

NATIONAL BROADCASTING COMPANY



ENGINEERING DEPARTMENT INFORMATION SERVICE



TELEVISION STUDIO TECHNIC

By

Albert W. Protzman

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Summary—The studio operating technic as practiced in the NBC television studios today is discussed and comparisons are made, where possible, to motion picture technic. Preliminary investigations conducted to derive a television operating technic revealed that both the theater and the motion picture could contribute certain practices.

The problems of lighting, scenic design, background projection, and make-up are discussed, with special emphasis on the difficulties and differences that make television studio practice unique.

An explanation is given of the functioning of a special circuit used in television sound pick-up to aid in the creation of the illusion of close-up and long-shot sound perspective without impracticable amount of microphone movement. The paper concludes with a typical television production routine showing the coördination and timing of personnel and equipment required in producing a television program.

IF ONE were forced to name the first requirement of television operating technic and found himself limited to a single word, that word would undoubtedly be "timing." Accurate timing of devices and split-second movements of cameras are the essentials of television operation. Personnel must function with rigid coördination. Mistakes are costly—they must not happen—there are no second chances.

Why such speed and coördination? Television catches action at the instant of its occurrence. Television does not allow us to shoot one scene today and another tomorrow, to view rushes or resort to the cutting room for editing. Everything must be done as a unit, correct and exact at the time of the "takes"—otherwise, there is no television show.

Now, to discuss some preliminary investigations conducted before production was attempted, and to describe the equipment and technic used in meeting these production requirements. Technical details are deliberately omitted. Wherever possible, we shall compare phases of television operation with their counterparts in motion picture production.

For so new a medium as television it is, of course, an impossibility to present a complete and permanently valid exposition. Television technic and apparatus constantly advance. Some technic now current may be outmoded in a day or a month. We have only to recall the early days of motion picture production, when slow-speed film and

* Reprinted from the *Journal of the Society of Motion Picture Engineers*, July, 1939.

inferior lenses were a constant limitation. So, with television, it is already possible to envision more sensitive pick-up tubes that will permit the use of smaller lenses of much shorter focal length, thus eliminating many of today's operating difficulties.

PRODUCTION TECHNIC INVESTIGATIONS

In May, 1935, the Radio Corporation of American released television from its research laboratories for actual field and studio tests. Long before the first program was produced in the middle of 1936, plans were laid, based on extensive research into the established entertainment fields, for the purpose of determining in advance what technics might be adaptable to the new medium of television. From the stage came the formula of continuity of action, an inherent basic requirement of television. This meant memorized lines and long rehearsals. Prompting could not be considered, for, as you know, the sensitive microphone which is as much present in television as it is in sound motion picture production, does not discriminate between dialog and prompting.

From the motion picture studio came many ideas and technics. If television is a combination of pictures with sound, and it is, no matter what viewpoint is taken, the result spells in part and for many types of programs, a motion picture technic at the production end. However, enough has already been said about the peculiarities of television presentation to justify saying that the movie technics do not supply the final answer. There remained the major problem of preserving program continuity without losing too much of motion picture production's flexibility. Our present technic allows no time for adjustments or retakes. Any mistake immediately becomes the property of the audience. The result of the entire investigation led to what we think is at least a partial answer to the problem. This technic, we hope, will assist considerably in bringing television out of the experimental laboratory and into the field of home education and entertainment.

GENERAL LAYOUT OF FACILITIES

In order to present a clearer view of our problems, we shall give a brief description of our operating plant. The present television installation at the National Broadcasting Company's headquarters in the RCA Building, New York, N. Y., consists of three studios, a technical laboratory, machine and carpenter shops, and a scenic paint shop. Our transmitter is located on the 85th floor of the Empire State Building. The antenna system for both sight and sound is about 1300 feet above the street level. Both the picture and sound signals are

relayed from the Radio City Studios to the video and sound transmitters either by coaxial cable or over a special radio link transmitter.

One of the studios is devoted exclusively to televising motion picture film, another to programs involving live talent, and the third for special effects. It is the operation of the live-talent studio with which we are concerned in this paper.

