understanding TELEVISION

WHAT IT IS AND HOW IT WORKS

by Orrin E. Dunlap, Jr.

discovery
development
antennas
broadcasting
receivers
programs
channels
definitions
maps
AND MANY MORE SUBJECTS

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by Orrin E. Dunlap, Jr.

a Vice President of the Radio Corporation of America, and author of *The Future of Television* and *Radio's 100 Men of Science*

This book has been written to answer the question of how television accomplishes the magic of bringing to the American home pictures in motion of important and lively events *the instant they happen.* It will help the layman to understand why and how he sees the President of the United States addressing Congress, a home run batted into the stands at the Yankee Stadium, or a puck flying over the ice in Madison Square Garden.

Beginning with the steps that led to television Mr. Dunlap explains the science of how you see by television: the

Continued on back flap

Best 73 to Gilbert Chase with
all good wishes for many happy
years in the realm of television
and education!

Orrin E. Dunlap, Jr.

Nov. 19, 1948.

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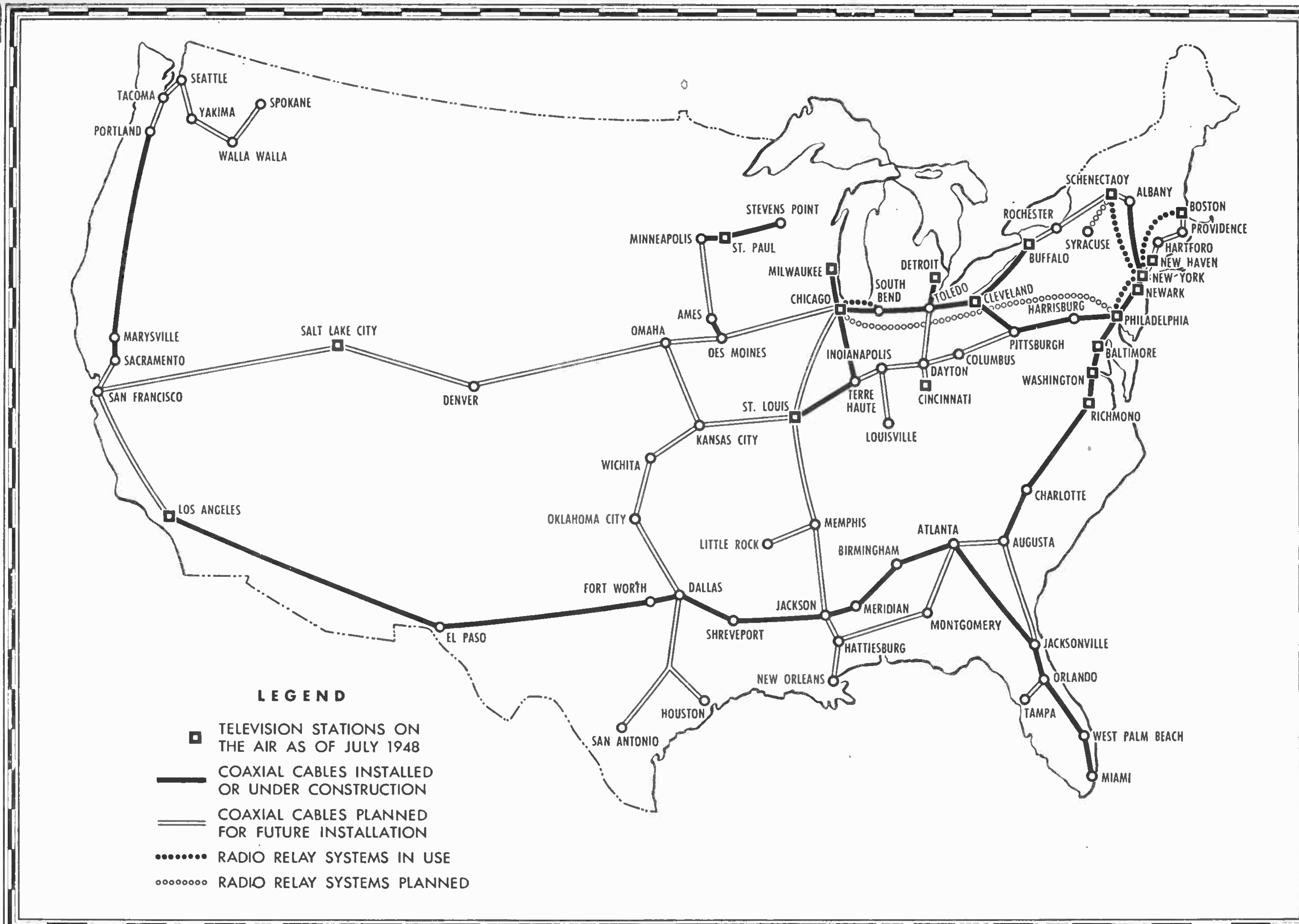
Dunlap's Radio Manual
The Story of Radio
Advertising by Radio
Radio in Advertising
The Outlook for Television
Talking on the Radio
Marconi: The Man and His Wireless
The Future of Television
Radio's 100 Men of Science
Radar: What It Is and How It Works



Television expanding across the nation.

To

Dr. Joseph E. J. King
Whose inborn worth his acts commend,
Of gentle soul, to human race a friend.

CONTENTS

	Page
Introduction	7- 10
Steps That Led to Television	11- 25
How You See by Television	26- 65
What Performers Should Know About Television	66- 88
Testing Your Television I. Q.	89-110
Television Glossary	111-121
Television Stations on the Air	122-123
Television Bibliography	124-125
Index	126-128

ILLUSTRATIONS

	PAGE
Map-Television Expanding Across the Nation	3
Table Model Television Receiver	14
Performance of Microwaves	18
Dr. V. K. Zworykin	24
Television Camerman	27
Image Orthicon	28
Diagram of Image Orthicon Tube	31
Electrical-Radio Route of a Television Program	33
Radio Relay Station	35
Television Transmitting Antenna	36
Microwave Reflector	39
New York-Schenectady Radio Relay Link	41
5-Kilowatt Television Power Tube	42
Kinescope	46
Projection Receiver	47
Electron Gun	49
Televising A Play	51
Television Studio	53
Control Men	55
Mobile Television Station	57
Monitoring a Field Event	59
Baseball Telecast	61
Football Telecast	63
Television Recording of Maestro Toscanini	65
Kyle MacDonnell	68
Televising National Political Convention	70
Television Camera	76
Theater Guild Telecast	78
Television Cameras in Studio	80
Television Recording of Thomas E. Dewey	83
Prizefight Telecast	85
Kinescopes on Production Line	90
Schematic Diagram of Television System	92
Large-Screen Projection Television Receiver	94
Dipole Television Antenna	96
New York-Boston Radio Relay System	99
Schematic Diagram of Niagara Falls Telecast	101
Coaxial Cable	103
Cross-Sectional View of a Radio Relay Station	105
Test Pattern	106

INTRODUCTION

Think of yourself blindfolded at a baseball game with somebody alongside describing each play, endeavoring through words to give you a mental picture of what is going on. That is radio broadcasting. But lift the blindfold and see the scene for yourself! That is *television,* with an expert sports commentator to explain every play.

Television is new as science measures Time; it is a new art, yet its name is of the ancients. *Tele* is Greek for "at a distance." *Video* is the Latin verb meaning "to see."

Officially, television is defined as "radio or electrical transmission of a succession of images and their reception in such a manner as to give a substantially continuous and simultaneous reproduction of an object or scene before the eyes of a distant observer."

Marconi described it as "the highest grade in the art of communication."

Qualifying as a science under the dictionary definition, television is "a systematic arrangement of the laws which Nature has established." It is an "infinite complexity" of invention. It is a science made up of sciences — the combined action of light and optics, electricity and radio, physics and chemistry, electronics and photography. And as an art, it is "the external manifestation of an idea, the revelation of invisible reality through the senses."

What television means to mankind can stir alike the imagination of schoolboy and sage. The social, economic, and recreational aspects of sitting in comfort at home and looking out upon the world, the shift from city to city for a great diversity of activities, make all the world a stage and every home a front-row seat for sports, drama, and news.

People now look upon scenes never before within their range; they see politics as practiced, sports as played, drama as enacted, news as it happens, history as it is made — they are face to face with celebrities! In 1840, weeks passed before pictures of Queen Victoria's wedding were printed in America, but when Princess Elizabeth was wed in 1947, films were flown across the Atlantic and telecast in New York the next day. Yet, to coming generations, even that speed will seem slow, for they will see events at the hour they happen — by international television!

Just as radio brings the chirp of a bird, the buzz of a bee, the voice of the President, or the "I do" of a Princess to vibrate eardrums half a world away, so will television enable the eyes to distinguish lights and shadows, scenes and people, in action at a distance.

Radio shriveled the size of the earth; it gave new speed to sound and annihilated Time. Now television promises to put the globe in the palm of everyone's hand, so that the eye may look around the sphere as if it were an orange. Nations shall look in upon nations. If the old adage be true that seeing is believing, then people everywhere should understand each other better, for television makes them neighbors as never before; the world enters the home as an animated panorama. No wonder that television, with its impact of scientific and social repercussion, is heralded as revolutionary as the invention of the printing press!

But it's only a motion picture, someone may say. Yes, but it is more than that — television gives us a picture in motion at the instant it happens. No other invention offers such a pictorial service, broadcast to the winds, to be intercepted at the will and pleasure of the public at home. Immediacy is its essence. That is its outstanding guarantee of success. Added to timeliness, television carries the picture directly into the home — and into the theater! Television events can be presented directly by large-screen theater television projectors, or they can be filmed from the picture screen of a receiver located in a theater and be processed in a few minutes for projection on the big screen.

All this in television didn't happen overnight. This miracle of science, which challenges industry, entertainment, and education to make use of electronic vision, has passed through a long period of evolution. Men of ideas and of science — with Tennyson — "dipped into the future, far as human eye could see," and "saw the Vision of the world, and all the wonder that would be." As a result, science moving "slowly, slowly, creeping on from point to point," fills the heavens with pictures, eventually for people everywhere to see!

This book is written to answer the question, "How does television accomplish this magic; how does it work?"

"It's incredible!" exclaimed a New Yorker as he watched a television screen. "At the very instant the President addresses Congress, we see him as clearly as if we were there; we see every gesture, see him turn the pages of the manuscript, and, as he reads, it is apparent that he has not memorized any paragraph of his speech.

"When he finishes, we see him take a drink of water. As he leaves the rostrum he folds up his papers and walks down the aisle, stopping here and there to speak to friends — then disappears through the crowd of Senators and

Representatives. And to think that this scene in the Nation's Capitol is coming to us over two hundred miles of cable and is being broadcast to us from the top of the Empire State Building! How in the world does television do it?"

It is hoped that this book will help the layman to understand why and how he sees the President so clearly; how he sees a home run as it is batted into the stands at Yankee Stadium; how he sees the football punted by a Princeton toe, a puck flying over the ice in Madison Square Garden, a tennis ball smashed across the net at Forest Hills, or the punch of a knockout blow delivered by a champion. When it happens on television, you're *there!*

Only science could pack so much action and magic into fleeting seconds!

New York City.

O. E. D. Jr.

Steps That Led to Television

IT IS EASY TO UNDERSTAND THE MAGIC OF TELEVISION, IF first you remember a few simple facts about light, the human eye, and radio.

Light is described as radiant energy — a form of wave motion. Generated in the form of tiny wave-lengths by the sun or other sources, light travels 186,000 miles a second! Man learned from the first page of the Bible that when the stars were made and set in the heavens, an open firmament was created through which light could reach the earth from millions of miles away. Centuries passed, however, before he began to comprehend the mystery of that light; how it came to shine upon the earth as "divine fire" from outer space — from the sun, moon, and stars.

Scientists discovered that light travels in a straight line, and that when its waves strike an object, they are either absorbed, diffused, or reflected. High absorption makes an object appear black; high reflection makes it seem white. Color depends on the reflected wavelength; that is, the distance from the crest of one wave to the crest of the next. Red has the longest wavelength, about three one-hundred-thousands of an inch. Yellow is the next in length, and so on down the spectrum through green, blue, and finally violet which has the shortest wave among the colors.

Color becomes apparent when some of the wavelengths of light are absorbed while others are reflected. For example, we see only the light that is reflected from cloth. If the dye in the fabric absorbs all colors except red, then red is reflected and that is the color we see. If a combination of colors is reflected, then we see a tint.

An object, such as a house, is made of materials that absorb and reflect light to varying extents, and it presents a number of angles to the source of light. It is this irregularity of absorption, diffusion, and reflection that creates contrasts and makes objects visible. In other words, we could not see anything unless light waves behaved in this manner.

The eye is the instrument by which vision is created in the human brain. The eye acts very much like a camera in which a lens produces an image on a photographic plate or film. Light reflected from an object passes through the iris of the eye and, by the crystalline lens, is focused on a light-sensitive surface or image "screen" called the retina, at the back of the eyeball. The fluctuations in light intensity and wavelengths on the retina are relayed to the brain over the optic nerve, and the brain integrates the messages to produce the sensation of sight.

From time immemorial people have had a desire to extend the range of their eyesight. To overcome limitations, they have used binoculars and telescopes, climbed mountains, gone atop towers, and soared in balloons and airplanes. But to achieve the goal by radio, scientists first had to find a way of duplicating the functions of the eye; second, of transmitting the intelligence thus obtained over great distances; and, third, of reproducing this intelligence in its original form at a distance.

Science found the answer. Today's television camera is an electronic "eye." It receives reflected light, transforms it into electronic energy, and passes it along for radio transmission to distant places.

Like the human eye, the television camera has an iris (lens opening), a crystalline lens (photographic lens), a retina (light-sensitive plate, or mosaic), and an optical nerve (coaxial cable and radio wave).

The television receiver is, in effect, an electronic brain. It takes the radio waves that carry television and, by electronic means, transforms their signals back into light, in quality and kind, corresponding exactly to the original reflections picked up by the television camera.

This explanation of television may seem over-simplified, but it serves as a basis for finding out what television is and how to understand it.

The popular RCA Victor table-model television receiver that gave the new industry its big start in 1947-48.

Onward to Television

Now let us recall the epoch-making steps in the history of science that gave man the clues which led him on to television.

In 1831, Michael Faraday, in his historic experiments with magnet and prisms, offered proof of a relationship between electricity and light. Could the electrical action—induction between two bodies—be conveyed by means of a field of magnetic force? What invisible, mysterious force was at work to cause electricity, coursing through a circuit, to make itself felt in another circuit or coil with which it had no contact? Was there such a thing as an all-pervading medium?

At the same time, Joseph Henry in Philadelphia "communicated orally" by what he described as "induction at a distance." Like Faraday, he was engrossed by magnetism as one of "the richer veins of science."

While these men were making discoveries that would write their names in electrical history, a Scottish lad was born in 1831 and named James Clerk Maxwell. He grew "into science," and as a youth "looking at the sun and wondering," inquisitively asked himself, "What's the go o' that?" In quest of the answer, he studied "the wonderful and mysterious power of magnetism, electricity, the flickering light of the candle, optics and chemistry"; he sifted "the grain of all electrical and magnetic phenomena from the chaff of medieval phantasy and legend." He read of "electrum" as discovered in ancient Greece, and of Christiaan

Huygen's theory of the undulation of light in an unseen conveying medium—an airy nothing filling the interstellar space between the earth and the planets.

If space were not filled with an invisible substance, how could sunlight reach the earth? So Maxwell pondered the phenomenon of light. Fascinated by an idea that the attraction or repulsion produced by electricity and magnetism were caused by some "action at a distance"—by an invisible medium in space—Maxwell determined to solve the riddle, mathematically at least. Equations led him to conclude that light and heat were electromagnetic undulations in an invisible medium called "the ether," which was believed to permeate the universe. Solely from mathematical reasoning he went on to predict the existence of ether waves. That was in 1867.

Nineteen years later—in 1886—Heinrich Rudolph Hertz, a German physicist, first created electromagnetic waves; he demonstrated that such invisible waves traveled at the same velocity as light and that they could be reflected, refracted and polarized like the waves of light. He concluded that if these electromagnetic waves could be made sufficiently short, they would be found actually to "wash" upon the frontiers of light.

As a result, scientists began to suspect that Maxwell's ether was no more real than the equator, although in the Victorian era it seemed necessary to explain "action at a distance." To see a star the eye must touch it in a sense; to hear a signal from the moon, the ear, too, would have to be connected with it, in a similar sense.

But such ideas proved to be "scientific fiction" as man became convinced that "there is no ether" as Steinmetz bluntly declared. "Radio is light," explained Tesla. The waves are "electromagnetic" as Hertz had proved. Said Sir Oliver Heaviside, "electromagnetic waves are everywhere." Then scientists, among them Sir Oliver Lodge, began to wonder if these electric waves might be made to radiate from a source of origin—and if they might be used for communication!

Enter Marconi

At the time, a young man in his teens, Guglielmo Marconi of Italy, with an ardent interest in things scientific, happened to be vacationing in the Alps when he picked up an electrical journal that told how Hertz had radiated electromagnetic waves. Why not use them for signaling through the air? Fantastic! Marconi thought otherwise; afire with the idea he rushed back to his home near Bologna to make the dream come true. In 1895, he invented a revolutionary system of communication, and declared "wireless telegraphy is possible anywhere, and it will, I think, soon be a reality in many places."

Wireless was a natural name for an invention that could send dots and dashes through the air without the use of interconnecting wires. But why limit it to the Morse code? If the waves could carry messages why should they not carry the spoken word, and even music! At the turn of the century a number of men were possessed of that idea, and they began to experiment in

Microwaves, which carry the television pictures and sound, travel on a straight line and therefore touch the earth over a limited radius of approximately 30 to 50 miles. That is why radio relay stations are used to intercept the waves and "bend" them around the curvature of the earth; and why high receiving antennas are sometimes needed to reach up to capture the overhead waves.

an effort to make wireless talk and sing. On Christmas Eve, 1906, Reginald A. Fessenden, obsessed with the radiophone idea, broadcast phonograph music and speech using the newly developed high-frequency alternator at Brant Rock, Mass. Wireless operators on ships as far away as the Virginia coast were startled by music in their earphones.

