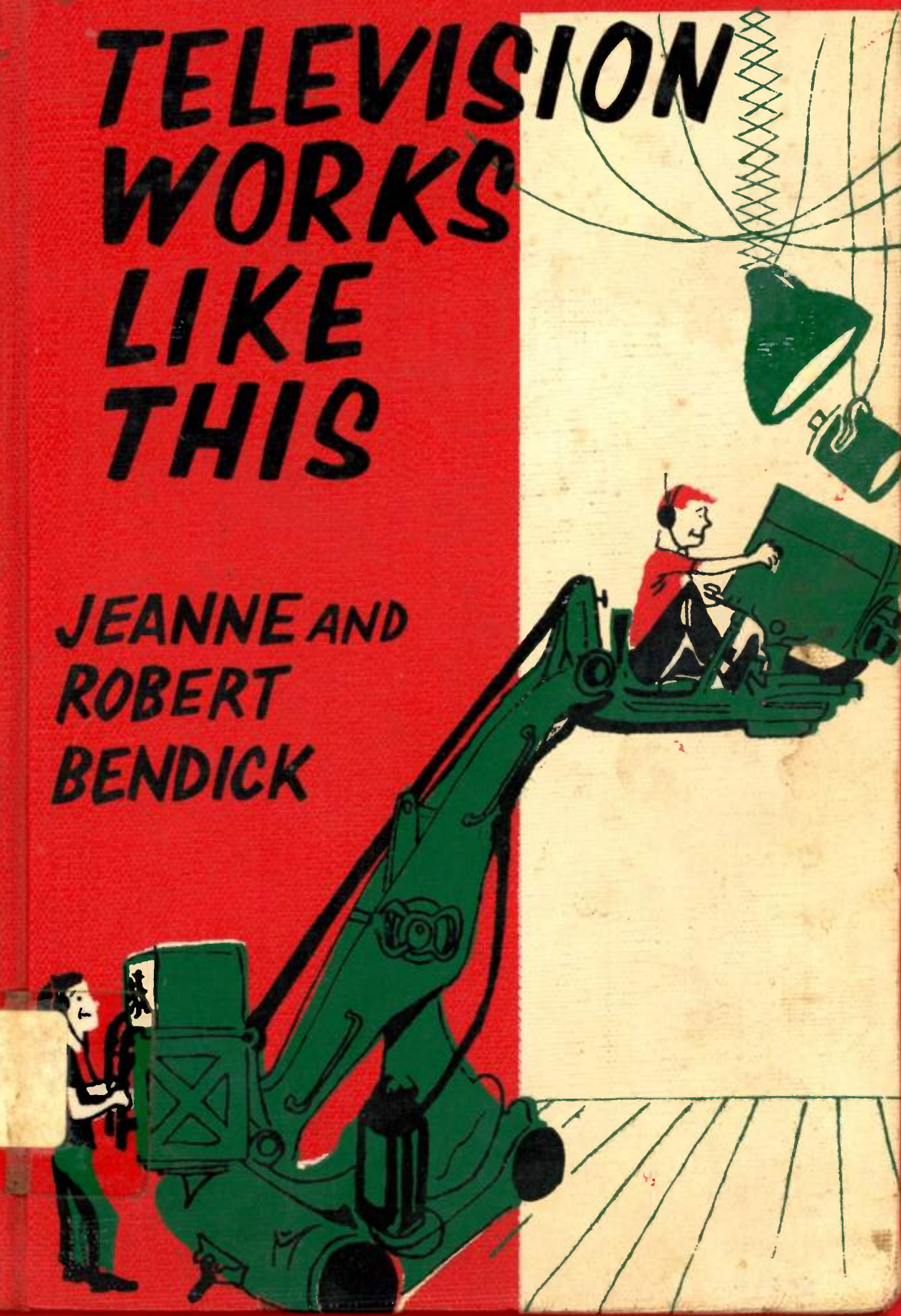
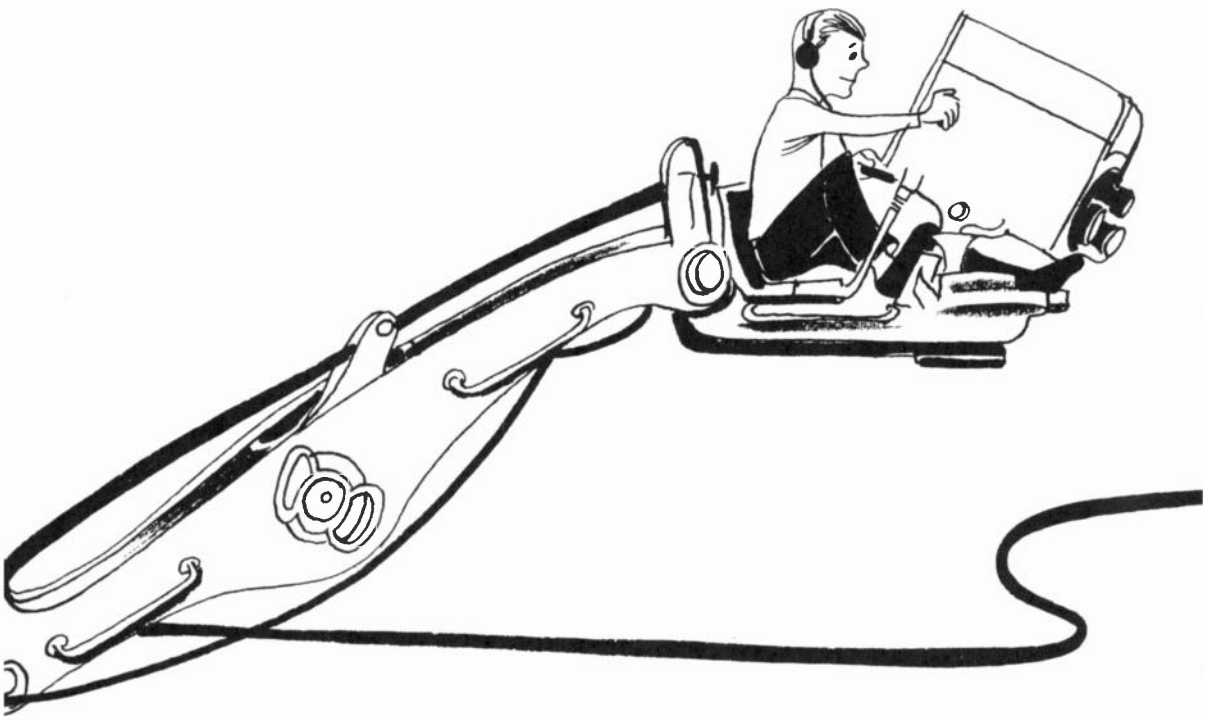
TELEVISION WORKS LIKE THIS

JEANNE AND ROBERT BENDICK



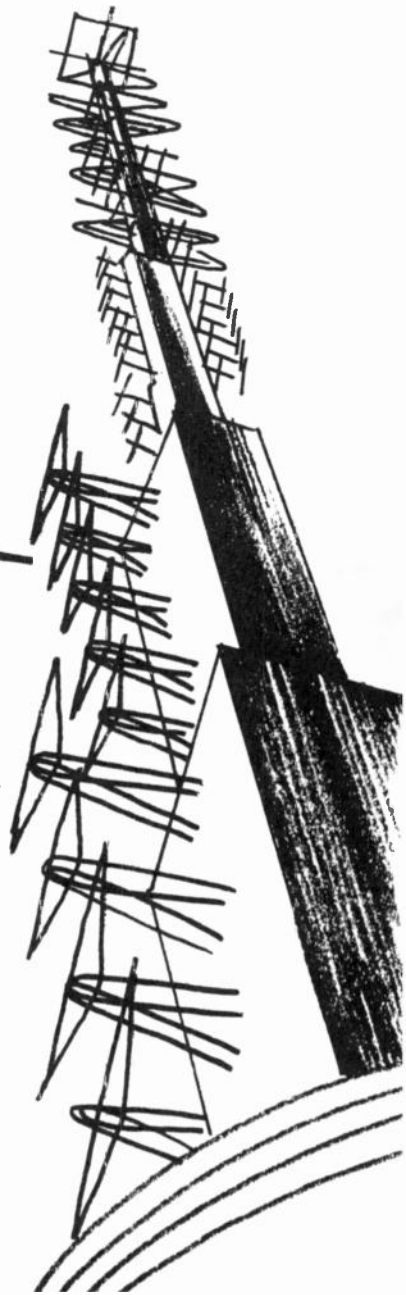
TELEVISION WORKS LIKE THIS

Fourth Edition, Revised and Enlarged



FOURTH EDITION ·
REVISED AND ENLARGED

TELEVISION WORKS LIKE THIS



JEANNE AND ROBERT BENDICK

McGRAW-HILL

NEW YORK • TORONTO • LONDON

AUTHOR'S NOTE

Television is a restless and changing medium.

Technically, it keeps pace with all the electronic advances that have been made in the 25 years since it began. Its programs change as the public taste changes and as the economics of television production change.

The entire method of television production has changed. Its mobility has increased and its scope has become international.

In the earlier editions, some people thought we were "too far out" in our predictions of television in the future, but even since the last edition, every single thing on the "Television Tomorrow" page has become television today.

There have been so many changes that this is a new book, rather than a usual revision.

Our thanks to all the television people on two coasts who helped with this book and earlier editions of it.

Jeanne Bendick
Robert Bendick

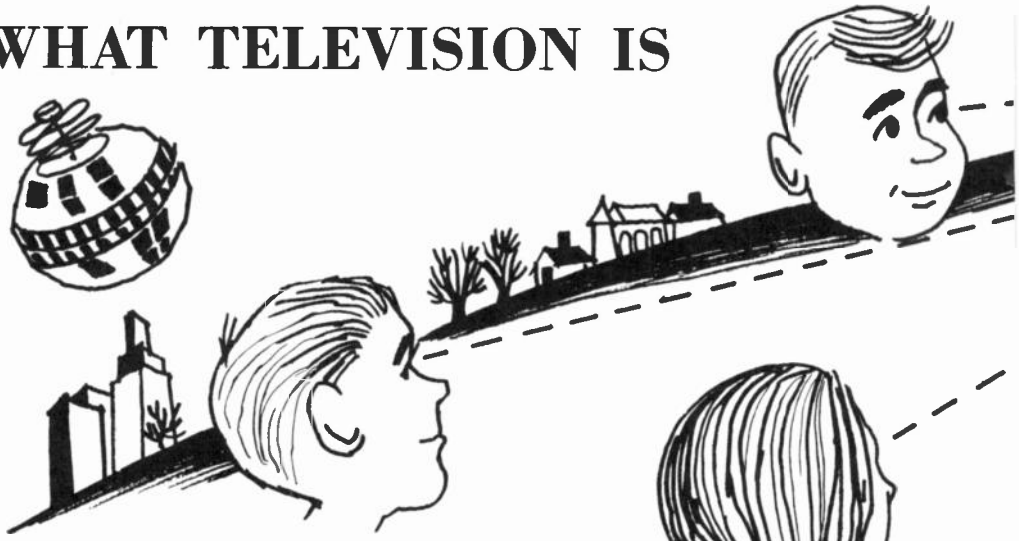
THIRD PRINTING

TELEVISION WORKS LIKE THIS, Fourth Edition

Library of Congress Catalog Card Number: 65-25538

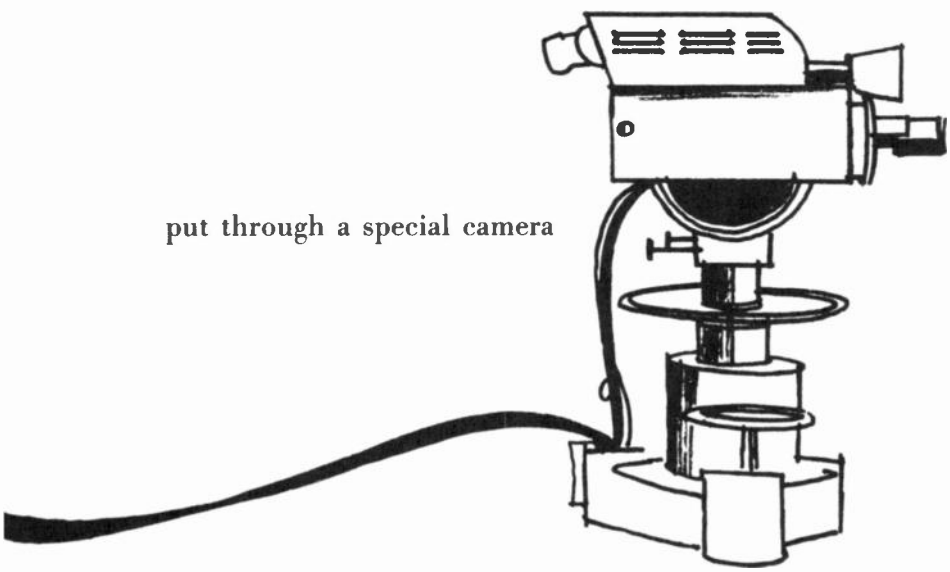
CONTENTS

WHAT TELEVISION IS

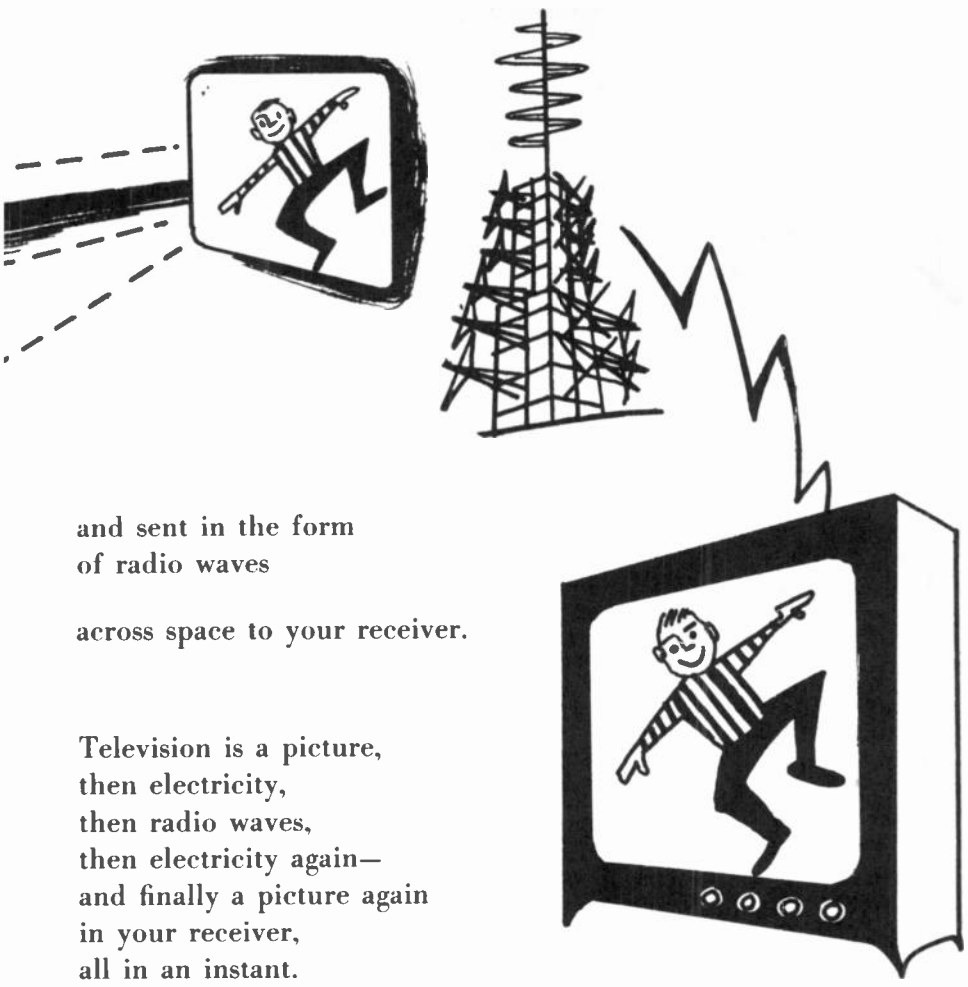


Television means seeing across space.

Television is a picture—
live, tape, or film,



put through a special camera



and sent in the form
of radio waves

across space to your receiver.

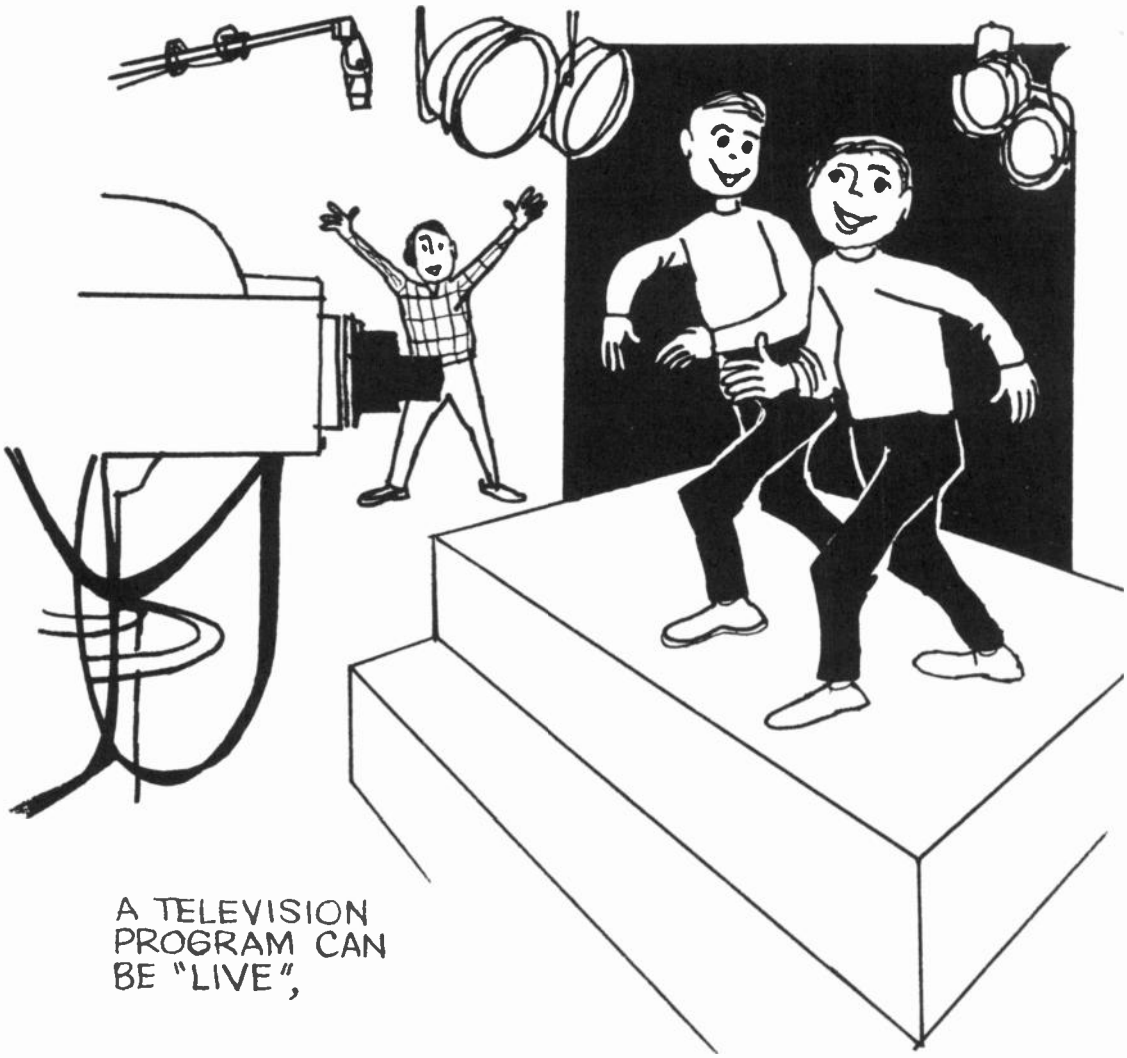
Television is a picture,
then electricity,
then radio waves,
then electricity again—
and finally a picture again
in your receiver,
all in an instant.

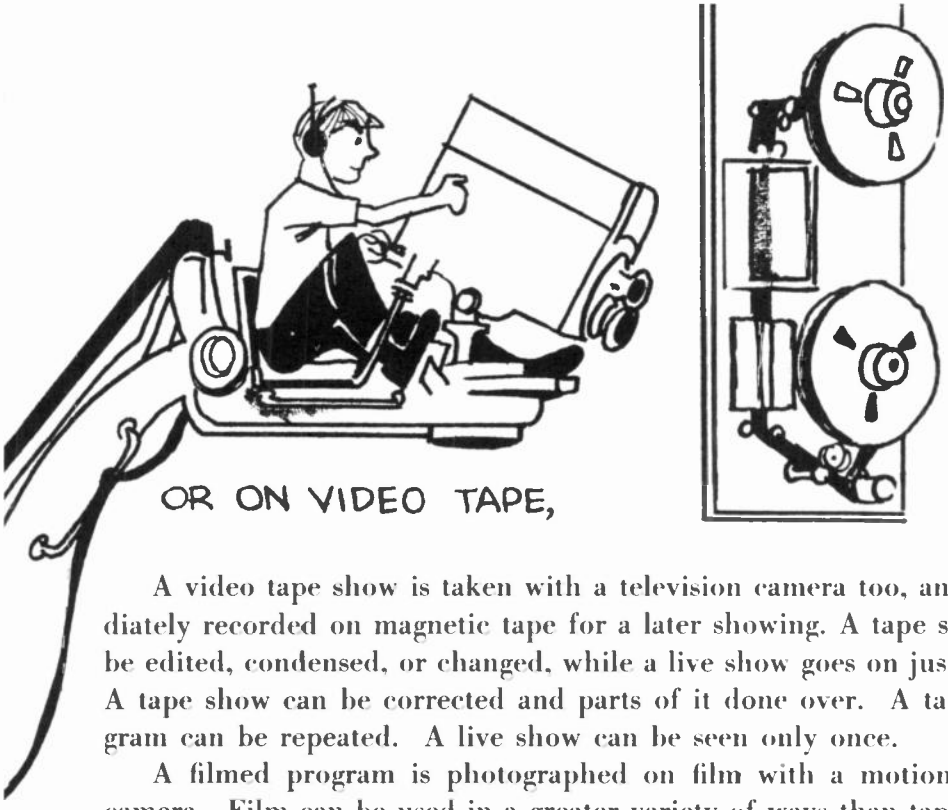
But television is more than this. Television is the greatest mass-communications medium ever invented. This means that more people can both see and hear the sights, sounds, and ideas of the world they live in than ever before.

KINDS OF TELEVISION

There are three kinds of television: live, film, and tape. A program may be any one of these or a combination of all of them.

Live television is the transmission of an event or action that is actually taking place at that moment. It might be a program from a television studio, such as a play or a panel show which has been planned and rehearsed. It might be an on-the-scene broadcast of a sports event or a news event that is happening. A live program is televised with a television camera, as it happens.





A video tape show is taken with a television camera too, and immediately recorded on magnetic tape for a later showing. A tape show can be edited, condensed, or changed, while a live show goes on just as it is. A tape show can be corrected and parts of it done over. A taped program can be repeated. A live show can be seen only once.

A filmed program is photographed on film with a motion picture camera. Film can be used in a greater variety of ways than tape, and it is easier to edit. For programs like television series, it is more economical. The finished film must be projected onto a special television tube to be transmitted.

All three kinds of television can be in black-and-white or color.

Sometimes television cameras are used to pick up a play and then the television pictures are photographed on motion-picture film from a special tube, to be shown later in theaters or on television.

TELEVISION WORDS

AMPLITUDE MODULATION

AFFILIATE. A local station associated with a network.

AD. Short for associate or assistant director.

AMPLIFY. To strengthen an electronic signal.

AMPLITUDE MODULATION (AM). A way of mixing the signal from the television camera or the microphone with the radio wave that is going to carry it through the air. The waves that carry television pictures are always amplitude-modulated, which means that the size or amplitude of the wave varies.

ANTENNA. The part of the television receiver that picks television waves out of the air, or the part of the transmitter that sends them into the air.

AUDIO. Anything to do with sound.

AUDIO-FREQUENCY WAVES. Electrical waves of the same length as sound waves.

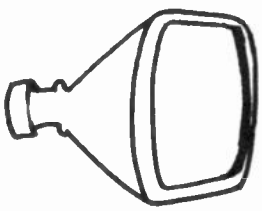
AUDIO SIGNAL. Sound that has been changed into electrical impulses.

BAND. A range of radio frequencies within two definite limits.

BLOCKING. Working out the camera shots for a program.

BOOM. A telescoping pole from which the mike is hung.

BOUNCE. Sudden changes in the brightness of the picture.



CATHODE-RAY TUBE

BRIGHTNESS CONTROL. The knob on your receiver with which you can change the amount of light in the picture.

BUSY PICTURE. One with so much background detail that it is confusing.

CARRIER WAVE. The electromagnetic wave that carries radio or television signals through the air.

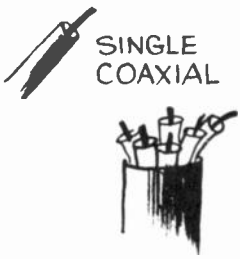
CATHODE-RAY TUBE. An electron tube in which the electrons are freed from their source in a ray or beam. The picture tube in your receiver is a cathode-ray tube.

CHAIN. A camera, a film, or slide projector and its auxiliary equipment.

CHANNEL. A band of frequencies given by the Federal Communications Commission to each television and radio station for broadcasting. Within the studio, the sets of cables and monitors assigned to "live," film, and still pictures are called channels. Each camera has its own channel.

CLOSED CIRCUIT. Television which is not broadcast for general viewing but is sent directly to selected receivers by means of coaxial cable or relay.

COAXIAL CABLE (CO-AX). A special copper cable with a conducting wire suspended inside. Also a bunch of these cables bound together.



COAXIAL CABLE

COMMERCIALS. The advertising on a program.

COMMUNITY ANTENNA. A master antenna that is connected by coaxial cable to home sets, serving hard-to-reach communities.

COMPATIBLE COLOR. Any system of color television broadcasting that also can be picked up as a black-and-white picture by black-and-white receivers.

CONTRAST CONTROL. The receiver knob which regulates the light and shadow of the picture.

CONTROL ROOM. The room where directors and engineers, working with monitors and controls, put a television show on the air.

CRAWL. A rolling device on which the credits, and sometimes the titles, for a show are shown.

CREDITS. The names of those who have been involved in the production of a program.

CUE CARDS. Large cards on which the script is printed. These are sometimes called "idiot cards."

CUE CARD

CUE TRACK. A magnetic signal on a video or audio tape which activates other electronic equipment such as tape recording machines or projectors.

DEAD SPOT. A place where radio or television signals are received badly or not at all.

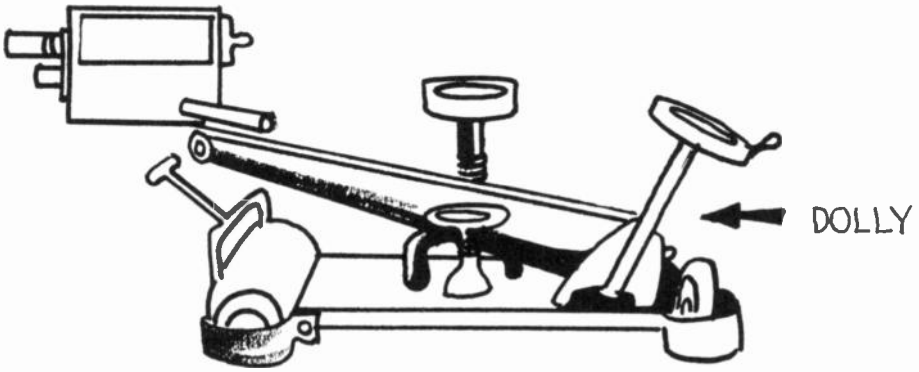
DECIBEL. The unit for measuring the loudness of sound.

DIPOLE ANTENNA. An antenna split in the middle.

DISH. The reflector of a microwave relay unit.

DIRECTIONAL ANTENNA. Any antenna, either broadcasting or receiving, which sends or receives radio waves more strongly in some directions than in others.

DOLLY. A wheeled platform on which the camera is mounted.



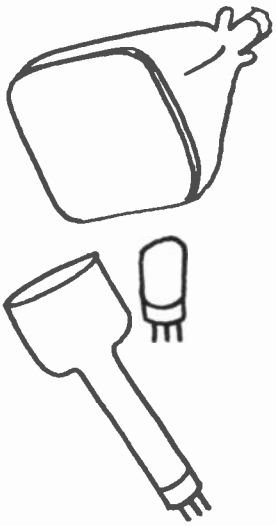
DRY RUN. A rehearsal without studio facilities.

DUB. Remake a sound track of a film in a different language, matching the actors' lip movements.

EDIT. To cut or rearrange film or tape into new or shortened sequences.

ELECTROMAGNETIC WAVES. The radio waves on which the signals of television pictures and sounds are broadcast.

ELECTRON TUBES



ELECTRON. A minute particle of electricity with a negative charge.

ELECTRON GUN. The place in an electron tube from which a beam of electrons is shot.

ELECTRON TUBE. A vacuum or gas-filled tube where electrons are put to work.

FACILITIES. Cameras, lights, and sound.

FADING. Unwanted lessening and increasing of a radio signal.

FCC. Federal Communications Commission.

FEED. Any picture, sound, or signal received by the studio.

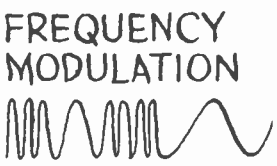
FLUORESCENT SCREEN. A chemically coated screen which gives off light when it is hit by electrons. The receiver screen is fluorescent.

FOCAL LENGTH (of a lens). The distance between the center of a lens and the plane at which distant objects are brought into focus.

FOCUS CONTROL. The adjustment on the receiver which makes the picture sharp.

FRAME. A single television picture. You see 30 frames a second. When the cameraman "frames" his picture, he gets his subject in just the right place on his camera screen. A single picture on a motion picture film is a frame too. There are 24 frames per second on motion picture film.

FREQUENCY. The number of cycles (or complete motions) of electromagnetic waves in one second.



FREQUENCY MODULATION (FM). A way of varying the frequency of the carrier wave to match the signal. All television sound is FM.

FRINGE AREA. An area on the edge of transmitter range.

GENERATE. To make.

GRAPHICS. Maps, photographs, drawings, objects, used as illustrations on a TV program.

GRID. A framework that holds studio lighting. Also an element of an electron tube.

HIGH-FREQUENCY WAVES. Very short radio waves.

HORIZONTAL HOLD. The receiver knob used to adjust the picture when it slips off to either side.

IMAGE ORTHICON (ORTH). The camera tube. A sensitive electronic tube which needs very little light.

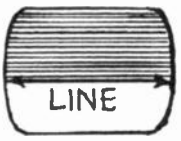
IMPULSE. A single burst of electric current in one direction.

INTERFERENCE. Any signal, natural or man-made, which disturbs the good reception of the sound or picture.

KILOCYCLE. A frequency of 1,000 cycles a second.

KINESCOPE. Film recording of a program, photographed directly from a receiver tube. Also called KINE.

LEAD-IN. The wire which conducts the signal from the antenna to the receiver.