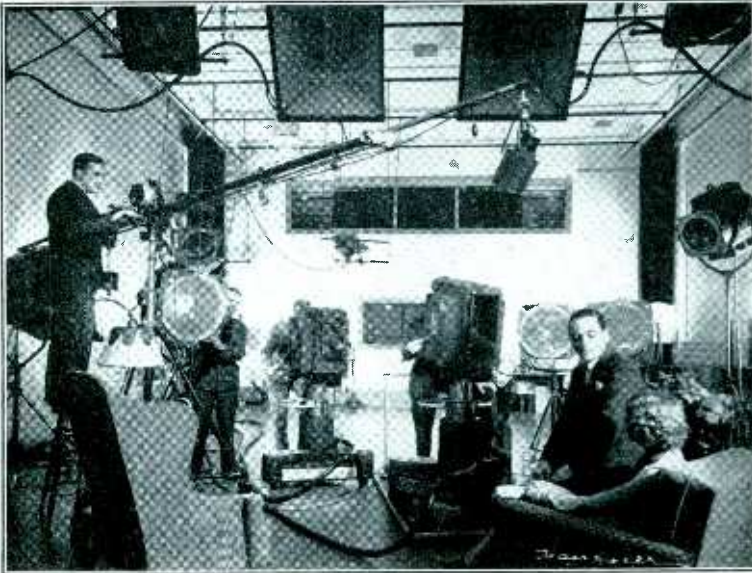


Fig. 1(a)—General layout of live-talent studio; control room at upper rear.

DESCRIPTION OF LIVE-TALENT STUDIO

Figure 1(a) shows the general layout of the live-talent studio. The studio is 30 feet wide, 50 feet long, and 18 feet high. Such a size should not be considered a recommendation as to the desired size and proportions of a television studio. The studio was formerly a regular radio broadcasting studio, not especially designed for television. To anyone familiar with the large sound stages on the motion picture lots, this size may seem small (Figure 1(b)). Yet, in spite of our limited space, some involved multi-set pick-ups have been successfully achieved by careful planning. Sets, or scenes, are usually placed at one end of the studio. Control facilities are located at the opposite end in an elevated booth, affording full view of the studio for the control room staff. Any small sets supplementing the main set are placed along the side walls as near the main set as possible, and in

such position as to minimize camera movement. At all times, we reserve as much of the floor space as possible for camera operations and such floor lights as are absolutely essential. At the base of the walls and also on the ceiling are scattered numerous light-power outlets to minimize the length of lighting cables. At the rear of the studio is a permanent projection room for background projection.

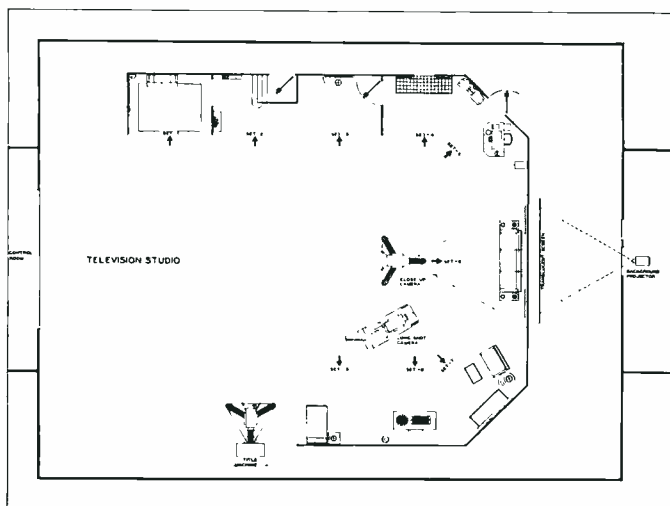


Fig. 1(b)—Television studio floor plan.

CAMERA EQUIPMENT

The studio is at present fitted for three cameras. To each camera is connected a cable. This cable is about two inches in diameter and fifty feet long; it contains 32 conductors including the well known coaxial cable over which the video signal is transmitted to the camera's associated equipment in the control room. The remainder of the conductors carry the necessary scanning voltages and current supplies for the camera amplifiers, interphone system, signal lights, etc. From this description, it is apparent that adding another camera in a television studio involves a much greater problem than that of moving an extra camera into a motion picture studio. In television, it is necessary to add an extra rack of equipment in the control room for each additional camera.