Fessenden's experiments confirmed the belief that wireless waves were capable of carrying much more than dots and dashes. But the practical triumph of radiotelephony required development of the electron tube. John Ambrose Fleming in England had opened the way for that great forward step in 1904 when he invented the Fleming valve—the first 2-element electron tube detector of wireless waves. Then, in 1906, Lee de Forest, an American, went a step further and invented the audion—the first 3-element electron tube, which not only detects the waves but amplifies the incoming impulses and also generates the waves for transmission or broadcasting. That invention revolutionized electric communications; it was the master key to radio broadcasting. Today, approximately 36 million, or 93 per cent of all homes in the United States have radio sets; more than 2,000 broadcasting stations are on the air!

All this came to pass because scientists and radiomen are restless souls. As soon as their vision of the radiophone became a reality, their imaginations were stirred again, and they asked themselves, if radio waves could carry the voice, why not pictures. If news could be flashed by radio, was it too much to expect that a picture of the event could likewise be sent by radio simultaneously with news dispatches? In 1922, still pictures, or radiophotos, were transmitted across the Atlantic!

Then, why not pictures in motion? Several men of radio science, convinced that this was the next big step, picked up the scanning disk which Paul Nipkow of Germany had invented in 1884, and started on the conquest of the "visible radiophone."

Dawn of Television

In the Twenties, while the sound broadcasting "craze" swept the country, a new word of promise—TELEVISION—came into print. Television challenged the ingenuity of scientists and radiomen; it became a promise that the day would dawn when people would go sightseeing through space by radio!

Fortunately, scientists and research men never let a mystery baffle them; once they see the problem in their minds it becomes only a matter of working out details and building devices to make the idea work. To them nothing is impossible. For example, in 1925, Charles Francis Jenkins, one of the earliest television experimenters, described it as a simple problem and remarked,

"There is really no mystery in the thing after all.

"Let's see whether or not I am warranted in assuming that television is a simple problem," he continued. "Let's analyze it; take it to pieces and examine it in detail.

"These are the essentials. We want a picture of a remote scene. We want it repeated fast enough to produce the motion and we want it carried into our homes from the distant baseball park, let's say. That's the problem—a picture of a distant activity.

"If a man puts his head under the black cloth of an old-fashioned camera pointed at the baseball game he sees in miniature on the ground glass an exact reproduction of the game as played. It is carried by light from the baseball diamond to the ground-glass screen. That is exactly what we want, only we want it in our homes. So light working alone won't do, because light goes only in straight lines, and obstructions cut it off. We must have some sort of a carrier which can go around obstruction and through the walls of our houses. A copper wire will do, but a wire carries only to one place. So let's take radio! That carries everywhere.

"Now we come to the consideration of the picture," explained Jenkins. "A picture is nothing but some black and white mixed up in a definite order. Pick up a modern photographic portrait, which is the almost perfect example we have of the delicate blending of light and dark and half-tone. Examine it analytically and you will see what I mean. But how are we going to make radio, which has carried these lights and shadows from the ballpark to our home, reproduce the ball game as the picture?

"That's easy!" exclaimed the inventor. "Don't you remember when we were little tykes, mother entertained us by putting a penny under a piece of paper, and, by drawing straight lines across the paper, she made a picture of the Indian appear. Well, that's the very way we do it . . . . Successive lines, one under another, are made so swiftly (by an electron beam) that the whole screen surface is covered—in one-sixteenth of a second we have motion picture speed, and the entire screen is illuminated . . . . These radio-light variations, when they follow a predetermined order, make up the picture of the ball game, just as the humps on the penny made up a picture of the Indian as the pencil scanned it. That's the way we make radio pictures and radio movies in your home. Easy, isn't it!"

"Let There Be Light . . . ."

Jenkins used mechanical devices to create his television pictures. It would have been much easier if electronic means rather than mechanical had been at his command. The electron tube is far more susceptible to light than a whirling scanning disk with its rim festooned with little lenses. "Light, light and more light" was the cry of the television pioneers—they needed every "ounce" of it to make the disk scanners see, for they had no television camera tube that would see even in the moonlight!

So, in the beginning of television, light became a counterpart of sound in radio, and radiomen had to learn all they could about everything related to light, for they were embarking in science as electronic photographers! They had the arts of optics, photography and radio to draw upon, but their big task was to join the three into a revolutionary system of communication. That called for inventive genius at its best!

"Once whispers and violins challenged us," said a radio engineer, "now lights and shadows!"

Zworykin Showed the Way

Slow, yet enchanting, was the progress. But it became increasingly evident that the practical solution would have to be found in electronics. Finally the old mechanical methods of rotating disck and motors, used by such pioneers as Jenkins, Alexanderson, Baird and others to prove that radio waves could carry pictures in motion were discarded. Electron tubes were developed to make practical "the broadcasting of sight."

The tide of progress turned from mechanical to electronic television on December 29, 1923, when Vladimir Kosma Zworykin* filed a patent application on a new tube which he called an iconoscope. Therefore, as the new name indicated, this tube was the "eye" in a television camera which would observe a scene and make it possible to televise it.

Zworykin went a step farther and developed another cathode-ray, or electron tube to receive the image as seen by the iconoscope. He called it the "kinescope"—"kinema" meaning movement in Greek. So the kinescope observes motion, and serves as a picture tube, or "screen" of a television receiver. Zworykin demonstrated the kinescope in 1924, and for the first time publicly in 1929.

One day, mindful that David Sarnoff, President of the Radio Corporation of America, was interested in

*Vice President and Technical Consultant of RCA Laboratories.

Dr. V. K. Zworykin of RCA Laboratories holding the iconoscope, which he invented as the "eye" of the all-electronic television camera.

all things new in radio, and that he had the vision to foresee their usefulness, Zworykin went to him and told him about his new electronic "eye."

Sarnoff listened intently for half an hour, and then exclaimed, "It's too good to be true! What will it cost to develop the idea?"

"Maybe about $100,000," answered Zworykin.

"All right," said Sarnoff, "it's worth it!"

Then scientists and engineers began in earnest the arduous task of developing a complete television system that would satisfy the exacting demands of the human eye.

Such a system, completely electronic, has become a reality. Carefully field-tested for three years, it was introduced in 1939 as a regular service to the public in the New York metropolitan area.* World War II interrupted its expansion as a service, but wartime developments advanced it technically, and, as a new postwar industry, television spread through the country.

In recognition of Sarnoff's vision and his continual encouragement to research as well as "the steadfastness of his leadership in face of natural and human obstacles in bringing television to its present state of perfection," the Committee on Awards of the Television Broadcasters Association in 1944 called him "The Father of American Television."

*Television receivers with 12-inch screens were put on the market by RCA, and regular broadcasting of television programs was instituted by the National Broadcasting Company from its station atop the Empire State Building.

How You See by Television

PRODUCTION OF TELEVISION PROGRAMS, LIKE THE MAKING of motion pictures, begins with the camera.

Actually, the television and movie cameras are much alike in appearance and in their method of functioning. But their mechanisms are entirely dissimilar and that of the television camera vastly more complicated. The latter contains an electronic "eye" and more than sixty other electron tubes which are kept busy putting electrons to work.

The television cameraman looks into a view-finder, which provides him with a view of the scene and also indicates when the lens is in focus. For field use, the camera is mounted on a standard newsreel tripod; in the studio, the camera is fixed on a mobile platform popularly known as a dolly. So far the process does not differ greatly from the motion picture counterpart.

Now let us examine the "eye" upon which the

The television cameraman, looking through a viewfinder, adjusts the lens on the front of the camera which focuses the scene on the image orthicon, or electronic 'eye." Bill Stern, sports announcer in the foreground, describes the game play-by-play.

The image orthicon, or "eye" of the television camera, is examined here by the scientists of RCA Laboratories who developed it—Dr. Albert Rose, Dr. Paul K. Weimer and Dr. Harold B. Law.

television lens focuses the scene. This electronic optic turns the picture into the electronic image which the television transmitter broadcasts in the form of radio waves.

The "eye" of the modern television camera is the image orthicon*, an electron tube which is 100 to 1,000 times more sensitive than its forerunner, the iconoscope. It resembles a 15-inch tubular flashlight with a 3-inch face, and it can see anything that the human eye can see, even in candlelight. And more miraculously, it can see in the dark if invisible infra-red rays are used to "illuminate" the scene. For example, if the camera is in a room that is "pitch dark," it will see everything in the room as if in daylight the instant an infra-red light is turned on, although a person in the room will see nothing.

Briefly, the image orthicon combines, with perfect precision, a series of three electronic actions performed by a photo-sensitive plate, an electron-image "painter," and an electron multiplier. In turn, these elements shape the scene into an electron image, then translate that pattern into electrical impulses and finally multiply the number of electrons at work so that in carrying the scene they will have sufficient electrical strength to travel over the circuits that lead to the broadcast transmitter.

*Developed by Dr. Albert Rose, Dr. Paul K. Weimer and Dr. Harold B. Law, working under the direction of Dr. V. K. Zworykin at RCA Laboratories.

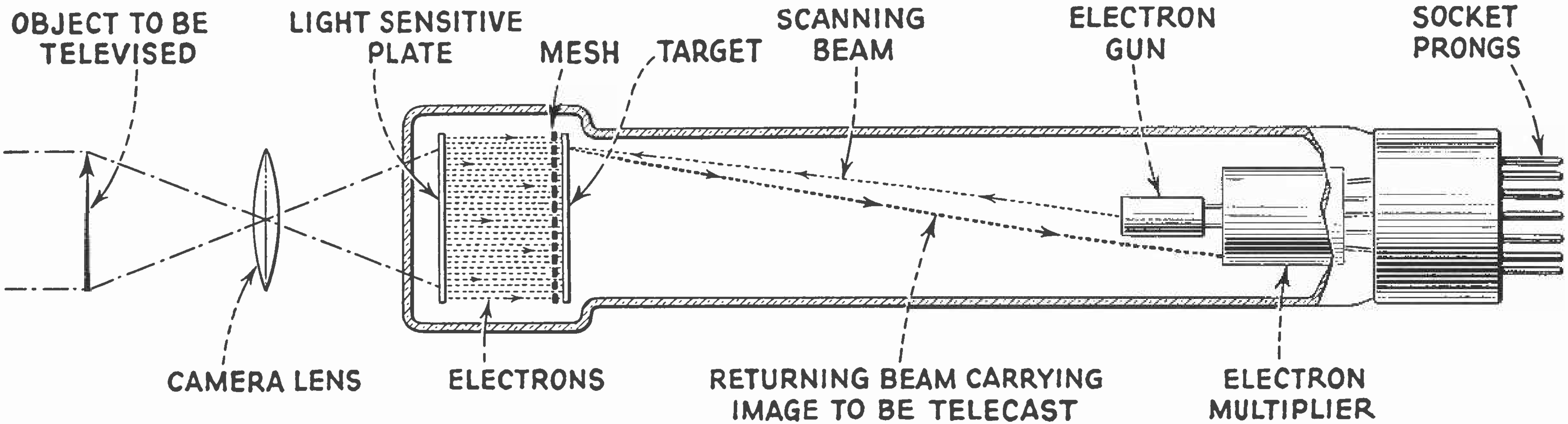
Matching the Human Eye

So complex, so intricate and so delicate is the image orthicon that it must be handmade. For example, one part is a polished piece of nickel about the size of a dime with a hole through its center .0005 of an inch in diameter—one-tenth the thickness of a hair! Another element is a smaller copper mesh which has 250,000 holes to a square inch, to permit electrons to pass through to a glass plate which is only .00013 of an inch thick. In contrast to the photographic film which is covered with an emulsion that reacts chemically when light strikes it, the specially treated surface of the television plate generates an electronic reaction when exposed to light. That action produces an electrical voltage proportional to the intensity of the light.

When a scene with various degrees of brightness is focused on the plate, the areas which have no light upon them generate no voltage; those struck with strong light generate maximum voltage. The portions receiving intermediate light generate voltages to correspond. Together, they comprise an electron pattern, or image, of the scene.

Naturally, if we are to have pictures in motion this pattern must be removed to make way for the next scene. This is done by transferring the electron image, by electrical means, to the glass disk which is called the target.

But the entire image cannot be transmitted at one



Sectional view of the image orthicon camera tube showing how light from an object is converted into electrons and then into electrical signals by the action of an electron gun.

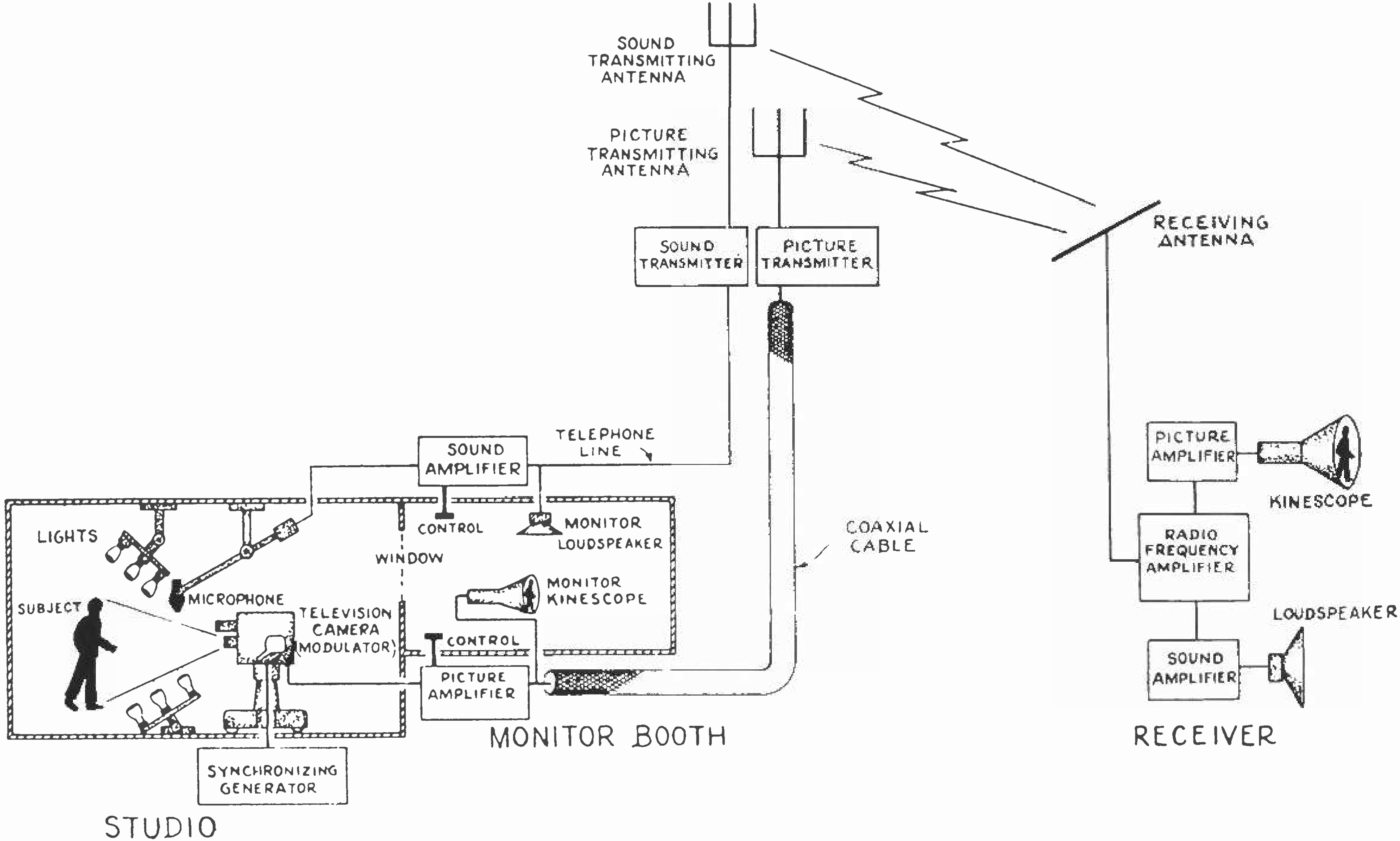
time. It must be broken down into tiny areas and changed into a continuous train of greatly magnified electrical pulses.

A pin-point beam of electrons performs that trick. Shot from an electron gun, also within the tube, the beam sweeps at incredible speed back and forth across the target in 525 accurately spaced lines. In this scanning movement, the beam picks off, one by one, the electrical charge of each little area along the lines of travel.

As the charges—some strong, some weak, according to the brightness of the part of the scene being scanned—are picked off and added to the strength of the electron beam itself, the combined electrons are pulled back by magnetic means to the electron multiplier.

It should be mentioned at this point that in the American system of television, the scanning beam does not begin at the top of the scene and work downward line by line, but instead follows an unusual pattern. That is, the first line is scanned and then the beam jumps to the third line, the fifth, seventh and so on to the bottom of the scene. It then returns to the second line and proceeds to fill in the even numbered missing lines. This is called interlacing and is done in order to eliminate the last trace of flicker effect when the picture is viewed by the human eye.

Although the electron beam, after scanning the target, contains millions of electrons, its energy is so weak that the pulses must be greatly reinforced before they leave the image orthicon. This is the function of the



The electrical-radio route which a television program follows from the studio to the receiver.