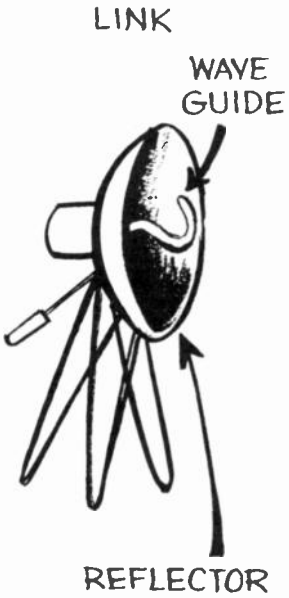


LINE. A single sweep of the electron beam from left to right across the television screen in either the camera or the receiver. There are 525 lines in the U.S. picture. Other countries have different numbers of lines.

LINE-OF-SIGHT. A straight path from transmitting to receiving antenna, with nothing in the way.

LINK. A system for passing along radio waves from a remote location or from one transmitter to another, by either microwave relay, coaxial cable, or satellite.

LIVE. Short for "alive"; television that's photographed and transmitted as it is happening, not film, tape, or still pictures.



MASTER ANTENNA. An amplifying antenna that serves a number of TV sets in one building or community.

MEGACYCLE. 1,000,000 cycles.

MICROPHONE (MIKE). A device which changes sound into electrical impulses.

MICROWAVE RELAY REFLECTOR. A dishlike metal reflector behind the antenna or wave guide of a transmitter to focus the microwave signals in one direction.

MICROWAVE RELAY STATION. A station which automatically picks up and rebroadcasts electromagnetic waves, greatly increasing the distance covered by the original transmitter.

MICROWAVES. Radio waves less than 1 meter (39 inches) long.

MODULATE. To vary the signal of a carrier wave.

MULTIPLEXOR. A part of the projection system in the telecine room.

NET. Abbreviation for National Educational Television.

NETWORK. A group of television stations connected by coaxials or relay stations, or one with a central plan of programming.

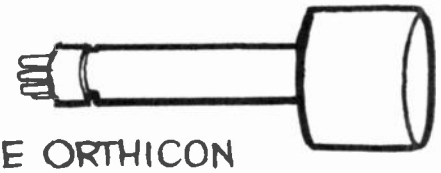


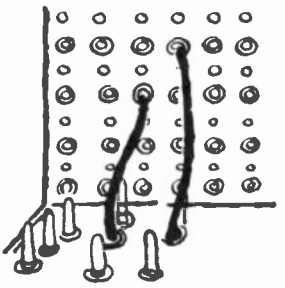
IMAGE ORTHICON

NOISE. A spot of unwanted light in a television picture. A noisy picture is one with flashes of light all over it.

ORTHICON. An image orthicon or studio orthicon camera tube.

PACKAGE. A program created and entirely produced by an independent producer or company and sold to an agency, a network, or a television station.

PATCH BOARD. A lighting switchboard for connecting studio lights to a light man's control board.



PATCH BOARD

PAY TELEVISION. A system of paying for special television programs, aside from the ones you receive free.

PILOT. A sample film or tape made to demonstrate a series.

POTS. The volume-control knobs on the audio engineer's desk.

PRESENTATION. A detailed explanation of a program idea.

PRIME TIME. Generally, the broadcast period between 7:30 P.M. and 11:00 P.M.

PROJECTION TELEVISION. A combination of lenses and/or reflectors which enlarge a television picture and project it onto a screen.

PROMPTING DEVICE. A rolling device, printed with the script, which allows anyone on television to see his lines while the program is in progress.

RACKS. Metal cabinets filled with operating electronic equipment.

RADIATOR. The part of the broadcasting antenna which radiates the waves out into space.

RADIO LINK. See LINK.

RADIO WAVE. An electromagnetic wave made by quick changes of current in the broadcasting antenna, and traveling through space at 186,000 miles a second.

RATING. A poll showing how many people are watching a program at a given time.

REMOTE. Any program originating outside the studio.

RESIDUALS. The money paid to some of the people involved in a program when the program is repeated.

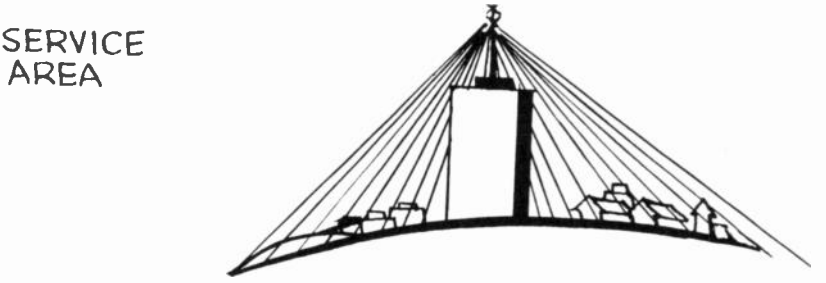
RUN-THROUGH. A rehearsal.

SATELLITE RELAY. Television retransmission from point to point by a satellite.

SATELLITE TRANSMISSION. Transmission of a picture from a satellite to a ground receiver.

SCANNING. The line-by-line sweep of the electron beam across the screen in the camera and receiver tubes.

SERVICE AREA. The region around a transmitter where its signals can be clearly received.



SIGNAL. The sound or picture after it has been changed into electricity or radio waves.

SLIDE. A transparent, glass-mounted photograph.

SOAP OPERA. A dramatic, daytime series, usually sponsored by a soap, or other household products, company.

STOCK FOOTAGE. Film from a film library.

SYNCHRONIZATION (SYNC). The process of keeping the electron beams in the camera and receiver doing the same thing at the same time.

SYNDICATION. The sale of a film series to local stations to sell and schedule as they please.

TALENT. The performers.

TAPE (AUDIO and VIDEO). A clear tape, coated with iron oxide powder, capable of recording sound and pictures in electrical impulses.

TD. Short for technical director.

TELECAST. The broadcast of a television program.

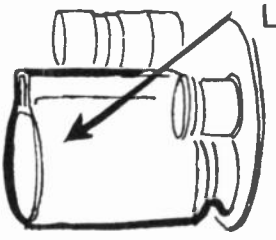
TEST PATTERN. A drawing of lines and circles broadcast by television stations for testing cameras and receivers.
TRANSISTOR. A crystal capable of performing the same job as an electron tube.
TRANSMISSION. The broadcasting of a television or radio signal.
TRANSMITTER. The equipment from which the signals are broadcast.
TURRET. The plate on which camera lenses are mounted.
UHF. Ultra High Frequency. In the transmission of electromagnetic waves, a frequency of very short waves.
VERTICAL HOLD. The control knob used to adjust the picture when it slips up or down on the television receiver screen.
VHF. Very High Frequency. The radio frequency band on which most TV signals are broadcast.
VIDEO. Means "see" and is used when talking about the television picture. Sometimes television itself is called "video."
VIDICON CAMERA. A camera used primarily for film or slide pick-up.
VIEWER. Anyone watching television.
WAVE GUIDE. A hollow metal tube which conducts electromagnetic waves.
WAVELENGTH. The distance between two waves, from the top of one to the top of the next.

TEST PATTERN

WAVELENGTH

WIDE-ANGLE SHOT. A camera shot taking in a large part of the field of action.
WING IT. To do a show without rehearsal.
ZOOMAR. A lens of variable focal length that can take a close-up or a wide-angle shot from the same position.

ZOOMAR LENS



HOW THE PICTURE BEGINS

The television picture begins in the camera.

There is no film in a television camera. Its job is to change the picture it sees into a sort of electrical picture that can be sent through wires and across space.

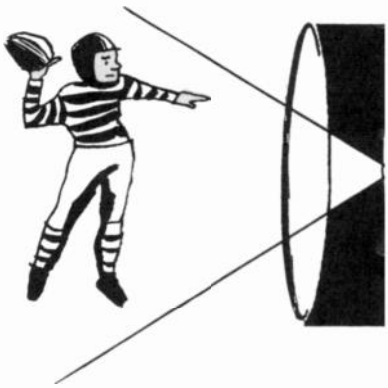
The heart of the camera is an electron tube called the orthicon, and it works like this.

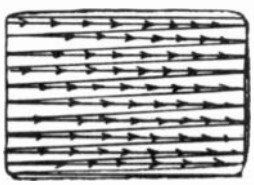
The picture comes in through the camera lens and is focused on a screen that is sensitive to light. The screen is made of thousands of tiny, chemically coated spots. As a ray of light hits each spot, it gives off tiny charges of electricity called electrons. The brighter the ray of light, the more electrons the spot sends out.

These electrons shoot along to another screen called the target, hitting it so hard that they knock more electrons out of the target. These displaced electrons are collected, leaving the target hungry for electrons.

At the other end of the camera tube is an electron gun, shooting out a thin stream of electrons the way a water pistol shoots out water. This stream of electrons moves swiftly back and forth across the face of the target, which has light-sensitive spots too.

1. LIGHT ENTERS LENS

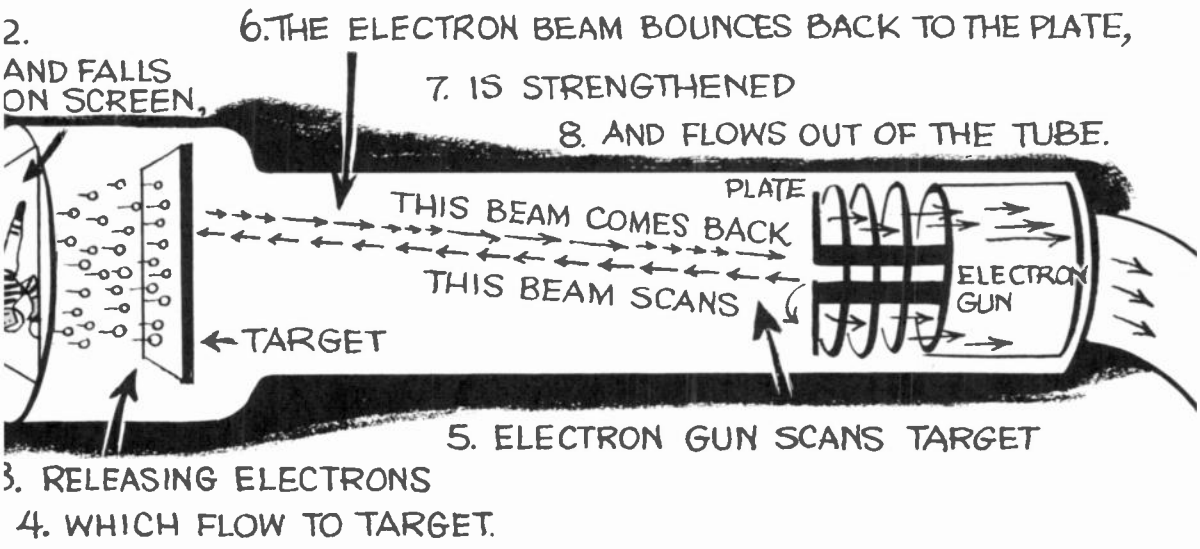




THE BEAM SCANS THE TARGET SOMETHING LIKE THIS - BUT IT TAKES 525 LINES TO MAKE A PICTURE. (THE ONES WITHOUT ARROWS DON'T COUNT.)

As it moves, each spot grabs electrons back from the stream to replace the ones that were knocked out of it.

Finally the stream bounces back to an electron collection plate. When it leaves the electron gun, the electron beam is of constant strength; but when it bounces back from the target it varies, because of the electrons it has lost. The beam varies just as the light and dark varied in the picture that came into the camera lens.

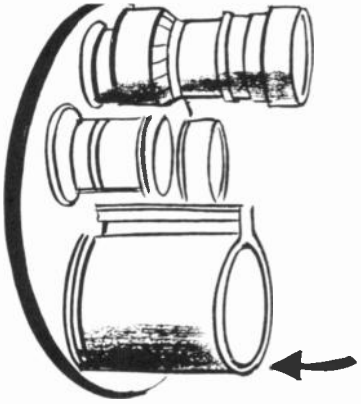


The stream sweeps back and forth across the target the way your eyes do when you read a book. It covers every point in the picture, line by line. This is called scanning.

When the varying beam returns to the plate it is called the signal. The signal is an electrical reproduction of the picture in light that came into the tube. Before it leaves the tube, this signal is made much stronger.

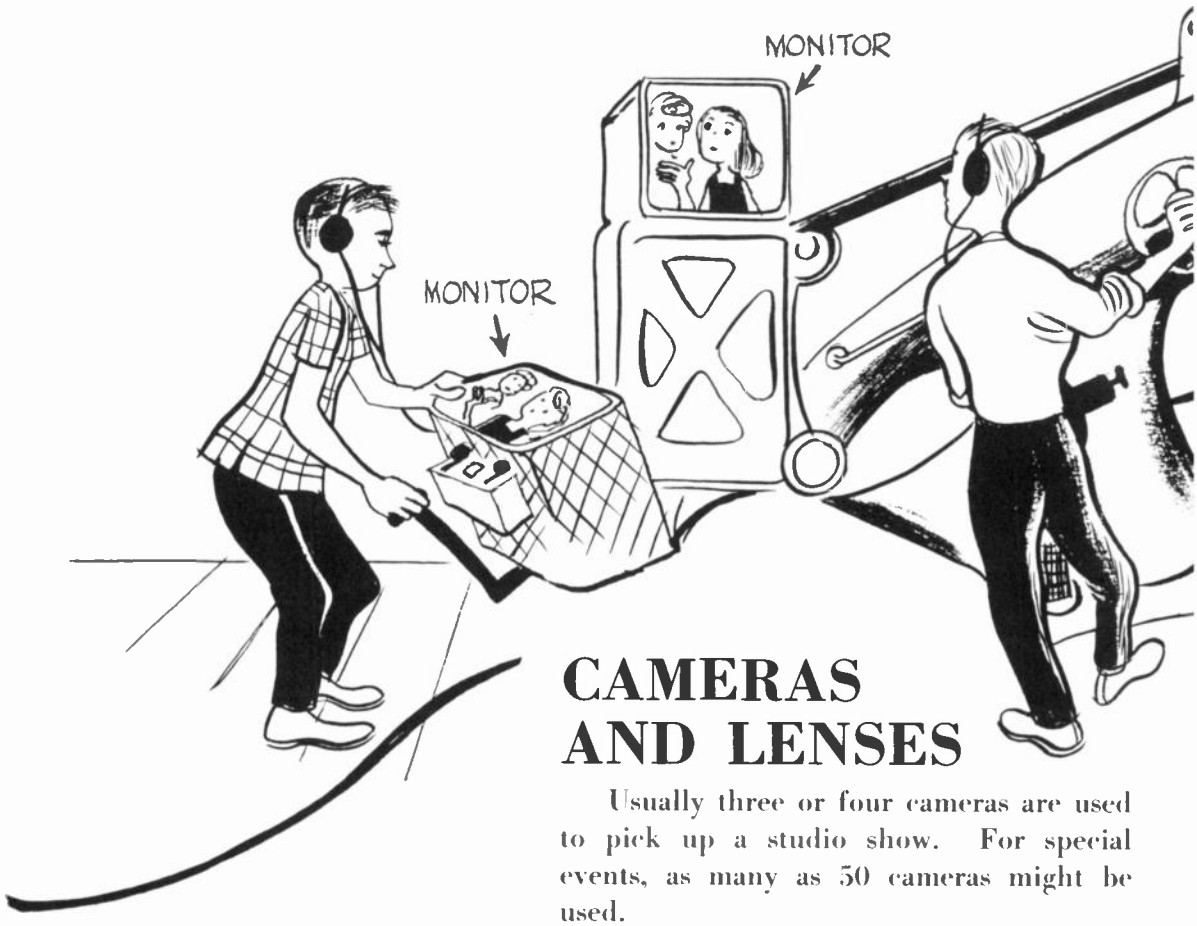
The electron beam scans so swiftly that 30 separate pictures are sent out of the tube every second. This is enough to catch the fastest action going on in front of the camera.

The picture size on the camera tube varies with different cameras but it is much smaller than the one you see on your screen.



THE TURRET USUALLY HAS A 2-INCH, A 3½-INCH, 5½-INCH AND A 13-INCH LENS FOR SHOTS FROM A WIDE ANGLE TO A CLOSE-UP

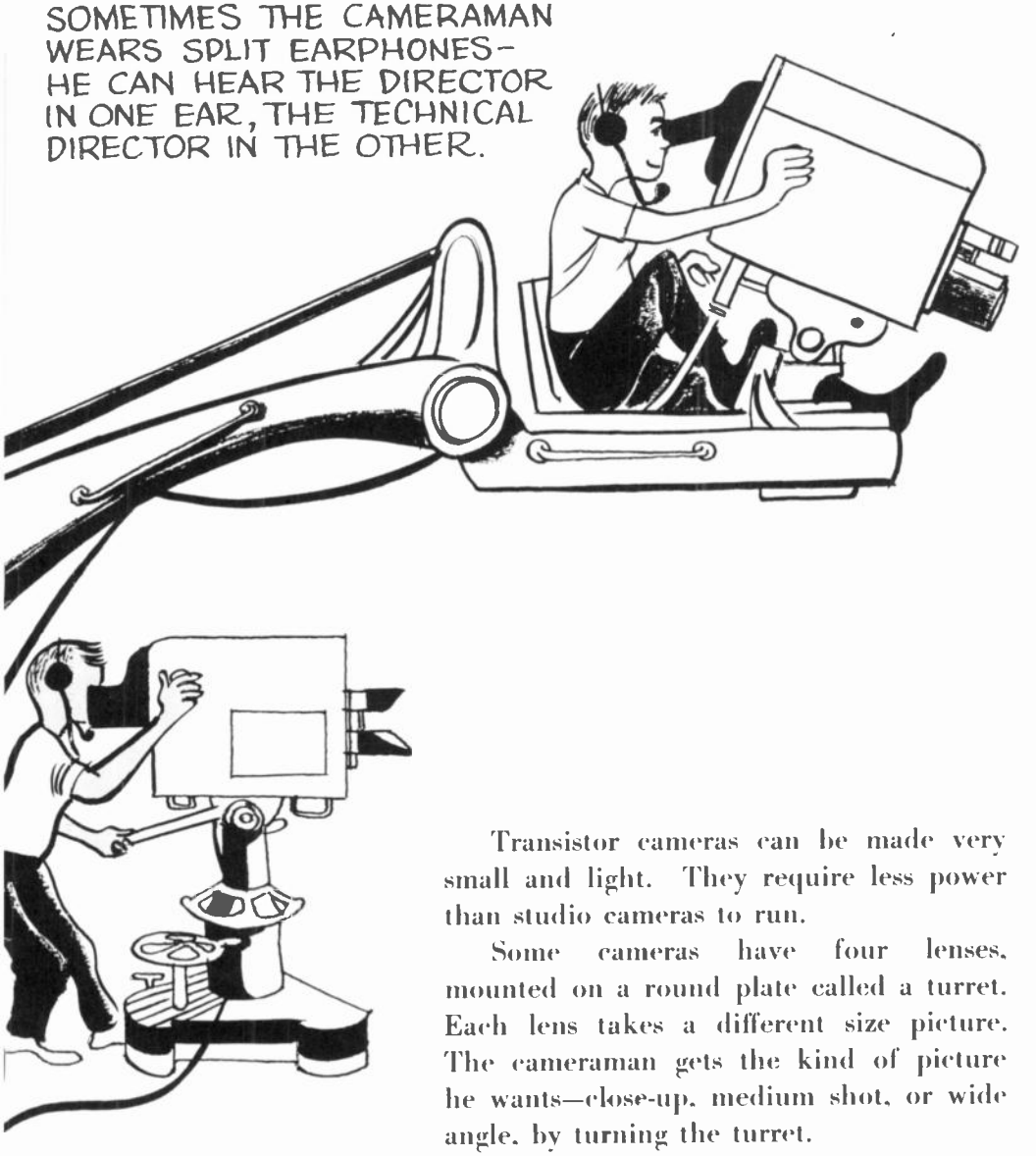
SOMETIMES, INSTEAD OF ONE OF THE OTHERS, THERE IS A ZOOMAR LENS



CAMERAS AND LENSES

Usually three or four cameras are used to pick up a studio show. For special events, as many as 50 cameras might be used.

A television camera runs on electricity, which is amplified and strengthened and made to do special things either by electron tubes or transistors.



Transistor cameras can be made very small and light. They require less power than studio cameras to run.

Some cameras have four lenses, mounted on a round plate called a turret. Each lens takes a different size picture. The cameraman gets the kind of picture he wants—close-up, medium shot, or wide angle, by turning the turret.

Other cameras use a single lens called a variable focal length lens, or zoomar lens. This single lens can get a wide variety of picture sizes because the elements move within the lens itself. They can be moved by hand, or by a motor built into the lens.

Zoomars come in different ranges. Some are good for studio work. Others are built for longer distances, and are used to cover sports events or conventions or parades. A camera with a zoomar lens can cover a complete action without flipping lenses or changing its position. But turret lenses are used for some work because they have sharper quality and can get better pictures with less light.

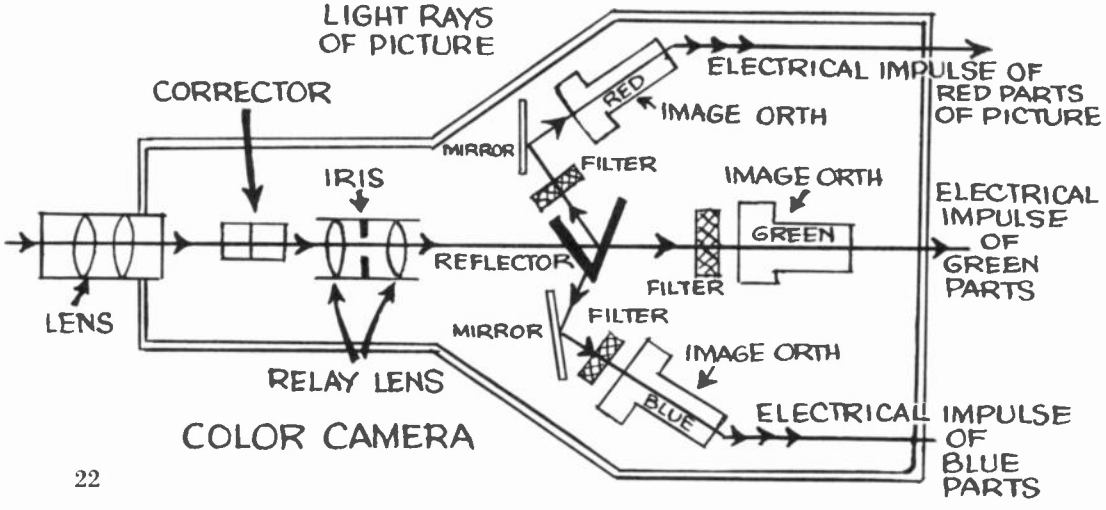
The cameraman looks at a small television screen built right into the camera, which shows him what his camera is taking. He is connected by earphones to the director and the technical director in the control room. The director tells him what picture to get and when to change his position to be in place for the next shot.

Most cameras are mounted on different kinds of wheeled stands. Some are on pedestals that can be pushed, raised, or lowered by the cameraman himself. Other cameras are attached to cranes that are so big it takes two men beside the cameraman to raise, lower, and move them about. Each of these assistants has his own monitor, a small television screen, so that he can see what the camera is taking.

Color cameras, which have three tubes, are quite a bit larger than black-and-white cameras.

Color cameras can have zoomar or turret lenses too. Color cameras look different from black-and-white cameras, and they use a different kind of tube.

A color camera tube works like this:



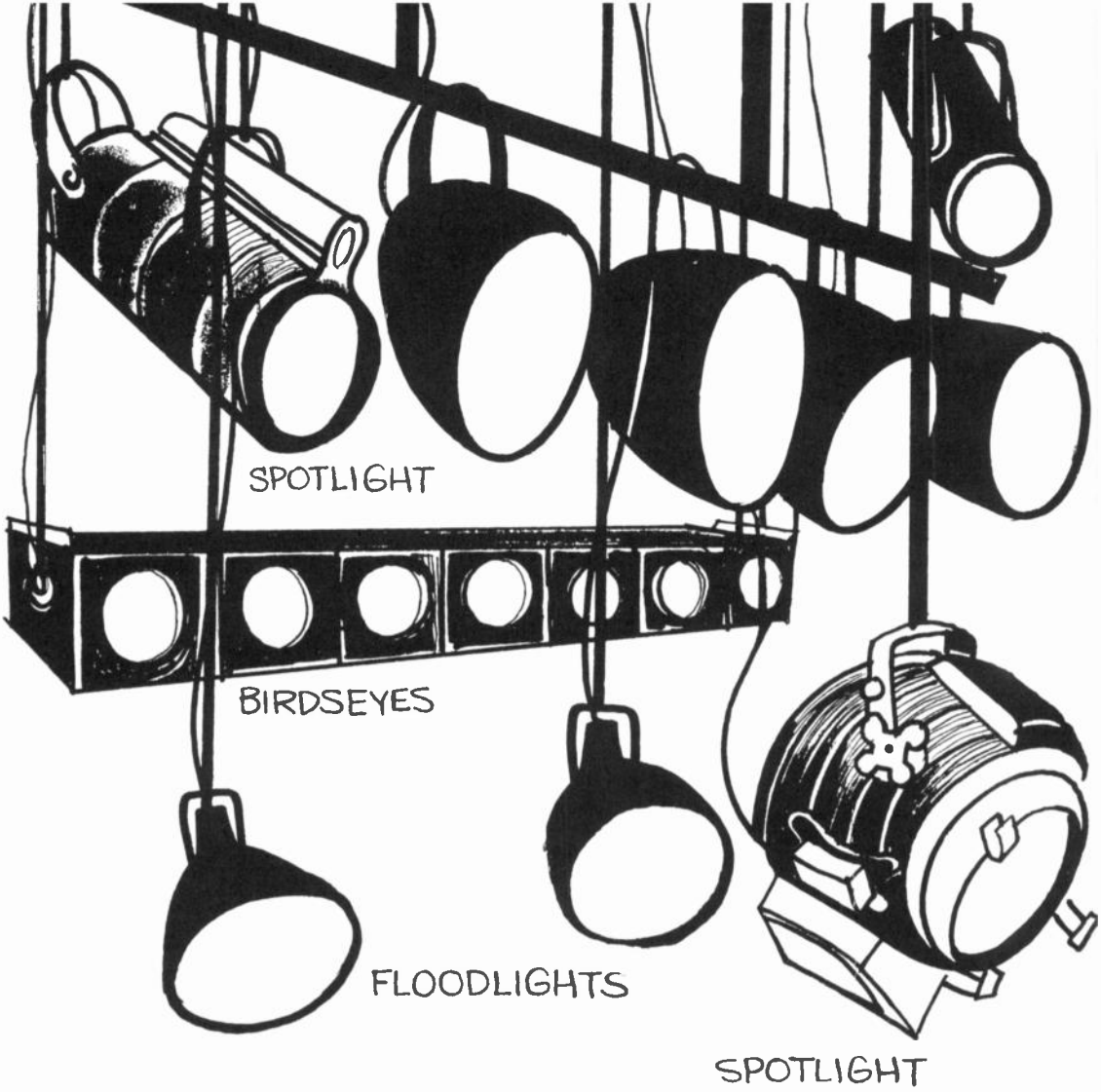
The camera lens focuses the picture through a series of mirrors and lenses onto three separate image orthicon tubes inside the camera. The light rays go through a red, a blue, and a green filter, which break up the picture. The red parts are picked up by one tube, the blue by another, the green by the third. Each tube converts its own color light rays into electrical impulses, which are amplified and transmitted the same way they are in the black-and-white system.

A color camera needs more light than a black-and-white camera.

SPECIAL PURPOSE CAMERAS

Special purpose cameras and equipment have been developed to do a variety of jobs. For news and special events coverage, a wireless, portable camera can be carried by the cameraman, who can also carry the necessary transmitting equipment in a pack on his back. Because there are no wires or cables attached to the camera, the cameraman can go anywhere with it. His transmitter sends the picture signal back to a mobile unit truck or a central control room.

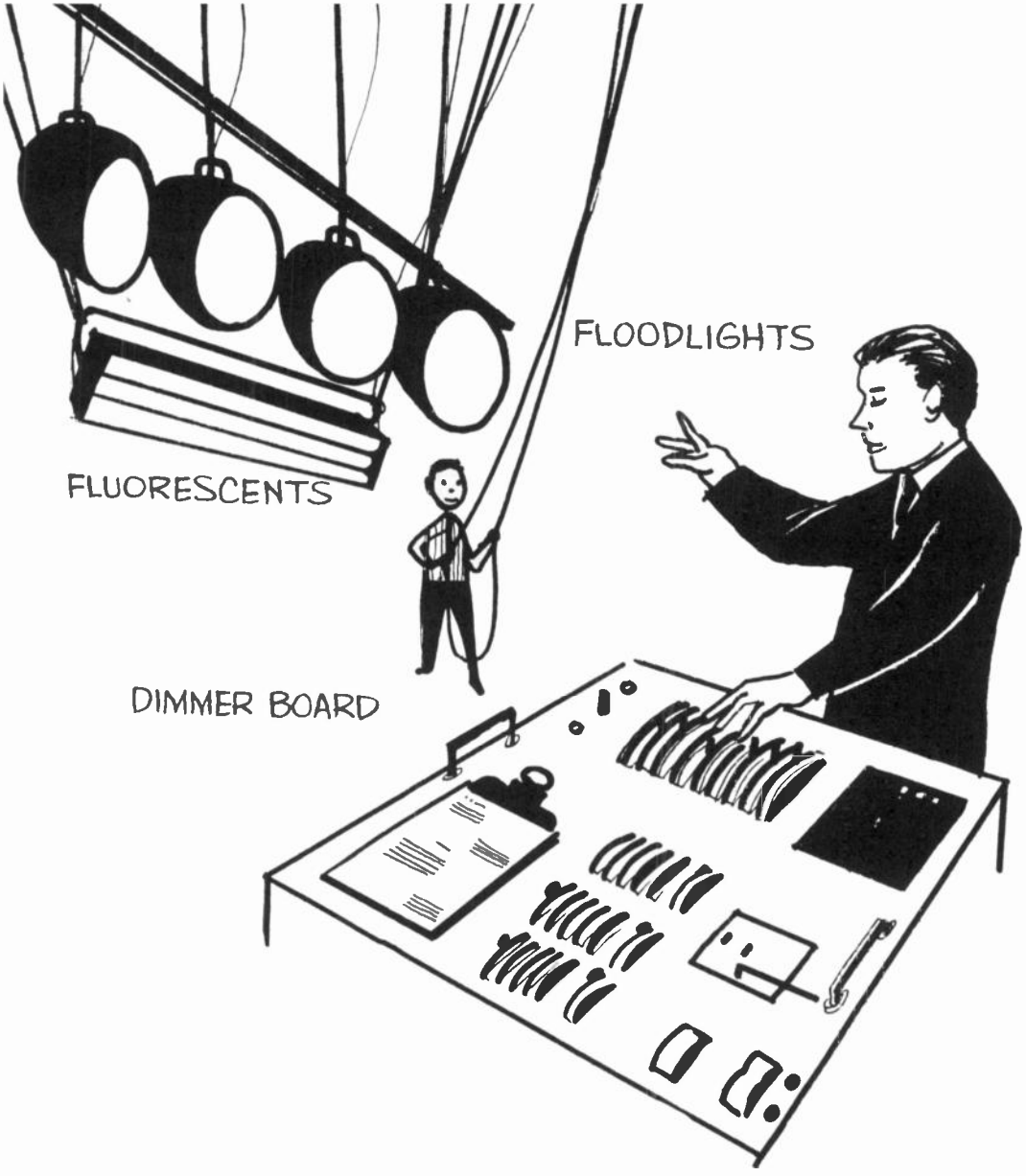
Small transistor cameras are used aboard satellites and space explorers, and for many kinds of industrial, medical, and other scientific jobs.