MOVEMENT OF CAMERAS

One camera, usually the long-shot camera using a short-focal length lens, is mounted on a regular motion picture type dolly to

insure stable movements. The handling of the dolly is done by a technician assisting the camera operator. It is impracticable to lay tracks for dolly shots as is often the motion picture practice, because usually each camera must be moved frequently in all directions during the televising of a studio show. Naturally, dolly tracks would limit such movement. The other television cameras utilize a specially de-

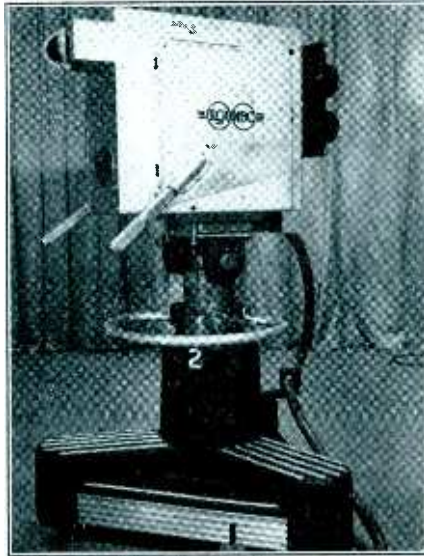


Fig. 2—Studio camera.

signed mobile pedestal (Figure 2). Cameras mounted on these pedestals are very flexible and may be moved in and out of position by the camera operators themselves. Built into the pedestals are motors which elevate or lower the camera; this action is controlled with push-buttons by the camera operators. A panning head, similar to those used for motion picture cameras, is also a part of the pedestal. It is perhaps needless to stress here that one of the strict requirements of a television camera is that it must be silent in operation. In the electronic camera proper there are no moving parts other than those used for focusing adjustments; hence, it is a negligible source of noise. When camera pedestals were first used they were the source of both mechanical noise and electrical disturbance when the camera-elevating motor was in use. Since then this problem has been overcome, and it can be stated that the entire camera unit is now free of objectionable mechanical noise or electrical surges.

LENS COMPLEMENT

Each camera is equipped with an assembly of two identical lenses displaced 6 inches vertically. The upper lens focuses the image of the scene on a ground-glass which is viewed by the camera operator. The lower lens focuses the image on the "mosaic," the Iconoscope's light-sensitive plate. This plate has for its movie counterpart the film in a motion picture camera. The lens housings are demountable and interchangeable. Lenses with focal lengths from $6\frac{1}{2}$ to 18 inches are used at present. Lenses of shorter focal length or wider angle of pick-up can not be used since the distance between the mosaic and the glass envelope of the Iconoscope is approximately 6 inches. Lens changes can not be effected as fast as on a motion picture camera, since a turret arrangement for the lenses is mechanically impracticable at present. However, it is probably safe to say that future advances in camera and Iconoscope design will incorporate some type of lens turret. Ordinarily, one camera utilizes a $6\frac{1}{2}$ -inch focal length lens with a 36-degree angle, for long shots, while the others use lenses of longer focal lengths for close-up shots. Due to its large aperture, the optical system used at present has considerably less depth of focus than those used in motion pictures, making it essential for camera operators to follow focus continuously and with the greatest care. This limitation will probably be of short duration, since more sensitive Iconoscopes will permit the use of optical systems of far greater depths of focus.

It is desirable here to point out a difference in focusing technic between motion picture cameras and television cameras. "Follow-focus" in motion pictures occurs practically only in making dolly shots. For all fixed shots, the lens focus is set, the depth of focus being sufficient to carry the action. Also, it is the duty of the assistant cameraman to do the focusing. This relieves the cameraman of that responsibility and allows him to concentrate on composition, action, and lighting. In television, the camera operator must do the focusing for fixed shots and dolly shots alike. This added operation, at times, is quite fatiguing.

Vertical parallax between the view finder lens and the Iconoscope lens is compensated for by a specially designed framing device at the ground-glass that works automatically in conjunction with the lens-focusing control. It may be of interest to note here that at first the television camera had no framing device. This meant that images, in addition to being inverted as they are in an ordinary view-finder, were also out of frame. The camera operator had to use his judgment in correcting the parallax. With this new framing device, the operator

now knows exactly the composition of the picture being focused on the mosaic in his camera. The framing device can be quickly adjusted to accommodate any lens between $6\frac{1}{2}$ and 18 inches focal length.

Because of the fact that several cameras are often trained on the same scene from various angles, and because all cameras are silent in operation, performers must be informed sometimes—such as when they are speaking directly to the television audience—which camera is active at the moment. Two large green bull's-eye signal-lamps



Fig. 3—Typical television set.

mounted below the lens assembly are lighted when the particular camera is switched "on the air."