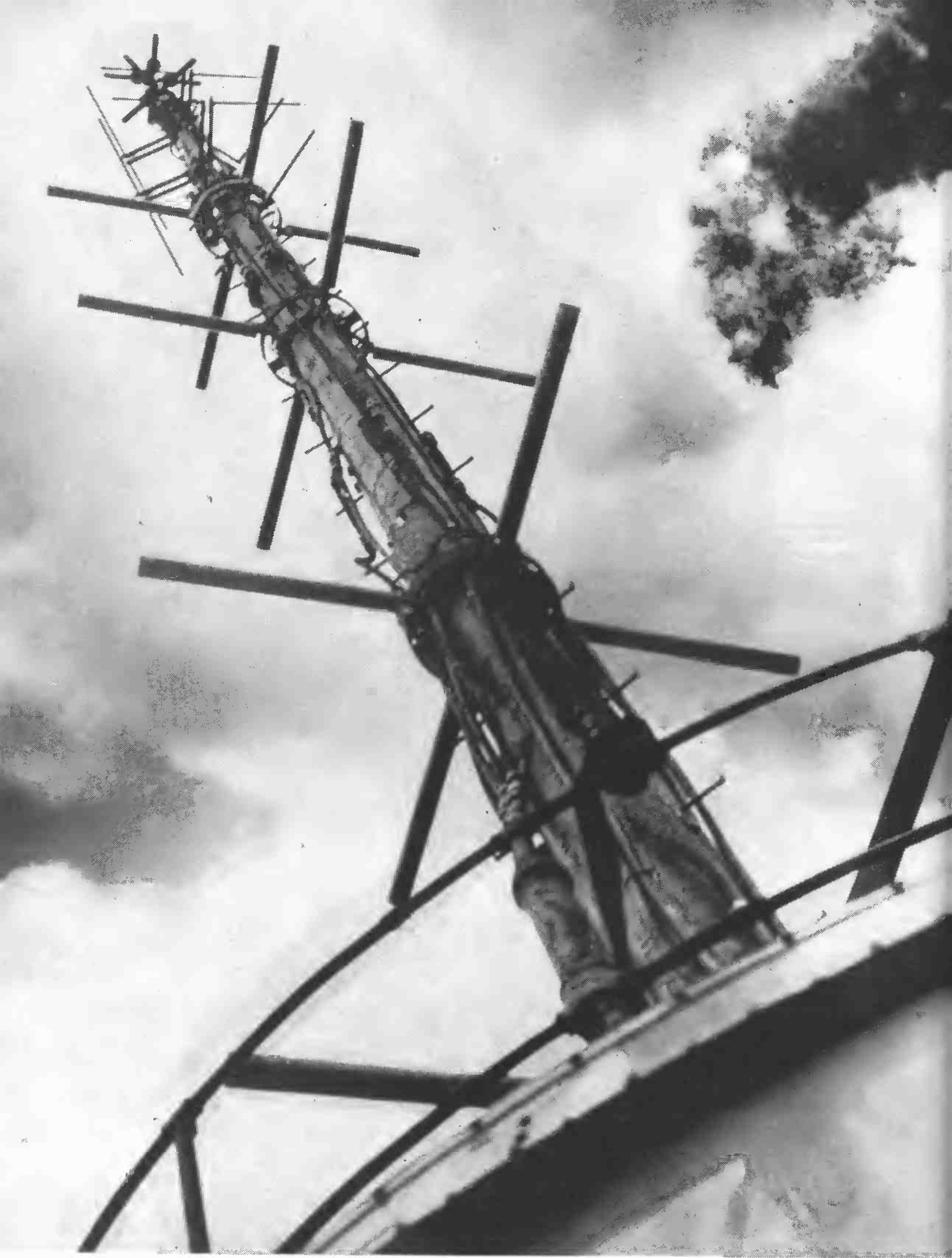
electron multiplier which multiplies the electrons about 500 times, thereby increasing the strength of the picture signal. After leaving the image orthicon, the signal is put through other electronic amplifiers which make it powerful enough to travel over either a coaxial cable or microwave relay to the television transmitter.

Once the television camera "clicks," the scene is in the home in less time than a pulse beat, although the process may be complicated and the distance long. For example, the camera in a studio at Radio City is linked with the NBC station WNBT atop the Empire State Building by coaxial cable, which runs under Fifth Avenue and up to the 85th floor of the skyscraper where the transmitter is located. Or, if the camera is at Palmer Stadium in Princeton, scanning a football game, the scene is sent over a radio beam to an automatic radio relay station at Mt. Rose, less than 5 miles away, and from there it is flashed 45 miles on a radio beam to the main transmitter at Empire State Building, in New York—all in less than a fraction of a second!

Why Lofty Antennas Are Needed

The very short waves of television travel in a straight line; in effect, like a pencil appears when placed against the surface of a basketball. In other words, the waves leave the earth on a tangent, so that usually they do not cover an area more than 25 to 50 miles in radius. Why this should be so, can best be understood by imagining a man standing on the shore looking out to

Radio relay stations with 10-foot "dish" reflectors on both sides pick up the television programs and automatically relay them to another relay station or to the main transmitter if it is within range.



Television antenna of the NBC station, WNBT, atop the Empire State Building, is 1,300 feet above the sidewalks of New York.

sea. Under no circumstances could he see an object on the water, such as a rowboat, more than four miles away. But if the man climbs a 100-foot cliff near the beach, the same object might be seen at a distance of 13 miles. On a 200-foot cliff, his viewing range would increase to about 18 miles. Therefore, the higher the transmitting antenna, the greater the area served by the transmitter.

Theoretically, the limit at which a television signal can be picked up is the area within view from the antenna elevation. For example, the antenna on top of the Empire State Building is 1,300 feet high and a line-of-sight view on a clear day is about 40 miles. But in actual operation, the television waves sometimes "bend" a trifle beyond the horizon and cover a wider radius thus explaining why New York telecasts are seen in Princeton, 47 miles away, at Poughkeepsie 68 miles, and occasionally at greater distances.

If the receiver is too far away from a television station, a higher receiving antenna must be used. For example, if someone in Pennsylvania, 90 miles or more from New York, wants to look-in on the telecasts from the Empire State Building, a high antenna is necssary to provide an approximate line-of-sight view. To demonstrate at what height the New York television waves are traveling when they reach Washington, D. C., an airplane with a television receiver on board had to go up about 18,000 feet before the pictures could be seen.

Relaying Scenes by Radio

It is obvious, therefore, that some means must be provided to "bend" the waves around the curvature of the earth, if programs are to be sent considerable distances from city to city. This need led to the development of the radio relay station and its special antennas. Some of these antennas look like large metal dishes set edgewise on tripods, towers, or atop high buildings. Others have the form of square horns. Actually they are reflectors and collectors, depending on whether they send or receive signals.

On the front of such a saucer-type antenna, and at its exact focal point, is a short rod-like projection. This is a hollow tube, called a wave-guide. When used for transmission it conducts the signal to the parabolic surface of the dish. This in turn reflects it, as a beam, on a straight line to the receiving relay station. There a similar dish-like antenna intercepts the beam and focuses it on its own waveguide, which conducts the signal to a receiver. It is then strengthened and transmitted automatically to the next distant relay point, or to a broadcast transmitter, if the latter is within range.

By being able to point the beam in a desired direction, all the energy is conserved thereby permitting the stations to operate with low power, sometimes as little as 5 watts. Placement of the reflectors on top of buildings, hills, and towers, will make it possible to relay television programs automatically from city to city on

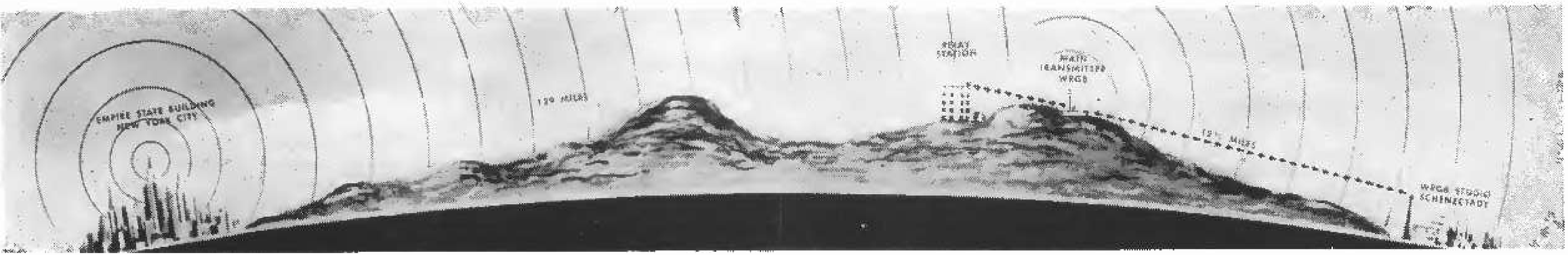
A parabolic reflector, popularly called a "dish," is used to reflect television's microwaves in much the same way that a searchlight projects a beam. The microwave transmitter is contained in a weatherproof cylinder attached to the back of the parabola.

a nation-wide scale. As times go on, broad-band relay stations will dot the countryside, not only to carry television and radio programs, but any other form of electrical communication whether telephone or telegraph, teletype or radiophotos, including facsimiles of written or printed matter in any form, even letters, at unlimited speeds.

Standard broadcasting stations do not require such relays because their longer waves do not leave the earth on a tangent as the television waves do. Furthermore, broadcasting stations can be linked into networks by telephone wires, whereas television, which needs a wider band of frequencies than sound programs, cannot be handled by telephone wires.

Three radio relay stations connect New York and Schenectady, while seven intermediate radio relay stations on hilltops about thirty miles apart link Boston and New York. On the roof of each of these latter relay stations are four microwave antennas, two facing along the beam toward New York, two facing toward Boston. This allows for two-way operation—with one antenna of each pair for transmitting, the other for receiving. These antennas are ten-feet square and incorporate a metal magnetic lens capable of focusing the microwave signals into a sharp beam. At each station there are repeaters, or amplifiers, to keep the signals at proper strength for relaying to the next station.

At the main telecast station, the incoming radio im-



New York-to-Schenectady radio relay link showing how the ultra-short-waves are "bent" across the Catskill Mountains.

Dr. Dayton Ulrey examines the 5-kilowatt power tube developed by RCA, the first electron tube of its kind for transmission of both television sight and sound.

pulses are again amplified and are fed into the transmitter which modulates, or forms, the picture on the outgoing broadcast waves.

Each television channel is 6 megacycles wide—600 times the width of the channel used by a standard broadcasting station. In this 6-megacycle path, sound and sight travel side-by-side. For example, over WNBT New York, the sound is on the 71.75 megacycle channel and the picture is on 67.25 megacycles. A slight separation of the two signals avoids interference. The sound portion of the program is transmitted by FM (frequency modulation), which is the standard method of transmission and reception adopted for television sound.

The Coaxial Cable

Paralleling the development of television and radio relay stations is the coaxial cable, originally developed for telephone purposes. Such a cable connects New York and Washington and is being extended across the continent, so that by 1953 Californians may be looking in on Broadway, and New Yorkers on Hollywood. This new artery provides the wide channel required for television. Incidentally, its eight one-way, or four two-way channels can handle 1,650 telephone conservations simultaneously. Supplemented by radio relay stations, this cable will make it possible to cover the country with television networks, just as telephone wires make up such a web for sound broadcasting stations.

At the Receiver

When the television wave leaves the transmitter, laden with sound and sight, it radiates in all directions, like the ripples on a pond when a stone strikes the surface.

The waves are plucked from space at the home receiver by an antenna—as in broadcasting. This television antenna is known as a dipole. For ordinary reception a so-called "single dipole antenna," which comprises two rods about 40 inches long placed end-to-end about 2 inches apart, is generally used. But a single dipole is not always adequate, especially when undesired reflected signals cause "ghosts," or multiple images. In such cases a "double dipole" may be the solution. This is more sensitive than the "single" one. Both of these antennas are "bi-directional," that is, they receive signals broadside from two directions.

In some locations where man-made static, or "ghosts," are particularly troublesome, another set of rods called reflectors are placed directly behind the dipoles. These reflectors stop the signals coming from the rear of the dipoles, and enhance the desired signals. In locations where the incoming signal is especially strong, the antenna may be placed indoors; but the outdoor antenna is generally recommended for best reception. Incidentally, if snow appears to be falling in a television picture, it may be caused by a weak signal; an improved or higher antenna may eliminate the "snow," and clear up the picture.

The Kinescope

When the incoming waves—both sound and sight—strike the receiving antenna, they cause radio frequency currents to flow down the lead-in wire to the receiving set. The latter is more complex than an ordinary sound radio set, for it is a combination sound-sight receiver designed to reproduce both the picture and its associated sounds. It is a mechanism of intricate circuits, using from twenty-one to forty-eight electron tubes. The main one is the kinescope, or picture tube.

The picture may be viewed directly, if the fluorescent face of the tube is placed on the front of the cabinet, thus serving as its own "screen." That is called "direct viewing." Or the kinescope may be arranged inside the cabinet so that the picture, magnified by lenses and mirrors, is projected on a special screen distinct from the tube face. This is known as a "projection receiver."

In the projection receiver, a special kinescope about four to five inches in diameter is suspended in the console with the fluorescent face of the tube pointing downward toward a bowl-shaped mirror. As the brightly lighted television image appears on the tube face, the light passes downward striking the mirror, which, in turn, reverses the direction of the light beam toward the tube. Surrounding the kinescope like a broad thin collar, is a special lens made of molded plastic, called a correcting lens. The reversed image passes through this lens, which corrects any distortion caused by the

The kinescope, or picture tube, on the fluorescent face of which the television picture appears; an electron gun in the long neck of the tube generates, controls and focuses the electron beam that "paints" the picture on the "screen."

Television takes its place as the "theatre of the home"; this projection receiver presents a picture 15- x 20-inches.

spherical mirror, and then strikes a flat mirror tilted at 45 degrees. The latter reflects the television picture onto the rear of a transluscent screen in the front of the console.

Although the original picture on the small projection kinescope may not be larger than two by three inches, the bowl-shaped mirror enlarges the image to 15 by 20 inches for home receivers, and even to much larger dimensions for auditoriums and theatres.

The funnel-shaped kinescope tube in any case has a flat face or "screen," coated with fluorescent materials which glow when bombarded by electrons. This kinescope, like the camera tube, also has an electron gun in its long glass neck. The electron beam in the kinescope is synchronized precisely with the electron beam in the camera's image orthicon tube. Again, an electron beam "paints" the picture. The incoming television signal varies the intensity of the beam and thereby forms the varying lines of light which make up the picture, as this "paint brush" sweeps across that fluorescent screen. No mechanical "brush" could be moved fast enough, but a beam of electrons can, because it is weightless.

This movement has to be performed at high speed, to "fool" the eye. A motion picture shows twenty-four different pictures, or frames, each second. Television projects thirty frames a second. Such a rapid succession of photographic images creates the illusion of continuous motion and helps to avoid flicker. Even at that rate, flicker would be objectionable were it not for

The electron gun, when sealed in the tubular neck of the kinescope, generates the pencil-like electron beam, or television "paint brush", which sweeps with incredible speed across the fluorescent face of the tube to "paint" the picture.

the fact that the human eye retains an image for a fraction of a second. That is called persistence of vision.

With thirty separate pictures flashed on the screen each second, the observer perceives a continuous motion. It is interesting to note that the television picture tube itself also has this persistence of vision—when you turn off the receiver you may notice a faint after-glow of the picture remaining for an instant on the fluorescent face of the tube.

Microphone Picks Up the Sounds

Television would be a silent picture, if it did not have the roar of the crowds at the ball game or the voices of the actors in the studio. Silent television would never do in this age of talking motion pictures! People have become so accustomed to radio sound that the sound accompaniment of the telecast is taken for granted. The picture may be the main interest, but turn off the sound and notice how lifeless and uninteresting the silent picture becomes!

Having mastered the handling of sound in the art of broadcasting and motion pictures, it was not difficult for radio scientists to couple it with television pictures.

How the Program Is Put Together

In television as in the movies, the microphone, like the camera, is kept out of the picture. In radio broadcasting the mike has always held the center of the stage, and has become a symbol of the art. Not so in television;

Televising the Theatre Guild play, "John Ferguson", with Thomas Mitchell (sitting on the right) in the stellar role.

its actors do not stand in a fixed spot and hover around a microphone. The mike must follow the players, so television has adopted the Hollywood technique of hanging the microphone on the end of a long movable boom, out of range of the camera lens.

So closely is television related to filmdom that the completely equipped television studio also has a projection room, for films and slides are an integral part of the art. Movies and slides enhance the flexibility of television; they are ideal for transitions, for creating moods and for setting the scene. For example, a film view of Niagara might set the locale for a honeymoon; or a picture of the pyramids might create Egyptian atmosphere for a studio drama related to the Nile. Films are to television what recordings are to sound broadcasting. They are particularly useful in presenting the advertising message between the acts, the innings and the rounds. Films are televised by projecting them on the light-sensitive plate of a camera "eye" in the same way that a live scene is focused on the plate.

In the Studio

Every studio, whether it be radio or television, has a nerve center, or control room. There the television program is "edited"; it is the "cutting room," where camera shots are fitted together. But there is no time in television for retakes. The director must take what the cameras see at the spur of the moment; the program is on the air!

Scene in the NBC television studio, New York; note the microphone suspended on a boom, and the cameras that travel on dollies.

Those who have attended studio broadcasts have seen the control men at work in glass enclosed booths. Every field event—baseball, parades, hockey and the like—also has control men nearby with portable equipment. So it is with television. In the NBC television studio at Radio City, the control room is elevated above the studio floor to permit the directors and engineers to have a direct view of the performance.

In the control room the normal operating personnel comprises five specialists—Program Director, Technical Director, Video Engineer and two Audio Engineers, one of whom plays recordings when needed. These men not only put the show together but control the picture quality, switch from camera to camera, produce novel visual effects, regulate the sound and do all sorts of tricks. They sit before viewing screens, which in effect are receiving sets for each camera—one is used for "on-the-air" observation, one for previewing forthcoming shots, and one for exclusive use of the Video Engineer, who also is provided two smaller screens, or oscilloscopes, which present a graphic report on operating conditions. To a layman it looks like a cobweb of bright lines but to the engineer it reveals just how the circuits are functioning.