THE LIGHTS

In order to get good television pictures in a studio, a variety of lights are hung from grids and can be raised or lowered from the studio ceiling. There are banks of fluorescents or floodlights and many different kinds of spotlights.

The lighting in a studio is supervised by a lighting director, working first with the set designer, then with the director and technical director. During the show the lighting director tells his assistants to turn lights on or off or dim them for special effects. The lights are connected into



a sort of a switchboard called a patch board, and their brightness is controlled by a dimmer board. The head electrician works the dimmer board, while the lighting director tells him what to do. They both work from a lighting script.

In location pickups, usually a great number of big spotlights and other lighting equipment are brought along to provide enough light for the cameras. Outside, in daylight, little or no extra lighting is needed.

Most new stadiums, theaters, and auditoriums are designed with television lighting as part of the planning.

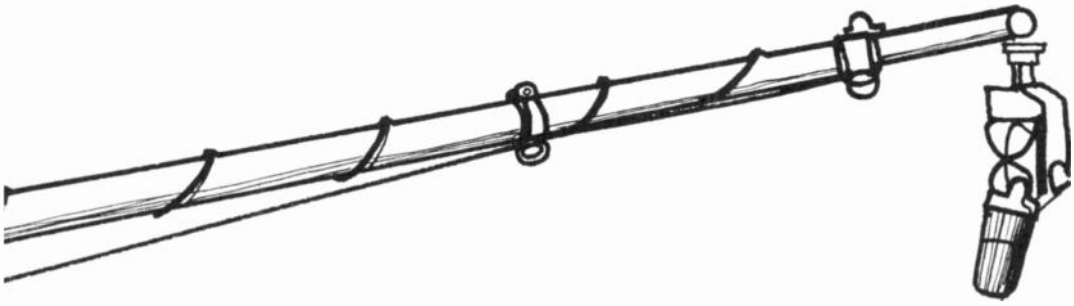
A LAVALIERE MIKE IS WORN LIKE A NECKLACE

THE MICROPHONES

The voices and sounds that are part of television are picked up by microphones, usually called "mikes." In the studio, one or two mikes are hung from a mike boom, which is a long, jointed pole set on a dolly. The mike man rides the dolly and moves the pole up and down, in and out, over the heads of the people who are talking. He takes directions, through his earphones, from the audio engineer in the control room.

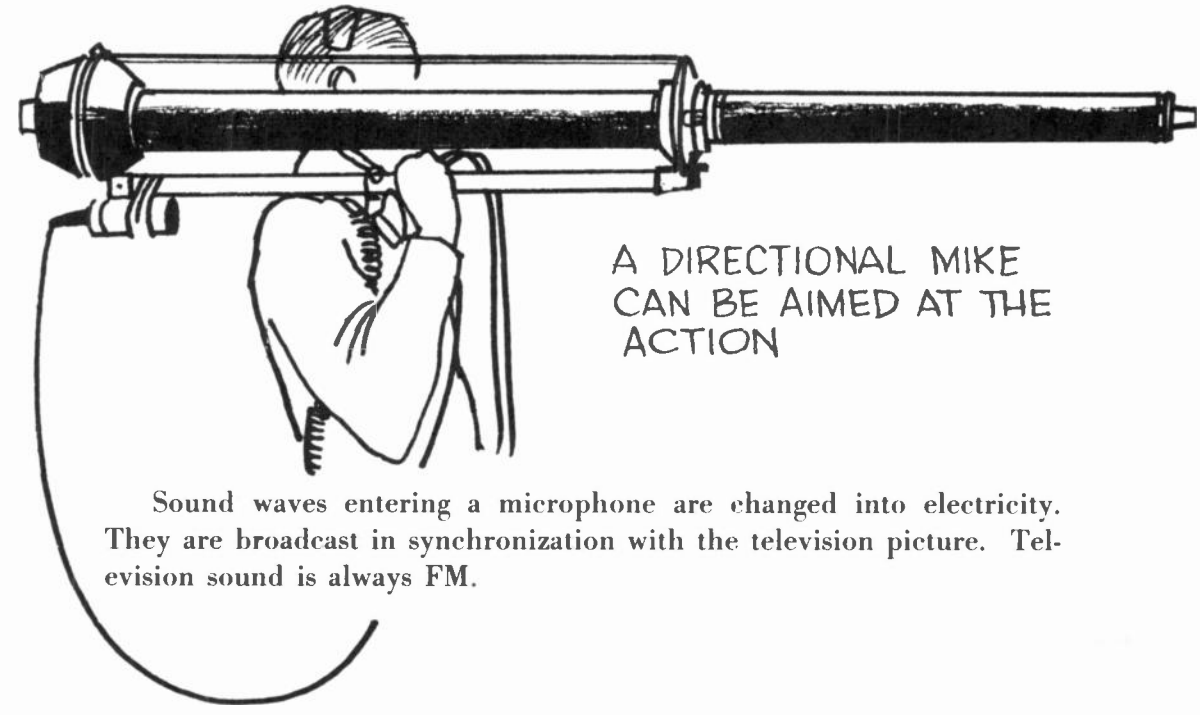
On some programs, where it doesn't matter if the microphone shows, mikes are hung like necklaces around people's necks.

If people on a program need a great deal of freedom of movement, wireless microphones are used. A wireless microphone has a very small, battery-powered transmitter, that can be hidden in a pocket.



On some taped programs, particularly variety shows where there is a lot of singing and dancing and movement, any microphone setup would impose great limitations on the performers. So the sound is recorded first, then this sound is played back while the cast does the action for the cameras, synchronizing their movements and lips with the sound as they hear it.

In news, sports, and other outside events where microphone cables would be awkward, extremely sensitive directional microphones are aimed at the action, to pick up the sound. The action might be a man speaking or a parade, a news event or a baseball game.



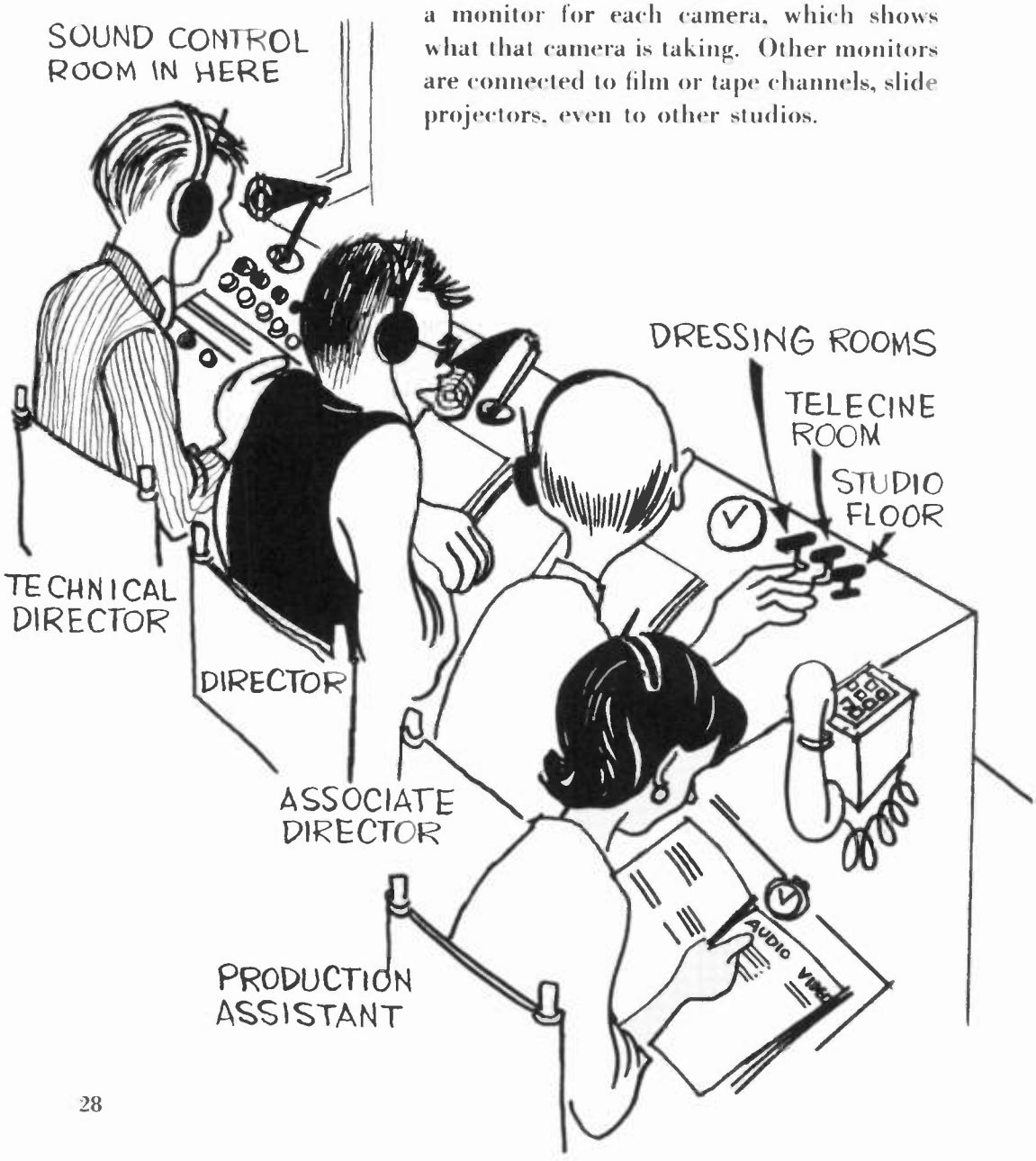
A DIRECTIONAL MIKE CAN BE AIMED AT THE ACTION

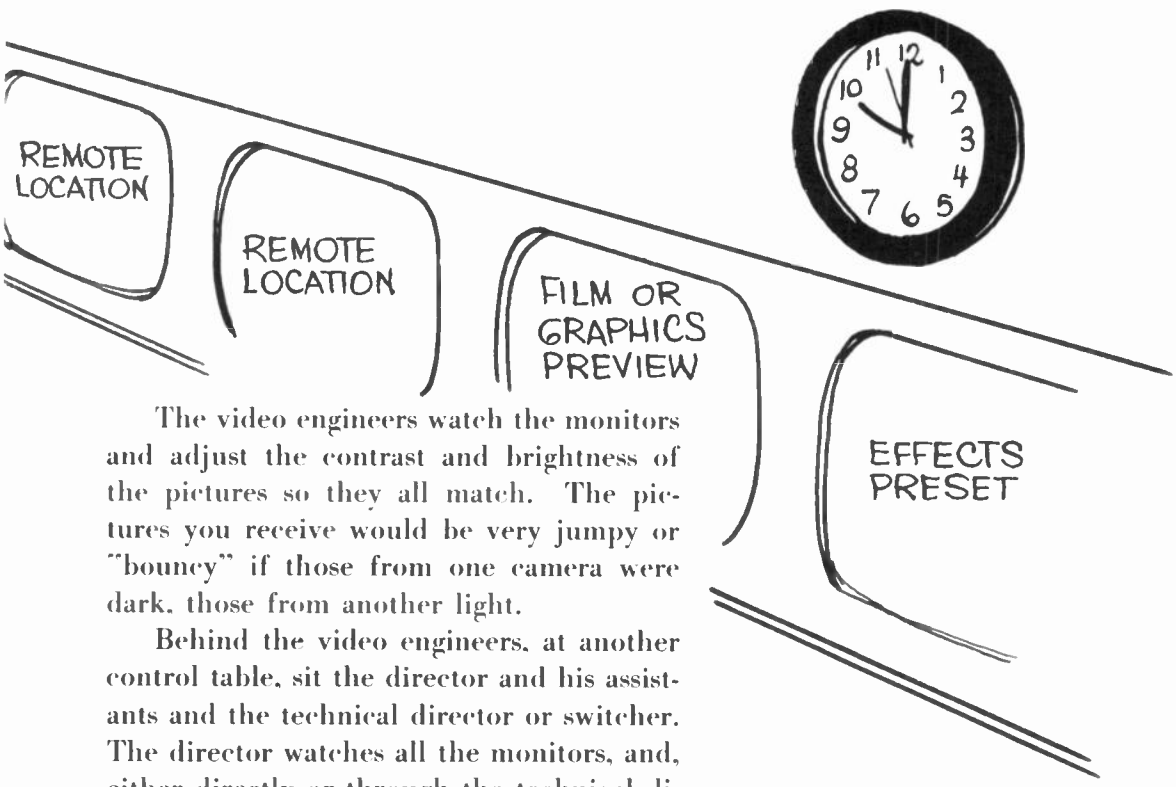
Sound waves entering a microphone are changed into electricity. They are broadcast in synchronization with the television picture. Television sound is always FM.

THE CONTROL ROOM

The control room is the center of operations in a television studio. The director and his assistants work there, and so do the video engineers. Some control rooms are placed so that they overlook the action on the studio floor, but most control rooms are "blind," and may be some distance away, even in another part of the building.

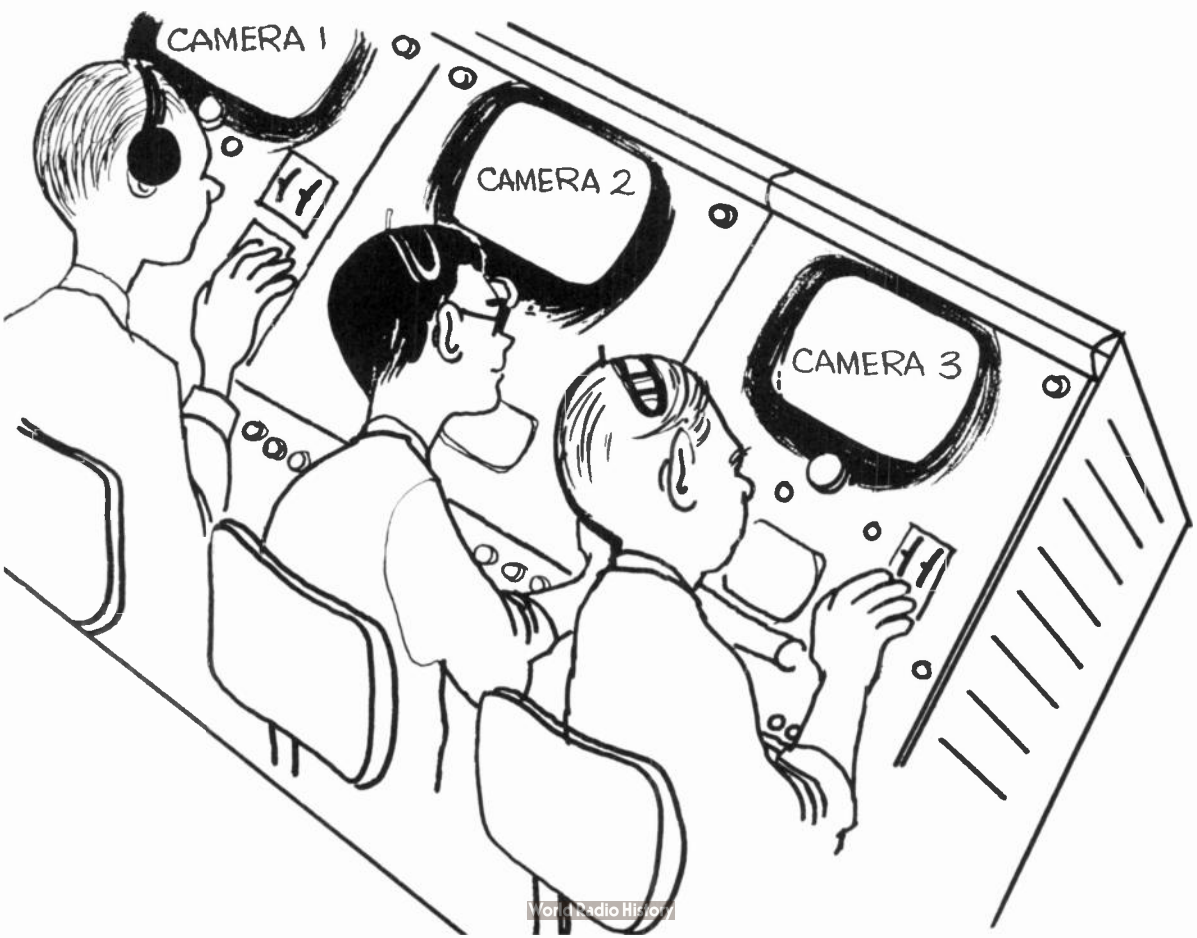
The video engineers sit at a control desk in front of a number of monitors. There is a monitor for each camera, which shows what that camera is taking. Other monitors are connected to film or tape channels, slide projectors, even to other studios.





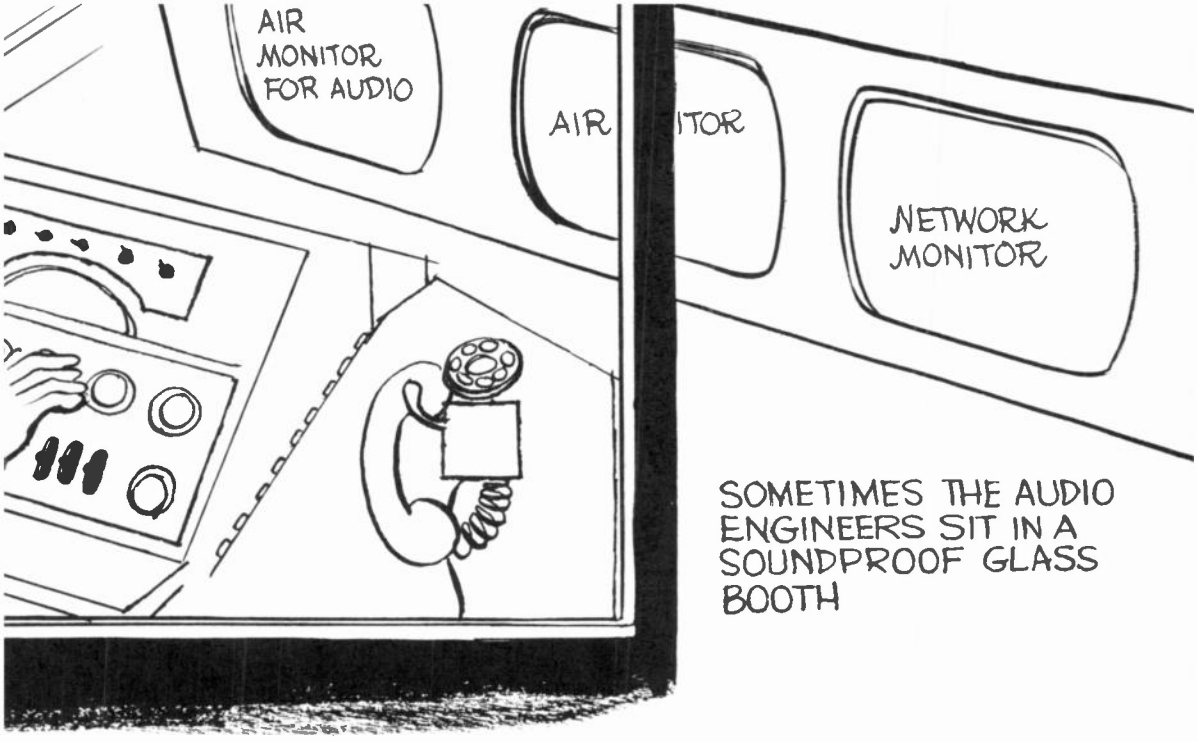
The video engineers watch the monitors and adjust the contrast and brightness of the pictures so they all match. The pictures you receive would be very jumpy or "bouncy" if those from one camera were dark, those from another light.

Behind the video engineers, at another control table, sit the director and his assistants and the technical director or switcher. The director watches all the monitors, and, either directly or through the technical director, tells each cameraman what shots he wants.



During a show all the cameras are operating all the time, and from these the director selects the picture to be broadcast. By number he tells the switcher which camera or channel he wants on the air, and the switcher puts it on by pushing the right button. The picture that is being broadcast appears on the air (or line) monitor. Sometimes the cuts come so fast that the switcher or technical director works his control buttons just like a typewriter.

In addition to the monitor controls, the control room has many cabinets or "racks" crammed full of electron tubes or transistors. Some supply and regulate power. Others amplify the signal before sending it on. The sync generator keeps the camera and film channels, the transmitter, and your home receiver all locked together in step.



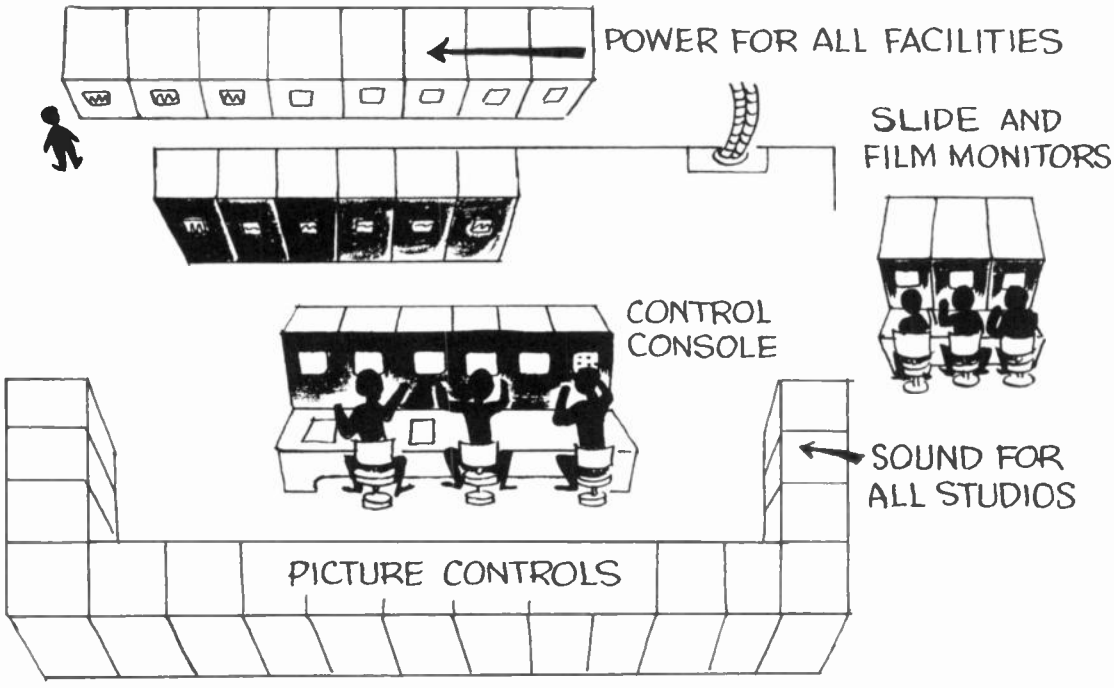
CONTROLLING THE SOUND

In a separate part of the control room there is an audio-control board, where the audio engineer works. This board has seven or eight sockets into which microphone cables and other kinds of sound equipment are connected. Each socket is called a position, and there is a knob at each position to control the volume or loudness of the sound. These knobs are called "pots," short for potentiometers. The audio engineer can actually see how loud the sound is on a gadget called the DB (decibel) meter. Loudness of sound is measured in decibels.

During a show, many microphones are used. Some pick up the actors' voices, some the music from the orchestra. The announcer will speak into another, the sound effects man has still others. When sound film or audio tape is being used on the program, this sound is controlled on the audio-control board too.

The audio engineer watches the air monitor to make sure he has the right mikes open at the right time. It is also his job to blend or "mix" all these separate sounds so that you hear them in proper balance.

An audio engineer may also be called on to play records on the turntables, or audio tapes if they are needed on the show. Sometimes there are two or more engineers to handle all the chores.



THE MASTER CONTROL ROOM

A network master control room is like the main switching yard of a railroad center. It controls the flow of incoming and outgoing program material. Often a number of things are happening in the master control room at the same time.

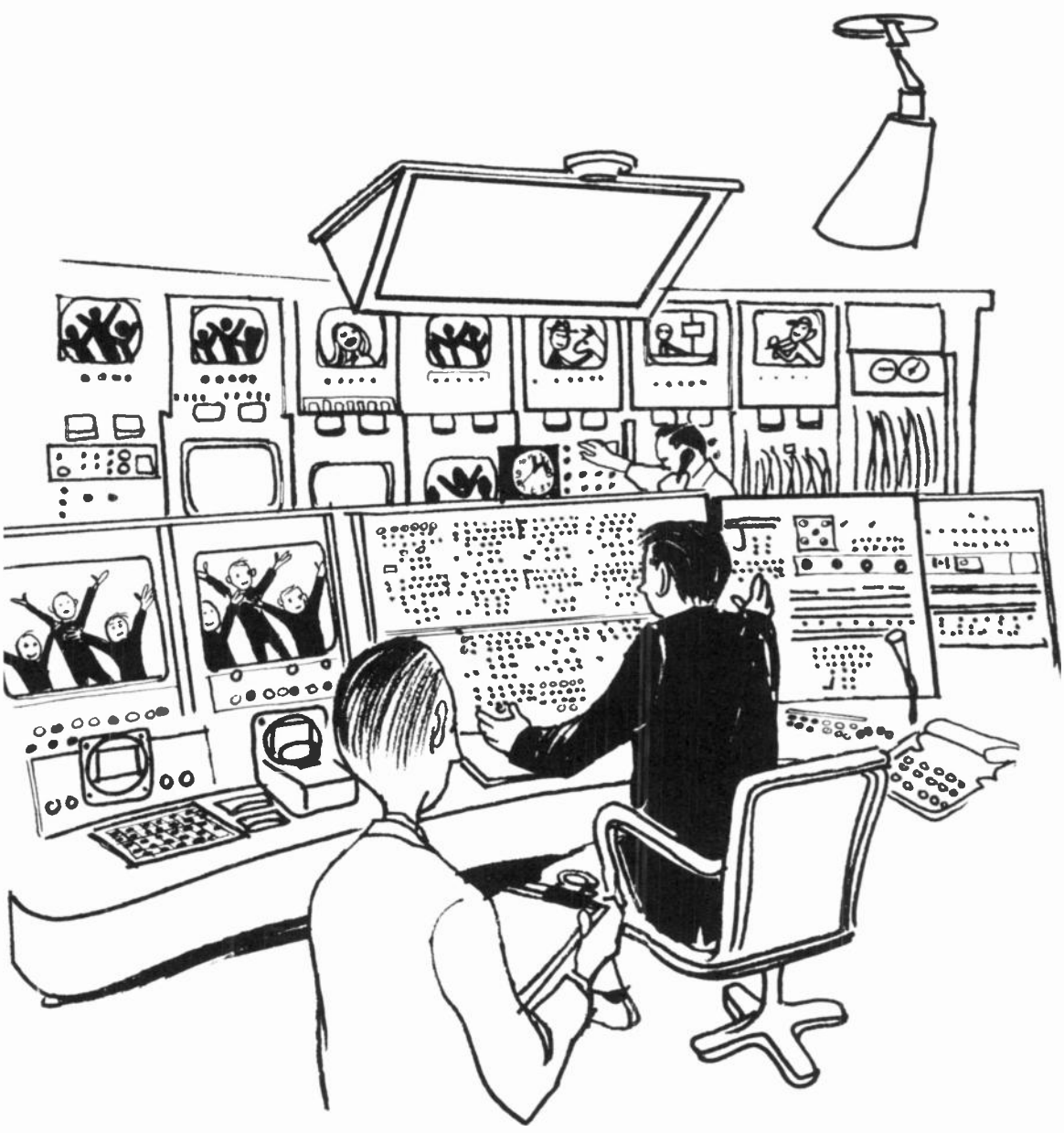
One program is being sent to the transmitter for local broadcast.

One or more programs, or segments of programs, are being fed from a studio or the video-tape room out to other stations along the network to be put on the air, or to be recorded for a later broadcast.

Incoming programs or program segments are switched into the video-tape room for recording, to be used later.

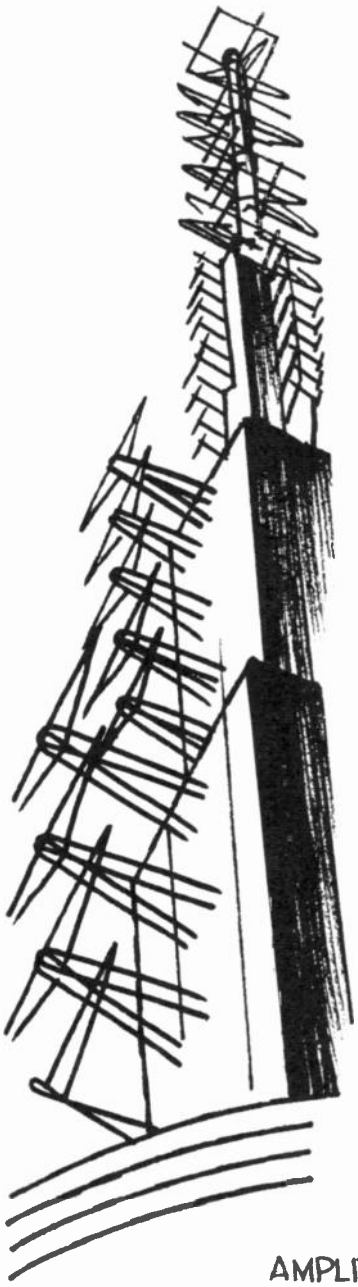
Programs in production are fed through master control to the video-tape room.

All the studios, theaters, audio and video facilities of a station, large or small, are connected to each other through the station's master control room.



The master control room is linked by coaxial cable or microwave relay, through the Long Lines division of the telephone company, to other stations and to remote locations across the country. It is connected to stations around the world by satellite relays in space.

Master control is the final link between a program and the transmitter which sends the program out on the air.



THE TRANSMITTER

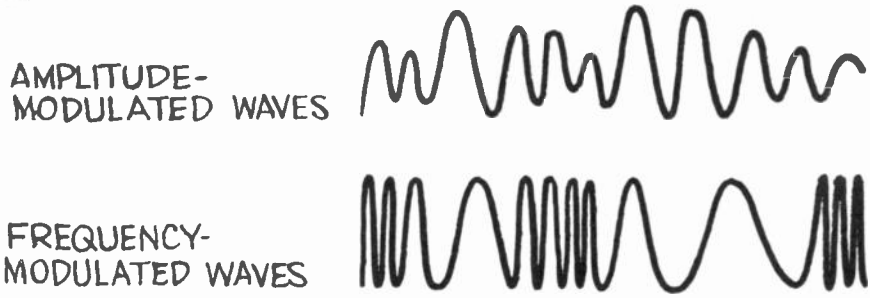
The transmitter is usually put in the highest possible place—on top of a mountain or a very tall building. The higher the transmitter antenna is, the greater the area to which it can send programs, because television waves travel only in straight lines. Anything in the way interferes, even a mountain, a building, or a big tree.

Sometimes several stations transmit from the same tower. There is no difference between color and black-and-white transmission.