SET LIGHTING

There are two outstanding differences between television lighting and motion picture lighting. A much greater amount of key light is required in television than in motion pictures. Also, a television set must be lighted in such a way that all the camera angles are anticipated and properly lighted at one time. Floor light is held to a minimum to conserve space in assuring maximum flexibility and speed of camera movements. Great care must also be taken to shield stray light from all camera lenses. This task is not always easy, since, during a half-hour performance, each camera may make as many as twenty

different shots. Just as excessive leak-light striking the lens will ruin motion picture film, it has a definitely injurious effect upon the photosensitive mosaic and upon the electrical characteristics of the Iconoscope. A direct beam of high-intensity light may temporarily paralyze a tube, thus rendering it useless for the moment.

SETS

Television sets (Figure 3) are usually painted in shades of gray. Since television reproduction is in black and white, color in sets is



Fig. 4—Background projection window shot.

relatively unimportant. Chalky whites are generally avoided because it is not always possible to keep "hot lights" from these highly reflective surfaces which cause a "bloom" in the picture. This, in turn, limits the contrast range of the system. Due to the fact that the resolution of the all-electronic system is quite high, television sets must be rendered in considerable detail, much more, in fact, than for a corresponding stage production. As in motion picture production, general construction must be as real and genuine as possible; a marked difference, for instance, can be detected between a painted door and a real door. On the legitimate stage, a canvas door may be painted with fixed highlights; that is, a fixed perspective, because the lighting

remains practically constant, and the viewing angle is approximately the same from any point in the audience. But, in television the perspective changes from one camera shot to another. Painted perspectives would therefore be out of harmony with a realistic appearance. This is also true in motion picture work. Sets must also be designed so that they can be struck quickly with a minimum effort and noise because it is often necessary to change scenes in one part of a studio while the show is going on in another part. At present, we find it desirable to construct television sets in portable and lightweight sections without sacrificing sturdiness.

BACKGROUND PROJECTION

The problems of background projection in television differ somewhat from those encountered in motion pictures. More light is necessary because of the proportionately greater incident light used on the sets proper (Figure 4).

Considering the center of a rear-screen projection as zero angle, we must make it possible to make television shots within angles of at least 20 degrees on either side of zero without appreciable loss of picture brightness. This requirement calls for the use of a special screen having a broader viewing angle than those used in making motion picture process shots. Also, in motion pictures, the size of the picture on the screen can be varied to the proper relation to the foreground for long shots or close-ups. For television, the background picture size can not be changed once the program starts. Our background subject matter must also be sharp in detail and high in contrast for good results.

At present, only glass slides are used. A self-circulating water-cell is used to absorb some of the radiant heat from the high-intensity arc. Also both sides of the slide are air-cooled. These precautions permit the use of slides for approximately 30-minute periods without damage.

MAKE-UP

This may be a suitable time to correct some erroneous impressions concerning the type of make-up used in television. It has never been necessary to use gruesome make-up for the modern all-electronic-RCA television system. At present, No. 26 panchromatic base, similar to that used for panchromatic film, and dark red lipstick is being used satisfactorily. From the very beginning, we have made tests to determine the proper color and shades of make-up, keeping in mind that a color closely approximating the pigmentation of the human skin is most desirable from the actor's psychological standpoint.

THE CONTROL ROOM

Now, a few words about the operations in the studio control room during a televised production (Figure 5). All camera operators in the studio wear head-phones through which they receive instructions from the control room. Directions are relayed over this circuit by the video engineer or the production director. Here the televised images are observed on special Kinescope monitors and necessary electrical adjustments are made. Alongside each of these monitoring



Fig. 5—The television control room. Note the two Kinescope monitors in the upper left corner.

Kinescopes is a cathode-ray oscilloscope which shows the electrical equivalent of the actual picture. Two monitors are provided in order that one may be reserved for the picture that is actually on the air, while the other shows the succeeding shot as picked up by a second or third camera. This enables the video engineer to make any necessary electrical adjustments before a picture goes on the air.

Seated immediately to the left of the video engineer is the production director whose responsibility corresponds to that of the director of a motion picture. He selects the shots and gives necessary cues to the video engineer for switching any of the cameras into the outgoing channel. The production director has, of course, previously

rehearsed the performance and set camera routines in conjunction with the camera operators and the engineering staff. The camera operator has no control to switch his camera on the air. All camera switches, which are instantaneous, are made by electrical relays controlled by buttons in the control room. At present, the video engineer's counterpart in motion picture work is the editor and the film processing laboratory.