The Program Director, or Producer, sits at a console or operating desk which permits him to concentrate on the production of the show, unbothered by technical details. During rehearsal and "on-the-air," he uses a microphone to communicate with his Program Assistant on the studio floor. In the NBC television studio at Radio City, the Director speaks through a special low-power transmitter; his assistant below on the studio floor carries a small radio receiver, which operates a tiny earphone that resembles a hearing aid. The "Pocket Ear," as this device is called, is a vest-pocket size radio using small batteries and even smaller tubes. It weighs only a pound. Wherever he moves on the stage, the assistant is thus enabled to cue the actors, cameramen and other crew members and to direct sound effects, while maintaining continuous contact with the Program Director in the control room.

Signals reach the tiny receiver from a high-frequency transmitter installed in the studio ceiling. Although the transmitted power is less than 1/10 of a watt, it is sufficient to give clear reception in any part of a large studio. But it is too weak to cause interference beyond the studio walls.

There is also a cue system leading from the Technical Director in the control room to the cameramen who are similarly equipped with small rubber earphones. Still another cue circuit permits the Audio Engineer to pass instructions to the operator of the microphone boom. And, of course, there are skilled electricians to handle the lights under the supervision of a Light Direction Engineer who is an expert on illumination.

In the Field

In the same way, the cameraman in the field has

Control men in a room adjacent to the television studio manipulate the knobs that monitor the contrast and regulate the lights and shadows of the television picture before it goes on the air.

The mobile television unit is virtually a "television studio on wheels." While the cameras telecast the scene, the 4-foot "dish" reflector relays the signals to the main station. Mounted in the rear is an operating desk for the monitoring controls and power supplies, while directly below the rear windows are six cable reels which permit easy winding and unwinding of the camera cables.

plenty of support from a staff of technicians. Televising events indoors or outdoors is no one man's job. For instance, in picking up a baseball game at the Polo Grounds or Yankee Stadium, the television crew on the spot comprises about fifteen experts including the engineers who monitor the picture and sound. Behind the scenes, in a room under the grandstand or in the mobile television vans outside the sports arena, they watch the images on a screen similar to that used by the standard television receiver. By manipulating knobs they regulate the lights and shadows. Their aim is to send out a sharp, clear picture with normal contrast. The control man is master over the picture in much the same way that the control man who manipulates the knobs at sound broadcasting stations handles the artistry of the musician and the conductor, the singer and the orator.

Alongside the control men are two important experts —the Technical Director and the Field Program Director. They have before them three or four viewing screens. These men are rarely in a position actually to watch the event being telecast; they look upon the game just as if they were viewers at home.

Both of these Directors are in phone communication with the cameramen, and there may be three or more cameras at a baseball or football game. Further assisting is the Commentator, who is located near the camera, and an Assistant Program Director who is in direct contact with the Director. He assists in relaying in-

Control operators inside the telemobile station monitor the pictures of field events before the scenes are relayed to the main television station.

structions to the busy announcer and cameraman, and spots interesting sidelights for both the cameraman and Commentator, or brings guests up to the camera to be televised.

The Program Director, through the Technical Director, tells the cameramen where to point the cameras and what scenes to pick up. As he gives the word, the Technical Director pushes a button that automatically puts the image being focused by a particular camera on the air for the telecast. Throughout the game he literally puts the show together as the cameras are quickly shifted from close-ups to long shots so as to cover every play. Obviously, these men must be "quick on the trigger"; they work with split-second precision and make decisions in a flash. Yet they do it so smoothly that the distant observer has no idea of all the button pushing and camera switching that goes on to keep the game on the air as a continuous picture. Through the keen eyes and quick work of these men the televiewer at home sees many plays and sidelights which the average sports fan misses, even in a grandstand seat.

At the World Series, or any big league game, one camera is in an upper box directly behind home plate affording a straight-line view of the pitcher, batter, and catcher. A second and third camera are placed in a box half-way between the home plate and first base; one for long shots and panoramic views and the other for plays along the baselines.

At football games, two cameras are usually located

Television gives baseball a vast audience counted in numbers never dreamed of in the days when Christy Mathewson was on the mound.

high up in the stands, near the 50-yard line, and a third is placed at a vantage point where crowd activities are likely to be interesting.

At a prizefight, such as the Louis-Walcott bout in Madison Square Garden, four cameras are used in the balcony, about 80 feet from the ring; all can be trained on the ring but one is used chiefly for panoramic views of the arena.

To follow the football down the gridiron, to see the home run drop into the bleachers, to watch the prize-fighter in the ring, the parade on Fifth Avenue, the political candidate on the platform or the actor on the stage, is to realize that television is another, and for the moment the newest, miracle of radio.

And in the spotlight of television, music also reveals that it has visual charms; it plays to the eye as well as to the ear. When Arturo Toscanini first waved his baton across television screens in directing the NBC Symphony Orchestra, he opened a new era in the evolution of musical performances.* The 81-year-old maestro proved to be a dramatic television personality for his face and hands were eloquently telegenic coupled with the grandeur and grace of the rhythmic motion of the baton. The television audience looked directly into his face, caught every expression and every gesture. First, they saw him close-up and then by a touch of electronic magic, the orchestra appeared in the background, first as a complete ensemble and then in groups as the score

*March 19, 1948

The television camera with its telephoto lens, although some distance back from the gridiron, gets a close-up view of the Army-Navy game; usually three, or more, cameras are used for football.

called for musical emphasis by one row of musicians and then another.

In superimposing one television scene on another, in this manner, two cameras are trained on the individual subjects, for instance, one on the maestro and the other on the orchestra. A Technical Director in the control room, watching the images picked up by the separate cameras, turns knobs which allow both scenes to go out on the air together. When desired, either of the two images may be faded in or out to produce the most pleasing effect. At the same time, the brightness of each scene is adjusted to give the proper balance so that one image will not obscure the other.

Greatly impressed by the television performance of Toscanini and the NBC Symphony Orchestra of Beethoven's Ninth Symphony, Olin Downes, music critic of The New York Times, remarked, "We are at the beginning now of a vast new era of scientific development which will affect the arts as it will affect all living . . . Television will bring music by visual as well as audible means nearer to people than has ever happened before in history. This will apply to all specialties of musical performance, and develop more intimacy between the interpreter and the listener than would otherwise be possible." And he added, in the words of the poet, "The seen is proved by the unseen and the unseen is proved by the seen."

Maestro Arturo Toscanini as photographed directly from the face of a kinescope or television picture tube.

What Performers Should Know About Television

WHILE THE SPECTATOR HAS A CONSUMING INTEREST IN the magic of television, the performers who are being televised must also learn more about the workings of this new art. It behooves the politician, as well as the actor, comedian, singer, teacher, newscaster, and commentator, to study television and comprehend how its cameras can be most effective for him. His "radio personality" alone is not sufficient. He must be telegenic. He must revise old formulas, and heed the simple rule that Franklin D. Roosevelt followed so successfully in the era of sightless radio: "Be natural, be yourself!"

For more than twenty-five years, the twenty-six letters of the alphabet have been the bullets of verbal broadcasting. But those days are gone. Now the spoken word by itself, while still important, is not the sole factor in influencing public opinion. A man's personality, his face, clothes, the way he wears his necktie, and the manner of the man himself is of new and cumulative significance. His appearance and his behavior more than ever are in the public eye. Even the decorum of those near the speaker is under constant scrutiny. One observer who watched the people in the background of an important national event noted that while a clergyman was delivering the invocation, a spectator behind him chewed gum in rhythm with the prayer.

Radio broadcasting has had an uncanny way of testing the sincerity of a speaker. Television doubles that uncanniness. Television's electronic eye makes a picture of everything; it reveals hokum like an x-ray. Ear and eye together are not easily fooled. The eye creates vivid, personal impressions—it sees people as they are; spots unnaturalness and exposes artificiality. No longer is it enough to "get the ear of the people"; the eye, too, is to be reckoned with.

Be Yourself

Television is a medium of informality and intimacy. Character and personality no longer are "painted" by words alone; seeing is believing—and that is television's strength. More than ever before, one's face is one's fortune. A natural smile may be worth many a dollar!

Like a new comet, Kyle MacDonnell appeared on television in 1948 to become the talk of the TV firmament, acclaimed as "television's first new star." Why? Because she was natural in every gesture; her cheerful smile, her songs, and her action were of "living-room

Kyle MacDonnell, acclaimed as television's first new star, has the essence of naturalness.

quality." She appeared on the television screen as naturally and graciously as if she had actually joined the family circle. Naturalness, intimacy, and friendliness are her halos of success. She is telegenic! Radio, stage, and screen are not so dependent on naturalness, intimacy, and simplicity as is television.

Thus, because television differs from every other medium, the performer who asks "What are the essentials for popularity?" must first realize that television is the art of scanning and transmitting scenes exactly as they appear to the eye. To be natural is the keynote.

On television characters must fit the parts; scenes must fit the story. Television has no place for the "paper actor"; he must live the part, not read it. A pretty young actress reading a script can play the part of grandma on the radio, but on television grandma must look like grandma.

Television is not the silver screen; it's a living room show. And for that reason televiewers are an audience of critics. They feel the right to criticize because they are the judges of what they want to see in their own homes.

What Politicians Learned

If there had been any uncertainty that television was destined to have a tremendous impact socially and politically, such thoughts were dispelled by the performance of television at the 1948 national political conventions. Before politicians entered the arena at Philadelphia, they were aware that radio itself had

Television cameras scanned the 1948 national political conventions and revealed to the politicians that their old radio techniques, appealing only to the ear, had to be revised to attract the eye as well.

shortened speeches, killed long harangues, and years ago put an end to the spellbinder and hell-roaring oratory.

When the deliberations were over, the same politicians had discovered that television is an even stronger promoter of brevity in speech. It calls for more showmanship and action, and demands less talk. No Demosthenes of television has yet appeared to hold an audience for an hour, or a half hour; the wise man of today condenses his message to 10 or 15 minutes at the most. A veteran politician in estimating that radio had trimmed convention speeches by two-thirds, said that he looked for television to cut them down another third.

Many were the lessons learned about television at Philadelphia. Editorially, The New York Times observed:

> Television made its convention debut in 1940 when Wendell Willkie was nominated by the GOP. This year (1948) the proceedings were more elaborate. There were instructions such as "take the toothpick out of your mouth," "keep your clothes neat," "don't take off your shoes." Still, the directors of the great television show could not foresee everything. Even though they had just risen from a barber's chair, the Governors, Senators, and favorite sons who presented themselves before the video camera looked as unshaven as Bill Sikes in his worst moments. While orators tried to impress 10,000,000 televisionaires scattered all over the country, men and women behind the cam-

> eras chatted about the heat or read newspapers with magnificent indifference.
>
> Only a few had prepared themselves—Governor Dwight Green by acquiring an ultraviolet light tan, many of the women by dabbing themselves with make-up and dressing in dark clothes relieved by white frills around the neck. Since convention speeches were broadcast for the first time in 1924, keynoters have had to consider their voices; now that television has come they will have to consider their double chin and their wilted collars. . . .

At the close of the convention, a Times writer further commented on television's effect on the delegates:

> Flashes of real emotion were exceptional. Most of the time the cheers were pumped up and kept going with visible effort. Among the reasons for the lack of enthusiasm, as conspicuous at the nomination of Warren this morning as in the long-drawn-out demonstration for Dewey last night, is the effect of television in blocking communication between the people in the hall and the people on the stage. When all the play and parade are directed to the spectators outside, and the speakers pose, gesticulate and make up for faraway eyes, the delegates become sightseers or scenery instead of participants in a deliberative assembly.

President Truman appeared at the Democratic National Convention in a white suit and dark tie, which incidentally, seems to be ideal masculine garb for the television cameras. His appearance was rated as "probably his most impressive since assuming office." Warned by radiomen that a speaker cannot project his personality over television if his head constantly bobs up and down over a script, Mr. Truman introduced a semi-ad lib format. He used a minimum of written notes and relied chiefly on extemporaneous remarks which enlivened his address with spontaneity and change of pace.

On the other hand, it was noted that those who read from prepared scripts were greatly handicapped in gaining visual interest, since the tops of their heads were in view most of the time.

How the Critics See It

Television has created a new crop of critics, who have found much to talk about, especially as a result of their watching the political conventions. Some of their observation might be frightening to performers. For example, one reviewer remarked that television "brings you the babble, the heat, the crowd, the chaos, without much information." But television transmits the heat only to the eye. The members of the video audience, who lounge at ease in comfortable seats, realize how fortunate they are to be away from the arena, for the wiping of brows, the fanning of faces, and complaints about the humidity demonstrate vividly that "there's no place like home." There is no denying, of course, that television does bring along the babble, excitement, and pictures of the screeching crowd, but that adds realism to the constant flow of information—

news as it happens! As one writer described it, television is "a new dimension in reporting."

Some newspaper reporters saw indications that television might change their technique, as one reporter said, "Some windbag gets up and yammers for an hour. We cut it and trim it, put it in shape and it reads fairly well the next day. But on television a windbag is a windbag and the people at home aren't going to miss it. We'll have to change the tone of our stuff to fit what these people see."

Several critics complained of the merciless lights, unaware that the excessive brilliance was not required for television but for the movie cameras; television's image orthicon camera operates with normal lighting. The critics also suggested that politicians, as well as entertainers, ought to use make-up; they noted that otherwise beautiful women may be turned into witches. And there was a general observation that the majority of men who face the camera look as if they need a shave. Women are told that if they are to be a "vision of glamour," they must use special make-up, and that they must devote more attention to the style and color of their dresses. It was remarked rather discouragingly by a critic that on the television screen the dress of one female politico looked like "a wrinkled gunny sack with busted eggs smeared on it."

In answer to such criticism, television producers suggest that apparently many of the critics did not have their television receivers properly adjusted. Or possibly the critics were merely looking for oddities to write about, much as radio critics in the Coolidge era commented—when listening to an inefficient loudspeaker—that the candidate's teeth appeared to rattle, that he had laryngitis, or that he sounded as if he were talking in a cave.

Television experts smile at much of the comment directed at their art; they find consolation in the old expression that "the camera doesn't lie." They are quick to admit that those who face the camera must cooperate by looking their best, taking all the advantages possible from dress and make-up. If gestures seem awkward and ill-matched, it is not because of television. Or if the face looks wrinkled, television may not be entirely to blame. Lighting effects are, of course, important and as the television producers learn more and more about lights and shadows, they will overcome some of the odd effects, such as a wrinkle "magnified into a deep gulley," or a double chin that looks triple.

And the producers agree that every man should face the camera cleanly shaved. The higher response of the television "eye," or camera tube, to infra-red rays emphasizes the "whisker effect" by "seeing" below the skin. Pancake make-up helps not only to remove 5-o'clock shadow but lessens the shadow-effect of facial lines. Incidentally, it is this infra-red sensitivity that often makes tuxedo lapels look gray, compared with the rest of the garment. This contrast is caused by the difference in the textures and dyes of fabrics.

The television camera is a complicated instrument that uses, in addition to the main electronic "eye", more than 60 other electron tubes.

Tricks in Technique

While the televisionaire has an academic interest in knowing what television is and how it works, the performer, whether entertainer or speaker, has a professional interest. If the latter is to adapt himself to the new art he must know the tricks and techniques of telecasting.

The actor cannot step over to television directly from Hollywood or Broadway without change of technique. Neither can the radio performer or the orator step from the microphone to the camera without careful preparation. First, it must be realized that television is a new medium and a new art form. It achieves something which no other medium can—it travels directly into the home as a talking picture in motion. Of equal importance, it moves into the living room to be seen by all members of the family; it reaches people in all walks of life and of all ages.

Television is homey. Actors are warned that they must face the shattering truth that few, if any, plays can be televised directly from the stage. The theatre is for an audience having a night out, for which they pay admission. Television on the other hand is intended for millions of small audiences having a night at home free. The difference in result, as a critic described it, is astonishing.

A direct-from-the-stage telecast as viewed at home made every effect too broad, every gesture too expan-

Janet Beecher and Leo Carroll as they appeared in the Theatre Guild's television adaptation of "The Late George Apley"; note the microphone overhead to pick up the sound.

sive, every tone too emphatic. When the leading actress flounced gaily upon the stage and shouted a remark to a character within a few feet of her, it was perfectly clear to the television audience that she was not addressing the character but flinging her voice to the gallery. The gallery folk responded as did the entire theatre. But not the television audience! They saw her close-up, seemingly only a few feet away. The emphasis of the stage was unnecessary. In fact, the effect, as the television critic sensed it, was "like somebody bringing down a sledge hammer on a button, and very much the same as when a misguided politician uses his mass meeting manner when talking to a radio audience."

On several occasions, attempts have been made to televise a radio studio show at the same time it was being broadcast; generally such telecasts have failed despite the fact that star radio performers were on the program. A group of radio actors hovering around a microphone reading scripts make a silly and unnatural performance for television; it lacks spontaneity and appears false as well as amateurish. Of course, it would be easier and less expensive to broadcast and telecast a show simultaneously, but nine times out of ten it cannot be done successfully anymore than the filming of a Broadway play directly from the stage would produce a good film performance.

Already, therefore, television has proved itself a new dramatic medium with its own possibilities, its own

Television cameras scanning a program in a studio at Radio City.

writers, producers and performers, its own techniques and its own plays. Indeed, television is the combining of many arts into a new one that is distinctive in itself. Stardom on the stage, screen or radio is no sure qualification for television stardom.

The rules of the game are relatively simple, more so in many instances than in radio broadcasting which calls for an appeal to the imagination; success in radio programming is often found in the creation of illusion. Not so in television. The eye is on duty as a window to the brain. The imagination is no longer prompted to action by mere sound. Pictures tell the story; little is left for the imagination.

Some Do's and Don'ts

Television is too young an art to have formulated all of its "Do's and Don'ts." Nevertheless, there are a number of self-evident truths to guide both artists and telecasters.

1. *All Performers*—be natural, be yourself, be sincere!