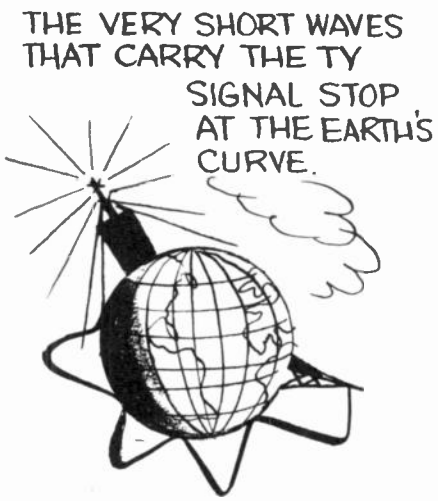
The electrical impulses that are the television signal come up to the transmitter by coaxial cable from the control room or master control. The picture and sound signals are always separate.

The transmitter generates the power to carry these signals through the air. The electron tubes that do this work get so hot that they must be constantly cooled by air or water. If the cooling system fails, automatic controls turn the tubes off to keep them from blowing up.

The electromagnetic waves that carry the signal through the air are called the carrier waves. When the signals are added, the carrier has been modulated. The waves that carry the picture are amplitude-modulated, or AM. The waves that carry the sound are frequency-modulated, or FM. (More about this on pages 10, 13.) The sound and picture waves travel side by side in the channel or band of radio frequencies that is allotted to each station by the Federal Communications Commission.

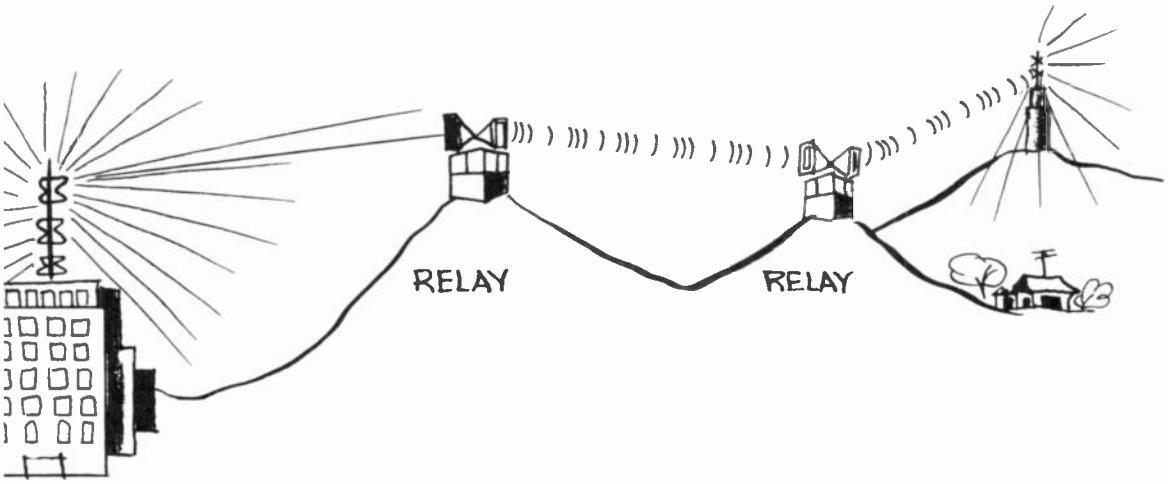


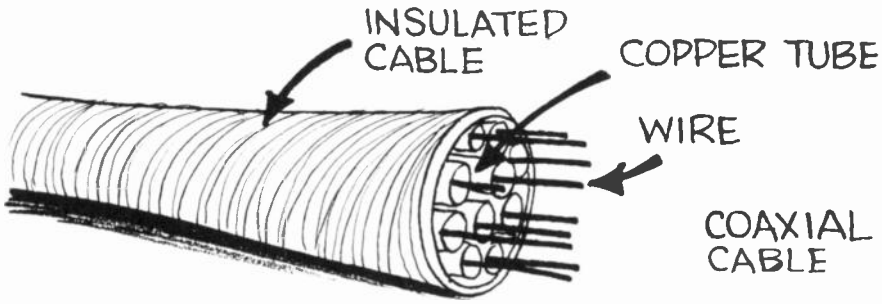
RELAYING THE SIGNAL



The electromagnetic waves which carry television signals cannot be broadcast over long distances like those which carry an ordinary radio program. Ordinary radio waves take long, easy bounces around the earth. But television waves are very short and they don't bounce. They stop as soon as they come to earth, or go shooting off into space where the earth curves. Direct television broadcasts seldom go farther than 60 or 70 miles.

A network of microwave relay stations and coaxial cables usually sends the signal over longer distances. Relay stations are placed on hills or mountains, as far apart as they can be and still be within line-of-sight of each other. On the top are big reflectors which scoop up the television signals aimed at them. Inside the relay station, special equipment strengthens the signals and sends them out again, on to the next station. This equipment works automatically. There doesn't have to be anybody at the station at all.

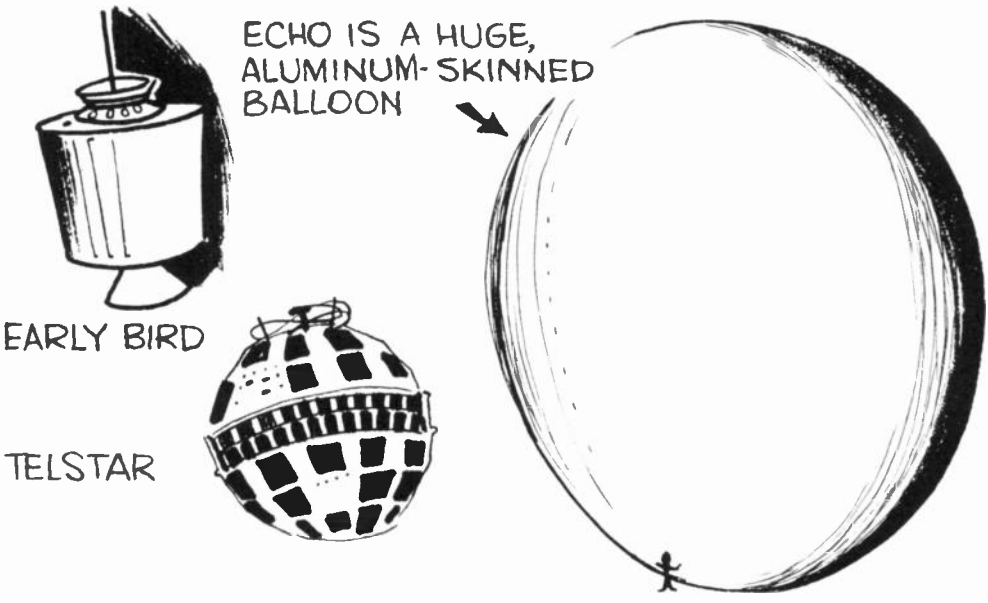




Coaxial cable is another way of sending television signals. A coaxial cable is a copper tube with a wire suspended inside of it. The inside wire carries the signal, and the tube around it keeps the signal from leaking away. A number of coaxial cables are bound together in a protective casing and laid underground or underwater. One coaxial cable can carry one television program at a time or thousands of telephone calls.

RELAY SATELLITES

Television signals are relayed over great distances by space satellite relay stations. There are three kinds of relay satellites. One orbits the earth from about 600–3500 miles up. Telstar is this kind of satellite.



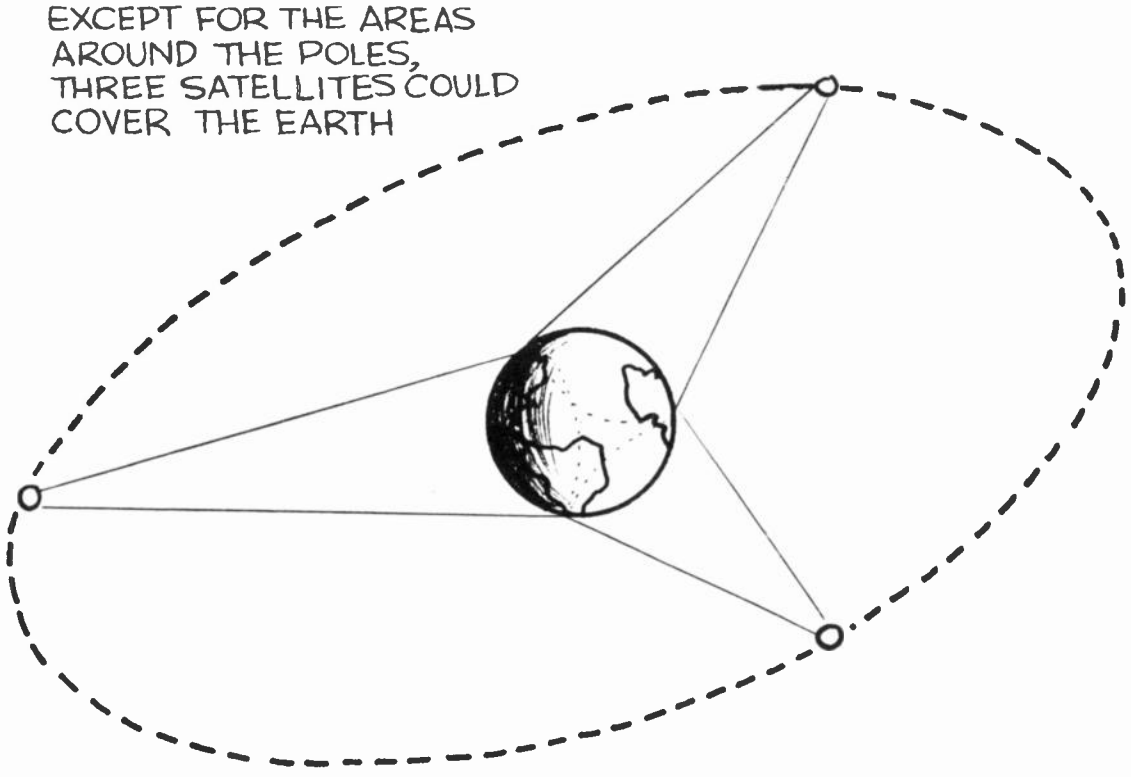
Another kind matches the earth's orbital speed, and therefore keeps a fixed position, 22,300 miles up. Early Bird is this kind of satellite. When three of the Early Bird (or Syncom) type satellites are hung in the sky, they will form a relay system around most of the earth.

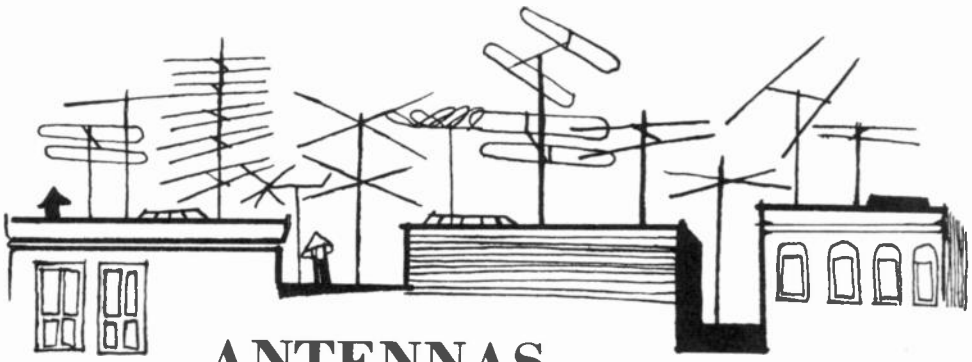
Early Bird is a Comsat satellite. It is owned jointly by the U.S. government and private stockholders.

These two kinds of relay satellites receive a signal from a special transmitter and then retransmit that signal to a highly sensitive receiving point thousands of miles away from the sending point. This signal is then sent by relay to various local station transmitters which broadcast it.

A third type of satellite relay is a large balloon-like satellite with a reflective surface, which orbits the earth from about 640–800 miles. It does not contain any transmitter, but is simply a bounce-off place for the signal between the sending and the receiving points. Echo is this kind of satellite.

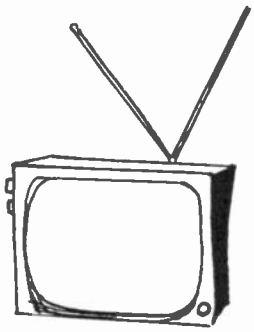
Some time before too long, television programs from anywhere in the world, transmitted to satellite relay stations, will be sent directly from the satellite to your receiver, eliminating many of the interference problems of ground transmission.





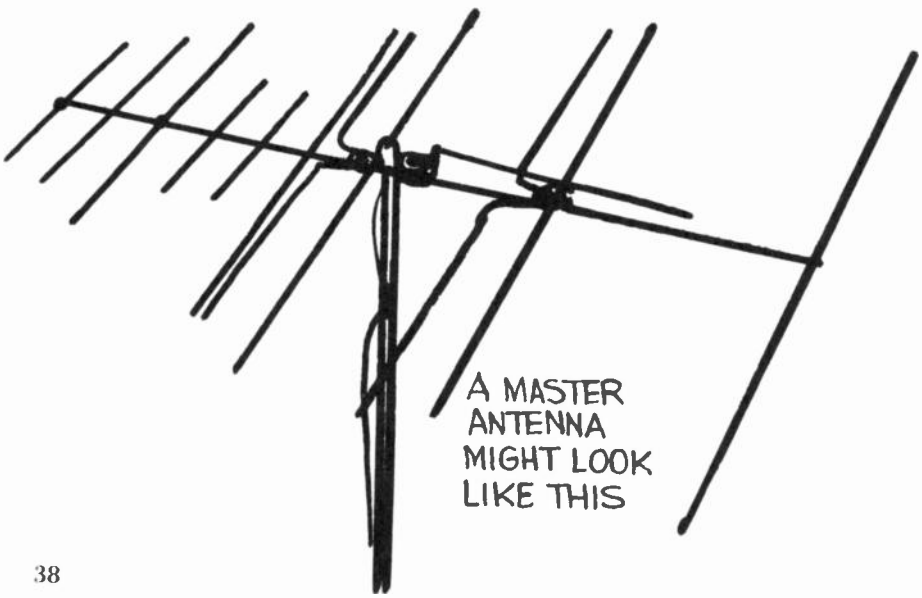
ANTENNAS

The air is full of television signals from many transmitters. In order for you to see a picture, these signals have to be caught and brought into your set. There are several ways of doing this.



If you live within 60 or 70 miles of the station transmitter and there are no mountains or very high buildings in the way, an antenna on top of your house or even on your set will do the job.

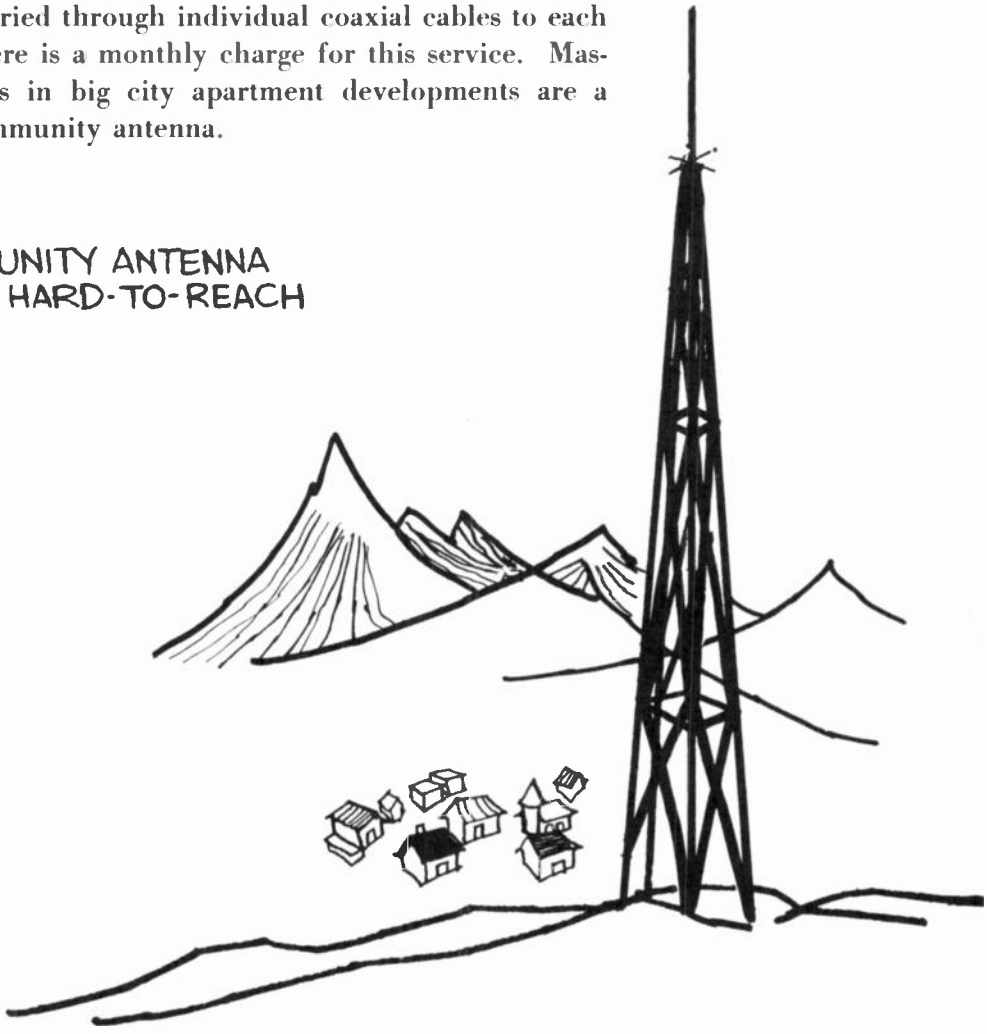
In a city, where hundreds of people live in big apartment houses, it would be impossible to have an antenna on the roof for each set. Usually, there is a master antenna and all the sets in all the apartments are connected into it by cable. Because there are so many sets drawing signals from one antenna, amplifier tubes strengthen the signal before sending it down to the different apartments. Sometimes, when there are several sets in a one-family house, they are connected into a smaller master antenna.



Sometimes people in a "fringe" area—perhaps a little more than 70 miles from the transmitter—put up extremely high antennas to get better reception. These may have amplifiers too.

In communities which are cut off from station transmitters by mountains, a community antenna system might be used. A private company erects a very high and complex antenna on the highest mountain in the area, to be in direct line with all the station transmitters in range. The signals that are received by this antenna are amplified and carried through individual coaxial cables to each house. There is a monthly charge for this service. Master antennas in big city apartment developments are a kind of community antenna.

A COMMUNITY ANTENNA SERVES HARD-TO-REACH AREAS

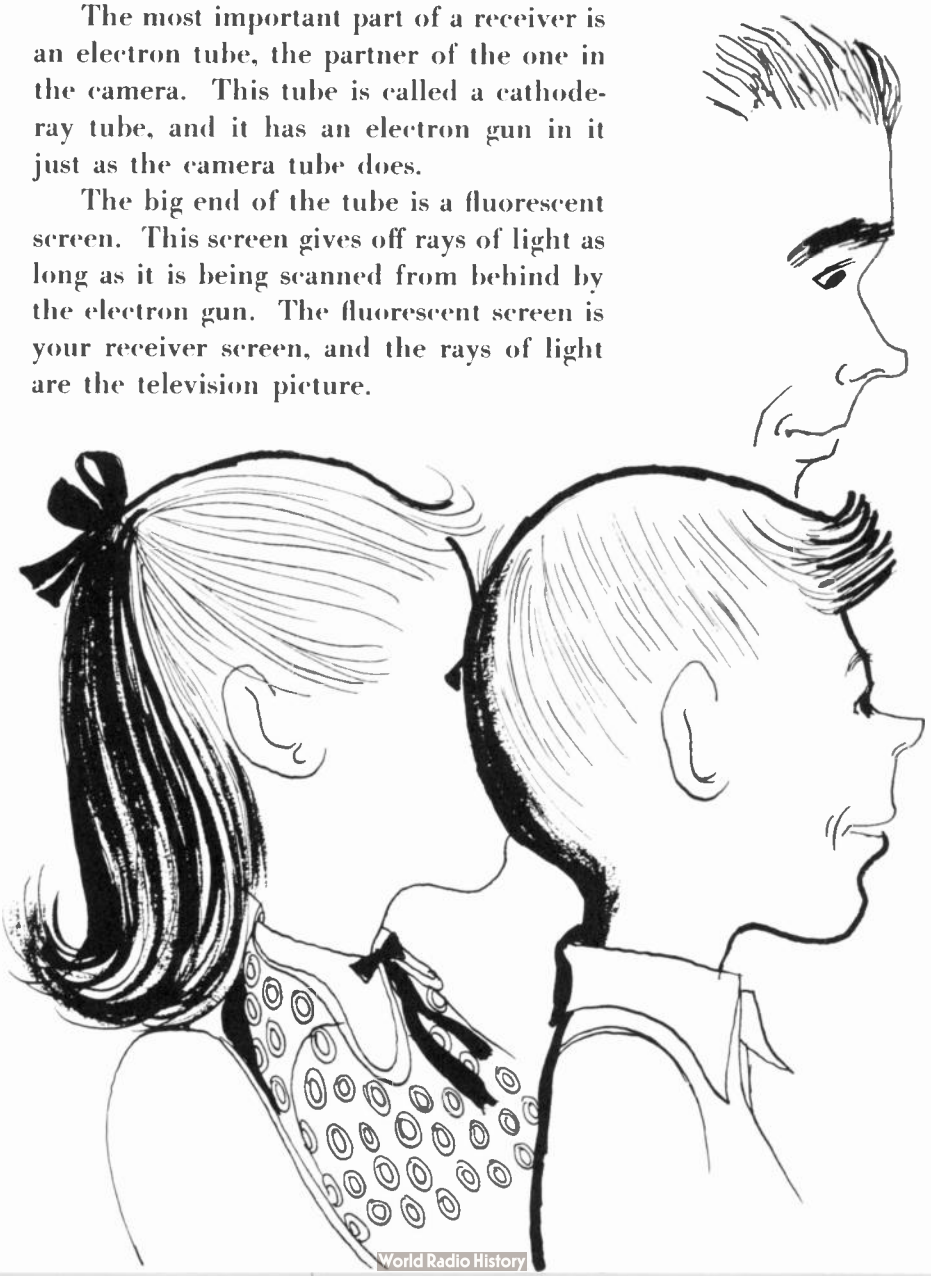


HOW THE PICTURE IS RECEIVED

When your receiver is turned on, the antenna on your house or on your set picks television signals out of the air. Since every station broadcasts waves of a different frequency, you put your set in tune with the station you want by tuning it in on your channel selector.

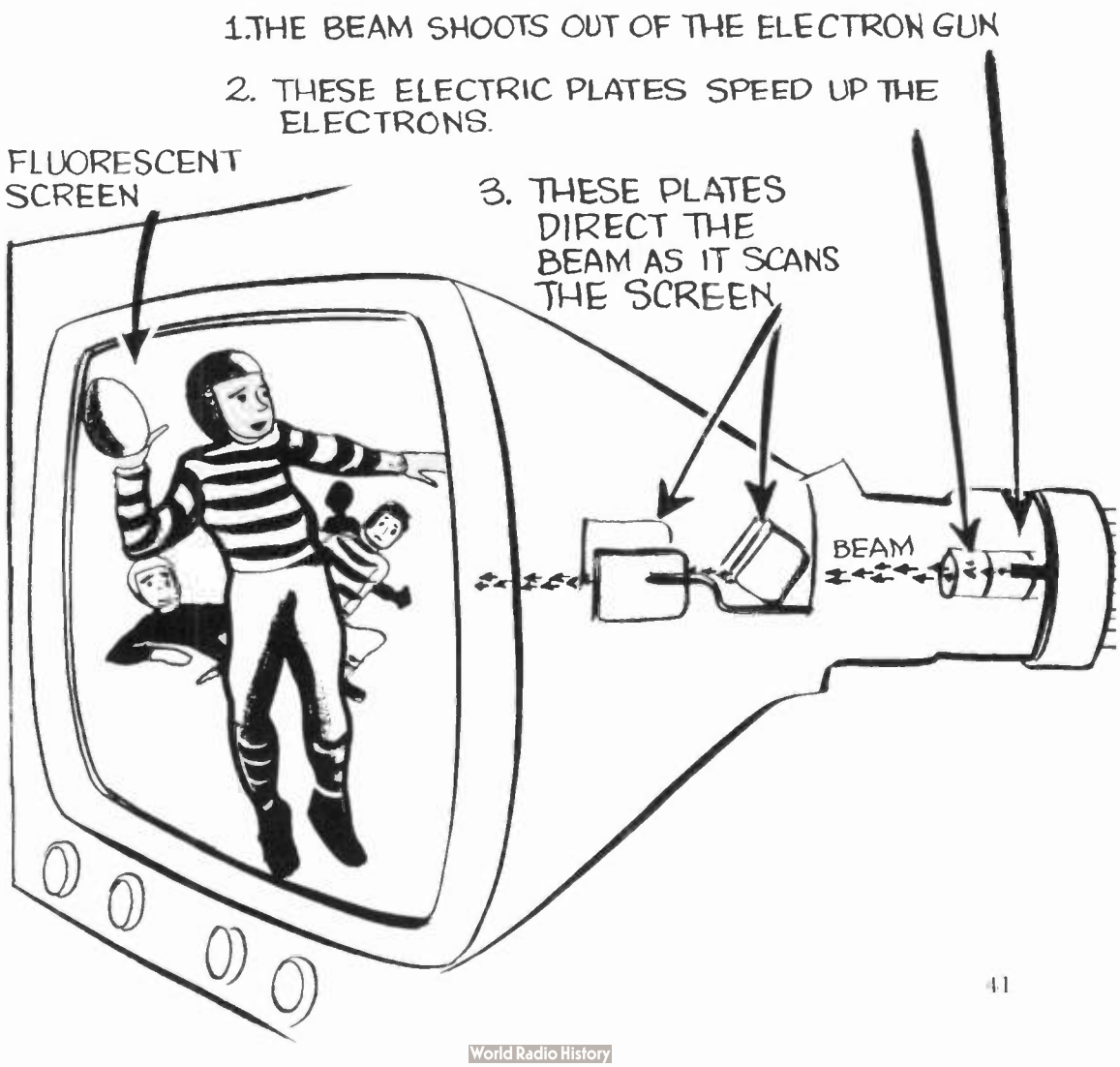
The most important part of a receiver is an electron tube, the partner of the one in the camera. This tube is called a cathode-ray tube, and it has an electron gun in it just as the camera tube does.

The big end of the tube is a fluorescent screen. This screen gives off rays of light as long as it is being scanned from behind by the electron gun. The fluorescent screen is your receiver screen, and the rays of light are the television picture.



The beam of electrons in the cathode-ray tube fluctuates just the way the beam in the camera tube does. It shoots out of the gun and scans the fluorescent screen in exactly the same way. Since the beam is made of little charges of electricity exactly like the ones that flowed out of the camera tube, it makes a picture in light on the receiver screen just like the one that first came in through the camera lens. And because electromagnetic waves travel at the speed of light, you see that picture at almost the precise instant the camera sees it. The time it has taken to get to you is too short to count.

The picture on the television screen is really built of 525 lines of light and dark spots, which you can see if you look closely. The beam repeats this 525-line picture 30 times a second. You see all this as a complete and moving picture because your eyes don't work fast enough to see the individual pictures being formed.



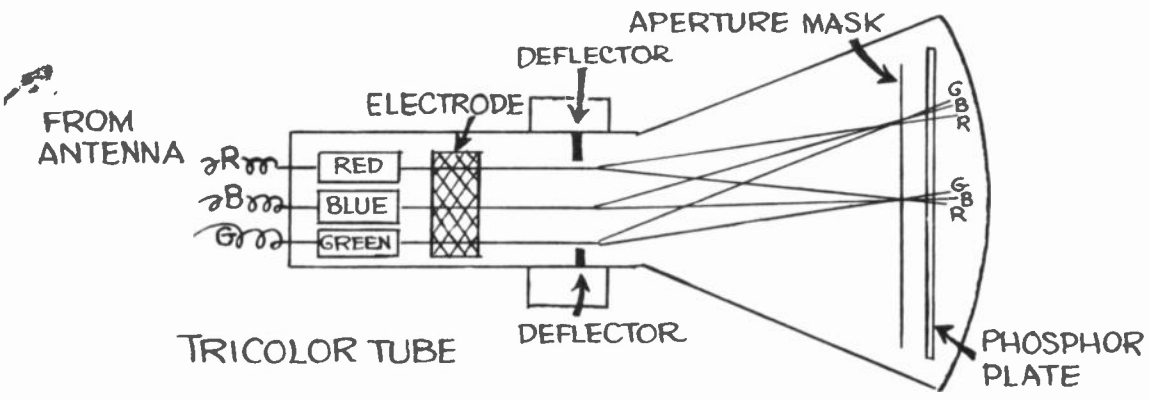
A portable television receiver works in exactly the same way, except that it gets its power from batteries. It does not have to be plugged into the electric current that supplies your house.

Except for the picture tube, most portable sets have transistors instead of electron tubes. Because transistors and other special kinds of crystals can be very, very small, it is possible to make portable receivers no bigger than a loaf of bread.

If you have a color receiver, it works like this.

The electrical impulses are picked up by the antenna and sent to the tricolor picture tube of the receiver.

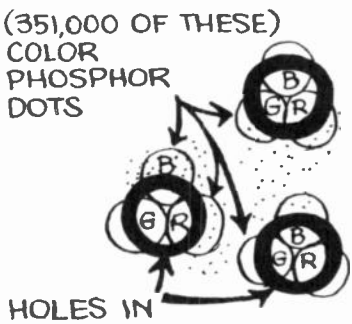
This tube has three electron guns in it instead of one. One gun is worked by the electrical impulses from the orthicon that picked up the red parts of the picture. The second electron gun picks up the impulses from the blue part of the picture. The third picks up the impulses from the green parts.

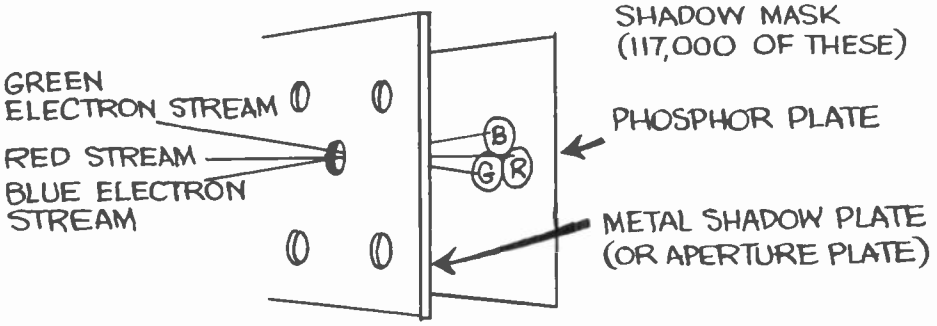


The three guns shoot their streams of electrons toward a plate at the flat end of the tube. The plate has been carefully coated with an equal number of red-, blue-, and green-colored phosphor dots, arranged in triangles of three each, one red, one blue, one green. There are thousands of these groups of dots in lines across the plate.

Between the electron gun and the phosphor plate is another plate, with lines of tiny holes punched in it. There is a hole for each group of red, blue, and green dots.

The electron streams from the three guns are focused so that they converge at the plate with the holes. The three streams cross going through every hole.

