

MCGRAW-HILL TELEVISION SERIES

Techniques of Television Production

RUDY BRETZ

*Head Television-Radio Division
Department of Theatre Arts
University of California at
Los Angeles*

McGraw-Hill Book Company, Inc.

New York Toronto London

1953

TECHNIQUES OF TELEVISION PRODUCTION

Copyright, 1953, by the McGraw-Hill Book Company, Inc.
Printed in the United States of America. All rights reserved.
This book, or parts thereof, may not be reproduced in any form
without permission of the publishers.

Library of Congress Catalog Card Number: 53-6038

VI

THE MAPLE PRESS COMPANY, YORK, PA.

TECHNIQUES OF
TELEVISION PRODUCTION

McGRAW-HILL TELEVISION SERIES

DONALD G. FINK, Consulting Editor

- BRETZ · Techniques of Television Production
CHINN · Television Broadcasting
DEUTSCH · Theory and Design of Television Receivers
DOME · Television Principles
FINK · Television Engineering, 2d ed.
FOWLER AND LIPPERT · Television Fundamentals
—Theory, Circuits, and Servicing
GROB · Basic Television: Principles and Servicing, 2d ed
KIVER · Color Television Fundamentals
N.T.S.C. · Color Television Standards
WENTWORTH · Color Television Engineering

PREFACE

One of the problems of television has been the division within the staff at many stations between so-called "technical" and so-called "production" personnel. The distinction is largely arbitrary because the areas overlap widely. With very few exceptions, one can define the job that a technical man is doing at one station and somewhere else find a production man doing the same thing. The reverse, of course, is also true. At small stations where the staff is very small, each employee will have a wide range of duties. "Technical" people must often perform many production functions, such as operation of cameras and other equipment. "Production" people are frequently used to ride video, shade film chains, and do other jobs which are considered at most stations to be purely engineering.

Television, more than any other field, requires the maximum possible cooperation from all involved. Where engineers have taken no interest in production problems and production people have left "technical things" up to the engineers, this vital cooperation has failed. The production man is generally baffled by the complexity of electronic engineering and gives up trying to learn anything about the equipment, while the engineer hesitates to teach him anything on the grounds that he couldn't do a thorough job and "a little knowledge is a dangerous thing." A little knowledge is dangerous only if it is mistaken for a lot of knowledge, and certainly a little is better than none if this mistake is avoided.

The aim of this book is to bridge the gap between the creative production man and the technically minded engineer. The book is directed toward the production man, the director, producer, or worker in any of the dozens of service departments, such as graphic arts, costume, make-up, special effects, or lighting. It is written from their point of view and in answer to their problems. It should be entirely understandable to any production man, and yet it goes quite far into the area he has generally considered "technical" and beyond his powers of comprehension.

By and large, the book concentrates on principles underlying equipment and techniques, the understanding of which is basic to the intelligent use of any model or design. The most important parts of the book, being basic, should not become obsolete.

The specialist in any branch of production may be familiar with most of the information in the chapter covering his particular field; the other chapters, however, will teach him much about the other fellow's job. This kind of understanding, vital to the close cooperation required in television production, is too often lacking. And certainly the advanced student of television techniques will find much in every chapter that he could discover otherwise only by working in many capacities and at many stations on many different kinds of production.

Since no other similar book exists, everything in the field had to be covered. Space and size limitations prohibited a full discussion of color television, but with the exception of the chapters on limitations of the TV system, the gray scale, etc., practically all of the basic techniques described will apply to color television. Different cameras will be used, more lighting will be needed, new technical limitations will come and go as the system progresses. But the basic techniques of camera handling, creative lighting, special effects, and so forth, will remain pretty much the same. Certainly the problems of remote pickup, discussed in this book, will change very little with the advent of color.

The writing and production of this book extended over a period of nearly five years of continuous work. During this period, two other books were written—with a collaborator—and published. These were done with the left hand, so to speak, while the right hand continued work on the "big" book. The number of contacts made, people visited, and material collected produced much more material than could be compressed into one volume. Each of the chapters in this book could, and should eventually, be developed into a book in itself. However, the original purpose of the book, to present in compact form a practical, useful reference book for the production man in television, has, it is hoped, been realized.