To the left of the production director sits the audio control engineer whose responsibility is entirely separate from that of the video engineer. He also is in a position to view the monitor, and may communicate by telephone with the engineer on the microphone boom. The audio engineer is responsible for sound effects, some of which are dubbed in from records. His job is somewhat similar to that of the head sound engineer on a motion picture production. Thus, we have the control room staff—three men who have final responsibility for the success of the completed show.

An assistant production man is also required on the studio floor. Wearing headphones on a long extension cord, he is able to move to any part of the studio while still maintaining contact with the production director in the control room during a performance on the air. Actors require starting cues, titles require proper timing, and properties and even an occasional piece of scenery must be moved. The assistant director supervises these operations and sees that the instructions of the production director are properly carried out.

Members of the studio personnel also to be mentioned include lighting technicians, the property man, and scene shifters, whose responsibilities parallel those of their motion picture counterparts. Specially trained men are also needed for operating title machines. In the future all titling will undoubtedly be done in a separate studio inasmuch as operating space in a television studio is at a premium. Today, however, title machines do operate in the studio and require the utmost care in handling. Types of titles used include dissolves and wipes similar to those used in moving pictures.

SOUND REPRODUCTION

As in motion picture work, a microphone boom is used in television production, and is operated in a similar way. Perspective in motion picture sound is accomplished by keeping the microphone, during a long shot, just out of the picture and moving it down closer to the action as the camera moves in for a close-up, thus simulating a natural change in perspective. In television this is not always possible because there are always three cameras to consider. This same condition pre-

veiled in the early days of motion pictures when it was thought desirable to take a complete scene, shooting both long-shot and close-up cameras, at one time. In the television studio at least one camera is always set for a long shot while the others are in position for closer shots. If the microphone is placed in such a position as to afford a "natural" perspective for close-ups, the succeeding switch to a long shot would reveal the microphone in the shot. You in motion pictures can order a retake; in television broadcasting we can not rectify the mistake. It is quite obvious, therefore, that the man on the boom can not lower his microphone to the "natural" position for each camera shot. We therefore place the microphone in a position just out of range of the long shot. In order to accomplish some sense of perspective between long and close-up shots, a variable equalizer that drops the high and low ends of the spectrum is automatically cut into the audio circuits when the long-shot camera is on the air. In this operation, sufficient change in quality and level is introduced to aid the illusion of long-shot sound perspective. Of course, when a close-up camera is switched in, the audio returns to the close-up perspective quality once more. This may be called remote control sound perspective.

Special sound effects, music, etc., from the studio picked up from recordings are mixed in the control room. In motion pictures, some of the effects and most of the music are dubbed in after the actual shooting of the scene.

The general acoustical problems in a television studio are similar to those in a motion picture sound-stage. Walls and ceiling should be designed for maximum absorption to permit faithful exterior speech pick-up. A stage or studio must be designed to enable presentation of an exterior or an interior scene. With the studio designed for maximum absorption, illusions of exterior sound characteristics can be created. For interiors, the hard surfaces of the sets and props offer sufficiently reflective surfaces to create the indoor effect.

TYPICAL PRODUCTION ROUTINE

After the foregoing discussion of the equipment and personnel, it may be interesting to follow an actual production from the beginning of rehearsal to its final presentation. For this example, assume that we are to produce a playlet (Figure 6). When the scenery has been erected, the first rehearsals begin without the use of cameras or lights. Besides familiarizing the actors with their lines, the rehearsals afford the production director and the head camera operator an opportunity to map out the action of the play. All action, including camera shots,

cues, and timing, is noted on a master script which thereafter becomes the "bible" of the production. Timing is very important because of the necessity of having a particular act time in with the other acts or film subject.

After several hours of rehearsing, the first equipment rehearsal is called. Cameras are checked electrically and mechanically. Focus controls and framing devices are lined up so that correct focus on the ground-glass is also correct focus on the mosaic plate. This completed, the cameras are ready for rehearsal. With the scene properly lighted, the camera operators begin working out movements to pick up the