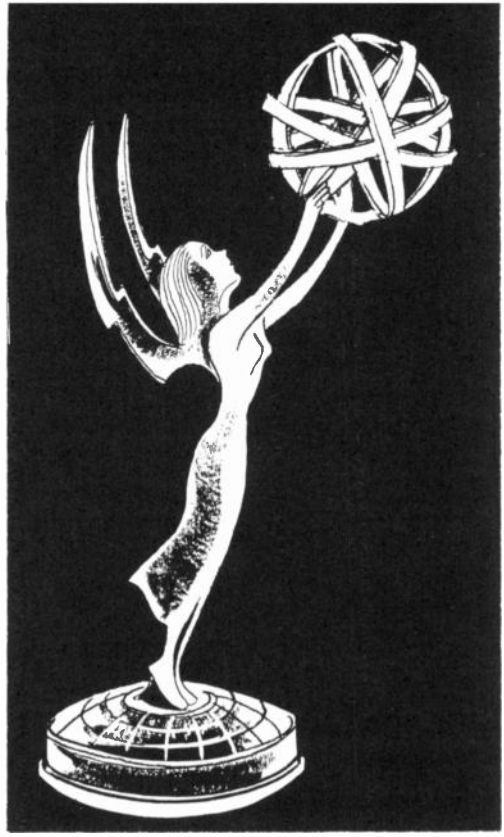




On the other side of the shadow plate, the stream from the red gun hits the red phosphor dot and makes it glow, but the stream is shadowed away from the blue and green dots of that group. The blue and green streams work the same way on their own dots. Since each electron stream is a translation in electricity of the amount of red, blue, or green light that came into the camera tube, it makes its own color dot glow more or less brightly. In a single group the red dot might be bright, the blue dot just glowing, and the green dot not even activated. This would make that particular group look purple.

The three electron guns scan across every hole, and through it to the phosphors dots, just as the electron gun scans the fluorescent screen in a black-and-white tube. But in the color receiver the picture is made up of thousands of glowing, colored dots. They are so many, and so small, and all this happens so quickly that you see only a clear, steady color picture. You are seeing color television.

THE "EMMY" IS TELEVISION'S HIGHEST AWARD



WHAT'S ON TELEVISION

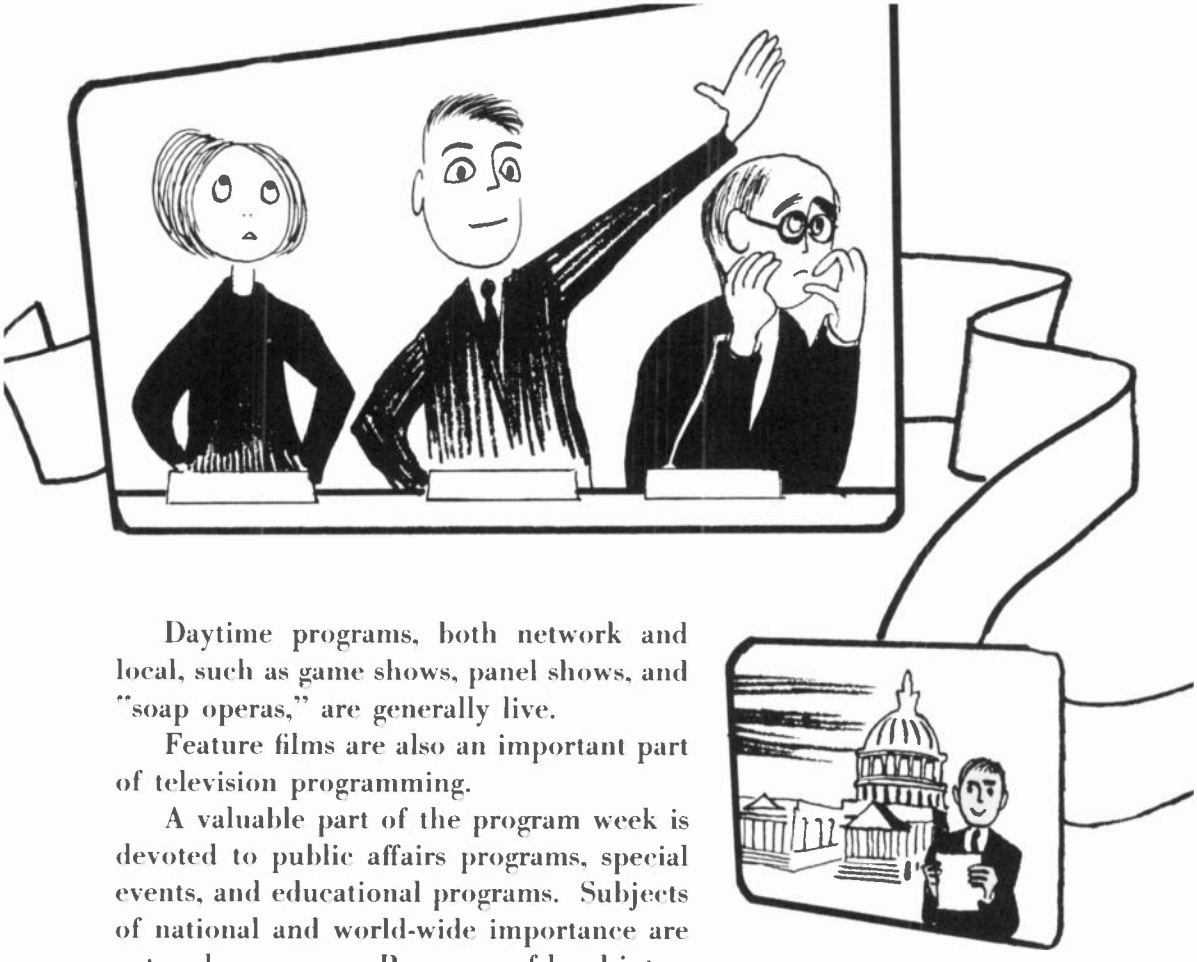
There are network entertainment shows that originate, generally, from New York or Hollywood.

There are news and special events and sports shows that might originate anywhere.

There are local shows which originate from a local station.

Any of these could be live, taped, or on film.

Evening programs, when the greatest number of people are watching, are called programs in "prime time." Most of these programs are series, and they are on film, made in Hollywood. Some are variety shows, and these are usually on tape. Network news programs which appear in prime time are live, with film and tape portions.



Daytime programs, both network and local, such as game shows, panel shows, and "soap operas," are generally live.

Feature films are also an important part of television programming.

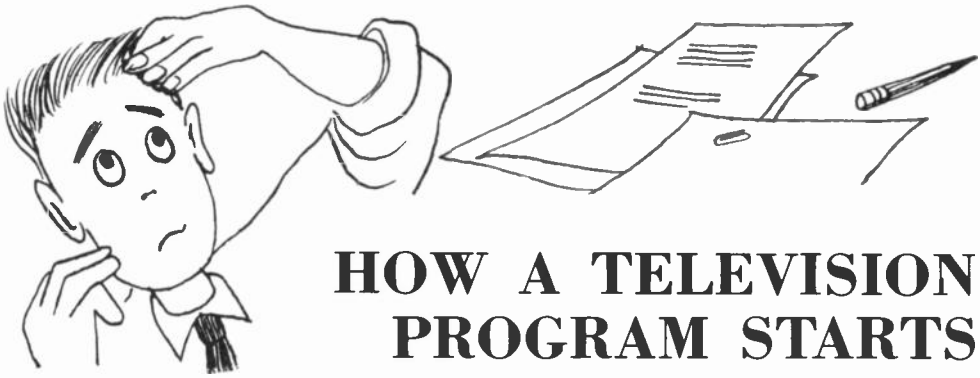
A valuable part of the program week is devoted to public affairs programs, special events, and educational programs. Subjects of national and world-wide importance are network programs. Programs of local interest are created by local stations.

Some of the best television programs are live sporting events, covering a game or contest while it is happening.

Every television network and every local station tries to create an exciting, well-balanced schedule that will be watched by the greatest number of people possible. This makes it more attractive to sponsors.

Shows may be created by the program department of the network or station, by television producing companies, by an independent producer, or by an advertising agency and a sponsor, working together.

The people who work at creating television programs—producers, directors, writers, actors, technical people—belong to the Academy of Television Arts and Sciences. Every year the Academy presents television's highest award, the Emmy, to those people who have been responsible for the most outstanding programs of the year in the opinion of the members.



HOW A TELEVISION PROGRAM STARTS

A program starts with an idea. The idea is usually originated by a writer, a producer, or the program development department of a network, but everybody involved in television is always thinking of new program ideas. The idea is put on paper. If it looks good, it is expanded into a treatment.

A treatment is a fuller treatment of the idea, with a number of details worked out. If the idea *still* looks good, it is made into a presentation, to be shown either to a network or an agency. Often a sample script is written.

If the network or the advertising agency shows a real interest in the presentation it is made into a pilot, which is an actual sample program on film or tape.

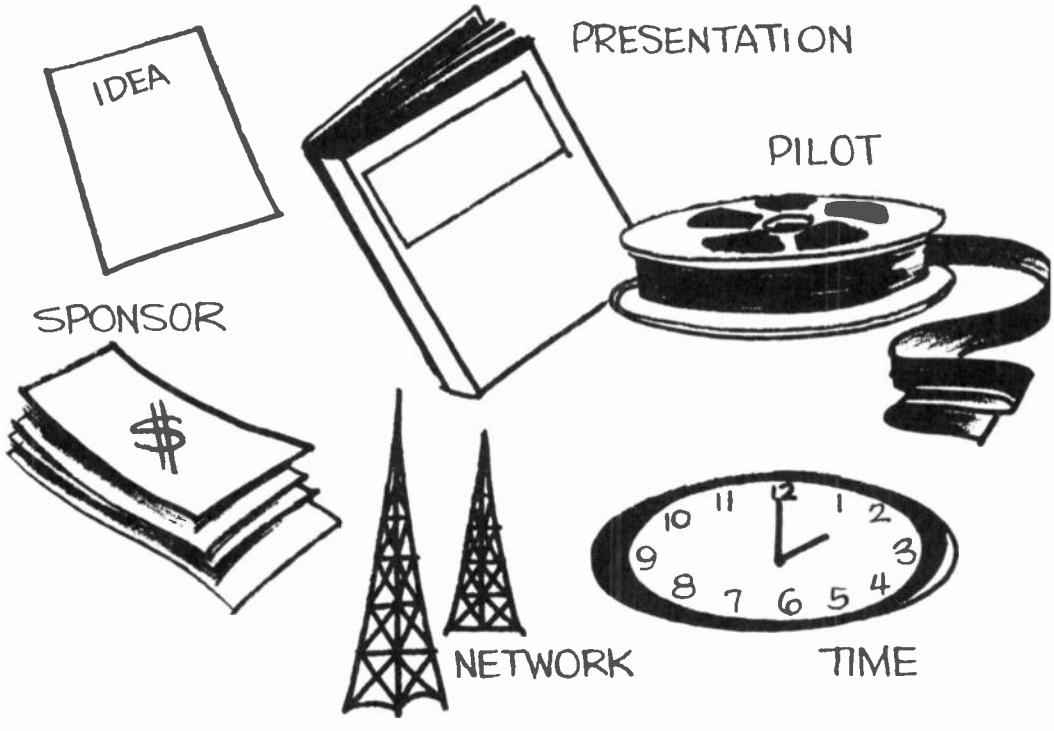
Now the pilot is shown to the networks, who generally will recommend it to the advertising agencies who, in turn, show it to various sponsors. If a sponsor buys it, the show goes into production.

There are thousands and thousands of ideas and scripts and presentations. Hundreds of pilots are made. Only a few dozen pilots ever become programs.

"Special" shows are sold and put into production on the basis of a treatment and presentation. Sports shows are sold if the event itself is of interest to enough people. Pilots for game shows, children's shows, discussion shows and soap operas are usually taped and shown to possible clients.

Before a program goes on the air, a network has to decide that it wants that program, and if it has the air time to show it.

The sponsor and agency have to decide that *they* want the program and come to an agreement with the network on the time it is to be played. There are more programs that sponsors would like to put on than there is prime time to show them on the networks.



LIVE STUDIO SHOWS

When you watch a "live" television show, you are seeing something at the moment it is happening. There is no chance to do a scene over or make corrections as there is in a show that is done on film or tape. No matter what happens, the show keeps going until it is finished. Whether it is a dramatic show, a quiz, or a musical variety, there is a feeling of something real unfolding.

THE PEOPLE WHO BUILD A SHOW

A producer is the overall head of a show. Some shows have an executive producer with other producers working under him.

An independent producer has his own company. He develops a show from the basic idea, which he sells to a network or a sponsor, to the finished production. The program is his "package."

A network producer is hired by a network to produce a network-owned show.

A producer decides what the show is going to be like. He controls the budget; hires everybody, including the talent; supervises the publicity and the distribution. Everyone connected with the show is responsible to him.

The writer puts the idea into words, and the director's job is to make the words into a show.

Together, the producer and the director choose the cast with the help of the casting director, decide on the sets with the help of the set designer, select the music with the help of the music director, and, if there are dances, work these out with the choreographer.

The program-operations department assigns associate directors and production assistants, studio facilities, and rehearsal time.

The technical department assigns engineering and camera crews.

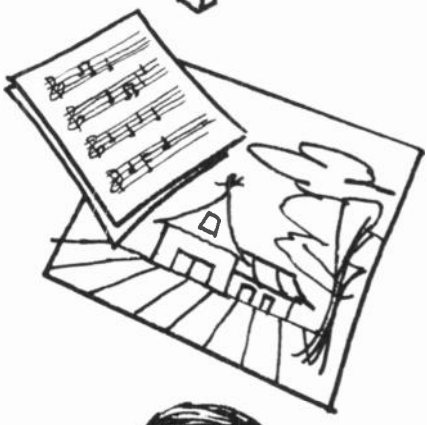
Network operations notifies other stations in the network of the time of the show and orders the necessary facilities to carry it.

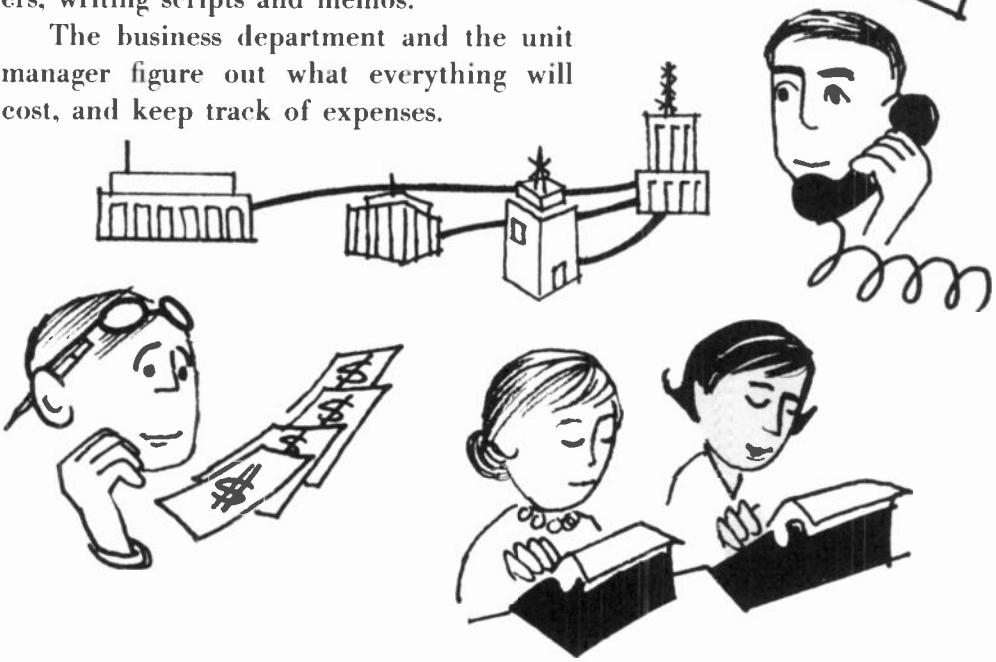
The production department starts work on the costumes, props, and scenery, and the publicity man gets out news stories.

The sponsor's commercials are prepared by the advertising agency.

Dozens of secretaries bang on typewriters, writing scripts and memos.

The business department and the unit manager figure out what everything will cost, and keep track of expenses.



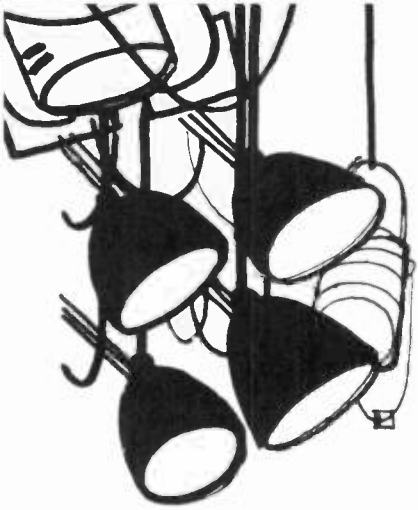


REHEARSALS

Some shows are not rehearsed, but it takes many hours of rehearsal to put on a big studio show. A 60-minute variety show begins with days of rehearsal without facilities (which means cameras, lights, and microphones). The dancers learn their routines, the singers learn their songs, the stars rehearse their parts, the musicians work with everybody. The sets are built, painted, and put in place. The costumes and props are collected.

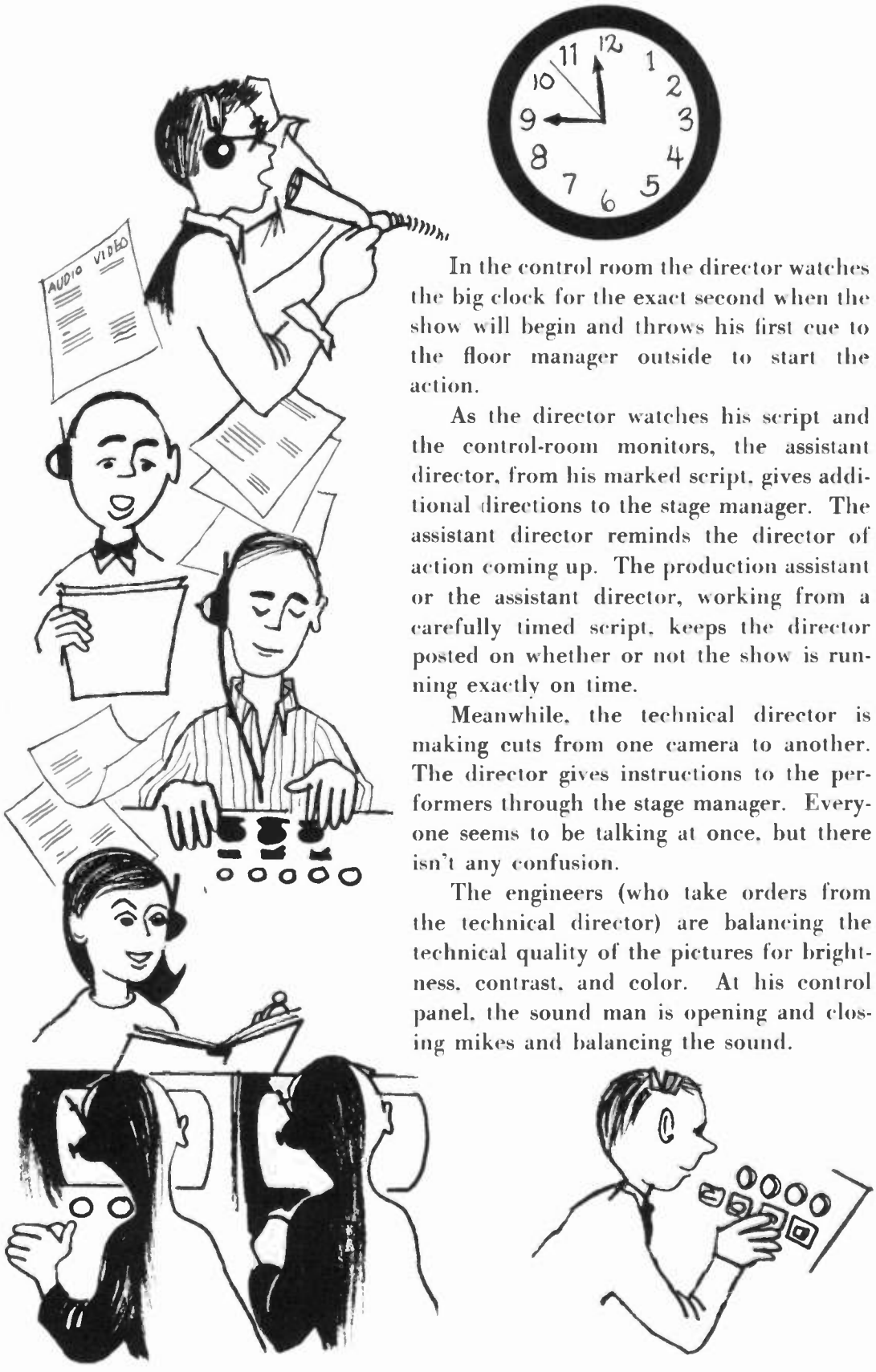
Then there are several days of rehearsal with facilities. Lighting effects are worked out and the mikes are set. Camera positions, which have been blocked out by the director beforehand, are tried out. Facilities include everyone—the talent, directors, choreographers, cameramen, musicians and all the technical people on the floor and in the control room.

Then there is at least one more day of complete rehearsal and dress rehearsal to make sure of everything.



ON THE AIR

The sets are in place, the lights are on, the mikes are "hot" (which means open), the members of the cast are in their places on stage, the television cameras are on. The floor manager yells "Stand by!" and awaits further cues over his cue phone from the director and his assistant in the control room.



In the control room the director watches the big clock for the exact second when the show will begin and throws his first cue to the floor manager outside to start the action.

As the director watches his script and the control-room monitors, the assistant director, from his marked script, gives additional directions to the stage manager. The assistant director reminds the director of action coming up. The production assistant or the assistant director, working from a carefully timed script, keeps the director posted on whether or not the show is running exactly on time.

Meanwhile, the technical director is making cuts from one camera to another. The director gives instructions to the performers through the stage manager. Everyone seems to be talking at once, but there isn't any confusion.

The engineers (who take orders from the technical director) are balancing the technical quality of the pictures for brightness, contrast, and color. At his control panel, the sound man is opening and closing mikes and balancing the sound.

On the floor, the performers are coming and going on cue and watching the floor manager for signals from the director. Sets and props are being swiftly and silently moved into place. Cameras are moving into position to be ready for each planned shot. Cranes are raised and lowered. The lighting director and his people are turning lights off and on.

The hands move around the clock, corrections are made, commercials and station breaks are inserted at the proper times, and the producer is worrying for everybody.

A live show is a tense experience for the people working on it, because even the most careful plans sometimes go wrong, and millions of viewers are sitting in on any error. But the people involved are so skillful that errors hardly ever show. When the last fade is made and the show goes off the air, there is a relieved, noisy outburst when the director says, "That's it. Thanks."

VIDEO TAPE SHOWS

Many shows are done on video tape. Much of the production technique is the same. However, on tape the show can be stopped or started at any point, acts can be done in the most convenient and economical order, mistakes can be corrected, and adjustments can be made in the length of the show so that it times out correctly.

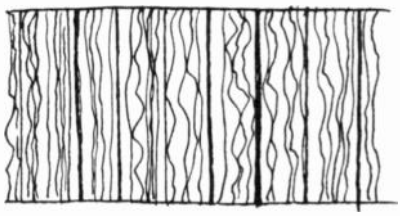
A taped show is taken with the same kind of television camera that a live show is. The picture travels from the camera through the control room equipment to the video tape recorder.

Video tape is a way of instantaneously recording, on magnetic tape, the electrical impulses that make up a television picture. Video tape can record anything the television camera can see and the microphone can hear. It does not have to be processed or developed in any way, and can be played back immediately. The quality of a video-tape recording is so good that it is difficult to tell from a live picture.

Video tape is a clear tape, 2 inches wide, coated with iron oxide, which reacts to electrical impulses. These impulses (the signal from the television camera and the microphone are electrical impulses) form a magnetic pattern on the tape. This can be played back into a picture, just as a phonograph record or tape can be played back into music. Once it is recorded, video tape retains its magnetism indefinitely, unless it is intentionally wiped off or erased. Then it can be used again. A piece of tape can be reused hundreds of times.

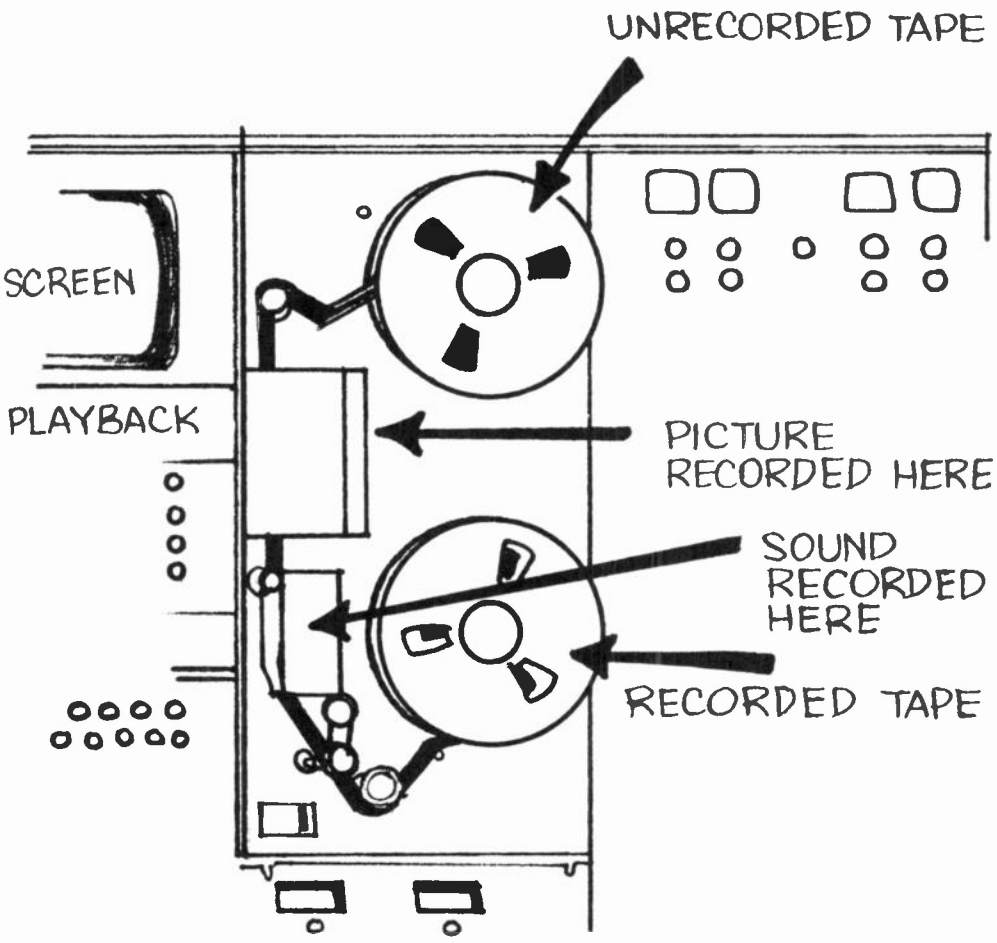
Video tape recorders are used in studios and on location.

THE PICTURE AND SOUND ARE RECORDED IN INVISIBLE LINES ON THE TAPE.



A FRAME TAKES UP ¼" ON THE TAPE. TAPE MOVES THROUGH THE RECORDER 15" A SECOND.

SOME VIDEO-TAPE RECORDERS LOOK LIKE THIS

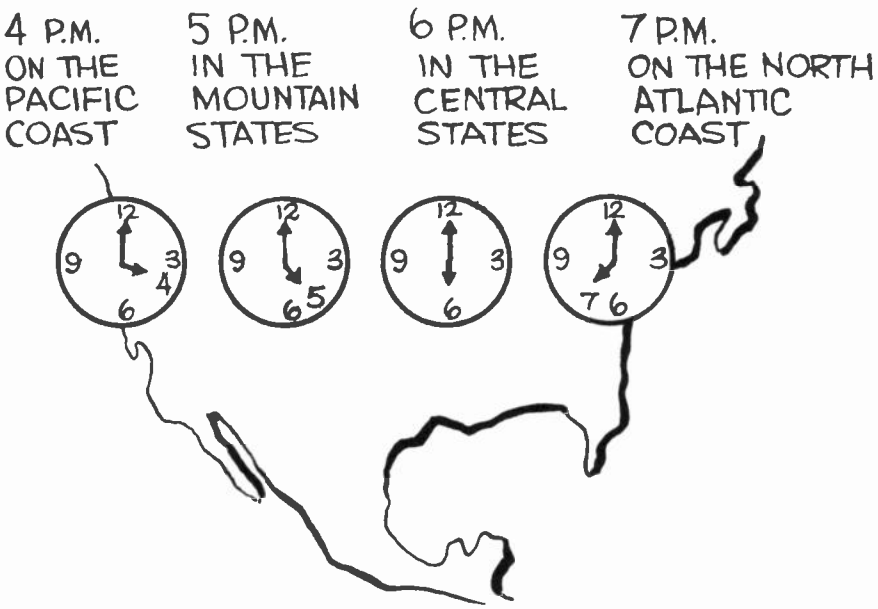


A video tape recorder consists of a console and two racks of electronic tubes. Tape unrolls from the reel past the video head, where four video recorders record on the tape. The video heads are mounted on a wheel which revolves at a very high speed. Then the tape rolls past an audio head where the sound is recorded. The tape moves at the rate of 15 inches a second. There is a space of $9\frac{1}{4}$ inches—$\frac{6}{10}$ second—between a picture and its sound on the tape.

With the addition of two racks of electronic tubes, the same tape and machine can record from a color camera as well as a black-and-white camera.

Many of the programs which were once done live are now done on tape, for several reasons.

Taping a show allows it to be seen at the same hour, even in different time zones. A live show, played at 7 o'clock in the evening in New York, would be seen at 4 o'clock in California if it were live there too. While 7 o'clock is prime time, most people are still at work at 4 in the afternoon.



Television shows cost so much that playing them only once is very expensive. Taped shows can be repeated.

Taping allows greater flexibility in the time and place of shooting. People who might not be able to be in a live show at a particular time or place can be taped at their convenience. Then the tape can be shown at the desired time.

Taping allows for a more finished production because it can be done over until it is right, and edited to remove rough spots. A tape, which does not have to be processed, can be viewed immediately by the production staff to see if it is satisfactory or if any parts need changing or reshooting.

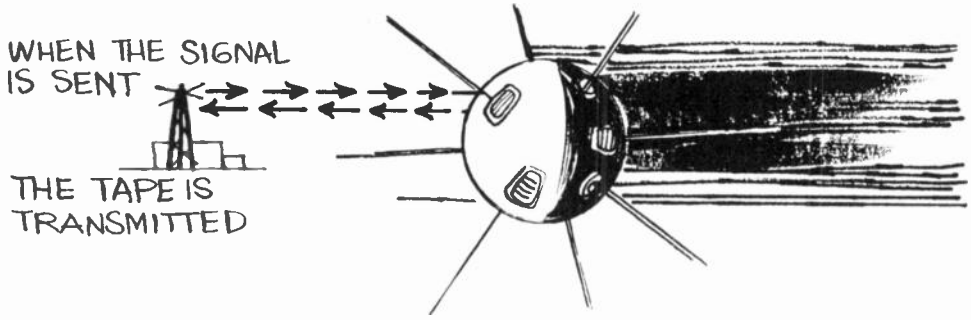
Sometimes two important live events take place at the same time. Taping allows them to be scheduled so you can see both.

