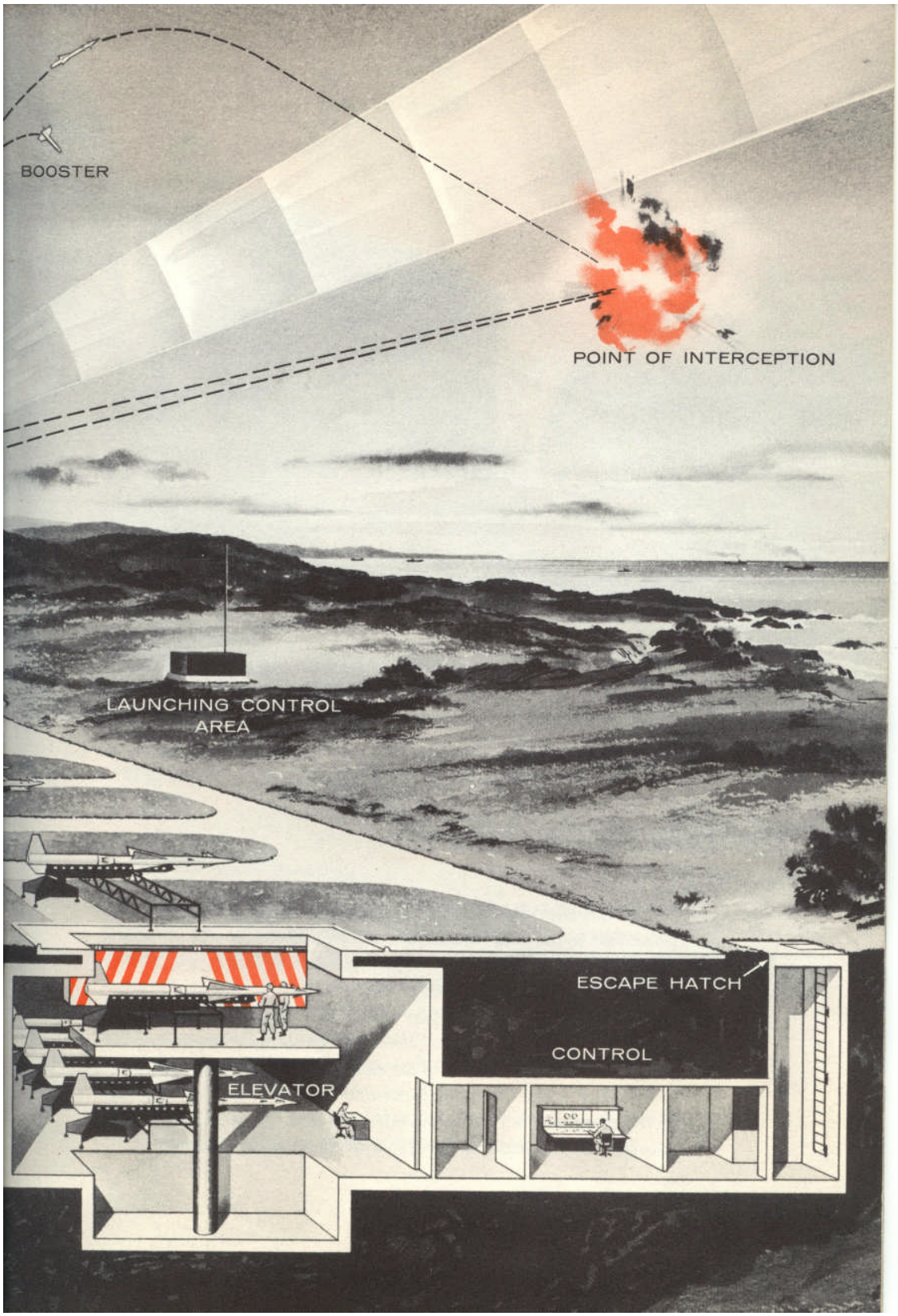
This then was Nike. This was what the Army wanted and to obtain it, issued a production contract to Western Electric.