2. *Speakers* will seem far more natural and will hold their audiences more effectively if they speak extemporaneously, or at least appear to. Reading from a manuscript with the head down and eyes fixed on the paper instead of looking at the audience creates a disastrous effect; many in the audience become bored and lose interest. It is realized, however, that the great advantages of a prepared speech are not to be overlooked. But they can be used on television if handled

intelligently and if the speaker is more intent upon his audience than on his script. Those who would read a prepared script will do well to emulate Thomas E. Dewey for he has mastered that art to perfection. In fact, it almost seems that he is speaking without notes or manuscript.

3. *Actors* should memorize their parts and act them naturally; they must cast aside the radio script and act with stage and screen techniques adapted for television.

4. *Comedians* should not perform on television without a studio audience. On the radio, the garb, facial gestures, laugh provoking antics and gestures have gone for naught, but now there is opporunity to use these vital props. With a studio audience, the comedian gains the added advantages of laughter, applause, cues for the proper timing of jokes and other emotional reactions which are infectious. The audience enthusiasm generated in the studio spreads to the television audience.

5. *Sports commentators* should not over-talk; they must remember that the audience is seeing the event too, and that it has seen every play and fistic blow before the commentator can describe it. Sidelights and explanations that will help the audience to understand and enjoy the game are the commentator's specialties; he need not go into such details as to mention that the pitcher is winding up, but to tell who is warming up in the bull pen is an interesting bit of information. The commentator cannot go wrong if he thinks of

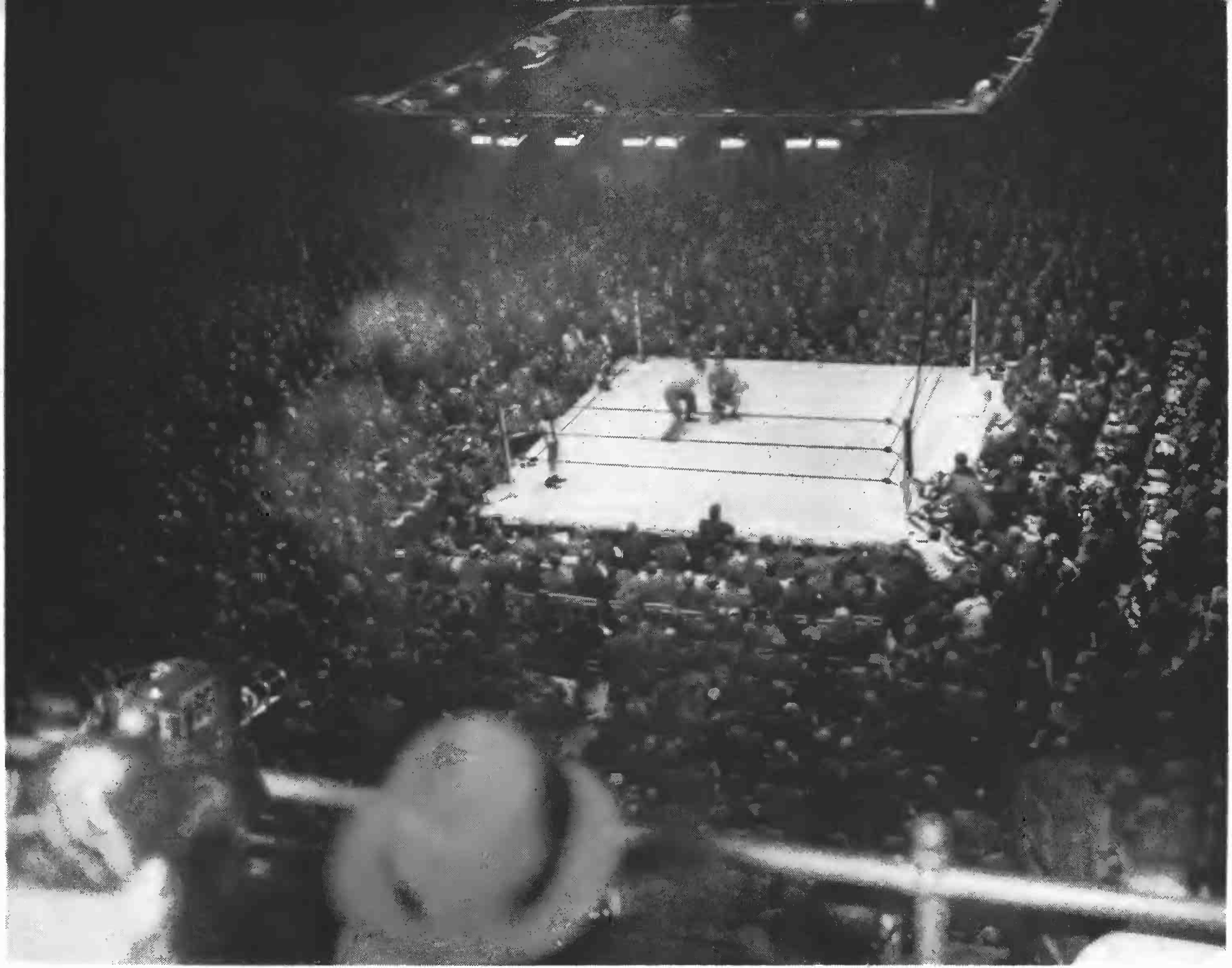
This picture, known as a television recording, was photographed directly from the face of a kinescope picture tube and reveals how Thomas E. Dewey, although using a prepared speech, gives little evidence to the audience that he is reading a manuscript. He looks straight at the television audience as if speaking face to face.

himself sitting alongside a friend in the grandstand or bleachers. Above all, he should not talk too much.

6. *Audience*—those present at an event being televised should remember television cameras may scan them at unsuspected moments, and that they will be seen afar. Therefore, those who are on the platform with a speaker or entertainer should show an interest and be enthusiastic, for the televisionaires may take their cue from them. If the visible audience appears bored and uninterested, its negative reactions may be infectiously broadcast to the telefans. If a person on the platform is reading a newspaper or smelling a bouquet, instead of listening to the speaker, he unwittingly may help to ruin the efforts of the speaker. Audience behavior and appearances within range of the television camera take on a new and candid significance; members of the audience are part of the show and should act accordingly.

7. *Singers*—television, for the majority of vocalists, is more difficult than radio broadcasting. No matter how golden the voice, it is now accompanied through space with a visual personality. The singer must be more of an actor than on the radio, remembering that he or she is entertaining the eye as well as the ear. For diversity to avoid monotony, the cameras should shift to pick up different views of the singer in order to add interest and variety that will fascinate the eye.

8. *Musicians* as soloists or in groups, can be interestingly presented on television provided the camera shots



The prizefight is ideal for television since the scene is well illuminated in an area of limited action; here the camera (lower left) scans a Louis-Walcott fight.

are varied; close-up views can illustrate their art and techniques. Television offers the instrumentalist an opportunity to be an actor as well as a musician.

9. *Conductors*—rhythmic motion, dramatic appeal and facial expressions are features that enliven pictures of the maestro. The electronic "eye" must be shifted to see him from various angles, to show the spirited movement of his arms and hands as well as his facial expressions and dynamic action. Added pictorial interest is gained as the camera sweeps from the conductor to the orchestra, to individual artists, and to the soloist. Also the trick of superimposing one picture on another offers unique effects. As an outstanding example, Maestro Arturo Toscanini has displayed every qualification for television. His artistry has set a superb pattern—a picture that dramatically holds the eye while the grandeur of the music enchants the ear.

10. *Magicians*—television comes to them as an ideal art for they are trained to entertain the eye, and they are the only ones, so far, qualified to fool it without losing favor with the audience.

11. *Cartoonists*—television brings them new opportunity in animation, but there must be showmanship and entertainment in the performance. Caricatures, comics and marionettes all find new life in television.

12. *Newscasters* should be timely and straighforward. To hold attention and to inject added interest, illustrations, maps and charts are often helpful. The newscaster should talk naturally, without the dramatic voice

styles which have characterized broadcast announcers and many news commentators. Above all, he should acquire a technique in reading bulletins which creates the impression that he is talking directly to the viewer as an individual without too obvious references to his script.

13. *Educators*—television brings them great opportunity in that vision accounts for 90 per cent of all learning; the other four senses combined contribute only 10 per cent. But television teachers must not neglect showmanship; they must dramatize and vitalize their lessons and give them increased attractiveness through reality and pictorial timeliness. Television is one of the most potent teaching aids ever developed for both school and mass education. It has tremendous potentialities—unlimited opportunity for illustrated lectures, travelogues, documentary films, demonstrations, and current events. Television brings greater animation, reality and pictorial timeliness into teaching and vastly expands radio's range of teachable topics.

14. *Quiz Groups* should be prepared to anticipate the questions and to avoid delays caused by slow thinking. For example, if the program is a book review telecast, the book should be thoroughly studied in advance, not merely spot read. An "Americana" program calls for knowledge of history and current events. Such programs are generally unrehearsed and therefore, the participants must be well informed, widely read, and alert. Erudition and poise are the essentials. Members

of such groups should think of themselves as meeting with friends in a living-room rather than as participants in a public forum or debate, and abstain from theatrics.

15. *Sponsors*—commercially television, with its widespread power for personal demonstration of products and marked ability to consummate sales, has created a new art form in advertising and merchandising. By so doing it aims to achieve what Hollywood never dared to do, or was convinced that it couldn't. Television for its revenue clings to the radio technique of sponsorship, while the films depend upon the box-office. Telecasters must be subtle in approach and be careful not to oversell; they must adhere to being natural and depend upon showmanship and brevity to make commercials entertainingly telegenic.

Testing Your Television I. Q.

Q. What is television?

A. Radio broadcasting of pictures in motion and associated sound, for reception at a distance.

Q. How is it done?

A. An electronic television camera translates light images into electrical impulses which the television transmitter broadcasts with the associated sound. The telecast is then picked up by a television receiver and the same pictures and sound are recreated on the screen and by the loudspeaker of the television set.

Q. What is a camera tube?

A. The electron tube, or "eye", used in a television camera. This tube reacts to light rays focused on its face by a photographic lens on the front of the camera. It converts the light rays into electrical impulses. Lighting conditions at the scene of the broadcast determine which type of tube is used. These tubes are known as the iconoscope and the image orthicon.

Kinescopes, television picture tubes, on the production line at the RCA plant, Lancaster, Pa.

Q. What is a kinescope?

A. The picture tube in a television set. It reconverts the electrical impulses sent out by a television station into the same pictures seen by the television camera tube.

Q. What is video?

A. This term, the Latin word "to see", is sometimes used in place of the word "television". Technically, it refers to that portion of the television signal that carries the television picture.

Q. How is the sound part of a television broadcast handled?

A. Sound is picked up by regular microphones and broadcast simultaneously with the television picture. The results are perfect co-ordination between picture and sound.

Q. How good is television sound?

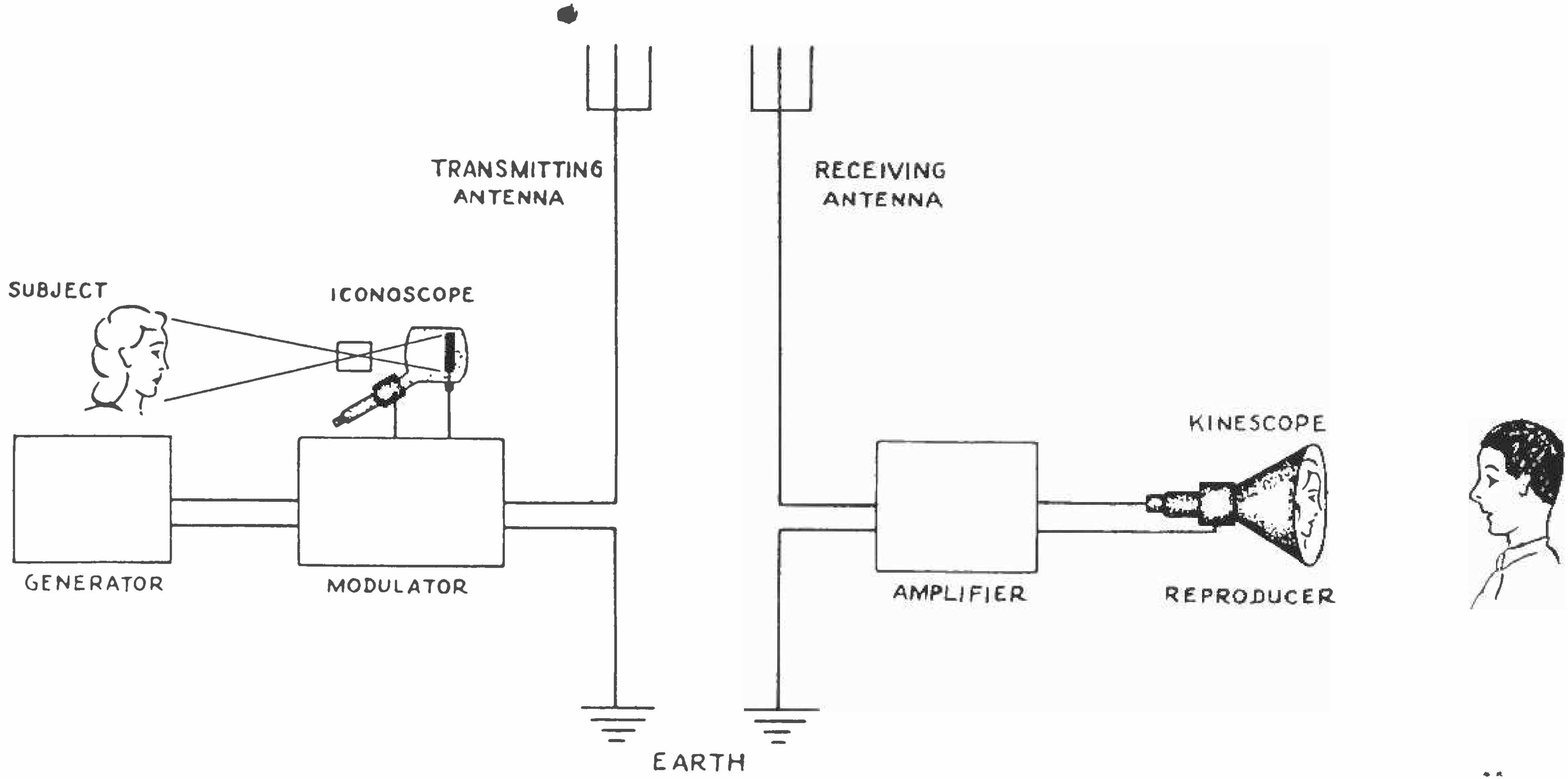
A. Excellent; FM (frequency modulation), which is the standard method of transmission and reception of the sound in television, operates on the higher radio frequencies which have a natural freedom from static and other interferences. It is capable of providing high fidelity service.

Q. What is a telecast?

A. A television broadcast.

Q. How well developed is television?

A. It is a highly developed product of science . . . ready for you to enjoy! RCA introduced it to the public in 1939 at the New York World's Fair. Today, pictures



Simple schematic diagram illustrating the television system.

are bright, clear, steady . . . the result of more than a quarter century of research and development—a project that cost millions of dollars.

WHAT IT COSTS?

Q. What do I have to pay for a television set?

A. Prices vary from approximately $150 to $2,700, depending upon the type of receiver, size of picture and style of cabinet—table model or console. An average price for a home-receiver is $400 including cost of antenna and installation.

Q. How many tubes are in a television set?

A. From 21 to 48 tubes, depending upon the model.

Q. How long will these tubes last?

A. The best answer to this question is the fact that there are television sets which have been in operation from five to seven years without requiring tube replacements.

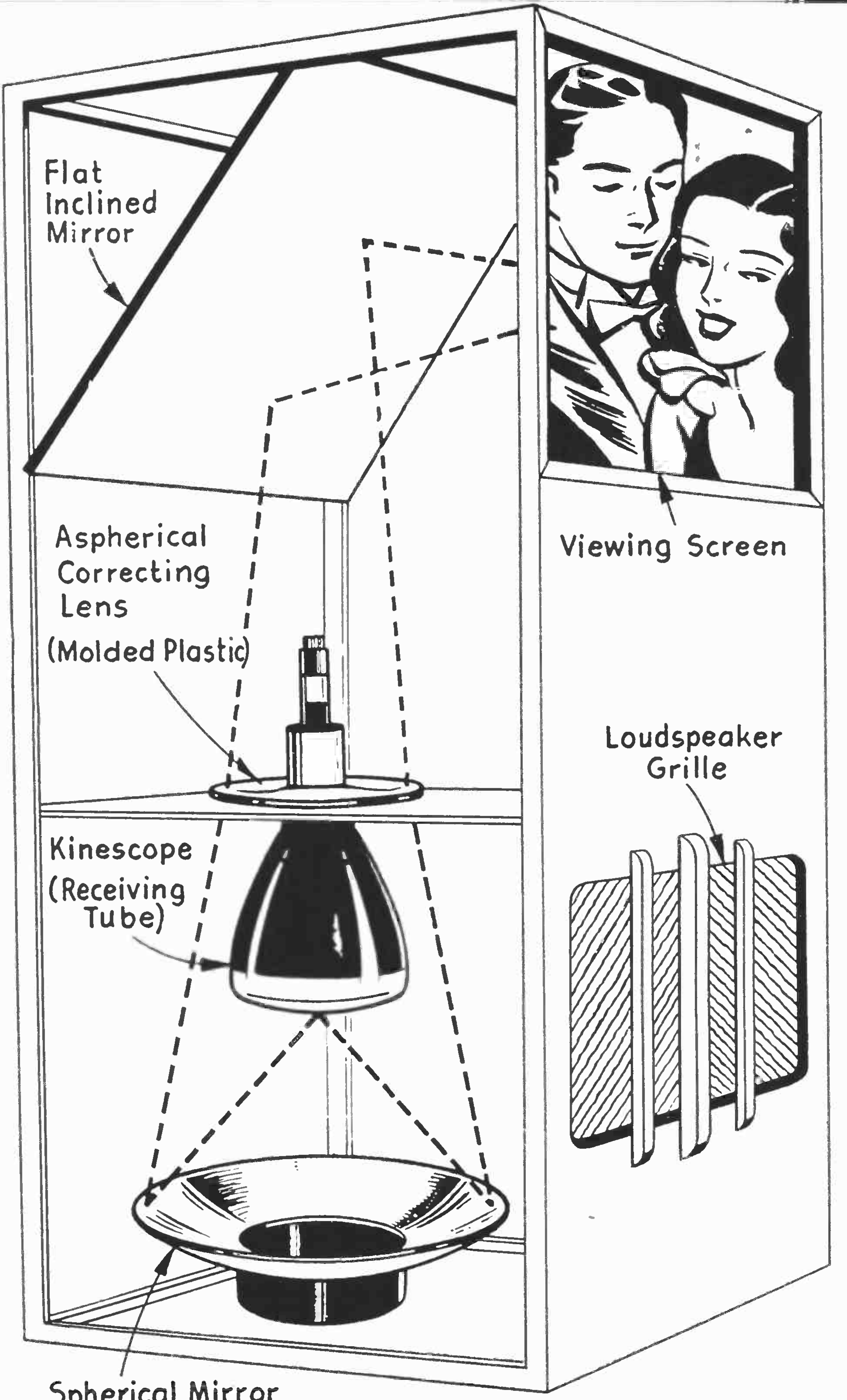
Q. How much does it cost to operate a television set?