RUDY BRETZ

ACKNOWLEDGMENTS

The author has a great many people to thank for help in the preparation of this book. As each chapter was completed, it was taken to a specialist in that particular branch of the field for review, both to check its accuracy and to catch any significant omissions. My purpose in listing these people and the specific help they gave me is not at all to pass the buck in case errors are found in the text. The first chapters to be written were reviewed two or three years ago and have been added to and brought up to date without benefit of the same careful reviewing.

First thanks must go to seventy-six television stations which the author had the opportunity to visit or to work at, whose personnel and management understood the purpose of this book and granted the author hospitality and assistance. They are:

KDYL-TV, KECA-TV, KGO-TV, KIHJ-TV, KLAC-TV, KNBH, KNXT, KPIX, KPRC-TV, KSD-TV, KSL-TV, KSTP-TV, KTLA, KTTV, WAAM, WABD, WAGA-TV, WATV, WAVE-TV, WBAL-TV, WBAP-TV, WBBM-TV, WBEN-TV, WBKB, WBNS-TV, WCAU-TV, WCBS-TV, WCCO-TV, WCPO-TV, WDEL-TV, WDSU-TV, WDTV, WEWS, WFBM-TV, WFIL-TV, WGN-TV, WHAM-TV, WHAS-TV, WIEN, WIHP-TV, WHUM-TV, WICU, WJAR-TV, WJBK-TV, WJZ-TV, WKBN-TV, WKRC-TV, WKTU, WLWC, WLWT, WMAL-TV, WMAR-TV, WNAC-TV, WNBK, WNBQ, WNBTV, WNBW, WNHC-TV, WOI-TV, WOR-TV, WPIX, WPTZ, WRGB, WSB-TV, WSPD-TV, WSUN-TV, WSYR-TV, WTMJ-TV, WTOP-TV, WTTG-TV, WTTU, WTVJ, WTVN, WWJ-TV, WXEL, WXYZ-TV.

In addition to these, the two Canadian stations CBLT in Toronto and CBFMT in Montreal should be mentioned, and the Navy Special Devices Center at Sands Point, Long Island.

Major acknowledgment is due the staff of the Canadian Broadcasting Corporation, Stuart Griffiths and Mavor Moore on the production side

and Reginald Horton and Harold Wright in engineering, who went carefully through the entire book, had it retyped into final form, and tested it thoroughly on their entire staff.

The author is indebted to Victor Allen, editor of the *Journal of the Society of Motion Picture and Television Engineers*, and to Boyce Nemic, executive secretary of the Society, for editorial help and encouragement in connection with the advance publication of several chapters from the book as articles in the *Journal*. Thanks also to Irwin Shane and *Televisor* magazine, which published the section on baseball coverage as an article. Thanks are due also to the School of Radio Technique, where the author has been an instructor, for the use of the school studio and technical facilities for the making of several off-the-tube photos to illustrate technical limitations and perspective in long and short lenses. Thanks to photographers Bill Thompson and J. Holubek for photos used in the book.

Thanks are due Gloria Brennan and Dick Robbins who assisted the author in the early stages of research. Of particular importance in those early days was Shirley Cohen Fisher, who as the author's secretary kept things organized in a way they have never been since. Thanks to Don Whitman, Colby Lewis, Bert Gold, my partner Ed Stasheff, Carol Van Sickle, Bob Hannum, Warren Jacober, and the many other friends who throughout this five-year period stood by with unswerving faith that something would finally result. Thanks to Bill Schwartz for editorial assistance on a manuscript which had until then been rather rough and loosely slung together.

For assistance in the chapter on camera handling, the author must thank CBS Cameraman Bill Guyon, ABC Cameraman Mike Freedman, and WPTZ Cameraman Joe Behar. Special thanks to Byron Paul and Howard Hayes for reading that part of the manuscript, and thanks to Hayes for taking a wonderful set of photographs demonstrating the use of the Fearless dolly. Thanks also to Al Protzman of the NBC engineering department for reviewing the chapter on the television cameraman.

Thanks to Harry Milholland of Du Mont for reading the chapter on lenses and for helpful suggestions on its improvement. Thanks to Dr. Frank Back and Jack Pegler for information and pictures. For review of the chapter on switching systems, the author thanks Otis Freeman of WPIX. Much of the information for the chapter on limitations of the television system came from Richard O'Brien of the CBS general engineering department. Thanks also to Louis Pourciau and his staff at General Precision Laboratories for checking the manuscript and suggesting improvements.