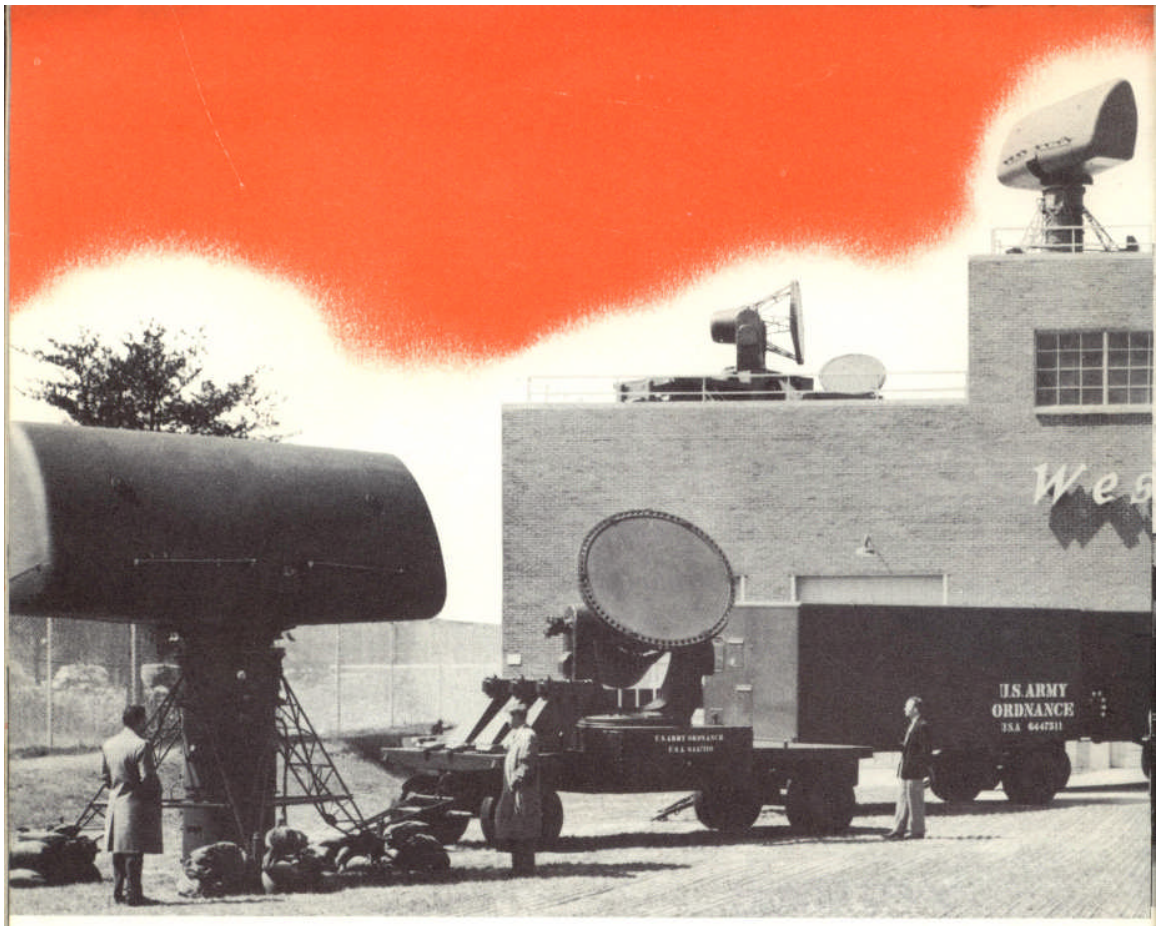
MISSILE



BOOSTER


LAYOUT OF TYPICAL NIKE BATTERY
RADAR
CONTROL AREA
TARGET TRACKING RADAR
ACQUISITION RADAR
MISSILE TRACKING RADAR
DEFENDED AREA
LIVING AREA
FUELING
AREA
STORAGE AND
MAINTENANCE