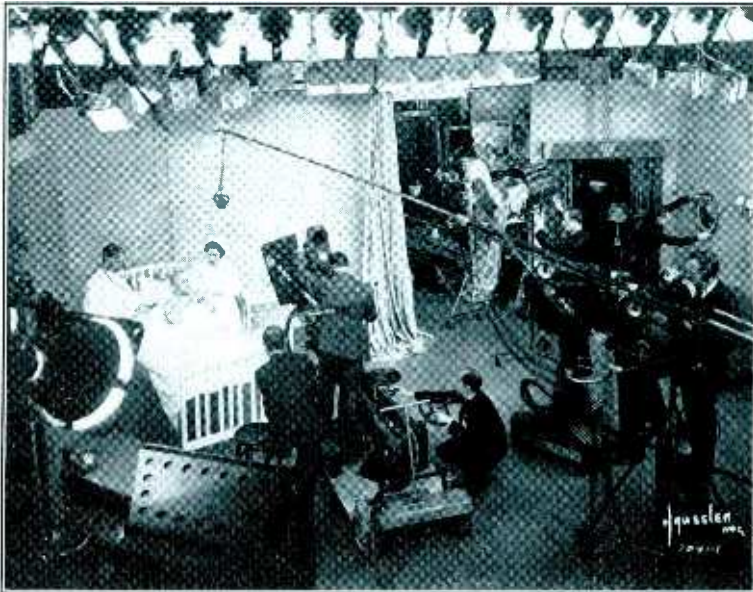


Fig. 6—(Left) Scene on the air. (Right) setting up for next scene.

desired shots in the proper sequence. The production director instructs the staff and personnel from the control room, speaking over a public-address system. Each shot is worked out and its camera location marked on the floor. At times, the actors may unconsciously depart slightly from the rehearsed routine during an actual show; the camera operator must be prepared and alert to make the best of the situation regardless of all previous floor markings. Continuity is so planned that while one camera is taking the action, another camera is moving to a new location and composing a new shot to be switched on at the proper time. This frees the first camera, which can now move to a third location, and so on. Sometimes during a twenty-minute per-

formance each camera may take twenty different shots. Of course, besides different floor locations, the height and angle of the cameras must be varied to comply with good composition. During rehearsals, timing must frequently be revised to allow for the actual camera movements.

Finally, a dress rehearsal is scheduled. The complete program is televised, including any film subjects or slides that may be needed to complete the program. Frequently the program will begin with a short film leader, followed immediately by a newsreel or a short subject, the film portion of the program coming from the film-televising studio. While the film is running, the live-talent studio is continuously warned as to the time remaining before it must take over the program. Once the studio program goes on the air the production director is no longer able to use the public address system to communicate with the personnel in the studio. Instead, he uses a telephone circuit to his assistant in the studio, and, through the video engineer, communicates by phone with the camera operators.

Another standby warning is usually given when there is one minute to go. Then, as the cue to begin comes, the green light on the title camera is lighted. From this point, continuity must be rigidly preserved. As titles move from one to another, appropriate music is cued in and actors are sent to their opening positions.

With the completion of titles, the image is faded out electrically and cameras are switched to the opening shot. Performers begin their action on a silent cue from the assistant director, who is instructed from the control room. During this first scene, the camera previously picking up titles moves quickly into position to shoot a second view of the action. Again cameras are switched, permitting the first to move to a new position; and so the action proceeds. If the play has several scenes, the concluding shot of the first scene is taken by one camera while others line up on the new scene and wait for the switch. Frequently, there are outdoor scenes. These are filmed during the first stages of rehearsal for transmission from the film studio at the proper time during the performance. The switch to film is handled exactly as another camera switch, except that the switch is to the film studio instead of to one of the studio cameras. The projectionist must be warned in advance to have his projector up to speed and "on the air" at the proper instant to preserve the production continuity. This requires very critical timing, as you can well appreciate. When the film is completed the studio cameras again take over the next interior scene.

Upon completion of the studio portion of the program, one camera lines up on the final studio title, which usually returns the program to the film studio for a concluding film subject.

Since the first program on July 7, 1936, many television programs have been produced. Each has been a serious attempt at something new. Although much has been accomplished, there remain a vast number of unknowns to be answered before it can be said that television's potentialities have been even partially realized. Today, as this paper has indicated, television bears many points of similarity to motion pictures. As a matter of fact, it is likely that television would be somewhat handicapped if it were unable to borrow heavily from a motion picture production technic that has been built up by capable minds and at great expense over a period of many years. Infant television is indeed fortunate to have such a wealth of information at its disposal. Possibly continued experimentation will lead us toward a new technic distinctive of television. During its early years, however, television must borrow from all in creating for itself a book of rules. The first chapter of that book is scarcely written.



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