Video tape is used extensively in educational television. At universities it is used for recording lectures and experiments and replaying them to many groups.

Industry uses tape to train salesmen and other workers.

The military uses of tape are enormous. It is used for recording statistical information, ground maneuvers, missile firing, training programs.

Many space satellites contain television cameras which record on video tape. A weather satellite, for instance, continuously records what its camera sees. The tapes are played back at a signal from the ground station when the satellite is in range.



THE VIDEO TAPE ROOM

A network video tape room is a very busy place. All the following operations might be going on at once.

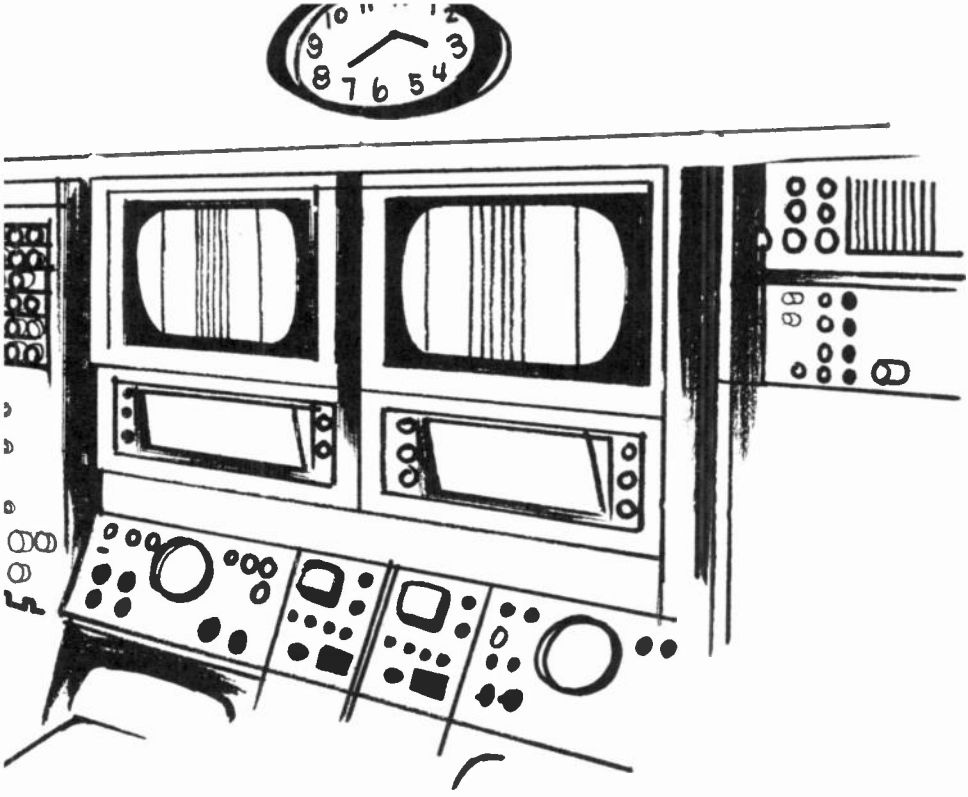
A taped program is being sent out across the network.

Another taped show is being sent by closed circuit to stations in other time zones to be retaped there for a later broadcast. If a major program is scheduled for 7 P.M. in each time zone across the country, the tape must be played at three different times. During daylight saving time, these schedules get even more complicated.

Taped news segments are being transmitted to other stations for inclusion in their local news programs.

Incoming programs from other production centers are being taped for later playing on the network.

Productions from studios inside the building are being taped.



Several shows are being edited. Tape can be edited mechanically by cutting the tape, rearranging the sections and then sticking it together again with a special splicing tape. This is an extremely precise and painstaking job.

Tape can also be edited electronically by re-recording, on a new tape, the precise sections that are wanted from the original takes of the show. As the editor and director screen the tape, they push buttons which electronically mark, on a cue tape, the sections where changes are to be made. Then the tapes and the cue tape are rerun through tape machines which automatically make the changes.

Safety copies of a show are being taped. When a network show goes on the air there are two machines running simultaneously, with identical tapes. If anything goes wrong with one there is an instantaneous switch to the other.

A commercial is being recorded.

A lot of people work in the tape room, controlling and monitoring the tape recorders and editing tape.

Tape operations are important in local stations too, but not on quite the same scale.

SPECIAL EFFECTS

SUPERIMPOSITION

Pictures from two cameras, a camera and a slide projector, or a camera and film or tape, are sometimes combined to form one picture. A dancer can look as if she were dancing on the clouds by combining a shot of the dancer being taken by the television camera with a film of clouds running through the projector. When you see titles on top of a scene, or people appearing out of nowhere, it is because two pictures are superimposed, which means they are placed one on top of the other.

SPLIT SCREEN

Split screen is a way of sharing the space on your television screen between two or more cameras. Part of the screen shows the picture from one camera, part from another. They are not superimposed. Each picture occupies its own part of your screen.

PROCESS SCREEN

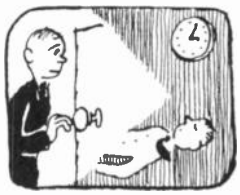
PROCESS SCREEN

The process screen is a way of projecting motion-picture film from the rear of a translucent screen so that it shines through and forms a background for the action on the set. For example, you may see a boy sitting on a train looking out of the window. The train is an actual set, but the scenery flashing past is on the screen. Still pictures can be projected as backgrounds too.

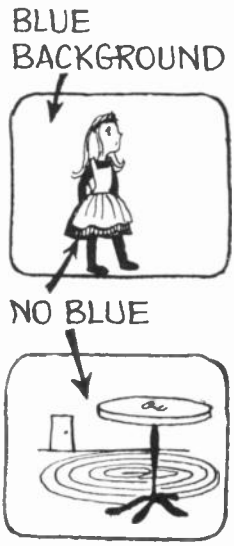
LAP DISSOLVES, FADES, WIPES

Transitions from one scene to another are made in several ways. The picture can be slowly darkened by the video engineer until it disappears (fade-out), and the new scene brought up into brightness (fade-in). Sometimes

one picture is faded out as the next picture is faded in, and they overlap. This is a lap dissolve. Pictures can also be electronically "wiped" off by a new picture. Wipes can be made in many shapes. They might be a circle growing larger and larger, or a wedge moving across the screen.



COLOR MATTING, OR CHROMO-KEY



Color matting is a way of combining two entirely different pictures so that they appear to be one solid picture. The actor can be set right *into* a scene, not just in front of it as he is when a process screen is used. Nor can you see one picture through the other as you can in superimposition. Color matting is a complicated way of screening out selected parts of a picture that are a particular color, and leaving everything else. Even if it appears in black-and-white, color matting must be done with color cameras. It is used when actors appear much larger or smaller than their surroundings; when they appear to pass rapidly from one place to another, as from country to country; when people who are actually in different places appear to be together.

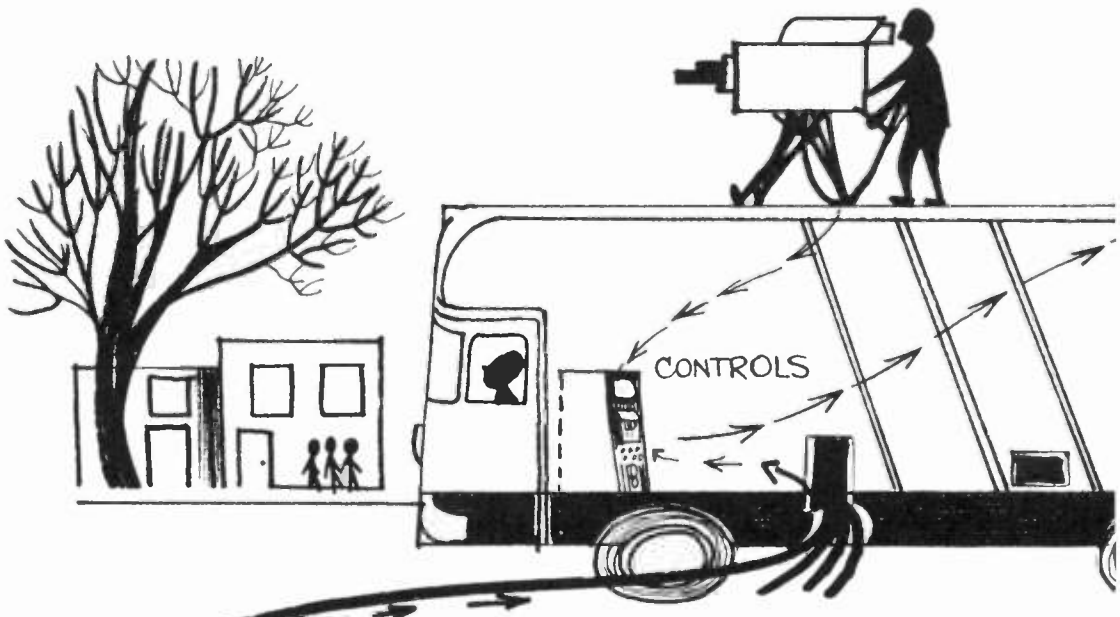
OTHER EFFECTS

Upside-down pictures are made by using a prism in front of the camera lens.

Whirling pictures are made by revolving a device behind the lens.

Rippled effects are made by having the camera take a reflected image in a rippled mirror.

Distorted pictures (dreams, maybe) are made electronically.

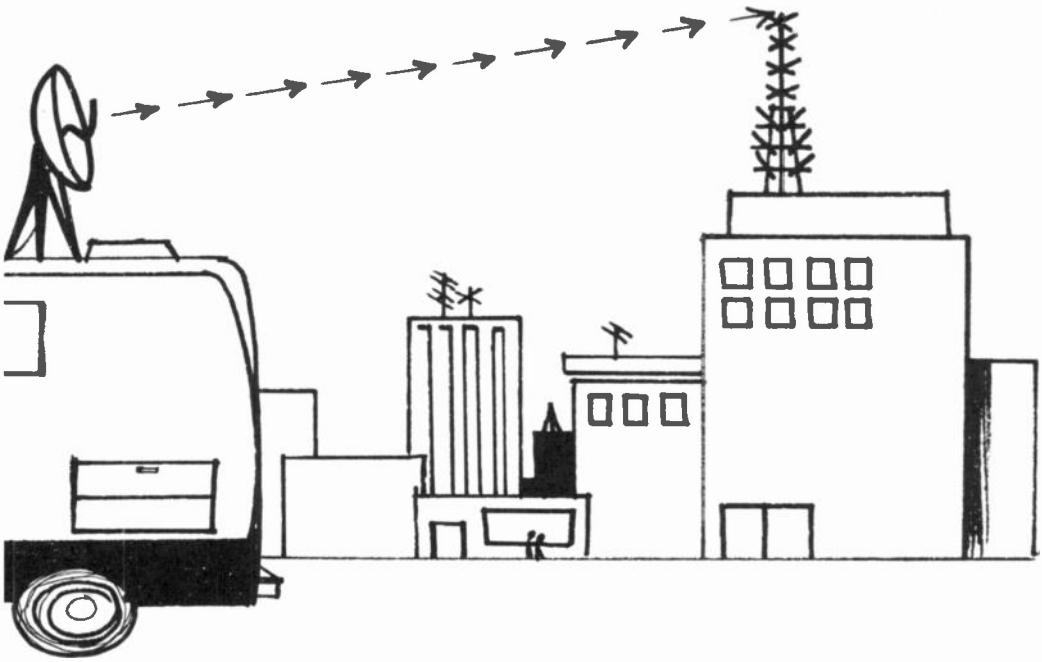


REMOTE OPERATIONS

Many programs originate outside of the studio. They might be sporting events, special events, (such as the launching of a satellite) a convention, a parade, or a beauty contest. They can be news stories: fires or riots or rescues. They can be entertainment shows such as a variety show taken on location, a Broadway play, or a hootenanny. All of these are called remotes.

A remote can be either live or taped.

Normally, one or more mobile units, which are trucks fitted out as control rooms, are used. Each truck generally has three or four cameras connected to it by coaxial cable. These cameras can be placed up to 1,000 feet away from the truck. There are complete audio facilities for using either wireless or cable mikes.



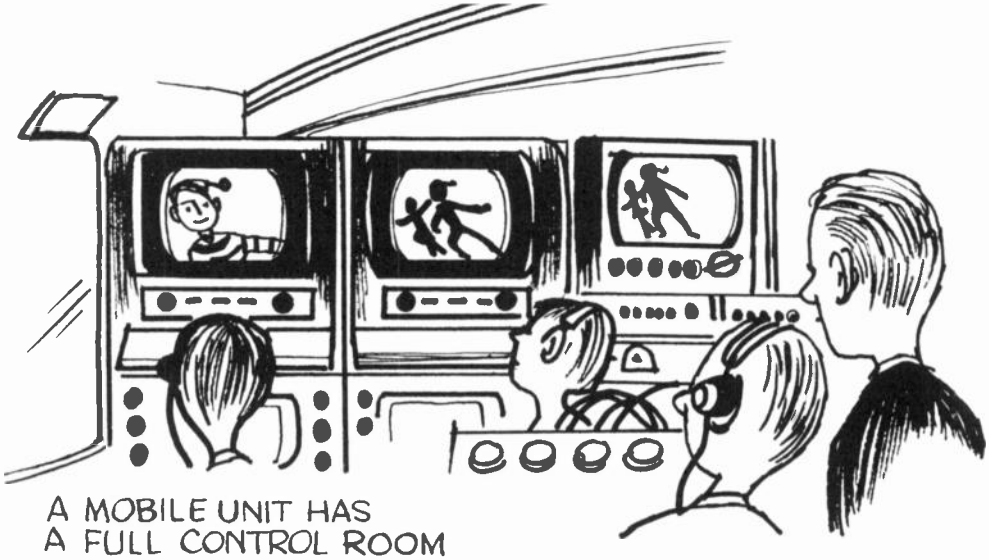
The signal from the mobile unit has to go back to the local station to be put on the station transmitter for broadcast. Some units send the signal back by connecting into telephone company coaxial cables. Some mobile units have a microwave relay transmitter that sends the signal back to the station.

The microwave relay, which television men call the link, is usually on the roof of the truck. The signal from the relay to the receiving antenna at the station must be in direct line-of-sight. That means there must be nothing between them to interfere. But suppose there are high buildings or mountains in the way? Well, then there has to be another link, or two, on a high place that is in the line-of-sight to both the mobile truck and the transmitter, to pass the radio waves along. If the truck is transmitting while it moves, or the telecast is being sent from a moving car, one of the engineers has to keep aiming the "dish" at the receiving point.

The program from the mobile unit can either be put on the air immediately, live, or recorded in the station tape room for broadcast later.

Some mobile units are equipped with video tape recorders and can tape directly on the scene. Others are connected to a separate, tape recording truck.

A mobile unit can get its power by plugging into an outside source, or from its own portable generators.



A MOBILE UNIT HAS
A FULL CONTROL ROOM

A mobile unit operates in much the same way as a studio control room. There are monitors for each camera. Video engineers control the quality of the pictures. There is a technical director who does the switching from camera to camera and an audio engineer who handles the sound equipment. The director sits with his assistant and the technical director. He watches the camera monitors and tells the technical director which picture he wants.

Color mobile units are larger than black-and-white units because they have to carry more electronic equipment.

Sometimes several mobile units are used on a single location and are interconnected with each other.

When planning any remote show, the director and a survey engineer go out to the location. They check the space they will have to work in, the positions for the cameras, the source of enough electric power to run the equipment, and the location for the relay link, so that it will be in direct line-of-sight with the transmitter. If the program is to be indoors or at night, a lighting director usually goes along to figure out what lighting will be needed.

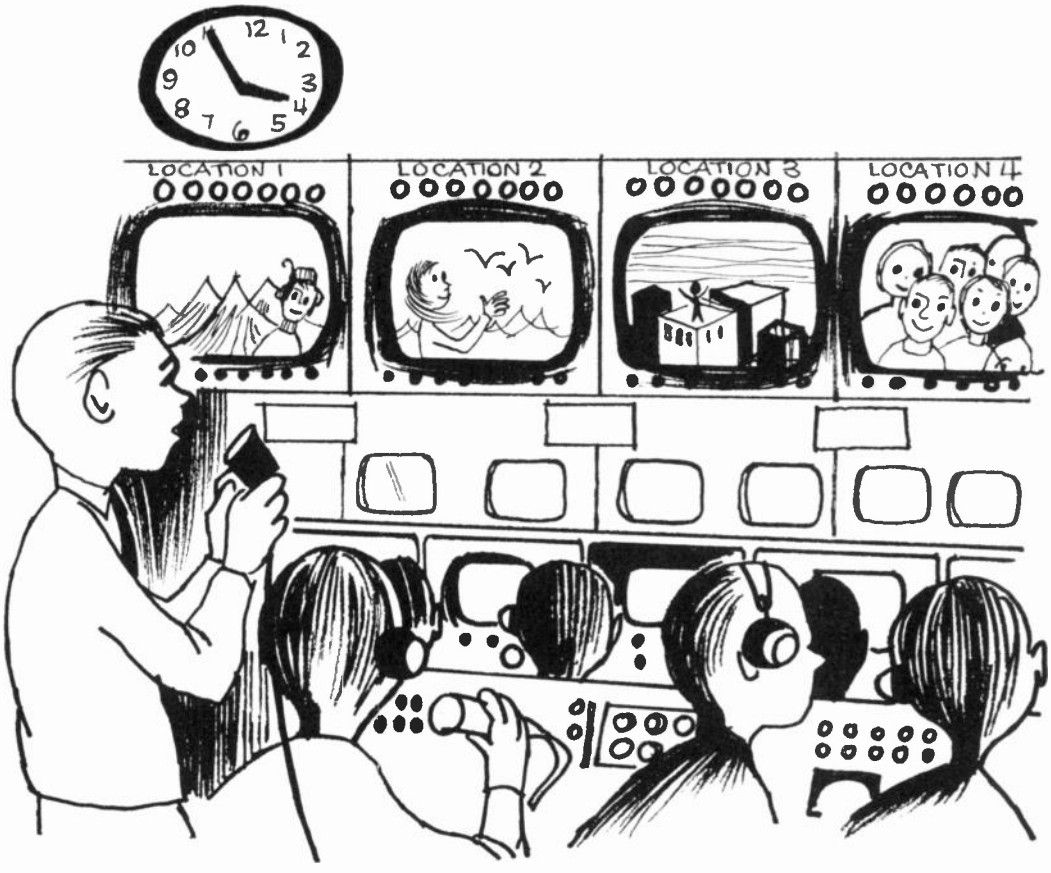
Hours or even days before the show goes on the air, the engineers move in with tons of equipment and start to work. As one group assembles the control-room gear, other engineers string the camera and power cables. Still others set up the microwave relay reflector. (Quite often the telephone company does this job.)

When remote shows come regularly from the same place, like a sports stadium, the installations there are semipermanent, and the surveying and setting up does not have to be done each time.

Once the cable is laid, the cameras and lights are set up. The transmitter, the cameras, and the control equipment are all tested, and the intercommunication system linking the director, the cameramen, and the engineers is checked. Constant telephone contact is kept with the studio, too.

The director prepares the show in much the same way the studio director does. If the program is a staged entertainment, he holds rehearsals, blocks out his camera movements, has several run-throughs, and then a dress rehearsal. Because working on location presents many more problems than a studio production does, the technical director works with the director from the beginning.

Where the mobile unit is picking up an event as it happens, the director works closely with the people who are putting on the event, so he will know what is going to happen and when. He places the cameras to get the best coverage. This could mean erecting towers or even putting the cameras in aircraft overhead. Later, when the event is in progress, he has to decide which camera tells the story best at each moment. He has to intersperse close-ups with wide shots and medium shots to tell his story. This on-the-air editing is called cutting.



Sometimes parts of a single show will originate from several locations, perhaps from as many as eight or ten widely scattered places. In putting on this kind of show, the producer, who is the overall head, has to consider not only the program material from each location, but coordinating the work of six or seven technical units and six or seven directors in the different locations. He has to see the program from each of the locations, and then rehearse all of them so that they fit together and come out on time. In a program like this, as many as 1,200 people can be involved.

The *most* remote operations in the world are in space ships. The cameras and other equipment in these space probes are automatic, but they can be controlled to some degree by signals from a control room on earth. From these mobile units in space we can see what it is like to crash onto the moon, or have man's first close-up look at another planet. These remote operations are enormously important to space scientists and television has given us a chance to share these first looks with them.

SPORTS

A great number of television hours are devoted to sports. The director who handles television sports has a special problem, and the success of the program depends upon how well he works it out.

Because of the size of the television picture, if the entire field of action is shown (the way you see it when you're there), the individual players are too small to be seen clearly. On the other hand, a close-up of just a few players shuts out the picture of the surrounding action. The director has to compromise between these two choices. He uses a basic shot showing a fair portion of the area, with medium-sized figures. Then, either by cutting back and forth between close-ups and long shots or by zooming his lenses to wide or close shots, he gives viewers the impresssion that they are seeing everything that happens.

Sometimes the commentator who describes the action works in the "cage" with the cameras, sometimes he works in a special press box with other commentators and reporters. But he always has an air monitor right in front of him. While he is talking about the play he sees on the monitor, he has to watch the field too, to see how the complete action is developing. Usually he has helpers who call his attention to things he might not notice and hand him notes about the various players. Often teams of commentators work together. One reports the action while another gives background color and statistics.

Sometimes the technical crews on sports shows work from the mobile truck, but most major sports stadiums have regular television control rooms. Camera positions are always selected carefully so that the action can be seen from various angles, but without confusing viewers who are accustomed to seeing the entire game from one position.

The cameramen, commentator, and director are a team who must know their sport well, in order to anticipate each play and get the important things on the screen.

Some sports events are very complex and must be covered by a number of units from a number of pick-up points. A major golf tournament is covered this way, as are automobile races and rowing races. The pictures from each unit are sent to a central control unit, and the director there chooses the coverage from point to point.

Some sporting events, such as a championship prize fight, are not broadcast over the air at all, but are sent closed-circuit (see page 87) to a special group of theaters and auditoriums which have large-screen television projectors. The audience pays an admission price and watches the event on large screen.

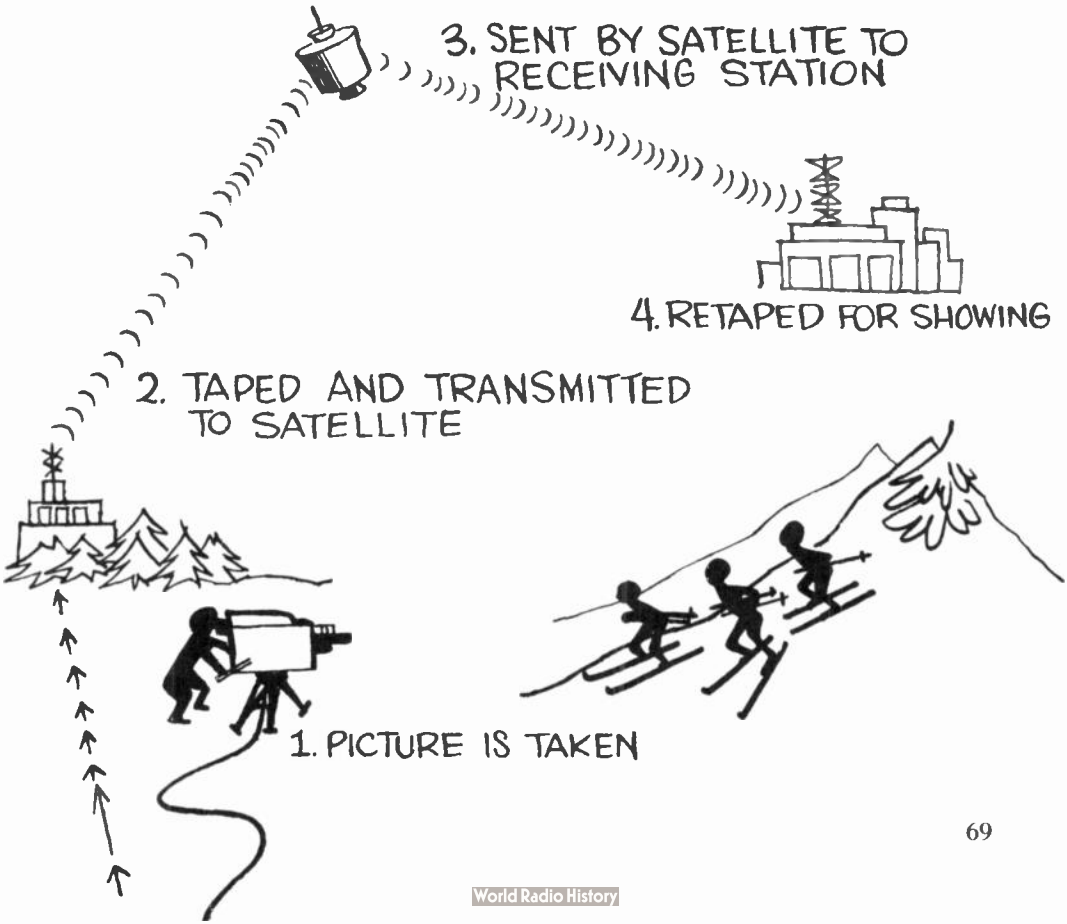
Live sports telecasts, with their suspense at the outcome, the actuality, the feeling of watching an event at the instant it is happening, is television at its best.

Some sporting events are covered with television cameras and recorded on video tape. These can be condensed, edited or shown just as they were recorded, at a later date. Sometimes a whole live broadcast is recorded, and the most spectacular plays are shown again in a recap, or during a slower portion of the game.

Some sports programs are a combination of live and tape. During the Olympics, for example, earlier events are taped and then shown during intermissions of a live event.

When an important sports event takes place in another country, the event is taped and transmitted by satellite, retaped at the satellite's receiving station and shown.

Some sports events are filmed and shown as regular sports series.



NEWS AND SPECIAL EVENTS

Network television news departments are the largest news-gathering agencies in the world, with correspondents and cameramen in action everywhere. Events and interviews with people in the news are filmed and videotaped 24 hours a day. Networks keep enormous film libraries of background material on every possible subject and person.

There are several kinds of news programs.

The "news in depth" programs report, explain and analyze major news happenings. They feature experts in the field, the people who are making the news, and pictures of the news events.

Most news programs are made up of live, tape, film, and graphic material.

Almost every television station has its own daily, scheduled news broadcasts and, big or small, some kind of news department. The job of all news departments is to get the news on the air promptly and accurately.

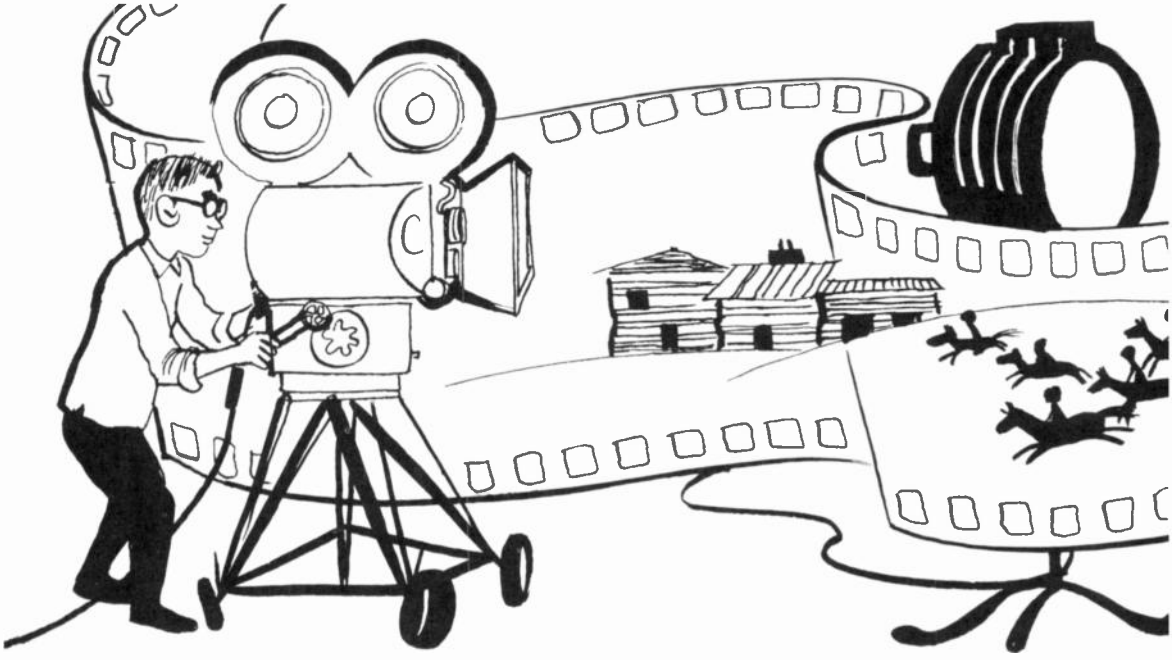
In larger stations or networks, getting the program together usually starts with a conference of the producer, the news editors and film editor, the director, writers, and commentator. They decide what are the important news stories of the day. The film editor reports what film is coming in locally, from other parts of the country and from abroad. To this film will be added maps and animated charts made in the art department and still pictures from the photographic services that supply the newspapers. The news conference decides the order of the stories and how much time each should take.

Now all departments go to work fast. Film cutters cut and edit the films. Artists draw the maps and charts, writers write the commentary, the picture editor gets the still pictures. By rehearsal time, all the parts of the show are assembled. Sometimes there is live material to be fitted in—perhaps an interview, or direct news pick-ups from other cities. This kind of news show uses all the studio facilities; the studio news set, the film channel, and the still and graphics projectors. All of this preparation has to be done from the beginning every day. If several news shows are scheduled, much of the material can be repeated.

Special events are often news, but generally can be planned in advance. A political convention, a spectacular parade, a military maneuver, the opening of the opera are all special events.

Sometimes in covering one of these events it is necessary to have remote units at many locations. At a Presidential Inauguration, for example, there would be a unit on the Capitol steps, several units along the route of the parade, another might be on the White House lawn, and still others watching the entire scene from the air.

The signals from each of these locations are sent to one central control room by coaxial cable or microwave relay link. There is a director with each unit to direct his own crew, and at the central control room an overall director switches from one location to another. From here the pictures are sent to the telephone company for distribution to the stations along the network.



FILMS FOR TELEVISION

Most nighttime entertainment television programs are made on film. These are the half-hour, hour, and hour-and-a-half series. They are situation comedies, westerns, mysteries, and dramas. Almost all of these are made in Hollywood. The motion-picture studios that once devoted their entire time to feature films now devote almost all of their time to making films for television.

Because of the great number of films which have to be turned out week after week, they must be made quickly and economically. Where a 90-minute feature film might take from 4 weeks to 6 months to shoot, a 90-minute television film is completed in 9 days. A 60-minute film has a 6-day shooting schedule, and a 30-minute film takes 3 days.

A television "season" is usually made up of 39 weeks, so many film programs are done in series of 13, 26, or 39 pictures. Sponsors may buy programs for one-third, two-thirds, or a full season.