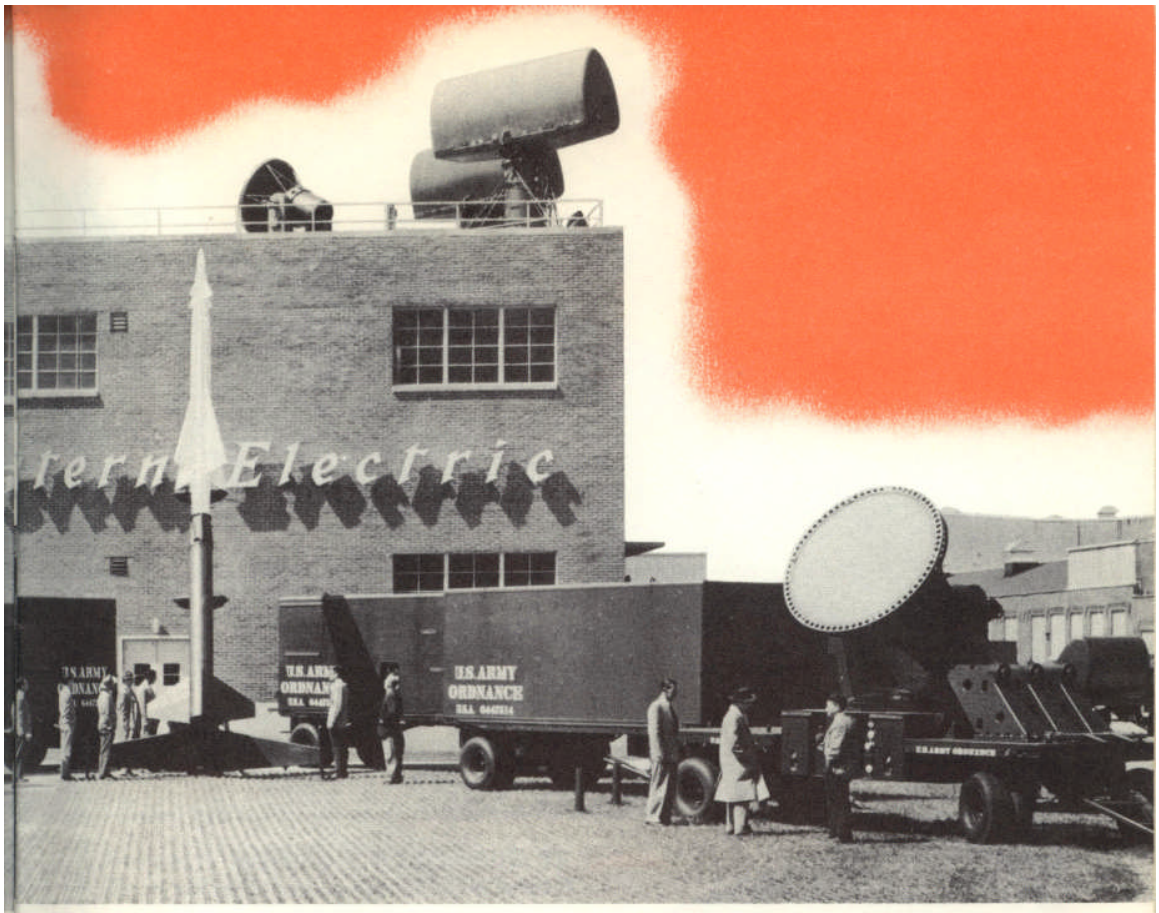

BOOSTER
POINT OF INTERCEPTION
LAUNCHING CONTROL AREA
ESCAPE HATCH
CONTROL
ELEVATOR



We Take on the Nike Job

Western Electric's history has been marked by prodigious contributions in the field of communications and electronics especially in the birth and growth of telephony, radio and network TV. To our credit are impressive performances in the production of radar, sonar, gun directors, military radio and telephone equipment. Thus, to Western Electric, the Nike proposal represented an obligation once again to be of service to the nation on a rush basis in a field in which our experience and skill has been outstanding.

We accepted the Nike production job and, when we did, it was natural that it should be entrusted to the Company's Radio Divi-



NIKE on display before test building at Burlington, North Carolina. Arrayed left and right of the missile are radar units and vans of control equipment.

sion which had long been responsible for the major part of our work for the Government. At the time the Army's production orders were received, the Burlington Shops at Burlington, North Carolina, one of the factories of the Company's North Carolina Works, were headquarters for manufacture of the Army's famous M33 anti-aircraft artillery fire-control system. Not only were parts of the fire-control equipment related to those used in Nike, but at Burlington existed a skilled organization, trained personnel, and basic facilities of the sort needed to get the job done. Thus, it was logical that the Nike assignment went to Burlington.

AT BURLINGTON—a skilled organization, trained personnel, facilities to get the job done.

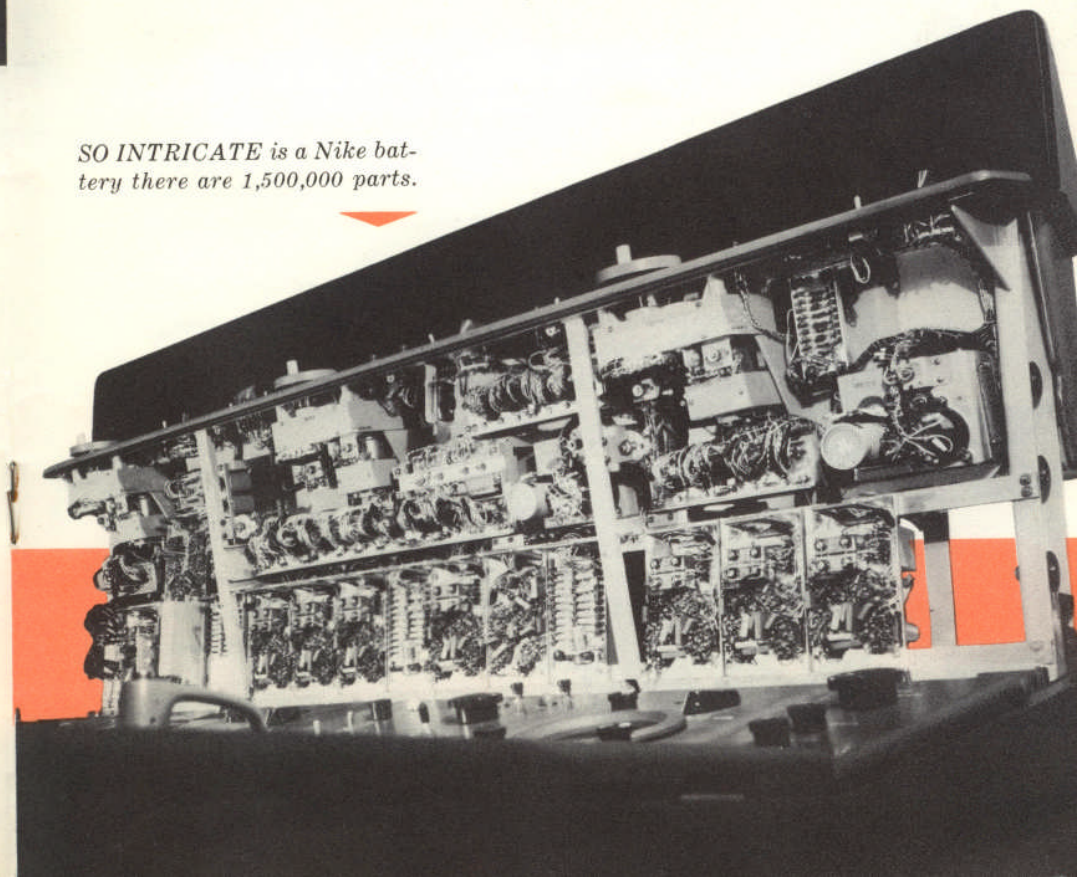
And the job had to be pushed. Nike batteries were needed for the defense of the nation. The demand for Nike was so urgent that manufacturing had to be rushed even though development was continuing. It was necessary for Western Electric engineers to figure out how to plan and set up manufacturing processes so that refinements and new elements of design could be incorporated into Nike as they emerged from the laboratories. Under the circumstances, "change orders" were numerous right from the beginning.

It was necessary to enlarge the Burlington factory by constructing a separate test building. Segments of the overall project were delegated to the Hawthorne Works in Chicago and elsewhere within Western Electric. Virtually all Western Electric manufacturing locations have contributed in one way or another to the Nike job with the Kearny Works, Allentown Plant, and shops at St. Paul, Haverhill, Winston-Salem, and Greensboro prominent among them.