A. Usually less than 1c per hour to operate . . . less than an electric iron.

ABOUT TELEVISION PICTURES

Q. How big are the pictures on a television set?

A. Models currently offer screens in three sizes. One is 8½ inches by 6⅜ inches presenting a 52-square-inch picture produced on the face of a 10-inch picture tube; a 16-inch tube offers a 10x13¼-inch picture. The third, or projection type receiver, has a large screen, 15 by



How a large-screen projection television receiver works: Broken lines indicate the path of light beams from a single picture element on the face of the cathode ray receiving tube to a corresponding point on the screen. A plastic lens is used to bring these light beams to a sharp focus on the screen. The combination of spherical mirror and correcting lens delivers to the screen about six times as much light as could be obtained with a conventional lens.

20 inches, giving a 300-square-inch picture, nearly the size of a newspaper page.

Q. How good are these pictures?

A. Pictures are so bright you can see them with room lights on; so clear you see the pleats in a dress, or the perspiration on a boxer's brow; and so steady that they're as good as home movies.

Q. What is meant by direct-view and by projection (big-screen) television?

A. In direct-view television, the picture is viewed as it appears on the end of the picture tube (kinescope). In big-screen television, the picture appears on a screen after being reflected by a mirror from the end of the picture tube and through a lens. An efficient, precision-built optical system, comparable to that in observatory telescopes, is used in the big-screen set.

Q. What is meant by the term "telegenic"?

A. A person who televises well, that is, one who is photogenic.

Q. How many people can watch a television program on a set at the same time?

A. That depends upon the size of the screen and the size of your room. As many as 25 people can see the picture on a table model. Sets installed in public places such as hotels are viewed by even larger groups.

YOUR RADIO SET AND TELEVISION

Q. Must I have a separate radio receiver to pick up the sound for the television set?

Dipole television antenna with reflector rod.

A. No. Television sets give you both picture and sound portions of a television broadcast.

Q. Can I attach my present radio to a television set?

A. No. And there's no reason why you should! Radio and television are two entirely different things. They are broadcast in different parts of the radio spectrum. Separate types of equipment are needed for the transmission and reception of each.

Q. Can I pick up the sound part of a television program on my present radio?

A. No. Television is broadcast on high frequencies—that is, on tiny waves—above the limits that can be picked up by standard broadcast receivers. However, there will be occasions when a program is sent out by radio and by television at the same time. In such cases, it will be possible to see and hear the program on your television receiver and also to tune in and hear the radio version of the same program.

Q. Can a television receiver be used to listen to regular radio programs?

A. Not unless the television set is also equipped with a standard broadcast or FM receiver. The reason is the same as that given in the preceding answer.

Q. Can an indoor antenna be used for television?

A. Yes; but generally best results are obtained from and outdoor antenna erected as high as possible above surrounding buildings, trees, etc. Antennas in the attics of private dwellings often are quite satisfactory, whereas antennas inside of apartment buildings generally are unsatisfactory. In the latter case, the effect is similar to the way in which an auto radio fades when the car passes underneath a steel structure. Steel absorbs television waves as it does radio waves.

Q. Is a standard radio antenna satisfactory for television reception?

A. No; for most efficient results a dipole antenna specially designed for television reception is necessary.

Q. Is a satisfactory centralized antenna system for multiple dwellings, such as apartments, now available?

A. Yes.

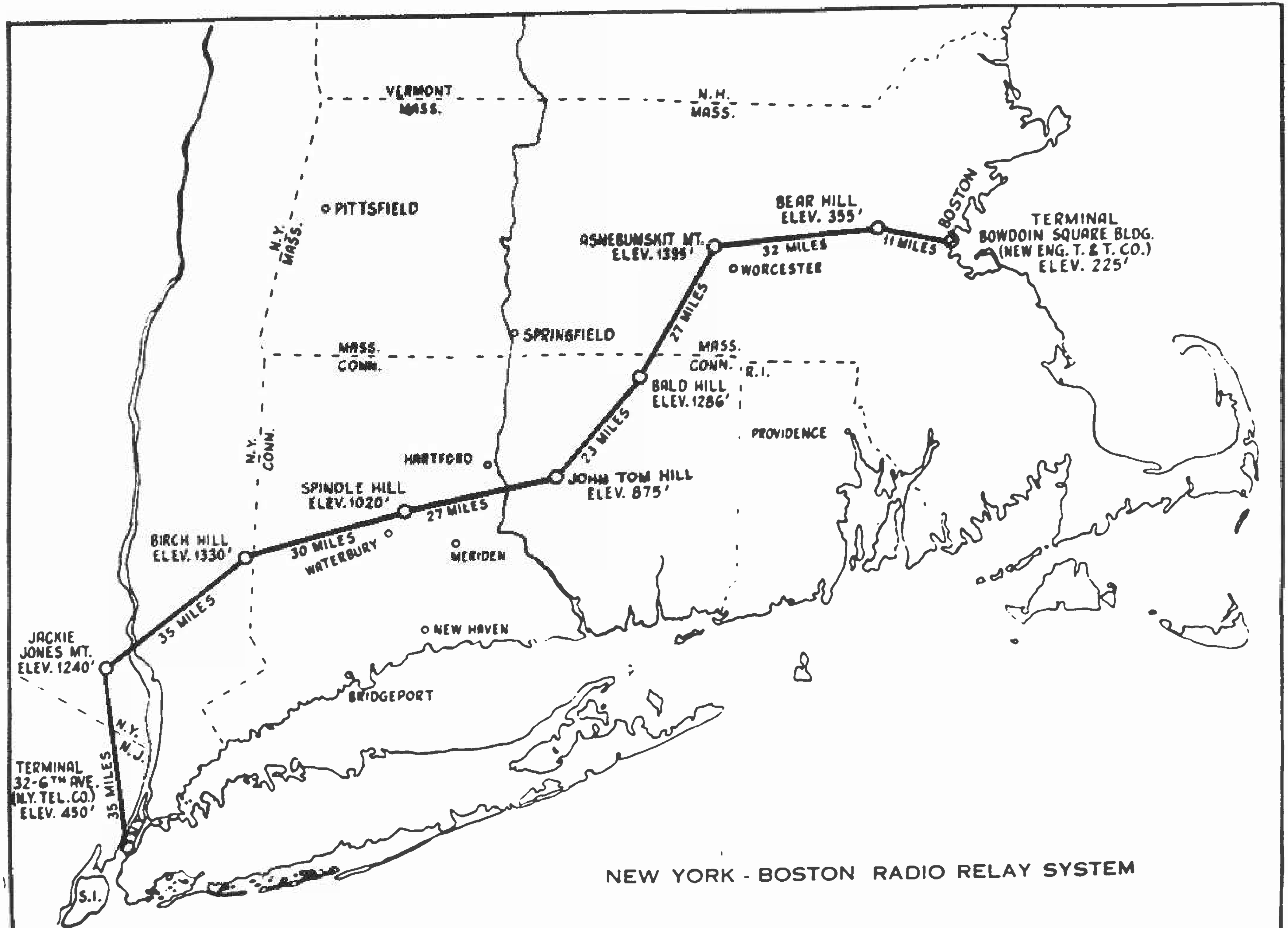
Q. Can picture interference effects, including those caused by electrical machinery, diathermy, automobiles, other receivers and reflections, be eliminated by adjusting the direction of the antenna?

A. Judicious positioning and orientation of the antenna can often minimize interference effects, but not always to a completely satisfactory degree. For example, if the antenna is located as far as possible from the street, the interference caused by automobile ignition systems will be eliminated or greatly reduced.

Q. When television stations serving a particular area are in different directions from the receiving location, can the antenna be adjusted for maximum signal pick-up from all stations?

A. Although the antenna rod, or dipole, must be broadside to a station to pick up maximum signal strength, it becomes necessary, when the stations are in

New York to Boston radio relay system operated by the American Telephone and Telegraph Company, with the automatic relay stations located on seven hills.



different directions, to compromise the orientation.

Q. What is the distinction between a television antenna that is a straight rod and one that looks like a flattened loop?

A. The straight rod antenna is a single dipole; the flattened loop is a folded dipole, and is generally more effective in reception of Channels No. 7 to 13.

TELEVISION PROGRAMS

Q. What kind of programs can I get on television?

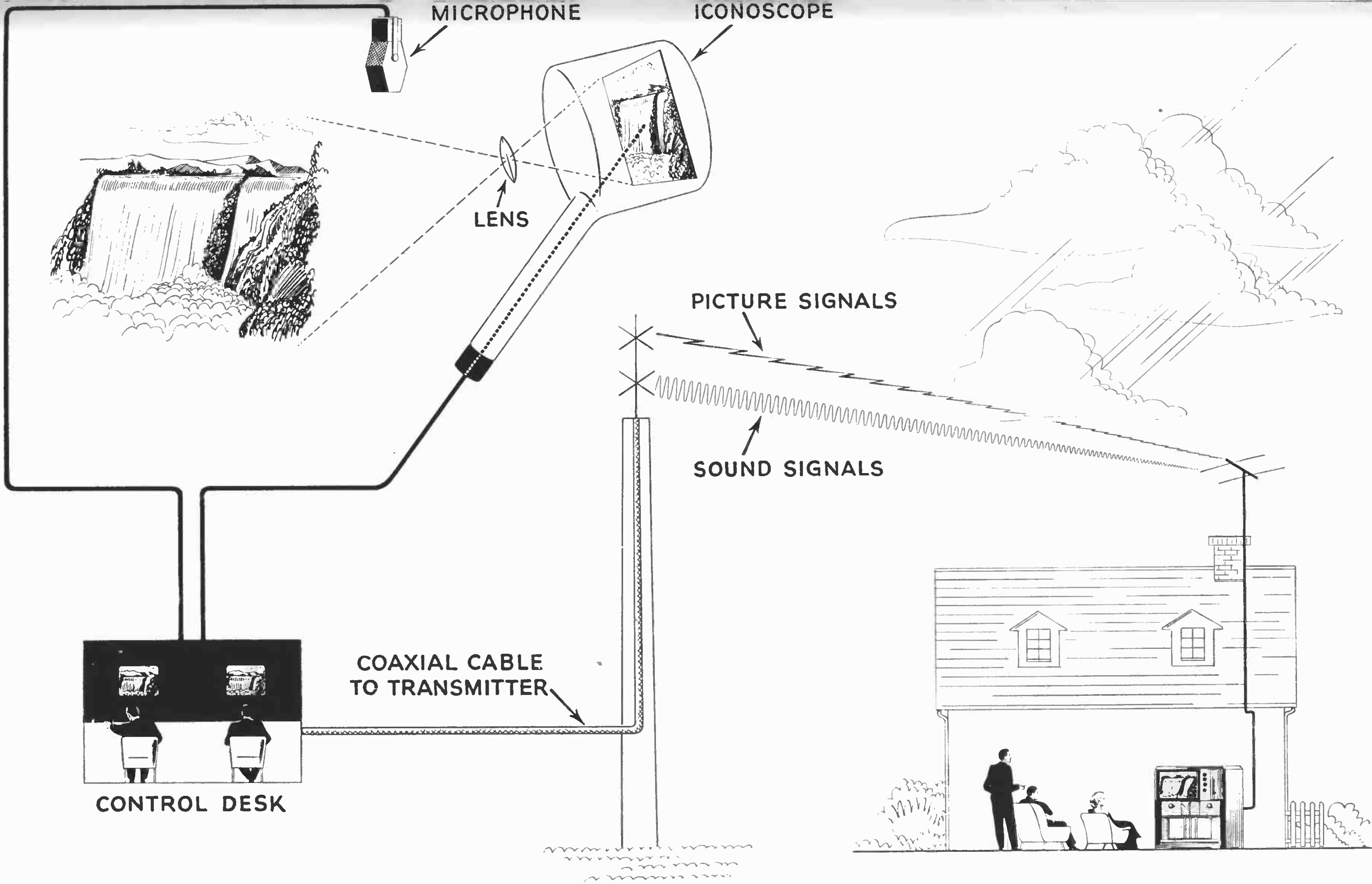
A. There's something for everybody . . . everything from quiz programs and sports to special events such as the opening of Congress. Many programs originate in television studios; others are televised as they happen, where they happen; others are projected from motion picture films.

Q. Will the big-time radio programs and radio stars appear on television?

A. Some of them have and more of them will. New faces will probably replace some of the favorites of both radio and the films . . . as happened in the change from silent movies to the talkies. Comedians, singers, dancers, magicians and vaudeville acts will entertain you by television.

Q. Do I actually see the event as it is happening when I am looking at a television receiver?

A. Yes, provided, of course, that the television camera is on the scene, and the telecast is not from a film. Views of sports events, parades, studio perform-



How a telecast of Niagara Falls would reach the home.

ances and the latest in fashion shows, travel from the spot where they are taking place to your television receiver at the incredible speed of 186,000 miles per second. In addition to these "live" telecasts, films are used to record programs so that they can be presented at hours convenient to you.

Q. How often are television stations on the air?

A. They average a minimum of 4 hours a day on the air. Many are exceeding this figure. In some weeks, New York audiences have enjoyed as many as 60 hours of programs.

Q. What hours are programs on the air?

A. Programs are scheduled so as to be convenient for the greatest number of people. They are generally on the air around noontime, during the afternoon and throughout the evening.

Q. If television should expand into the higher frequencies, will existing television receivers, designed for the original 13 *channels, be obsolete?*

A. No; a simple adapter has been developed which will permit present television receivers to pick up telecasts on the higher frequencies as well as on the channels currently used for television.

TELEVISION STATIONS AND NETWORKS

Q. How many stations can I get on a television set?

A. It depends upon the number of stations in your locality operating within the frequency range your receiver is designed to cover. For example, New York City

Typical coaxial cable showing the eight coaxial conductors (the large cylindrical tubes), and the secondary conductors which are used to carry control signals and power supply to the repeater or booster stations, located every 5 to 7 miles.

has six stations—and will have seven—operating on the channels now (1948) used for television.

Q. Will my television set be able to pick up each new station that comes on the air?

A. Yes, if the new station operates on one of the 12 channels which all modern sets now are designed to receive. But if the new station is assigned a channel beyond the present frequency allocations, an inexpensive adapter will be needed to extend the tuning range of the set.

Q. What about television networks?

A. The ground work has been laid for network television broadcasting. Already several cities are directly linked for network television programs, and it is estimated that coast-to-coast network television will be in operation by 1953, or earlier.

Q. What is a coaxial cable?

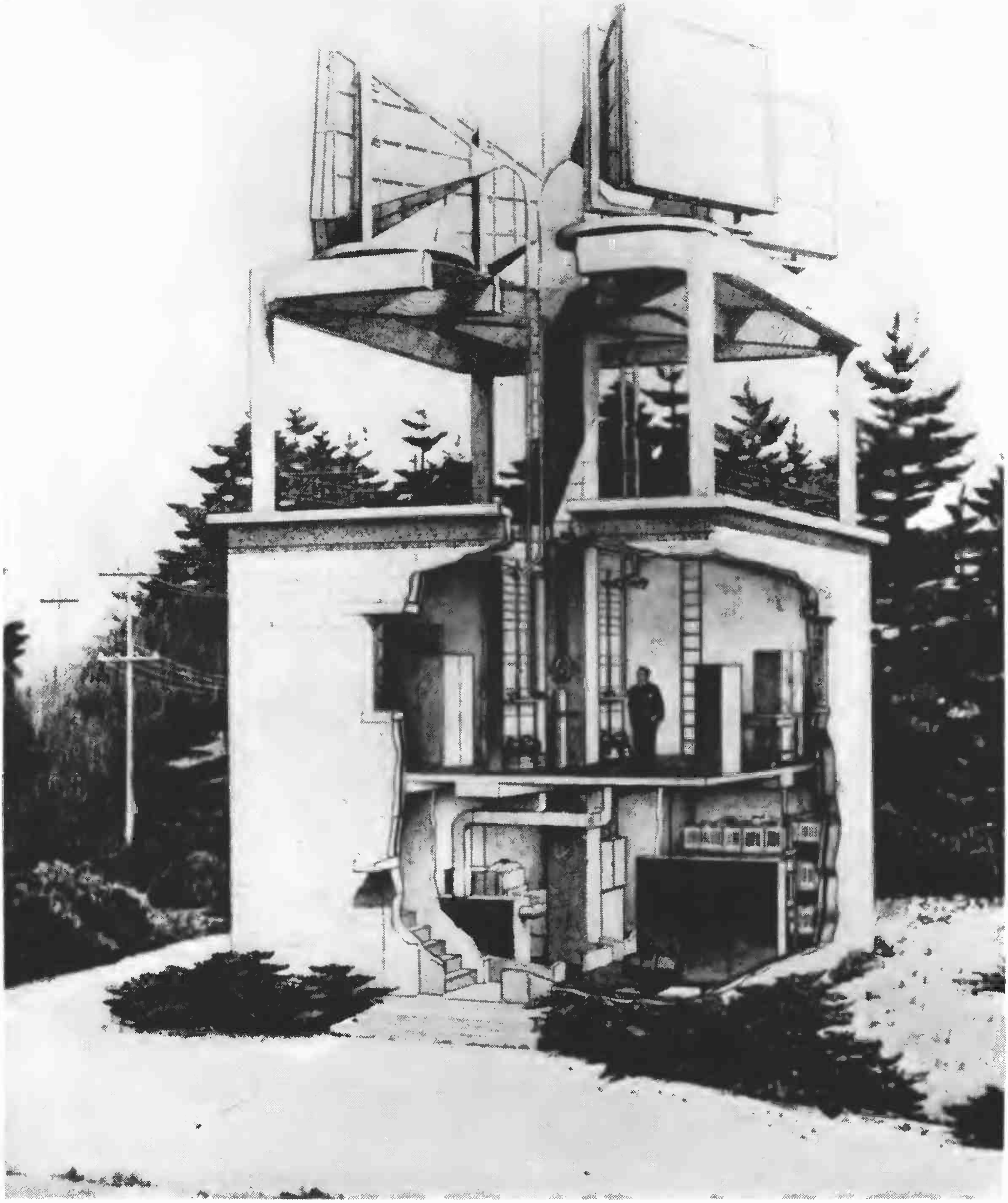
A. This is a special type of cable used for high-frequency transmission in telephony as well as for radio and television programs. It is one of the arteries being used to establish television networks.