Film series, after their first run on a network, are often syndicated, which means that they are sold to a number of local stations to be rerun out of prime time—usually in the afternoon. All of these stations may have different sponsors or several sponsors for the same series.

Because a television series is made up of many stories using the same actors and locations, a whole new technique of film production has been worked out.

Before any shooting starts, a number of scripts in the series are written. Then the best of these is made into a pilot film, one complete story in the series which shows the characters, locations, and the kind of stories the series will have. (Often the pilot is made before other scripts are completed.) The pilot is the salesman for the series, and is shown to sponsors and networks until the series is sold. If nobody wants to buy it, the series usually stops right there.

A SINGLE PRINT IN A SYNDICATED SERIES CAN BE MAILED TO MANY STATIONS IN SUCCESSION FOR SHOWING

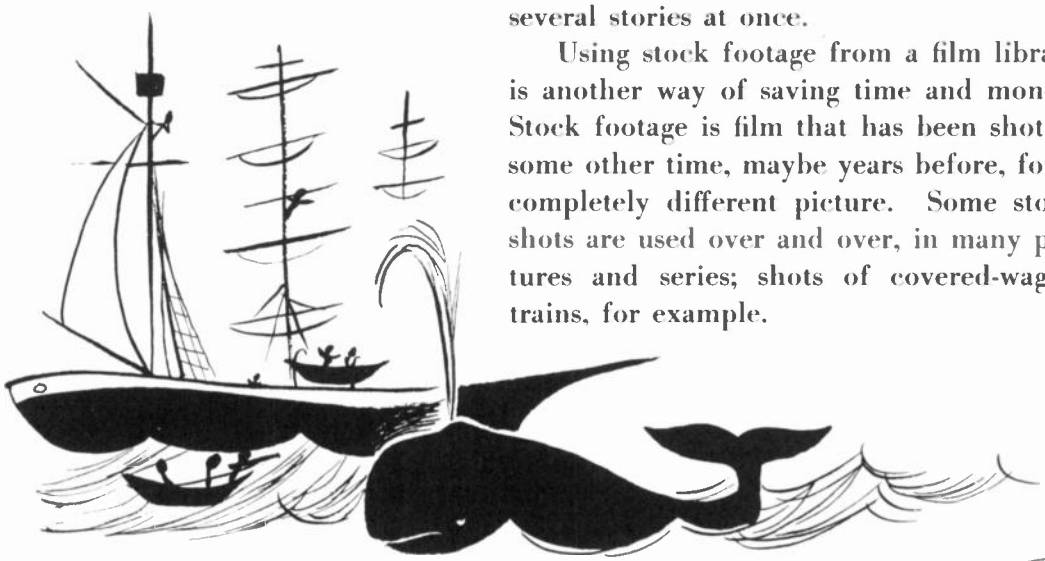
ALL SCENES SHOWING THE OUTSIDE OF THE SHIP MIGHT BE SHOT AT ONCE.

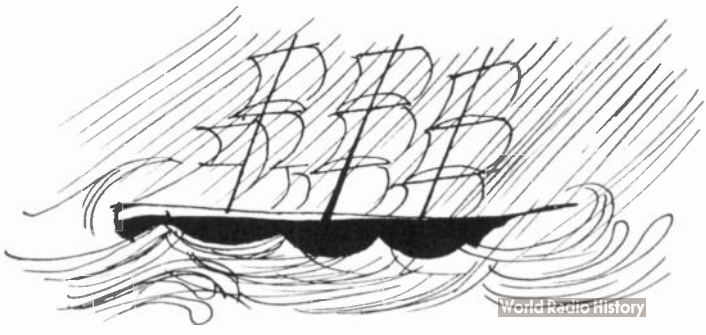
Once the series is put into production, all the scripts are studied and carefully broken down into lists of what sets will be used over and over again. These are built as permanent sets and pre-lit so that sequence after sequence, from any of the scripts, can be shot rapidly and without major lighting changes. Scenes where locations will be repeated, or situations will be similar, all are shot at the same time too, even though they belong to different stories. This saves a lot of money, time, and trouble.

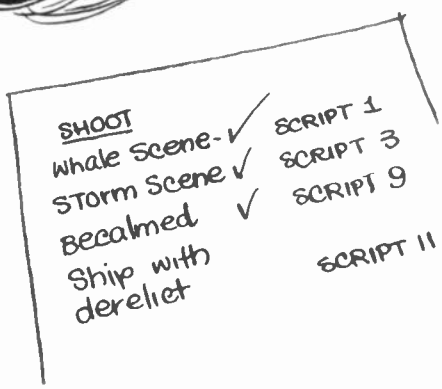
For example, if three scripts in a series have Indian battles in them, all the battles would be shot at once, one after another.

If the series uses a ship often, most of the background shots of the ship for all the stories could be made at the same time. There are many other ways in which time and money can be saved by working with several stories at once.

Using stock footage from a film library is another way of saving time and money. Stock footage is film that has been shot at some other time, maybe years before, for a completely different picture. Some stock shots are used over and over, in many pictures and series; shots of covered-wagon trains, for example.







All the scenes from a particular script, along with the stock footage, are then edited into a finished story. Music is added. A good part of this, like stock footage, is from a music library. The sound is re-recorded, titles and effects are put in, a finished print is made, and the story is "in the can."

There is usually only one producer working on a film series, but there may be several writers and directors working on different stories.

Sometimes the networks make the films themselves, sometimes a star will form his own company to make a series, some films are made by motion-picture companies that do only television films, and some are made by motion-picture companies that make feature films too.

There are a number of advantages to telling television stories on film instead of doing them live or on tape.

It is possible to get more action and variety of location which television audiences like. This can be done more cheaply on film than on tape.

It is easier to edit film than tape, so a film can be done in short "takes," with actors only having to memorize a few lines at a time. This means less rehearsal too.

Film is more practical for world-wide distribution of television programs because film size is the same throughout the world, but tape standards differ from country to country.

People like the way a story is told in movies. A movie has action and greater variety than a story on tape, so film programs can be repeated many more times than taped programs. This means that a single film can make more money.

A great many feature films, which were originally made for theaters, are shown on television. Now feature films are being made for showing first on television, then in theaters.

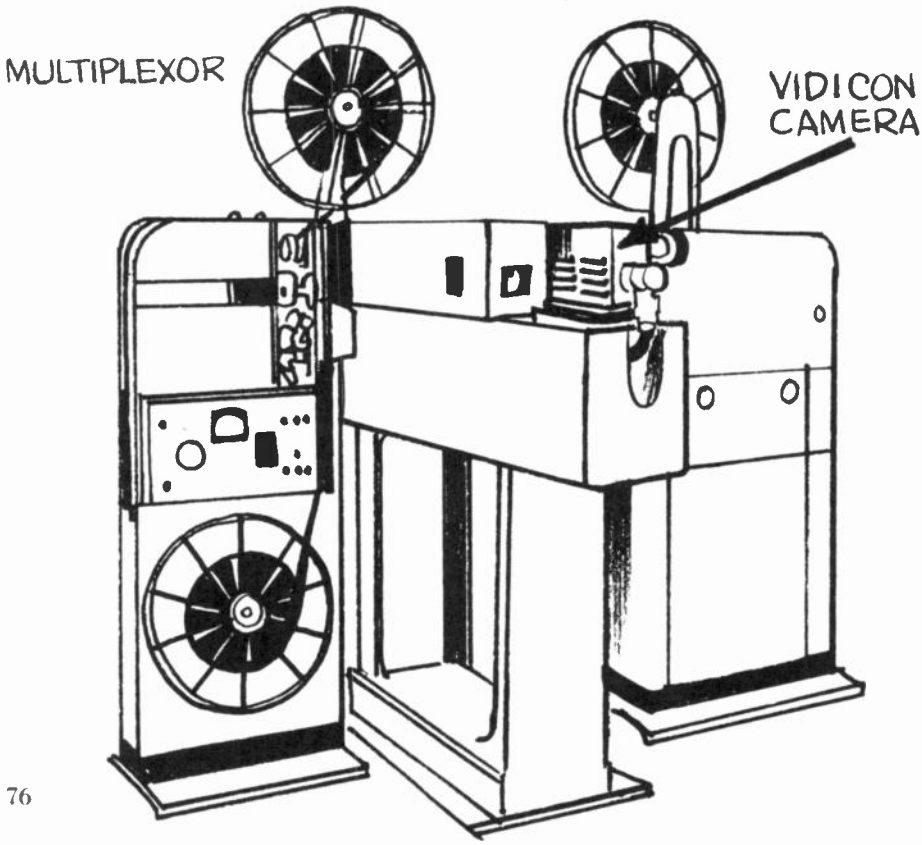
THE TELECINE ROOM

The room from which movies, slides, and still pictures are sent out over the air is called the telecine room. The movies can be made on either 16 millimeter (usually written: 16 mm.) film, or on the larger 35 mm. film, which is the size shown in theaters. In the telecine room there are motion picture projectors, slide projectors, and another kind of projector for showing still pictures, drawings, or objects, like cans or bottles.

All of these projectors are focused into a system of lenses and mirrors called a multiplexor. The multiplexor directs the picture from any one of them into a special camera called a vidicon camera.

There are two separate vidicon systems, one for black-and-white and one for color. In the color system, the color picture, movie or slide, is separated into its primary red, blue, and green images, which are projected separately onto three separate vidicon tubes that change them into electrical impulses for broadcasting. These impulses are reassembled into a single color picture in home color receivers, or a single black-and-white picture in black-and-white receivers.

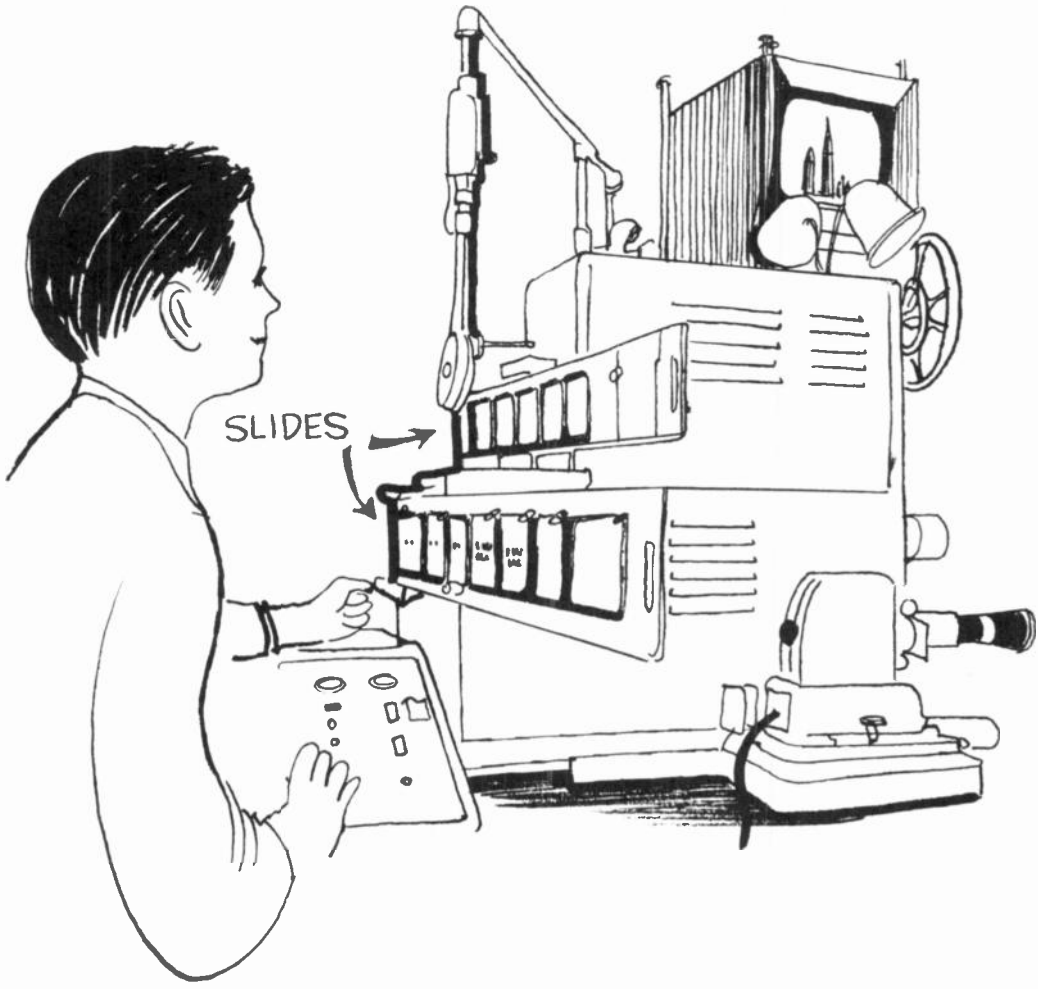
All the equipment in the telecine room is mounted on stands. Vidicon cameras do not move around like regular television cameras.

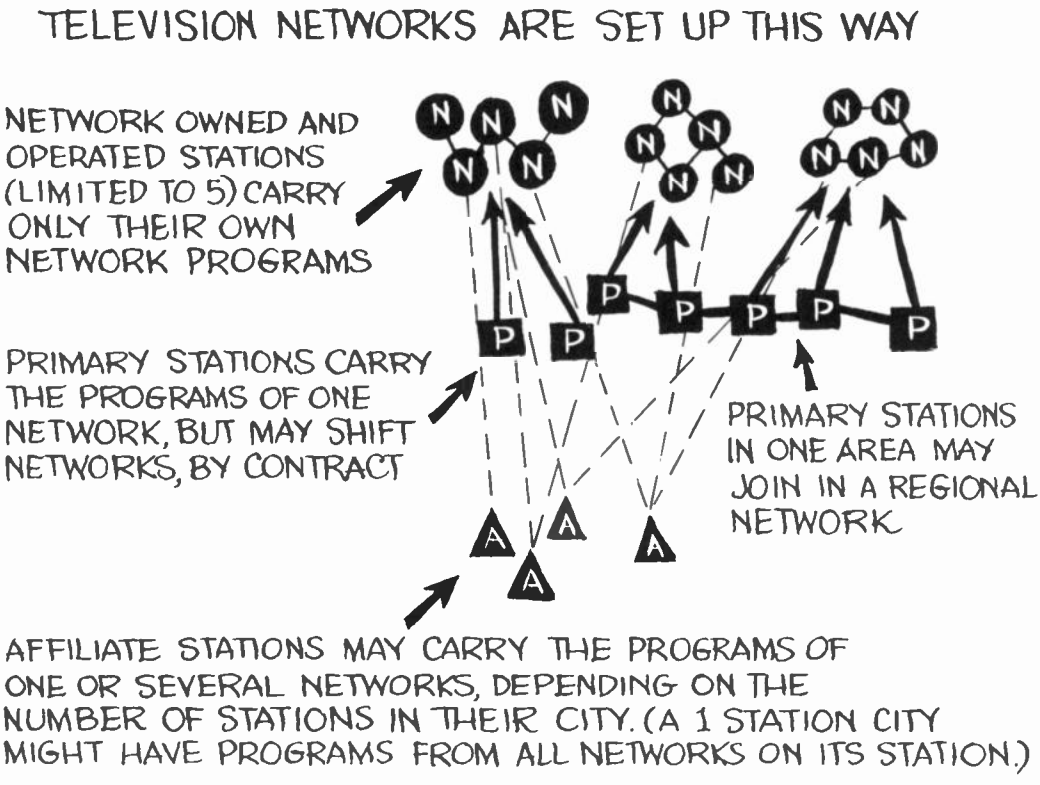


A number of technician projectionists work in the telecine room. They thread the film projectors, load the slide projectors, and change the slides. They control the quality of the pictures. They start and stop the machines on cue from the control room.

In some local station operations the film and slide projectors and other operations in the telecine room have become automated. For example, automatic cue marks on the film stop the projector and start another that projects the commercial. Or the cue marks might start the slide projector which puts a pre-cued series of slides on the air. When these are finished, the original film is cued to start again.

In some stations hours of programming, including station breaks, are run by automation.





TELEVISION NETWORKS

A national network broadcasting company supplies major programs and services to an interconnected group of local stations. It also sells these programs to a sponsor and shares the proceeds from those sales with the local stations. A broadcasting company may own and operate five of the local stations in its network. The other stations that make up a network sign contracts to carry only the programs of that broadcasting company. These stations are known as the primary stations. Each of the three major networks has about 170 primary affiliates.

The remaining stations that make up a network are generally in cities with only one or two local stations. They carry the programs of more than one network. These stations are known as optional affiliates.

In addition to national networks there are regional networks. These are local stations, operating in the same general area, which join together to program and sell programs of particular interest to that region, such as important regional college football games or other special events.

There are also groups of stations owned and operated by a single company which makes up programs for its own particular group.

Stations combine in many ways. A local station might belong to a group, a regional network, and a national network. Every station also produces and broadcasts its own local programs. It also broadcasts programs that it buys from outside producers or syndicating companies.

A national network has many advantages. It offers the public an opportunity to see outstanding productions, with talent no local station could afford. No local station could afford the world-wide news and special events coverage a network offers.

Because networks control the prime viewing time and they can deliver to a sponsor the greatest audience for any single program, it is much simpler for a sponsor to buy a program from a national network than to go to hundreds of individual stations. On a network, a program can be seen at the same hour straight across the country, which simplifies publicity for the program.

When a local station owner belongs to a network, the network supplies him with good, sponsored shows, which he does not have to sell. The network news programs, which he could not duplicate, are available to him.

Unless the program is live, most network shows are broadcast at the same hour in their time zones.

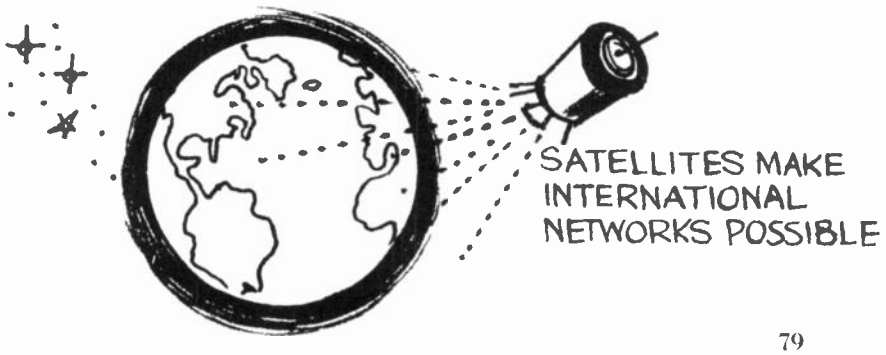
There are educational networks for broadcasting to schools and universities.

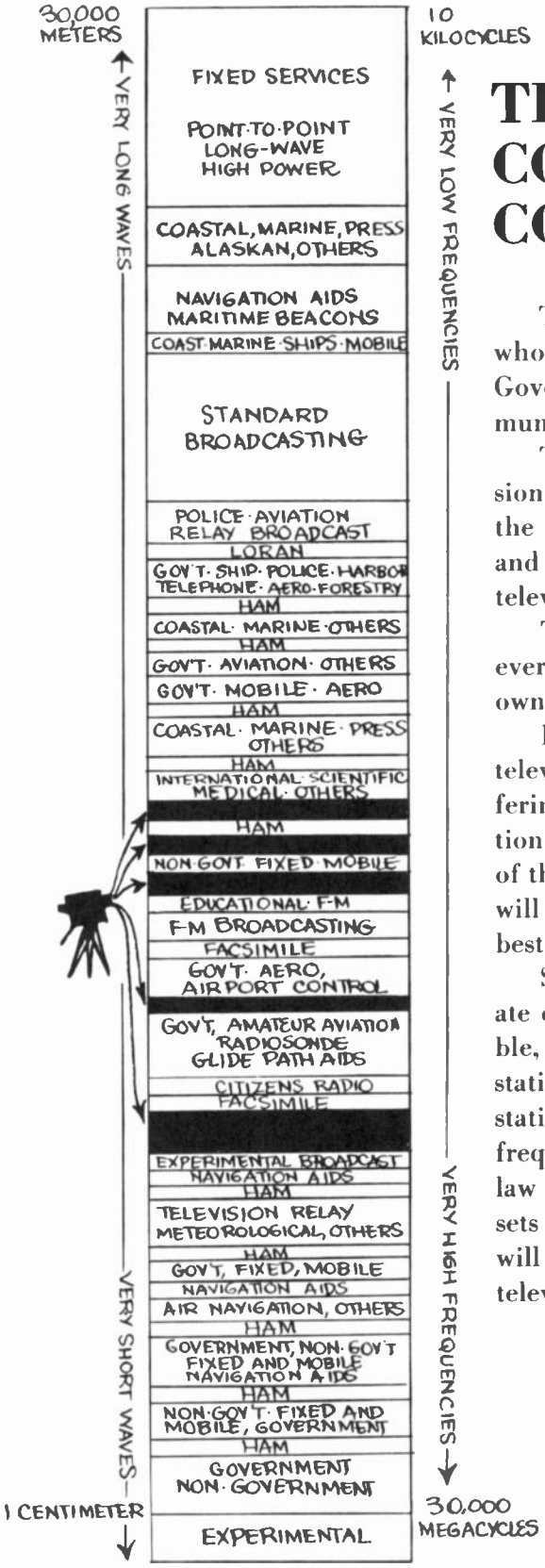
There are community antenna networks which link community antenna systems for common programming.

There are tape networks which are groups of stations that are supplied with programming produced by a central production organization, for scheduling at the most advantageous local time.

Pay television is a kind of network too.

With satellite and Long Line cable facilities, international network broadcasting is increasing. Network television in Europe covers many countries on special occasions.





THE FEDERAL COMMUNICATIONS COMMISSION

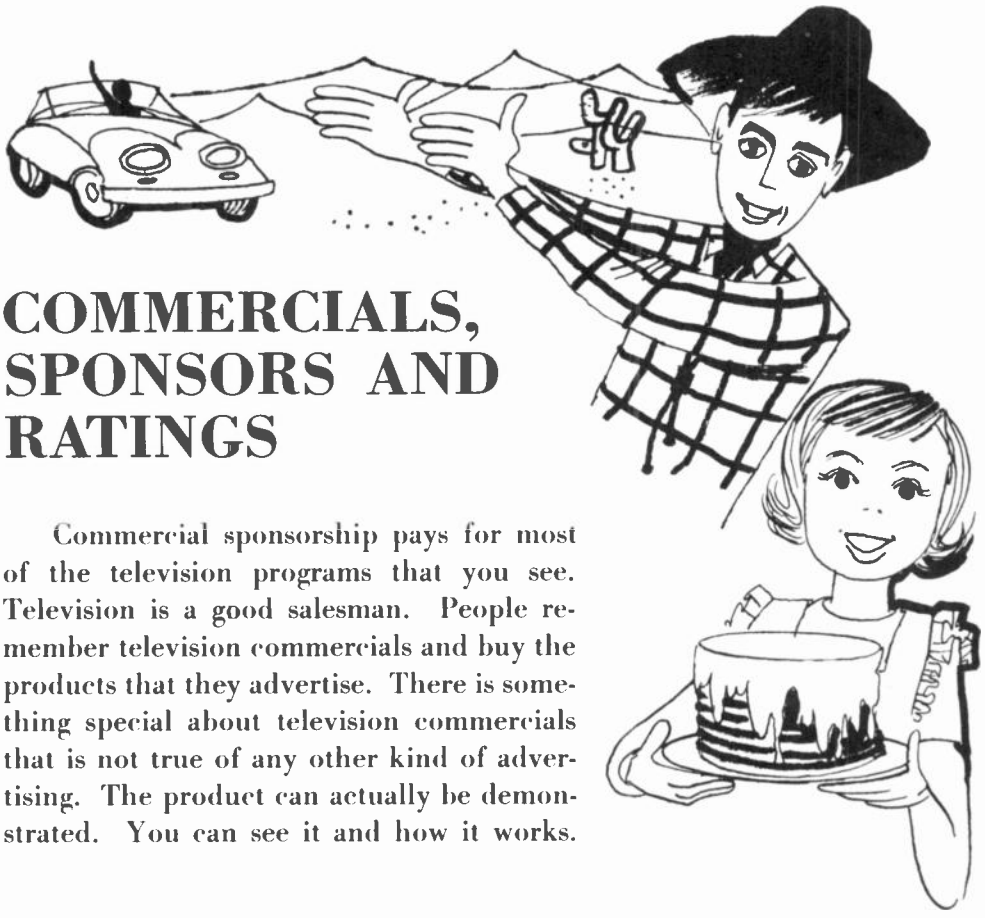
The airwaves belong to the people, whose interests are guarded by the Federal Government, through the Federal Communications Commission.

The Federal Communications Commission, or FCC, is a government bureau in the Department of Commerce. It regulates and controls the operation of all radio and television stations.

The FCC allocates the wavelength that every station must use. Each station has its own channel or band of radio frequencies.

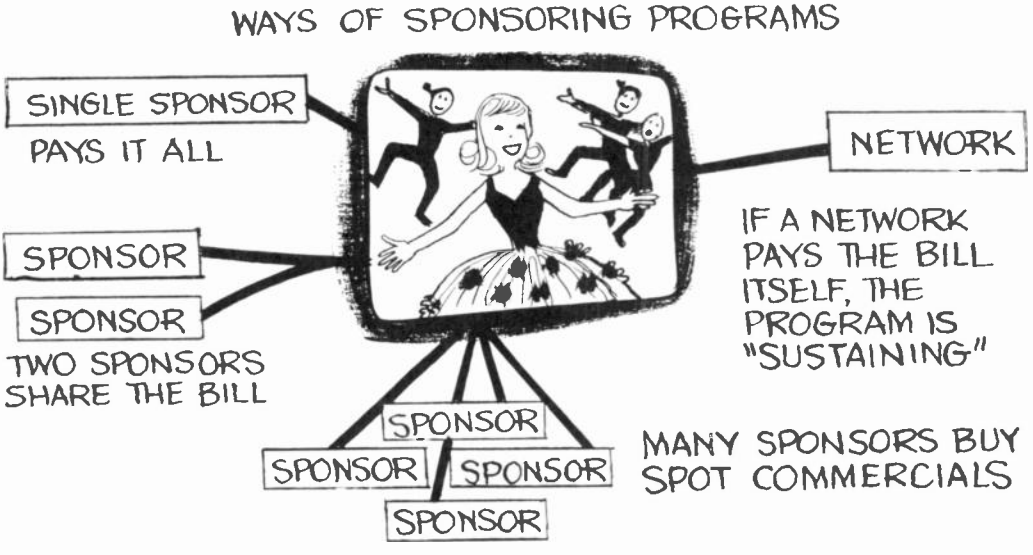
In any area only a limited number of television stations can operate without interfering with each other, so there is competition for each license. The FCC studies all of the applications and decides which group will serve the public interest of that area best. The FCC grants licenses to broadcast.

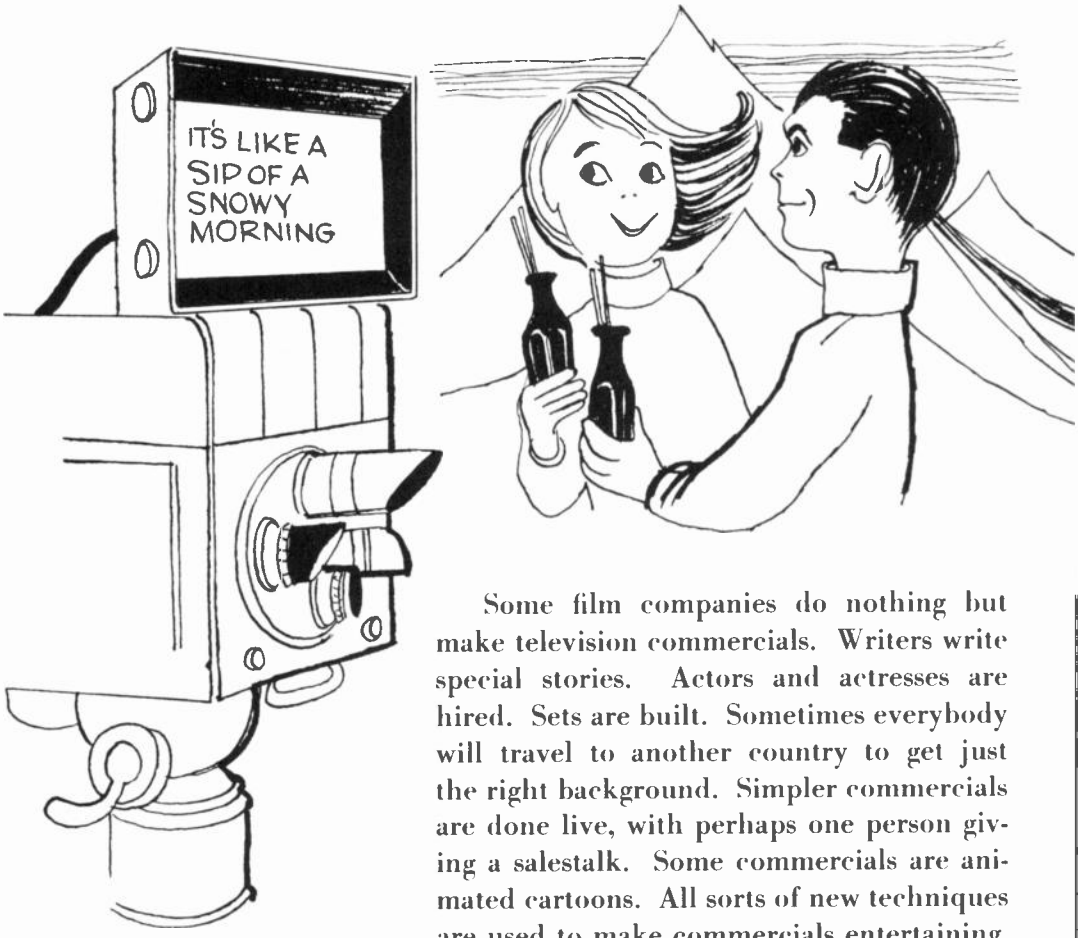
Stations quite a distance apart can operate on the same channels without any trouble, but to make room for all the additional stations that want to operate, additional stations are being added in the ultra-high frequency bands. New sets are required by law to include the UHF channels. Older sets require an adaptor. These new stations will give viewers a much greater choice of television programs.



COMMERCIALS, SPONSORS AND RATINGS

Commercial sponsorship pays for most of the television programs that you see. Television is a good salesman. People remember television commercials and buy the products that they advertise. There is something special about television commercials that is not true of any other kind of advertising. The product can actually be demonstrated. You can see it and how it works.





Some film companies do nothing but make television commercials. Writers write special stories. Actors and actresses are hired. Sets are built. Sometimes everybody will travel to another country to get just the right background. Simpler commercials are done live, with perhaps one person giving a salestalk. Some commercials are animated cartoons. All sorts of new techniques are used to make commercials entertaining. Commercials are such an important part of most television shows that often they are reviewed by the critics just like the entertainment part of the program.

Television programs not only sell products but create good will for the sponsors. You think well of the sponsor—and the company—that gives you a program you enjoy. The sponsor has to think of all these things, because the cost of putting on a television program is very high. A network show, including the air time, may cost anywhere from $25,000 to a million dollars or more.