Many firms large and small outside Western were given Nike manufacturing assignments by the Company. Largest of the subcontractors and shouldering an important responsibility was and is, of course, the Douglas Aircraft Company. Douglas's job has been to manufacture and assemble Nike missiles, inserting in each bird's body a delicate electronic brain made by Western, and to produce the launching and handling equipment. More than 1,300 subcontractors contribute resources and skills to the Nike project.

A Nike system is so complex that if you performed a disassembly job, you would wind up with a total of approximately 1,500,000 parts. You would find 217,000 feet of conductor wire, enough to stretch from the sidewalk to the top of the Empire State building 150 times. You would discover 2,000 feet of coaxial cable, 2,000 vacuum tubes, 12,000 resistors, 5,000 capacitors, 460 relays, 1,250 coils, 7,125 feet of interconnecting cables for the ground guidance section and 5,600 feet of similar cable for the missile handling section, plus a telephone switchboard for 20 or more lines—and much, much more.

SO INTRICATE is a Nike battery there are 1,500,000 parts.



TELEPHONE techniques like this traditional cable forming method are used in making Nike.

Getting the Job Done

Obviously from the foregoing, the manufacture of Nike takes some doing.

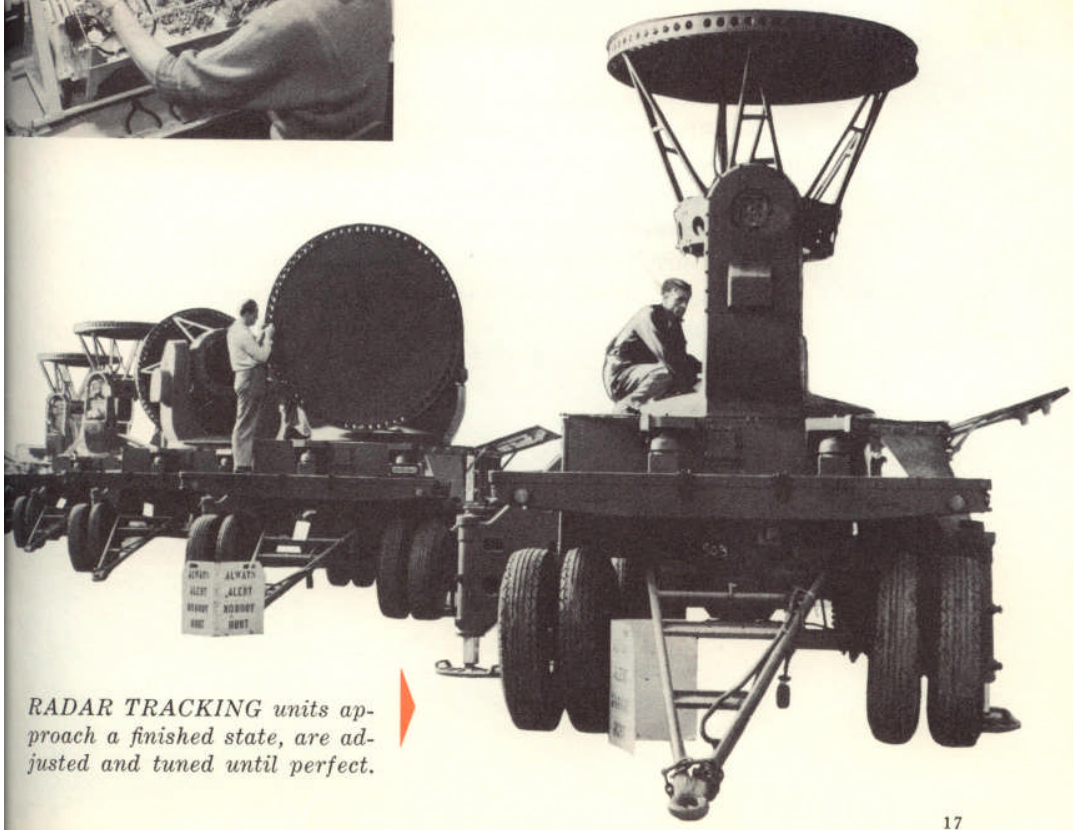
Western couldn't produce Nike without expert product engineering and the closest possible working relationship with the development engineers at Bell Laboratories. The job couldn't be carried through without constant cooperation with suppliers and subcontractors to help them meet the stiff product specifications and production schedules.

There were, for example, the tremendous tasks of designing, specifying, ordering, purchasing, negotiating—in short, the problem of organizing the production of a million and a half parts. Not all of these, of course, were to be made by Western Electric. Many of them were to come from individual manufacturers scattered in far corners of the country. How could the multiple and diverse streams of components be coordinated best to flow smoothly into final assembly? The circumstances required special production control methods for maximum efficiency.

The control methods devised at Burlington for the Nike job have been particularly successful. The various parts of the Nike system have moved to completion as though conveyorized and

PARTS OF NIKE require the careful attention of W.E. people who check operating characteristics during manufacture.

SOLDERING CONNECTIONS in Nike units demand utmost care and skill. Much handwork is needed in Nike manufacture.



RADAR TRACKING units approach a finished state, are adjusted and tuned until perfect.

For the final testing and check-out at Burlington the specially constructed test building is used. Here each Nike system is put through its paces in a series of stiff, comprehensive tests which in effect duplicate battle conditions.