Q. What is a television recording?

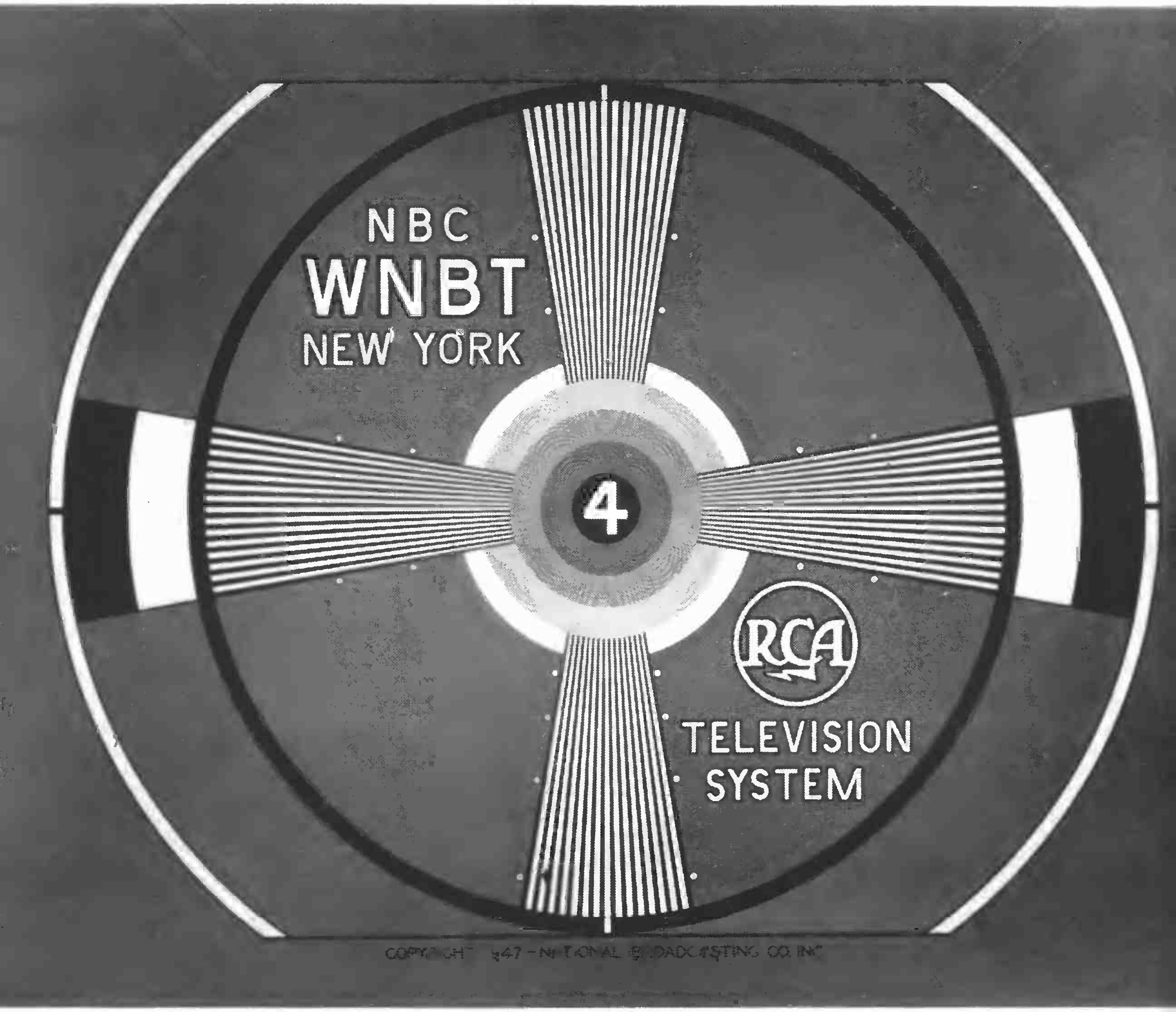
A. A motion picture film made by recording the pictures as they appear on the screen of a kinescope receiving tube.

Q. What is the purpose of television recording?

A. To make it possible for television programs to be distributed for use by television stations that are not connected by coaxial cable or radio relay; and to record



Cut-away view of one of seven radio relay stations on the Bell System radio relay route between New York and Boston, showing the arrangement of equipment in the building. Emergency power equipment and storage batteries are on the first floor, radio equipment on the second floor, and the microwave antennas which feature special electromagnetic lenses that receive and beam the communications signal, are on the roof.



Television broadcasters send out a geometrically-designed test pattern before each program so that the viewer may determine that his set is correctly adjusted. The pattern should be round, clear, and steady with distinct shades, or gradations of black and white. When the set is properly tuned, these five shades of gray are discernible on the circles in the center of the test pattern. The converging lines should be clear and sharply separated all the way to the center. By means of the "brightness control" and the "contrast control" knobs, the observer is able to adjust the various shades of gray in the pattern.

historic telecasts on film.

Q. How far away can I pick up a television station?

A. This depends upon local terrain, the power of the station, height of your antenna and proper installation of your set. Generally, you can directly receive a station 30 to 40 miles.

Q. What is a remote pickup in television?

A. Whenever you see a television program that originates outside the main studios, you're witnessing a remote pickup. Mobile transmitters accompany the television cameramen and flash pictures back to the main television transmitter, which puts the program on the air for reception on your set. You see the event as it is happening.

Q. What is a relay telecast?

A. The television program is passed along by one or more automatic radio relay stations between main television stations thereby relaying the program from one point to another.

Q. Why is the range of a television station less than that of many standard radio stations?

A. Because of the nature of the electromagnetic waves used in television broadcasting. They are tiny waves that travel in a straight line. When they reach the horizon they continue on into space . . . they are not reflected by the upper layers of the atmosphere as in the case of radio waves. The normal range of a television station is the horizon distance, or line-of-sight, that is, as far as the eye can see from atop the transmitting antenna site.

Q. Are there any hazards in operating a television set?

A. No.

A TELEVISION SET IN YOUR HOME

Q. Must I have a special place in my home for a television set?

A. No; locate it for your convenience in viewing.

Q. Is it necessary to darken the room when watching a television program?

A. No; television sets are designed to operate efficiently, with excellent picture brightness and definition under normal lighting conditions in your home—day or night!

Q. Can the set be moved to some other part of the house once it's installed?

A. Yes; providing the proper connection is made between television set and antenna.

Q. Is there any "trick" in tuning a television set?

A. No; the automatic station selector makes it as easy as push-button tuning in radio. Just turn the dial to the channel number of the station you desire. The set is then "locked" in tune with the television station.

Q. What is a television channel?

A. Television channel is the term used to refer to the frequency assigned by the Federal Communications Commission to a specific television station. All you do to tune in any particular television station is turn the station selector to the number assigned to that station.

For example, in New York WNBT, is on channel No. 4; WPIX, on 11; WCBS, 2; WABD, 5; WBEN, Buffalo, 4; WCAU, Philadelphia, 10; WTMJ, Milwaukee, 3; WGN, Chicago, 9; KFI, Los Angeles, 9. When stations are far enough apart they may operate on the same channel without interference.

Q. Why do I sometimes hear a whistle-like tone when the television test pattern is tuned in?

A. The whistle-like note is an audio signal transmitted along with the test pattern to facilitate tuning, and particularly to aid service men in adjusting and checking the sound portion of television sets.

Q. Will my set become out-of-date if I buy now?

The FCC, in establishing present television standards and channels, has indicated that they are as permanent as those assigned to any of the other radio services.

Q. How about color television? What will happen to my set then?

A. Present indications are that color television, at prices and with quality comparable to present black-and-white television sets, is still some years away. In 1946, RCA Laboratories demonstrated its system of simultaneous color television, along with a small, inexpensive radio frequency converter, or adapter, which will permit a regular television set to receive this type of color television in black and white. The converter also enables all-electronic color receivers to pick up the programs of low or high frequency black-and-white transmitters. This will make it possible in the future to introduce all-electronic color without causing obsolescence of black-and-white television sets.

Q. Will people who live in the great rural areas be able to see television programs in their own living rooms?

A. Eventually all parts of the country will be within range of television programs either through nearby local stations, or radio relay stations serving as satellite transmitters which will broadcast local as well as network programs.

Q. Why should I buy a television set now?

A. Because once you see television, you won't want to miss the pleasures it affords; as an 88-year-old observer remarked, "It's incredible; a dream come true—it opens a new world to me and takes me sightseeing to places I never thought I'd see outside of picture books!" Thus, for everyone there is an entire new world of entertainment. It's exciting . . . it's educational . . . it's a lot of fun! Television more than doubles the pleasures of radio; it takes you to distant places in the comfort of your home and provides you a front-row seat in which you become an eye-witness to events as they happen.

Television Glossary

AMPLITUDE MODULATION (AM) — A method of modulating a carrier wave to cause it to vary in amplitude (strength) corresponding to the frequency of the original sound.

ANTENNA — The portion, usually wires or rods, of a radio or television transmitting or receiving system for radiating waves into space or receiving them. Also called AERIAL.

AUDIO FREQUENCY — A frequency corresponding to a normally audible sound wave — between 20 and 15,000 cycles a second.

BAND — A range of radio frequencies within two definite limits and used for a definite purpose. For example, the standard broadcast band extends from 550-1600 kilocycles, television from 54-216 megacycles, and international broadcasting uses several bands between 6,000 and 22,000 kilocycles.

BEAM — A directed flow of radio energy into space.

BLANKING PULSE — A pulse that "blanks out" undesirable signals in television.

BRIGHTNESS CONTROL — Knob on a television receiver which varies the average illumination of the image.

BROADCASTING — Radio transmission, intended for general reception by the public.

CAMERA TUBE — An electron tube in the television transmitting system that translates light rays into corresponding electrical impulses.

CARRIER (or CARRIER WAVE) — The radio wave produced by a transmitter, which may be modulated to carry signals, voice, music, or pictures.

CARRIER FREQUENCY — The number of complete cycles per second (frequency) of a carrier wave.

CATHODE-RAY TUBE — An electron tube in which a beam of electrons from a heated element, the cathode, is used to reproduce an image on the fluorescent face of the tube.

CENTERING CONTROLS — Controls on a television receiver for moving the image to the center of the cathode-ray tube face, or "screen."

COAXIAL CABLE — A cable in which one conductor is accurately centered inside another. Used for high-frequency transmission in telephony, radio and television.

CONTRAST CONTROL — Knob on the television receiver which regulates the brightness of the highlights and shadows by controlling the picture signal strength. Corresponds to volume control in broadcast receivers.

CONTROL ROOM — The room or location where the monitoring equipment is placed for the direction and control of a television program.

CYCLE — A wave pattern that recurs at regular intervals. The number of cycles occurring in one second is the frequency of the wave.

DEAD SPOT — A location where signals from a radio, or television transmitter are received poorly, or not at all.

DEFINITION — The fidelity with which the detail of an image is reproduced by a television receiver. Also called RESOLUTION.

DIPOLE ANTENNA — An antenna, usually one-half wave in length, split and fed at its electrical center. Also called a DOUBLET.

DIRECT CURRENT — Electric current which flows through a circuit in only one direction.

DIRECTIONAL ANTENNA — Any antenna which sends out or receives radio waves better in some direction than in others.

DISTORTION — An undesirable flow in the reproduction of sound or a television picture.

DOLLY — A mobile truck-like platform on which the television camera is mounted to facilitate its movement to different positions in the studio.

ELECTRODE — An essential part inside an electron tube. An electrode may be a filament, cathode, grid, anode, etc., according to its function in producing, controlling, or collecting electrons. Also called ELEMENT.

ELECTROMAGNETIC WAVES — The waves of all radio transmissions.

ELECTRON — The smallest negative electrical charge. Electrons are emitted by the heated cathode in an electron tube.

ELECTRON EMISSION — The process of releasing electrons from an element, as from the cathode of an electron tube.

ELECTRON GUN — Source of a highly concentrated stream of electrons in cathode ray tubes.

ELECTRON TUBE — A vacuum or gas-filled tube for the emission and control of electrons.

ELECTRONIC (adjective) — Pertaining to electrons or to apparatus operating by means of electron emission.

ELECTRONICS — The science of the application of electron tubes in electrical circuits or apparatus. Radio and television are two important branches of electronics.

ETHER — A hypothetical medium assumed to occupy all space and to act as a "conductor" for light, heat and radio waves.

FADING — Variation in the intensity of a received radio signal, generally caused by changes in transmission paths.

FIDELITY — The exactness with which a radio or television system reproduces sound or picture signals.

FIELD FREQUENCY — In television, the number of times per second (sixty) in which the frame area of a scene is fractionally scanned.

FILAMENT — In an electron tube the filament itself may be the cathode, or a heater which raises the temperature of a cathode high enough to cause it to emit electrons.

FLICKER — Abnormal fluctuation in the brightness of motion pictures and television.

FLUORESCENCE — Emission of light under excitation by the energy of electrons.

FLUORESCENT — The property of giving off light when activated by electronic bombardment or by another source of radiant energy.

FLUORESCENT SCREEN — The coating of material on the face of cathode-ray or television tubes, which glows under electronic bombardment.

FOCUS CONTROL — Adjustment on the television receiver which brings the picture into sharp definition.

FOLDED DIPOLE — A television antenna formed by folding back the two outer ends of the dipole rods and connecting them together.

FRAME — A single complete television or motion picture scene. Thirty frames per second are shown on a television screen; twenty-four frames per second are generally used in motion pictures.

FRAME FREQUENCY — The number of times per second a television picture area is completely scanned — 30 times a second.

FRAMING CONTROLS — The adjustments on a television receiver for regulating the picture height and width.

FREQUENCY — The number of cycles completed each second by an electric current or a sound wave.

FREQUENCY MODULATION (FM) — A method of modulation in which the frequency of the carrier wave is varied according to the signal transmitted; thus the frequency is varied while the strength (amplitude) of the carrier wave remains constant. FM is the standard method of transmission and reception of the sound in television.

GHOST — An undesired multi-image appearing effect in the television picture as a result of reflection of waves from buildings and other obstacles.

HEAVISIDE LAYER — A layer of highly ionized air in the upper atmosphere which reflects, or acts as a "mirror" of certain radio waves.

HIGH FREQUENCY (h-f) — Any radio frequency between 3 and 30 megacycles, which is higher than the standard broadcast band.

HORIZONTAL CONTROL — Adjustment on a television receiver for regulation of the horizontal scanning synchronization.

ICONOSCOPE — A sensitive television pickup tube, or camera "eye," invented by Dr. V. K. Zworykin.

IMAGE ORTHICON — Television camera tube which is so sensitive, even under low lighting conditions, that it can televise any scene that the eye can see.

INFRA-RED RAYS — Invisible waves longer than the longest visible red waves, and shorter than radio frequency waves. Also called BLACK LIGHT.

INTERFERENCE — Disturbance in radio reception caused by undesirable signals or stray currents from electrical apparatus, atmospheric, static, etc.

INTERLACED SCANNING — A type of television scanning in which every other horizontal line of the image is scanned during one downward movement of the scanning beam, with alternate lines scanned during the next downward movement.

ION — An electrified particle formed when electrons are added to or removed from an atom of gas.

KILOCYCLE (kc) — A frequency of 1,000 cycles per second.

KILOWATT (kw) — A unit of electrical power equal to 1,000 watts.

KINESCOPE — The television picture tube developed by Dr. V. K. Zworykin in which electrical impulses are translated into picture elements at the receiver.

KINESCOPE RECORDER — A motion picture camera which makes a continuous film record of a television program direct from the face, or "screen" of the kinescope receiver tube.

LEAD-IN — The conductor or conductors in an antenna system which complete the electrical path between the elevated portion and the radio equipment. The television receiver generally is connected to the antenna by a flexible tape-like transmission line which contains two copper wires accurately spaced within a waterproof covering of plastic material.

LINE — A single trace of the electron beam from left to right across a television picture screen. The present American standard is a system of 525 lines to each complete television picture.

LINEARITY CONTROL — A manual control on the television receiver for the adjustment of wave-shapes in scanning.

LOUDSPEAKER — A device which translates electrical impulses of audio frequencies into sound waves of corresponding frequencies.

LUMINESCENT — A material which will give off light without heat when energized by an external source, such as a stream of electrons or light rays.

MAGNIFIER — A lens formed either of glass or by filling a plastic shell with mineral oil, for placement in front of the kinescope "screen" of a television receiver to enlarge the pictures.