Sometimes, because the cost is very high, a program will have two sponsors. Each may pay for half of a single show, or they may sponsor a series on alternate weeks. Sometimes shows are not sold to any one sponsor, but are paid for by a number of sponsors who buy commercial spots on the show. Often, many advertisers buy short commercials between shows.

A network program may have different sponsors in different parts of the country. Syndicated programs are sold to local stations in many different places, to schedule and sell as they please. And often a local merchant will sponsor a show that appears only in his own town.

Big companies usually buy network programs through an advertising agency. The agency buys the program and arranges for the network facilities and time. An agency tries to match the type of program with the product to be sold, in order to reach the people who will be possible customers. Products designed for housewives sell better in daytime hours. The advertising agency usually designs the commercials, and has them produced.

The rating of a program is very important to the sponsor, the agency, and the network.

The rating tells how many people are watching a particular program at any time. Special companies make surveys of television viewers, while programs are being broadcast. Using these surveys they estimate how many people are watching; what kind of people are watching; and where they live. Different companies use different methods for making these surveys. Some do it by telephone, some by electronic devices attached to television sets, some by questionnaires. These surveys are made on a small group, carefully chosen to represent a cross-section of all viewers. There are even new ways of monitoring television sets inside houses from a cruising control truck outside.

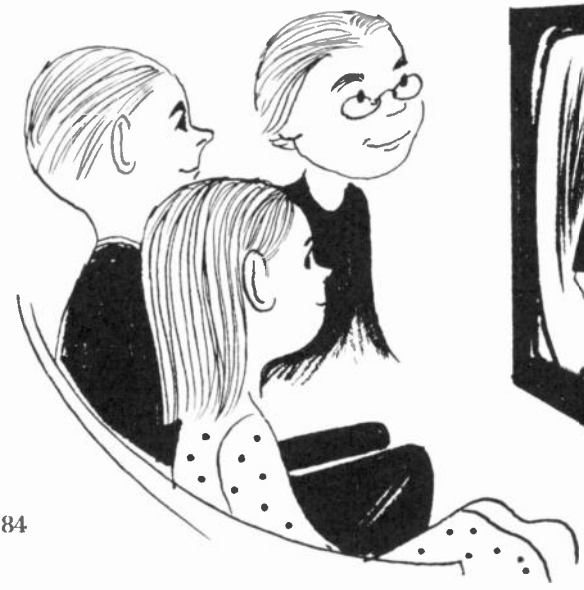
How many people are watching is important to the sponsor and the advertising agency because the more viewers, the more possible customers; the more people watching, the less the cost of the advertising message reaching every thousand customers.

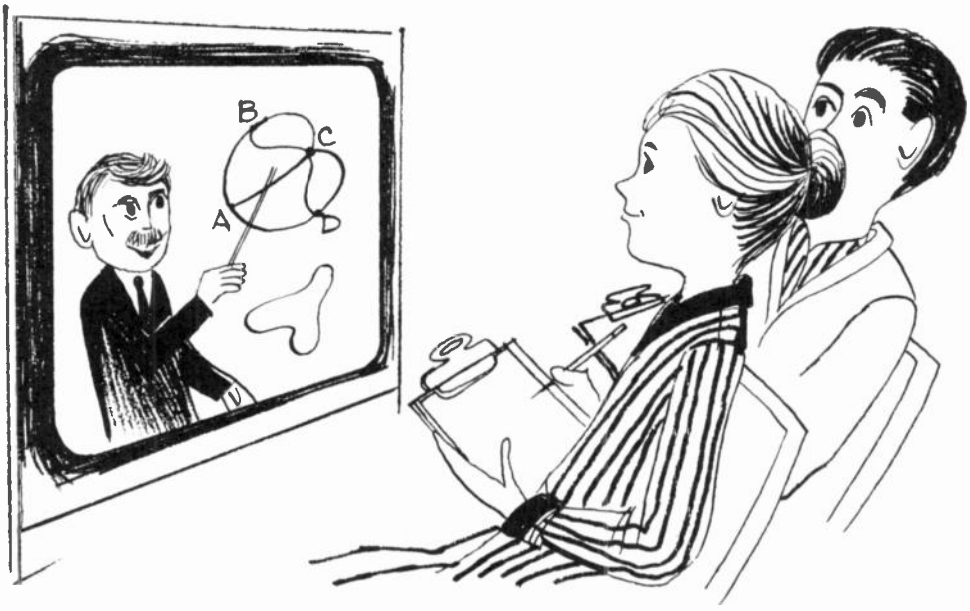
Television networks check the ratings very carefully too. Even if millions of people watch a particular program, a network will often switch it for another program that they think will have an even larger audience, or to get an audience away from a rival network.

EDUCATIONAL TELEVISION

There are many television stations in the United States devoted to education and public service. These stations operate on a non-profit basis. Some are supported by appropriations from their state governments. Others are connected with universities and are endowed by funds from those universities. Still others are supported by money from foundations.

Educational television has two main objectives. One is to further formal education, either in schools or for adults who have not been able to complete their school education but are eager to get their diplomas. The other objective is to give everyone a broader general knowledge of the world, an appreciation of the arts, and the background to become a better citizen.



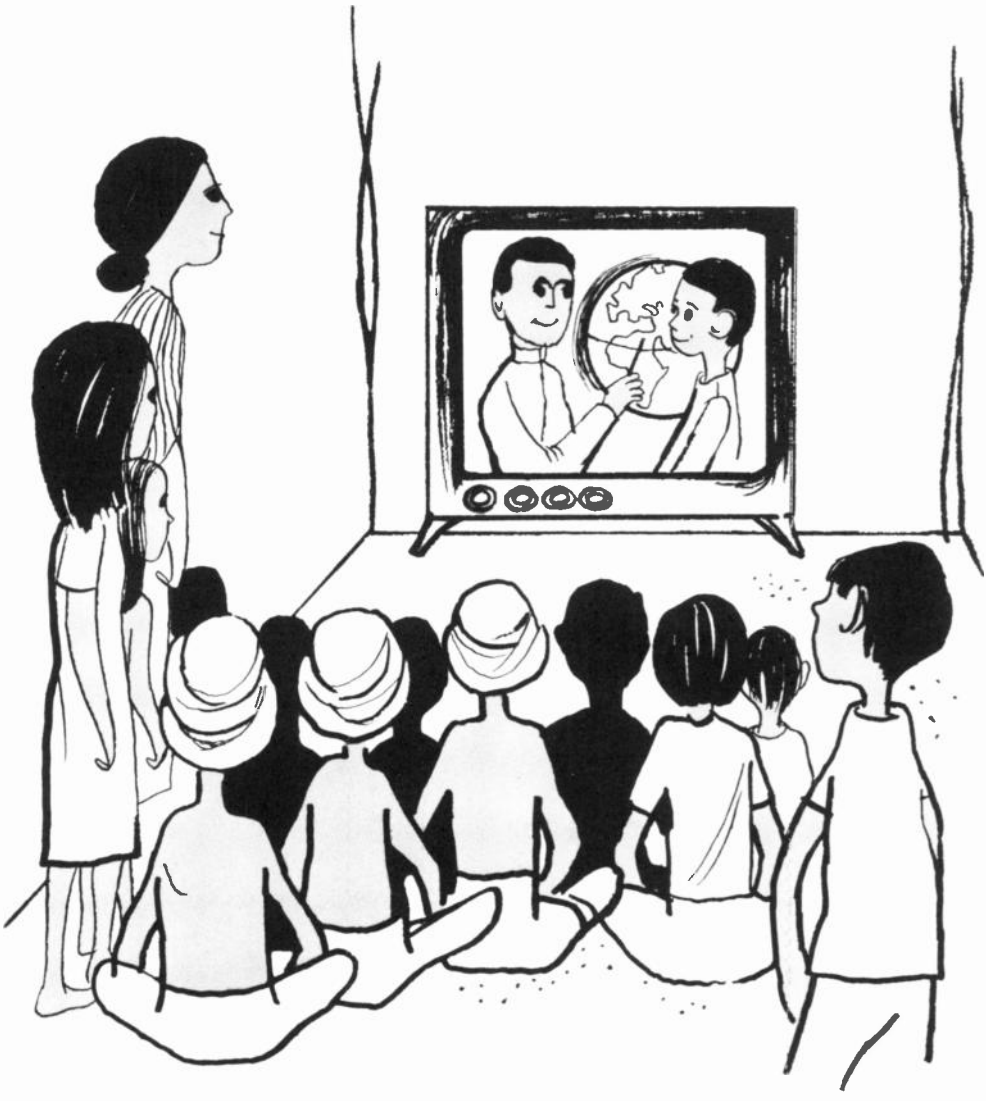


Some formal courses given over television carry the same kind of credits that regular in-school courses do. The pupils register beforehand, in some cases pay a tuition fee, study, and even take examinations.

Some programs are directed to classrooms in school and are integrated into their regular courses. Because of the enormous increase in the number of students in schools and colleges, television lectures and courses make the best possible use of a limited number of teachers. Television also makes it possible to bring the great teachers to a greater number of students than they could possibly reach otherwise.

Many universities make a variety of programs on tape and film to be shown on educational television stations. Most of these are coordinated through the audio-visual departments of a few large universities.

Educational programs, like any television programs are expensive to produce, in most cases more expensive than any single educational station could afford on its own limited budget. National Educational Television, or NET, was created as a non-profit organization to create and produce major educational programs with the financial assistance of foundations, the government, and industries that want to lend a hand. NET produces series on science, careers, current affairs, art, film, and many other things, and makes these programs available to local educational stations for a nominal fee.



In the underdeveloped countries, television is generally government-owned, and one of the chief functions is its use for mass education. Using television, these countries hope to convert, in one generation, a basically illiterate population into a society that has at least a fundamental education. A community set in a village or a school makes the best possible use of a small number of teachers.

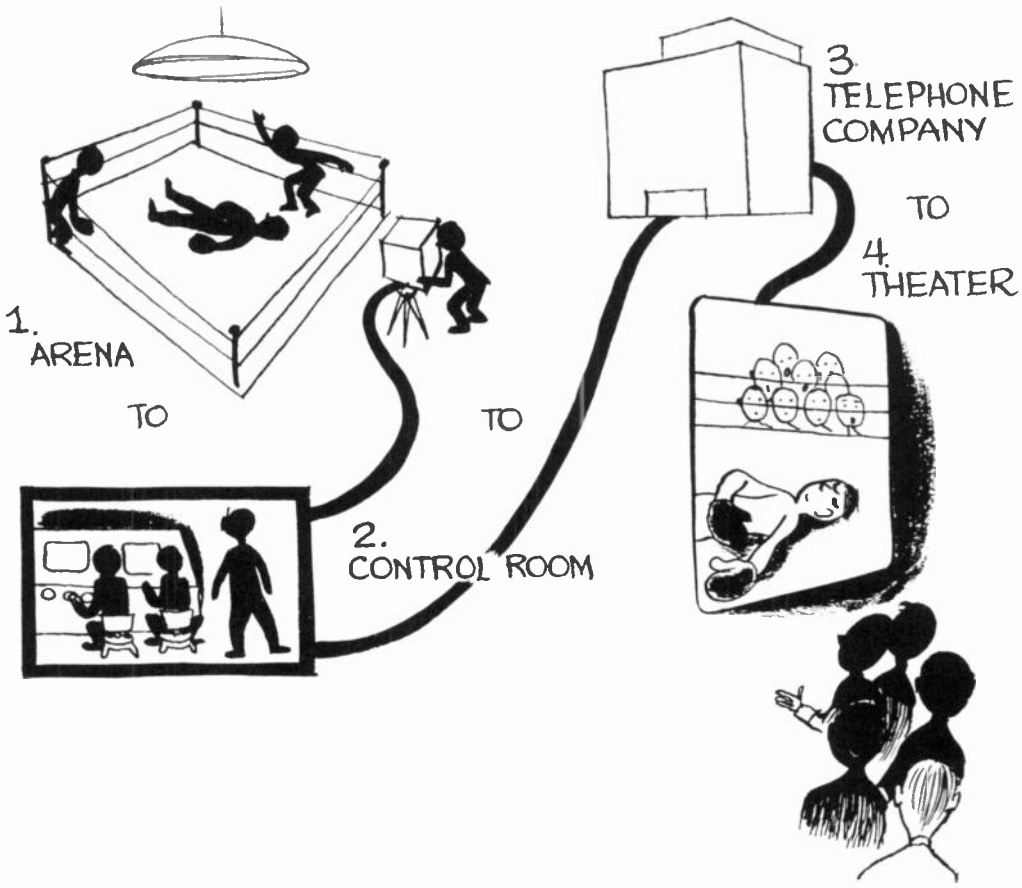
Educational television is going to play an increasingly important role in bringing to many millions of people a knowledge of art, science, music, and literature.

CLOSED-CIRCUIT TELEVISION

Closed-circuit television is not broadcast over the air for general viewing. It is sent to a particular viewer or viewers, by means of coaxial cable or relay, directly to selected receivers. Sometimes it is broadcast on a special frequency no other sets can tune in on.

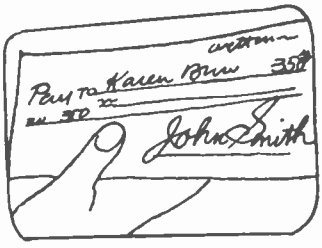
There are many uses for closed-circuit television.

One of the most familiar is the broadcast of sporting events into theaters or auditoriums where the audience has to pay to see them. The live cameras are in the sports stadium, and the pictures are sent, by cable or relay, directly to theaters across the country. In the theaters they are projected onto a large screen for viewing.

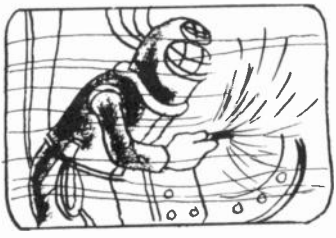


MEDICAL TECHNIQUES

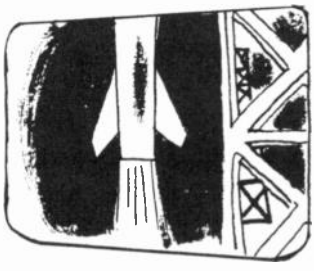
SIGNATURE IDENTIFICATION



UNDERWATER WORK



ROCKET FIRING



Over a closed-circuit television system, a single teacher can give special kinds of lessons to many students in many classrooms, even in many cities, at the same time. Television teaching works out best for lectures, scientific demonstrations, and many kinds of films. It isn't a good everyday teacher, because a television set can't answer questions or exchange ideas.

Over closed-circuit television, a famous surgeon can demonstrate an operation technique to many doctors and medical students across the country.

Radioactive experiments can be observed from a safe distance. The television camera, which is not affected by radiation, can be right in the "hot spot"; the television receiver can be rooms, or even miles, away. Special equipment allows watching scientists to control experiments as they watch.

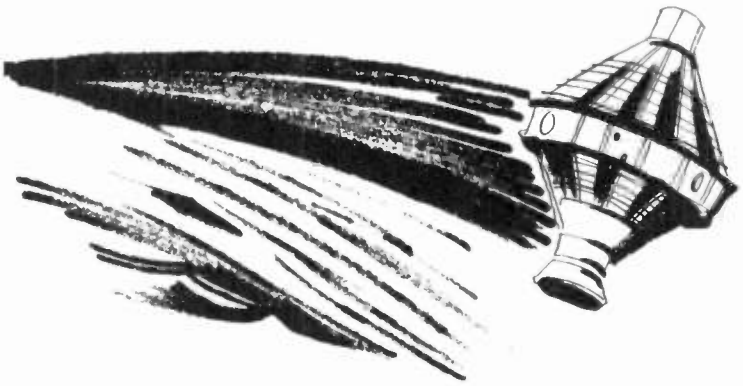
All kinds of underwater work can be watched and directed from the surface, or even from shore.

Many industrial processes are watched over closed-circuit television (steel melting in a blast furnace, for example).

Military officers can observe action in the field from several vantage points by means of a closed-circuit television camera operating from an observation plane.

A closed-circuit system monitors rocket launchings from close-up.

In a spacecraft a television camera observes the take-off, monitors the flight instruments, keeps an eye on the astronaut and everything else in the spacecraft, and makes observations out in space.



TYROS WATCHES THE WEATHER

Orbiting satellites equipped with television cameras watch the weather and send back pictures. Satellites make many other kinds of television observations.

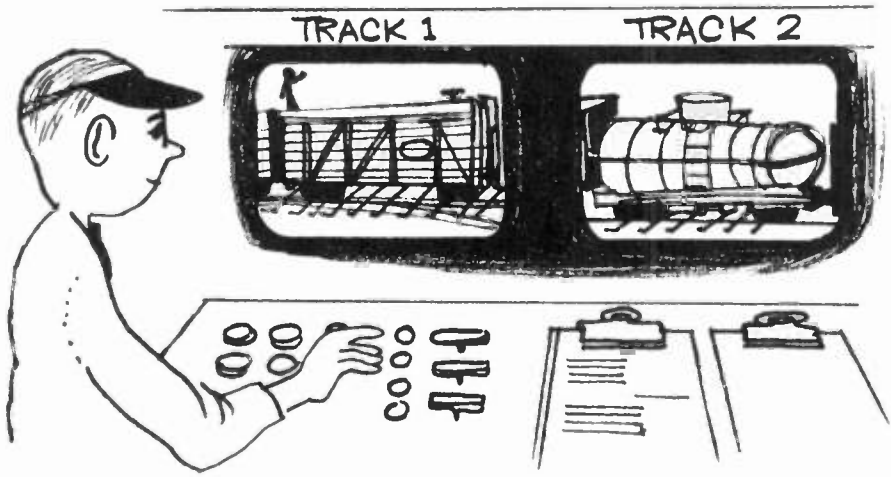
By means of a closed-circuit television system, a traffic-control officer at police headquarters can observe traffic movements at critical spots, and prevent traffic jams by broadcasting announcements, by changing traffic signals, by ordering additional officers to the scene. Some police helicopters have cameras in them to do the same work.

A single security guard can watch many gates of a factory at the same time.

In some apartment houses a doorman can monitor the elevators on a television screen and tenants can see anyone in the lobby who is ringing their bell.

Watchers in a central monitor room of a subway system can keep an eye on every station platform.

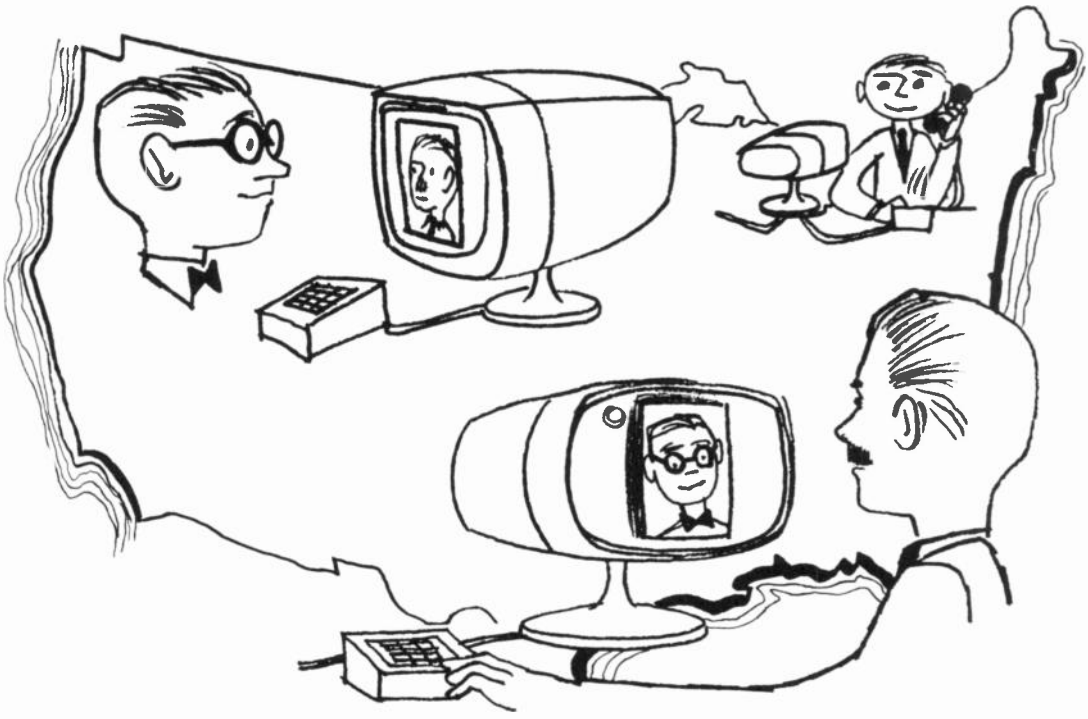
A railroad clerk in a freight-yard office can check the names on freight cars coming into the yard from many directions, then direct individual cars to the proper sidings.



Signatures on checks presented at branch offices of a bank can be identified instantly at the main office.

Conferences can be held among people in many cities.

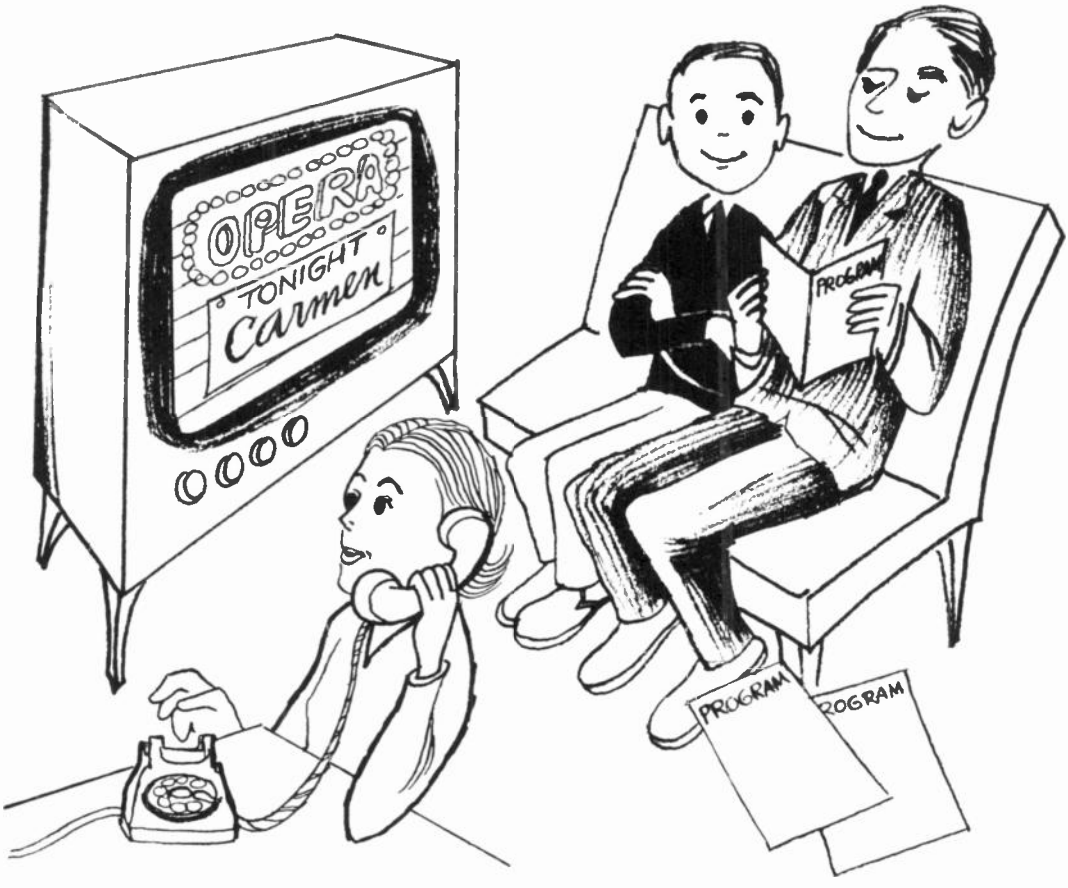
Telephone calls on Phonovision, which is actually closed-circuit television, allow the callers to see one another while they are talking.



A new product can be introduced and demonstrated to salesmen at sales meetings in many places. Many products are sold from a central showroom, with buyers tuned in in many cities. Their orders are transmitted by telephone directly to the central showroom or market.

Many hotels in big cities have a closed-circuit channel on the television set in each room. Visitors can find out about theaters, restaurants, movies and events of interest and also see special entertainment. In the biggest cities, a visitor can tune in the commentary in one of several languages.

Community antenna systems (see page 39) are a form of closed-circuit television and more and more special material is being transmitted to the people connected into these systems. Sometimes products are displayed and sold directly over community antenna systems.



PAY TELEVISION

The television programs you see now are free as the air. You buy your set, twist your dial, and make your choice. The television station or the sponsor pays for the show. But the cost of putting on a television program is so high that a sponsor wants to get the greatest possible audience he can, so he chooses the most popular kind of programming. Ballet or opera, theater or lectures appeal to fewer people, but if the cost of putting these things on is paid directly by pay TV viewers, a pay television company can afford to show them.

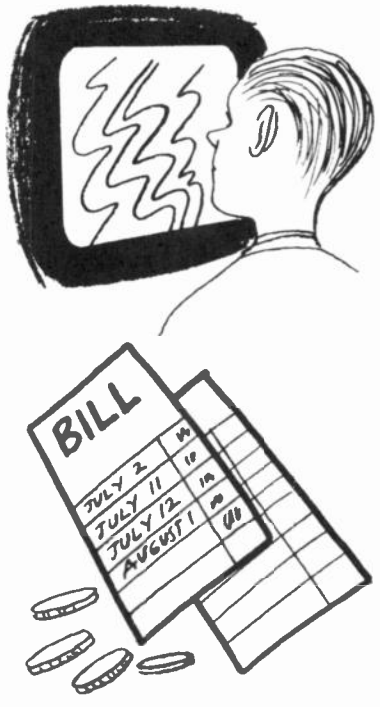
To a sponsor, an audience of a million or two is a very small audience. But two million people, paying a dollar each, is much, much more than a single performance of a play or an opera would ever make. Pay television is a way of letting the viewers themselves pay for the programs they want.

Certain programs, perhaps a big, first-run movie, or a hit Broadway play would be too expensive for any sponsor, but these events would attract a very large pay audience who would pay millions of dollars to see them.

Pay television programs are shown without interruptions or commercials, and many people are willing to pay for this.

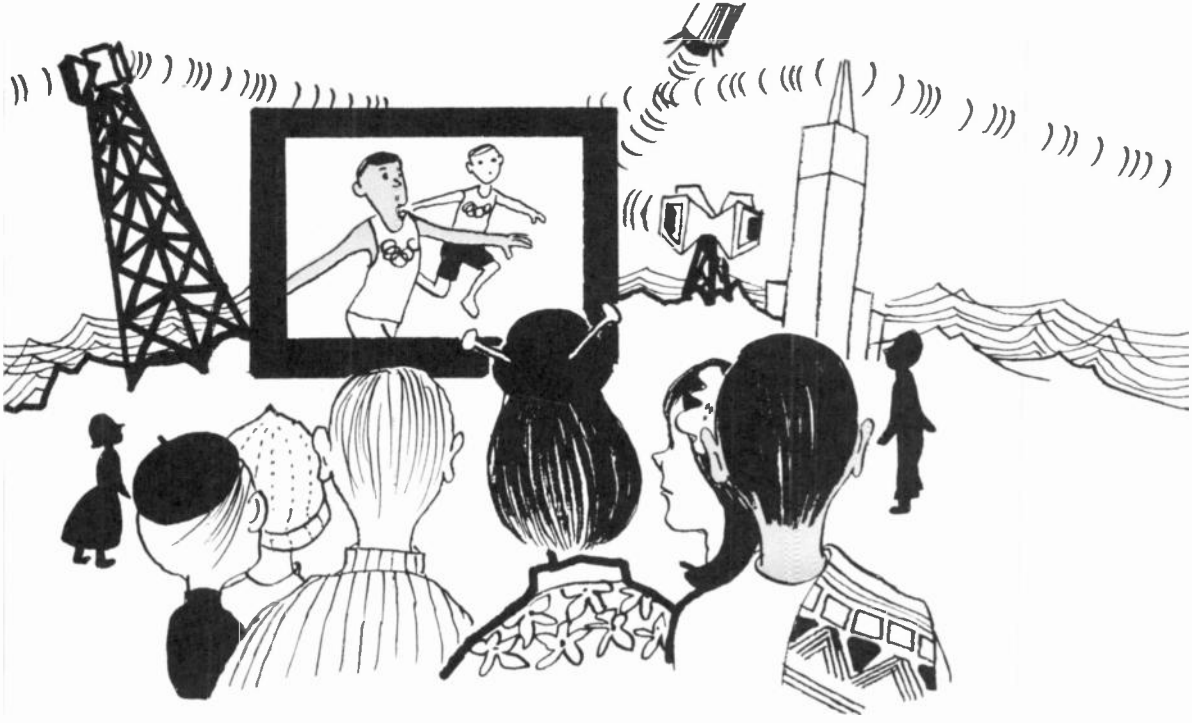
There are two main ways for putting pay television on your home set.

One is by transmitting it over the air in such a way that the picture is all scrambled up. To make it look right, you have to put money in a special meter attached to your set, or turn a special key, or push a button, which records the fact that you have watched the show. (You are billed for the program later.)



Another method brings special programs into your house closed-circuit, through a cable. You turn a key or push a switch which turns the program on, or you call a central office to be connected into the cable.

The big question about pay television is how much it will affect free television. Some people think it will simply supply additional hours of good television. Others think it will reduce greatly the number and quality of free programs and services.



AROUND THE WORLD

There is television all over the world.

The television stations of many countries are government-owned and operated. In some—Great Britain, Japan, Canada, and others—there are both government and privately owned networks.

No country broadcasts as many hours of television as does the United States. Some stations abroad are on the air only an hour a week.

Programming is usually quite different from that in the United States. Many countries regard television as a unique educational opportunity; a chance to offer their citizens a broader knowledge of the arts and sciences, of their own country, and of the outside world. Most programs are cultural and educational, featuring music, ballet, and dramatic presentations of great plays. News events and sports are popular everywhere.

Many countries are close together geographically but cannot receive each others' broadcasts because their television systems are different. Most countries in Europe broadcast a 625-line picture. So do Russia and Australia. France and most French-speaking countries broadcast and receive 819 lines. Great Britain has a 405-line system.

Most North and South American countries, Japan, and the Philippines broadcast a 525-line system.

Often countries around the world are interconnected as a great network. This means that in each country the program has to be converted into the standard of that country before it is retransmitted for viewing, if the original transmission is on a different system. This is done instantaneously by rescanning the picture with a live camera, then transmitting the new picture, which has the proper number of lines.

There is a considerable exchange of film and taped programs between countries. Often programs are "dubbed" into different languages so they can be shown without translation titles.

Committees are always working to standardize television transmission. Now that satellites have made live broadcasts possible throughout the world, it is more important than ever to have an international, world-wide standard.

Television is the most remarkable communications tool that man has ever had for reaching and influencing great numbers of people.

Television can elect presidents, teach school, flash news, travel into space, amuse you, entertain you, and make you a participant in the history of the world.

Television is still very young. The first practical television broadcasts were made in about 1939. Real commercial television started in about 1947. In this short time, it has become so much a part of our lives that it is hard to think of a time when there was no television.

Not long ago it seemed a miracle to be able to see across a city. Now we can see entertainment and watch events on other continents at the instant they are taking place. Now people everywhere can enjoy the same things together, and learn about each other and from each other.

Television belongs to all the people in the world.

INDEX