When okay, the completed units—the large vans with wheels, and radar "tracking" units—are loaded with great care on railroad flat cars in the Burlington yard. Then under military guard they roll down the railroad siding destined for duty at strategic stations somewhere in the United States—the Nation's first combat-ready surface-to-air guided missile systems.

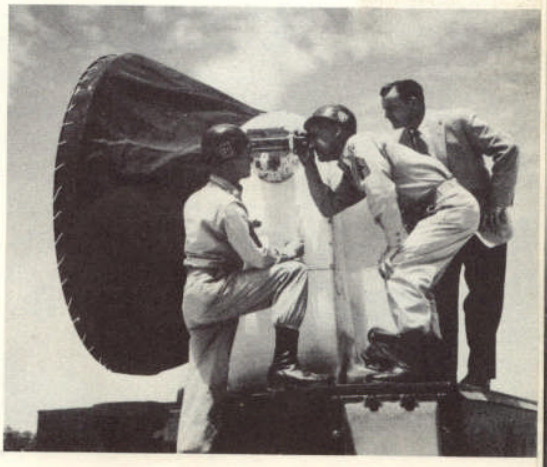
The F. E. F.

Nike systems are not delivered to the Army and forgotten. The Company's responsibility continues into the field and is shouldered by the men of the Radio Division's Field Engineering Force.

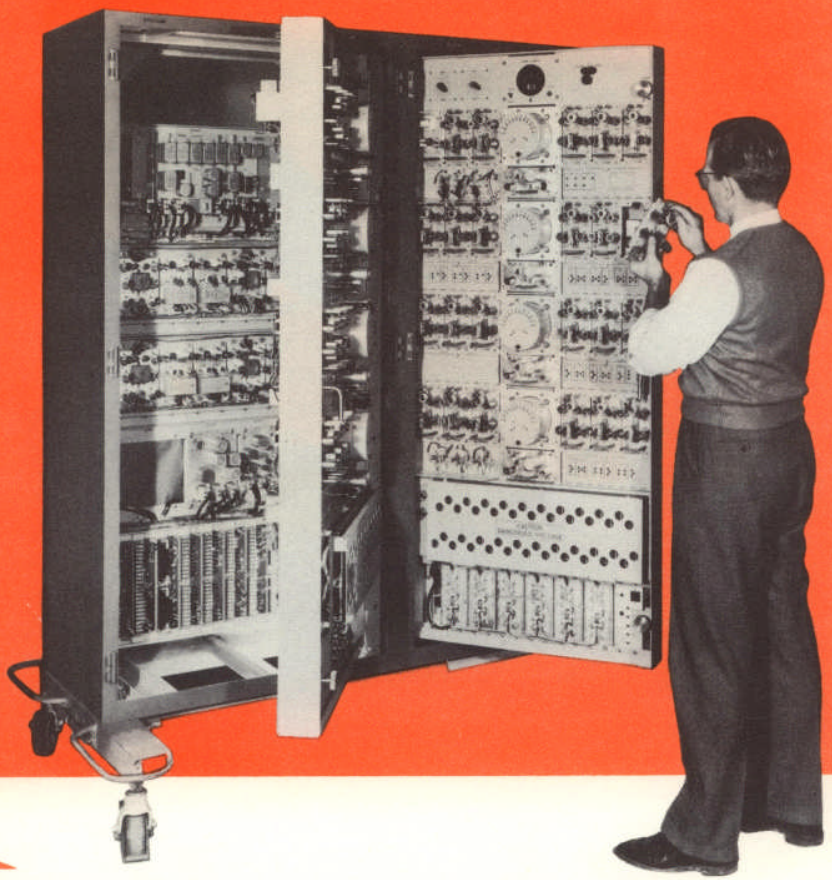
More than 150 F.E.F. engineers together with 70 Douglas Aircraft Field Representatives live with the troops of Army Ordnance to assist with tactical emplacement of Nike systems and to lend support in maintenance and operation problems.

F.E.F. men have been on the Nike "firing line" from the earliest days of the Nike development program at the Laboratories. The initial training schools for Company engineers and military personnel were established by the F.E.F. and some 70 engineers are now associated with military training and test programs. Instruction books and maintenance manuals for use in the field are the work of the engineers of the technical publications organization at Winston-Salem.

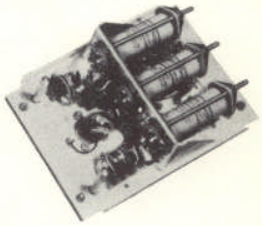
As you read this, wherever there is Nike, there too are Western Electric's Field Engineers.

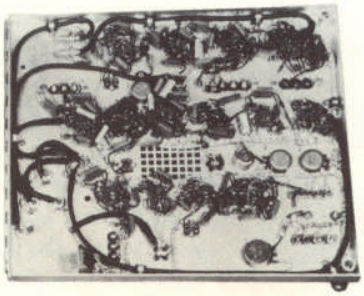


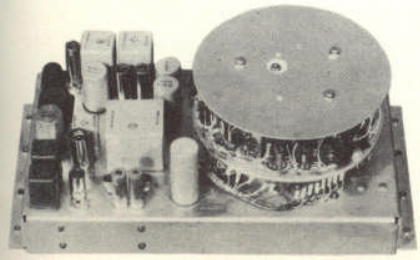
F.E.F. ENGINEER helps to adjust radar at Nike installation.