MECHANICAL SCANNING — A system, now obsolete, using a beam of light controlled by a rotating mirror, a rotating scanning disc, or similar mechanical device, to separate an image into a rapid succession of narrow lines which can be converted into electrical impulses, as in a television transmitting system. In the mechanical method a scanning disc also is used at the receiver.

MEGACYCLE — A million cycles.

METAL TUBE — An electron tube with a metal envelope.

MICRO — A prefix meaning one millionth, as microvolt.

MICROPHONE — A device which translates sound waves into electrical impulses of corresponding frequencies.

MICROPHONE BOOM — An adjustable crane from which the microphone is suspended.

MICROWAVES — Radio waves less than one meter in length.

MILLI- — A prefix meaning one thousandth, as milliampere.

MODULATION — A process by which a carrier wave is varied in frequency, phase, or amplitude by the imposition upon it of the electrical impulses corresponding in frequency to radiotelegraph code, sound, or television signals.

MOSAIC — Photo-sensitive plate in the iconscope television camera pickup tube.

MULTIPATH EFFECT — The condition which results when radio waves are received at slightly different times because they are traveling over paths of different lengths. (The multi-image effect is called a ghost.)

NETWORK — A group of television stations connected by radio relays or coaxial cable so that all stations may simultaneously broadcast a program.

ORTHICON — Television camera tube, or "eye." (See Image Orthicon.)

PANNING — Rotating a television or motion picture camera in either a vertical or horizontal plane, or both, to keep a moving object within picture range.

PERSISTENCE OF VISION — A characteristic of the human eye which causes it to hold the image of a scene for a brief period, normally about one-thirtieth of a second.

PHOTO-ELECTRIC EMISSION — Emission of electrons from certain materials when exposed to light.

PHOTOTUBE — An electron tube in which variations in applied light cause corresponding variations in electron emission.

PROJECTION TELEVISION — A combination of lenses and mirrors which projects an enlarged television picture on a home receiver screen, or on a theatre screen.

QUARTER-WAVE ANTENNA — An antenna the electrical length of which is one-quarter the wavelength of the signal to be transmitted or received.

RADIO — Communication through space by means of electromagnetic waves for transmission and reception of messages, sounds, photographs and pictures in motion without the use of connecting wires.

RADIO CHANNEL — A band of frequencies allotted by the Federal Communications Commission to each station for radio, communication and broadcasting purposes. At present, the width of standard television channels is

6 megacycles; FM, 200 kilocycles; standard radio broadcast channels are 10 kilocycles wide.

RADIO RELAY — A station which automatically relays, or retransmits television or sound programs to increase the service area.

RADIO WAVE — An electromagnetic wave produced by rapid reversals of current flow in a conductor known as the antenna, or aerial. Such a wave travels through space at the speed of light, 186,000 miles a second.

RASTER — The illumination created by the scanning lines on the cathode-ray screen when no television picture signal is being received.

RECTIFIER — A device for changing alternating current into direct current.

REFLECTIVE OPTICS — A system of mirrors and lenses used in PROJECTION TELEVISION. (Also called SCHMIDT OPTICS.)

SCANNING — Action of the electron beam in traveling line-by-line across the mosaic or photosensitive plate in the television camera pickup tube, also across the face of a kinescope.

SCANNING LINE — In television, a single continuous narrow strip, one of the 525 lines comprising a complete picture.

SELECTIVITY — The degree to which a radio receiver can accept the signals of one station while rejecting those of all stations on adjacent channels.

SENSITIVITY — The degree to which a radio receiver or other device can detect weak signals.

SERVICE AREA — The region surrounding a broadcasting station in which that station's signals can be received with satisfactory results.

SHORT WAVES — Radio waves shorter than those within the standard broadcast band, from 1.6 to 30 megacycles.

SIDEBANDS — The bands of frequencies on each side of the carrier frequency produced by modulation.

SIGNAL — The intelligence, message, or effect conveyed in radio communications.

SIGNAL-NOISE RATIO — The relative strengths of a radio signal and static at a given location.

SPECTRUM — The entire range of electromagnetic radiations, from the longest known radio waves to the shortest known cosmic rays. Light, the visible portion of the spectrum, lies about midway between the two extremes.

SPOT — Focal point of the electron beam on a television screen as it scans the picture.

STATIC — Extraneous noises heard in a radio receiver caused by atmospheric electricity or by man-made electrical devices.

SUPER-HIGH FREQUENCIES (shf) — 3,000 to 30,000 megacycles.

SUPER TURNSTILE ANTENNA — An efficient radiator of television signals comprising a series of wing-like grids, resembling a turnstile, spaced along the length of the antenna mast. (Also called "BAT-WING ANTENNA.")

SUPERHETERODYNE RECEIVER — A radio receiver in which the received signal voltage is combined with the voltage produced by a local oscillator. The resulting voltage of an intermediate frequency then is amplified and detected to reproduce the original signal.

SWEEP — The uniform and repeated movement of an electron beam across the face of a cathode-ray tube.

SWEEP CIRCUIT — Scanning circuit.

SYNCHRONIZATION — The process of keeping the electron beam on the television receiver screen in the exact position relative to the scanning beam at the transmitter.

TELEVISION — The radio or electrical transmission of a succession of images and their reception in such a manner as to give a substantially continuous and simultaneous reproduction of an object or scene before the eyes of a distant observer.

TEST PATTERN — A drawing usually comprising a group of lines and circles, in various shadings, broadcast for television test and adjustment purposes.

TRANSMITTER — Equipment for generating and sending radio signals.

ULTRA-HIGH FREQUENCY (uhf) — Standardized to refer to frequencies between 300 and 3,000 megacycles. Waves of these frequencies are called microwaves.

VERTICAL CENTERING — The vertical adjustment of the position of a television picture on the screen.

VERTICAL HOLD — A manual control for adjusting the vertical scanning synchronization in television.

VERY HIGH FREQUENCY (vhf) — Standardized to refer to frequencies of 30-300 megacycles.

VIDEO — A Latin word meaning "to see." It is applied as a prefix to the name of television parts or circuits which carry picture signals.

VIEWING MIRROR — A mirror used in some television receivers to reflect the image formed on the screen of the picture tube at an angle convenient for viewing.

WATT — The unit of electrical power.

WATTMETER — A meter used to measure the power being consumed by an electrical device, in watts or kilowatts.

WAVEGUIDE — A hollow tube, usually of metal, or a dielectric cylinder which conducts electromagnetic waves.

WAVELENGTH — The distance between successive peaks of the same polarity in a wave. It corresponds to the distance traveled by the wave in one cycle.

WAVE TRAP — A resonant circuit connected into the antenna system of radio or television receivers to suppress signals at a particular frequency.

TELEVISION STATIONS

(As of September 15, 1948)

CALL	CHANNEL	LOCATION	OWNER
KOB-TV	4	Albuquerque, N. M.	Albuquerque Broadcasting Corp.
WSB-TV	8	Atlanta, Ga.	Atlanta Journal
WAAM	13	Baltimore, Md.	Radio-Television of Baltimore
WMAR-TV	2	Baltimore, Md.	Abell Co.
WBAL-TV	11	Baltimore, Md.	Hearst Radio
WBZ-TV	4	Boston, Mass.	Westinghouse Electric Co.
WNAC-TV	7	Boston, Mass.	Yankee Network
WBEN-TV	4	Buffalo, N. Y.	Evening News
WNBQ	4	Chicago, Ill.	National Broadcasting Company
WBKB	4	Chicago, Ill.	Balaban & Katz
WGN-TV	9	Chicago, Ill.	Chicago Tribune
WENR-TV	7	Chicago, Ill.	American Broadcasting Co.
WLWT	4	Cincinnati, Ohio	Crosley Broadcasting Corp.
WEWS	5	Cleveland, Ohio	Scripps-Howard
WWJ-TV	4	Detroit, Mich.	Evening News
WBAP-TV	5	Ft. Worth, Tex.	Carter Publications
KTSL	2	Los Angeles, Calif.	Don Lee

KTLA	5	Los Angeles, Calif.	Television Productions
KFI-TV	9	Los Angeles, Calif.	E. C. Anthony
WTMJ-TV	3	Milwaukee, Wisc.	Milwaukee Journal
WATV	13	Newark, N. J.	Bremer Broadcasting Corp.
WNHC-TV	6	New Haven, Conn.	Elm City Broadcasting Corp.
WCBS-TV	2	New York, N. Y.	Columbia Broadcasting System
WNBT	4	New York, N. Y.	National Broadcasting Company
WABD	5	New York, N. Y.	Du Mont
WPIX	11	New York, N. Y.	N.Y. Daily News
WJZ-TV	7	New York, N. Y.	American Broadcasting Co.
WPTZ	3	Philadelphia, Pa.	Philco
WFIL-TV	6	Philadelphia, Pa.	Triangle Publications, Inc.
WCAU-TV	10	Philadelphia, Pa.	WCAU, Inc.
WJAR-TV	11	Providence, R. I.	Outlet Co.
WTVR	6	Richmond, Va.	Havens & Martin
KDYL-TV	2	Salt Lake City, Utah	Intermountain Broadcasting Corp.
WRGB	4	Schenectady, N. Y.	General Electric Co.
KSD-TV	5	St. Louis, Mo.	Pulitzer Publishing Co.
KSTP-TV	5	St. Paul, Minn.	KSTP, Inc.
WSPD-TV	13	Toledo, Ohio	Fort Industry
WTTG	5	Washington, D. C.	Du Mont
WNBW	4	Washington, D. C.	National Broadcasting Company
WMAL-TV	7	Washington, D. C.	Evening Star Broadcasting Corp.

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INDEX

Actors, 69, 78-80, 82, 84
Advertising, 52, 88
Alexanderson, Dr. E. F. W., 23
Antenna, 34, 36, 37-44, 96, 97-100, 111, 112, 114, 120
Audience, 84
Audio engineer, 54, 55

Baird, John Logie, 23
Baseball, 58, 60
Bibliography, television, 124-125
Broadcasting, 18-20, 40, 61, 111

Camera, 13, 23, 26-34, 51-64, 76, 89, 111
Camera man, 27, 51-64
Cartoonists, 86
Cathode-ray tube, 23, 112
Channels, 43, 102, 104, 108-109, 118-119
Coaxial cable, 34, 43, 103, 104, 112
Color television, 109-110
Comedians, 82
Commercial announcements, 88
Conductors, 86
Control room, 54-60, 112

Definitions, 111-121
De Forest, Lee, 19
Dewey, Thomas E., 72, 82, 83
Dipole Antenna, 44, 96-100, 112, 114
Downes, Olin, 64

Educators, 87
Electromagnetic waves, 16-17, 113, 120
Electron, 113
Electron beam, 32, 49
Electron gun, 32, 49, 113
Electron multiplier, 29, 31, 33-34
Electron tube, 19, 23, 25, 26-35, 45, 46, 93, 113
Electronic television, 23-25, 26-64
Electronics, 113
Empire State Building, 25, 34, 36, 37
Ether, 16-17, 113
Eye, how it functions, 11-13, 48, 50

Faraday, Michael, 15
Federal Communications Commission, 108, 109, 118
Fessenden, Reginald A., 19
Field events, 55-62
Films, 52, 100, 102, 104-105
Fleming, John Ambrose, 19
Fluorescence, 48-50, 114
FM (Frequency Modulation), 43, 91, 115
Football, 60, 62
Frames, 48, 114

Ghosts, 44, 115
Glossary, 111-121
Green, Dwight, 72

Heaviside, Sir Oliver, 17
Heaviside layer, 115
Henry, Joseph, 15
Hertz, Heinrich, 16-17
Huygen, Christiaan, 16

Iconoscope, 23-25, 91, 115
Image orthicon, 28, 29-34, 74, 89, 115
Infra-red rays, 29, 115
IQ, television, 89-110

Jenkins, Charles Francis, 20-23

Kinescope, 23-25, 45-50, 91, 95, 116
Kinescope recorder, 116. See Recording

Law, Dr. Harold B., 28, 29

Light, its relation to television, 11-17
Luminescent, 114. See Fluorescence

MacDonnell, Kyle, 67-69
Magicians, 86
Make-up, 71, 72, 75
Marconi, Guiglielmo, 17
Maxwell, James Clerk, 15-16
Mechanical system, 20-23, 117
Microphone, 50, 52, 91
Musicians, 84, 86

National Broadcasting Company. See NBC
NBC, 25, 36, 54-55, 62, 64
NBC Symphony Orchestra, 62, 64
Networks, 3, 38-43, 99, 101, 104, 105, 118
Newscasters, 86-87
Nipkow, Paul, 20

Orthicon. See Image Orthicon

Performers, 66-88
Picture tube. See Kinescope
Political conventions. See Politics
Politics, television in, 66-67, 69-75, 81-82, 83
Prizefight, 62, 85
Producer, 54
Program director, 54, 56, 58, 60
Programs, 50-64, 100-102
Projection receiver, 45-48, 93-95, 118

Quiz groups, 87-88

Radio, relation to television, 97-98, 118
Radio Corporation of America. See RCA
Radio relays, 3, 33, 35, 38-43, 55-62, 99, 105, 107, 119
Radiotelephony, early developments, 19
Range, of television, 34-37, 102, 104
RCA, 25, 91
RCA Laboratories, 23, 29, 109

Receiver, 13, 14, 44-50, 91, 93-97, 100-104, 107-110
Recording, 104, 116
Roosevelt, Franklin D., 66
Rose, Dr. Albert, 28, 29

Sarnoff, David, 23, 25
Scanning, 20-23, 32, 115, 117, 119, 121
Schenectady, 41
Screen, 45-50, 93, 95
Singers, 84
Sound, 43, 50-52, 91, 97
Speakers, 81-82
Sponsors, 88
Sports, 59-63, 82, 85
Sports commentators, 58-60, 82
Stage plays, 77-82
Stations, television, 122-123
Steinmetz, Charles Proteus, 17
Studio, 52-55
Superheterodyne, 120
Synchronization, 120

Technical director, 54-64
Telegenic, 95
Television,
  actors, 69, 78-80, 82, 84
  advertising, 52, 88
  antenna, 34-44, 96-100, 111, 112, 114, 120
  audience, 84
  baseball, 58, 60
  bibliography, 124-125
  camera, 13, 23, 26-34, 51-64, 76, 89, 111
  cameraman, 27, 51-64
  cartoonists, 86
  channels, 43, 102, 104, 108-109, 118-119
  coaxial cable, 34, 43, 103, 104, 112
  color, 109-110
  comedians, 82
  commercial announcements, 88
  conductors, 86
  control room, 54-60, 112
  cost of receivers, 93-94
  definitions, 111-121
  dipole antenna, 44, 96-100, 112, 114

directors, 52-64
do's and don'ts, 81-88
educators, 87
electron beam, 32, 49
electronic "eye", 22-25, 26-34, 45-52
electron gun, 32, 49, 113
evolution of, 11-25
field events, 55-62
films, 52, 100, 102, 104-105
fluorescence, 48-50, 114
FM, 43, 91, 115
football, 60, 62
frames, 48, 114
ghosts, 44, 115
glossary, 111-121
how you see by, 26-64
iconoscope, 23-25, 91, 115
image orthicon, 28, 29-34, 74, 89, 115
IQ, 89-110
kinescope, 23-25, 45-50, 91, 95, 116
light's relation to, 11-17
magicians, 86
make-up, 71, 72, 75
mechanical system, 20-23, 117
music, 62-64
musicians, 84, 86
NBC, 25, 36, 54-55, 62, 64
networks, 3, 38-43, 99, 101, 105, 118
newscasters, 86, 87
performers, what they should know about TV, 66-88
politics, 66-67, 69-75, 81-83
prizefight, 62, 85
programs, 50-64, 101-102
projection receiver, 45-48, 93-95, 118
questions and answers, 89-110
quiz groups, 87-88
radio relays, 3, 33, 35, 38-43, 55-62, 99, 105, 107, 119
range, 34-37, 102, 104
RCA, 25, 91
receiver, 13, 14, 44-50, 91, 93-97, 100-104, 107-110
recording, 104, 116
scanning, 20-23, 32, 115, 117, 119
screen, 45-50, 93, 95
singers, 84
sound, 43, 50-52, 91, 97
speakers, 81-82
sponsors, 88
sports, 59-63, 82, 85
sports commentators, 58-60, 82
stage plays, 77-82
stations, 122-123
studio, 52-55
synchronization, 120
techniques, 77-88
test pattern, 106, 109, 121
transmitter, 33-43, 57, 92, 97, 99, 101, 107
tuning, 108-110
ultra-short waves, 18, 34-44, 97-99, 107, 121
Television Broadcasters Association, 25
Tesla, Nikola, 17
Test pattern, 106, 109, 121
The New York Times, 71-72
Toscanini, Arturo, 62-65, 86
Transmitter, 33-43, 57, 92, 97, 99, 101, 107
Truman, Harry S., 72, 73
Tuning, 108-110

Ultra-short waves, 18, 34-44, 97-99, 107, 121

Video, 91, 121
Video engineer, 54, 59

Waves. See Ultra-short waves
Weimer, Dr. Paul K., 28, 29
Wireless, invention of, 17
WNBT, 34, 36, 43, 53

Zworykin, Dr. V. K., 23-25, 29, 115, 116

Continued from front flap

mechanisms which match the human eye, the necessity for lofty antennas and relay stations, the coaxial cable, then the receiver itself. He describes how a television program is put together, both in the studio and in the field; where the television cameras are placed at sports events, music concerts, etc.

One whole section of the book is devoted to testing your television I. Q. — questions most frequently asked by the average listener and direct answers in simple, every-day language. Another section is virtually an everyman's television dictionary. There are many full-page photographs of television in action: mobile field units, studio productions, relay stations, operating technicians, production details, television baseball games, boxing matches, football games, etc. There are charts illustrating television principles and maps showing station locations. Here, indeed, is the simple direct explanation of what television is and how it works to bring its modern scientific miracle into the American home.

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