A LARGE UNIT of complex electronic equipment for Nike nears completion. On the frames and panels of this equipment cabinet are mounted the many smaller plug-in units.







NINE BUILDING BLOCKS, from far left to right, of the sort needed to assemble the larger equipment above. There are 300 similar units of various types in each Nike system.

COMPLETED RADARS atop the test building at Burlington point toward the sky ready for thorough operational tests.

Nike design calls for the production of *units* of Nike apparatus in which there may be many small parts, each unit—in relation to a completed Nike system—actually being like a building block. A unit with all its tiny parts can be plugged into position in a Nike system and pulled out again for a replacement about as easily as you change a fuse at home. There are 138 different types of electronic "building blocks" in a Nike system. Some types are used only a few times, others many times. In a Nike battery ready for action are more than 300 "building blocks" of all sorts. The building block principle helps in the production of Nike and simplifies and speeds maintenance in the field.

There comes a time in the manufacture of any product when it is complete and ready for the final check-out. The big questions are: Is it okay? Will it work properly? And upon completion of each Nike system at Burlington these questions have a vibrant character which might be lacking when more humdrum products are involved. After all, this equipment has been made to control an explosive, lethal "bird" in the sky in the defense of our cities, homes and factories. It *must* be right.

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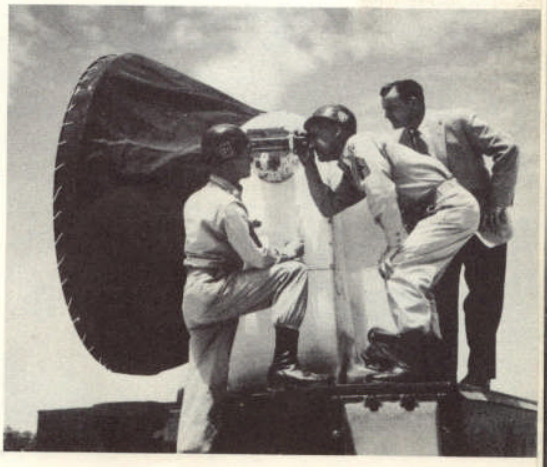

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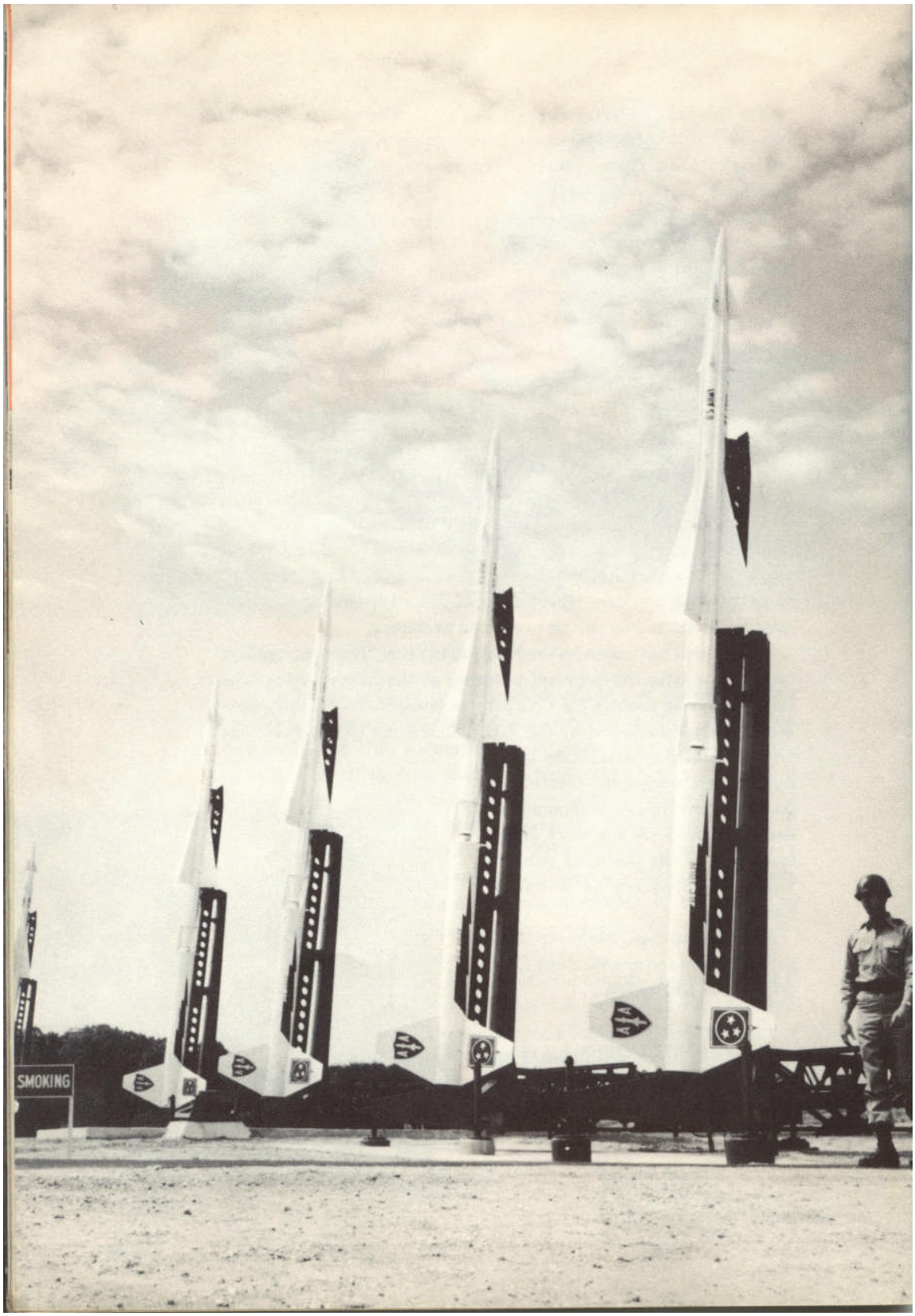

SMOKING

Nike is Ready

How many Nike systems Western Electric has made and will make is a military security matter. But Nike batteries are already in place and more are springing up across the nation with increasing frequency, our innermost line of a vast system of national and continental defense.

Our outermost line—which is another story entirely—is also an outstanding example of Western Electric and Bell System service to the nation. This is the DEW Line, the Distant Early Warning Line beyond the Arctic Circle in the Far North, which functions as a radar fence to detect the approach of aircraft across the top of the world. The responsibility for setting up the DEW Line is Western Electric's under contract with the U. S. Air Force, and in cooperation with the Canadian Government. Thus, we are contributing to our first as well as to our final lines of defense.

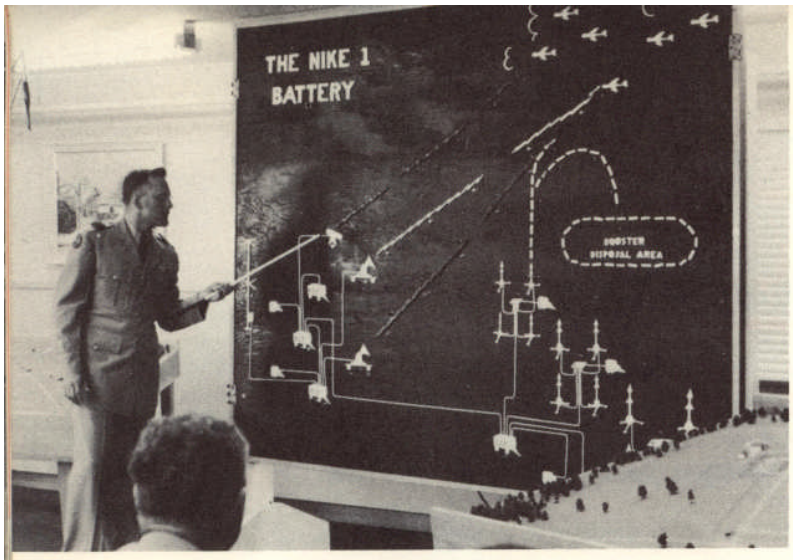
The initial Nike battery to become operative was installed at Fort Meade, Maryland, in December, 1953. Another Nike battery at Lorton, Virginia, also one of the earliest to go into commission, has been visited by representatives of the press and widely publicized. It has been announced that Nike is now on guard outside more than 15 major cities of the Nation.

These batteries, like others we may learn about, are permanent installations. Since the cities they protect are there to stay—so are the Nike batteries which guard them. A permanent setup enables the Army to take maximum strategic advantage of the topography of the country. These batteries can function more efficiently, too, with permanent quarters and equipment.

The Army makes every effort to integrate each Nike installation into the municipality where it is located with a minimum of interference with the life of the community. The Army points out that a Nike site is not dangerous, but as safe as a gas station and as important to security and as much a part of the local community as the police and fire departments.

READY FOR LAUNCHING, these Nike missiles stand at attention during a practice drill at the Lorton, Va., Nike battery site.

A Nike



(1) *NIKE OPERATIONS are studied and reviewed regularly.*

(2) *MISSILES must be fueled for action.*

(4) *UNDERGROUND storage is provided for missiles.*

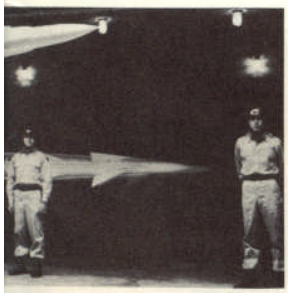
(5) *MISSILES ride elevator up from storage.*

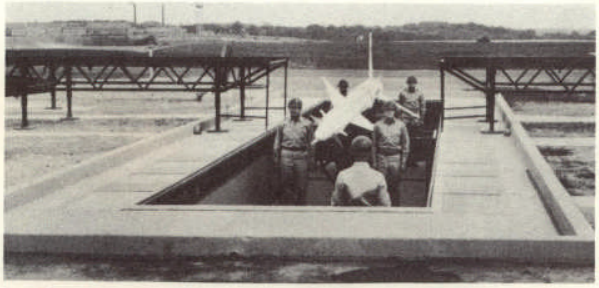
(7) *INTO POSITION goes the missile with help from the crew.*

(8) *MISSILE rises to firing position.*

Battery Rehearses

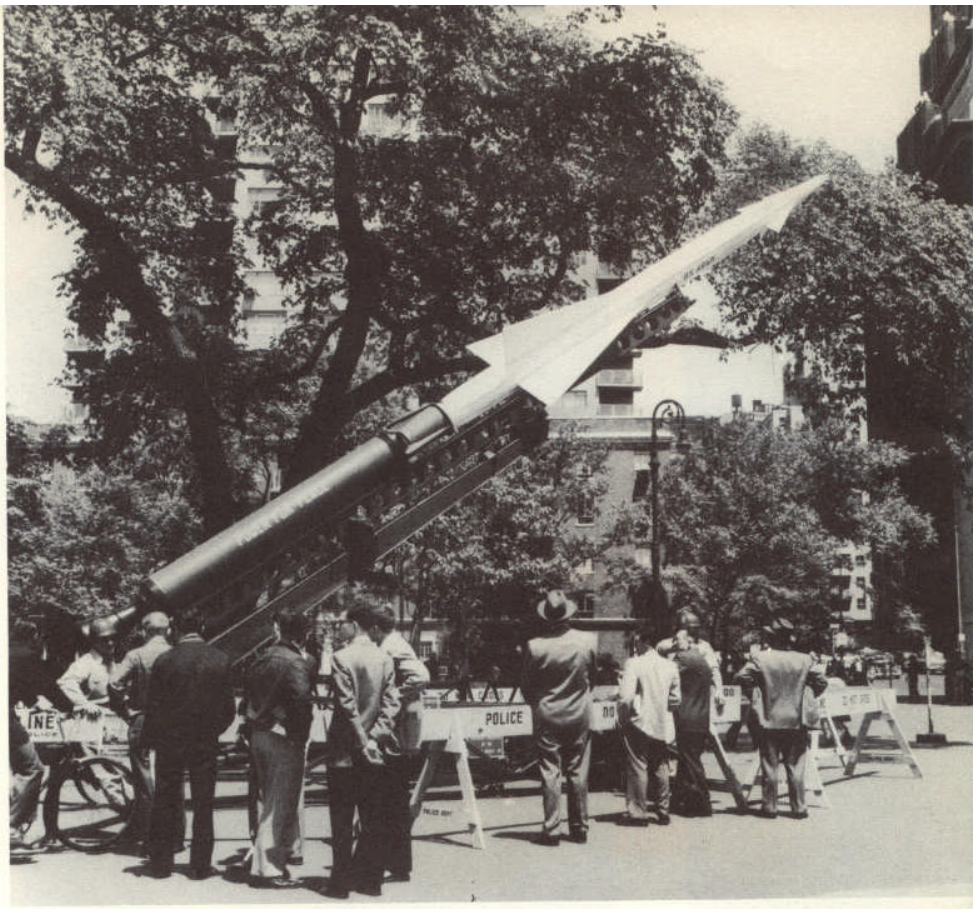
(3) *BOOSTERS must be attached to missiles.*





(6) *THE CREW comes up from below with the missile.*

(9) *CREW members at the controls check all phases of the operation.*



MILITARY EXHIBITS to inform the general public about Nike are being shown in cities where batteries are being located. This show was in Washington Square, New York City.

A SPECIAL DIORAMA, built by Western Electric, demonstrates how Nike operates. It is vividly animated and spectators listen to the Nike story as they watch the action. The diorama is being shown to the public in cooperation with the Army and Bell Telephone Companies.

The permanent character of such installations contributes to safety since protective revetments are constructed and Nike missiles are stored in underground chambers. Disposal areas are established into which booster sections of missiles may fall harmlessly when they break away from Nike "birds" in flight. It is possible in the near future that booster sections will be made self-destructive in the air so that disposal areas can be dispensed with. As a final safety precaution, the missile is designed to destroy itself by exploding high in the sky if, for any reason, it should not intercept its target.

While it is hoped that these nests for our slender supersonic "birds" will never go into action, operational parts of a Nike battery are nonetheless tested daily – checked by means of test equipment designed by Bell Laboratories and built into the system by Western Electric. There is no need to fire a missile to make sure it will work. Nike batteries remain on guard 24 hours a day, manned by trained men of the Army who go to established Nike firing ranges for regular annual practices. Nike is ready if needed.

In Peace and War

Thus the Bell System, through its design-production team of Bell Laboratories and Western Electric, has made another outstanding contribution to national security.

Success in the Nike project is clearly due to our long experience with electronic technology and equipment—gained through telephone work. For there is a very real technological kinship between telephony and the special sort of magic of a Nike battery.

Actually, each Nike guided missile system is a communications system, designed for the instant determination and transmission of missile and target information to the Nike battery unit, together with interpretation of such data. The language used, of course, is comprehended by vacuum tubes, relays, capacitors, coils, resistors, and such devices. But, nonetheless, the messages are capable of automatic translation into the devastating action of roaring missiles that seek and destroy targets in the sky, in any kind of weather, night or day, targets many miles away and beyond the range of the most highly developed anti-aircraft artillery.

You can find in a telephone central office many close relatives to Nike's tubes, relays, capacitors, coils, resistors. Your dial telephone speaks the same language as that employed in a Nike battery—but with far different results. The peaceful messages transmitted to your dial central office are translated automatically into a "connection" so that you may talk to a person perhaps a half-continent or more away.

Yes, Nike has been created by the Bell System's superior combination of skills encompassing research, design, engineering, manufacture, and operation. These skills which have built the finest telephone plant in the world have always been dedicated to SERVICE TO THE NATION IN PEACE AND WAR.

This guiding principle of the Bell System takes on powerful new meaning as Nike assumes its place among the battle weapons of our country and adds to our security as a potent weapon of defense.

SYMBOLIC of the Bell System's guiding principle of Service to the Nation in Peace and War *is this statue in the main hall of the American Telephone and Telegraph Company building at 195 Broadway, New York City.*


TO THE
NATION
IN
PEACE
AND
WAR

WESTERN ELECTRIC BOOKLET RACK SERVICE

FOR EMPLOYEES

PREPARED BY WESTERN ELECTRIC COMPANY, INC., NEW YORK, N. Y.