The chapters on graphic materials were made richer through the contributions of Georg Olden, CBS art department head, Tom Nagaele of

WATV, Jack Rose of NBC, Arthur Rankin of ABC, Don Figlozzi of WPIX, and Ray Sherwin. Thanks to Georg Olden and Richard Smith of WOI-TV for careful reading and improvement of the manuscript. For data contributing to the projection-equipment chapter, the author is indebted to Paul Adanti and Gene Crow of WHEW Syracuse.

Much help in the realm of special effects was contributed by John DeMott, then head of CBS special effects, as well as Austin Huhn at NBC, Jim Furness, Bob Banner, John Casagrande, Bill Helion, Joe Fox of WTMJ-TV, and Karl Weger of WPTZ. These chapters were read and improved by Karl Weger, Jim Furness, Austin Huhn, and also by Chuck Holden of ABC. Al Jenkins contributed in the field of rear projection. George Gould, Roy Fee, and Rolf Drucker contributed some special off-the-tube photos of their "Gizmo" device.

The scenery chapter was checked and improved by Austin Huhn of NBC and Dean Wagner of WOI-TV. Thanks here to WTMJ-TV for some special photos of their scenery, to Jim MacNaughton and Bob Bright of ABC and to Otis Riggs of NBC for preparing a typical floor plan. The television make-up chapter was written in close cooperation with Dick Smith of NBC who supplied the information and thoroughly checked the manuscript. Bob Jiras of CBS and Irene Kent of CBC Toronto also checked the material.

Lighting, the province of Gil DeStefano of CBS, was checked by him and also by Karl Weger, lighting director of WPTZ. George Gill contributed generously.

Paul Hale, CBS audio engineer, contributed to the audio chapter as did also Neal Smith of NBC. Al Protzman of NBC was again helpful by having that chapter reviewed in the engineering department there. Harold Wright of CBC found improvements to make. S. Young White added to this and other parts of the book from his vast store of experience.

The chapter on remotes could not have been as complete without the help of Don Hallman, Rod Mitchell, Ray Barrett, Oliver Fulton, and Jack Murphy of WPIX, Bill McCarthy of J. Walter Thompson, Marshall Diskin of ABC, Ernest Sindelar of WEWS, Cleveland, Ad Schneider of NBC, and Paul Levitan of CBS. Les Arries of Du Mont also contributed, and Peter Dimmock, director of outside broadcasts for the BBC, supplied the author with interesting data on the pickup of the boat race on the Thames.

I would like to thank all the manufacturers of TV equipment who supplied the author with data and photographs. To mention only a few: RCA, Du Mont, GE, and GPL were very helpful. Kliegl, Century, Translux, The Gray Company, Camera Equipment Company, Houston-Fearless, and many others were generous with their assistance.

The photographs on page 169 are reproduced by permission of Philip

x **ACKNOWLEDGMENTS**

Morris & Co., Ltd., sponsors of the Racket Squad television program.

To Don Fink, consulting editor of the McGraw-Hill Television Series, my thanks for his excellent suggestions in the work of revising, editing, and compressing the manuscript into its final version.

Finally, I gratefully acknowledge my debt to my patient family and long-suffering wife, who through thick and thin managed somehow to stick by me through those busy years. I thank her for endless typing and retyping of manuscript, for keeping three children and then four children out of Daddy's office during working hours, for never losing—at least never for very long at a time—an understanding of the importance of the book and of the time that had to be taken from a growing family to make it possible.

RUDY BRETZ

CONTENTS

Preface	v
Acknowledgments	vii
1. Introduction	1
2. The Television Cameraman	11
3. Television Cameras	15
4. Camera Handling	28
5. Television Lenses	57
6. Television Cutting	87
7. Television Switching Equipment	105
8. Technical Limitations and the Production Problems Involved	122
9. Graphic Materials	136
10. Projection Equipment	171
11. Mirrors and Prisms	200
12. Composite Shots and the Illusion of Space	219
13. Special Effects with Graphic Materials	242
14. Studio Effects	263
15. Electronic Effects	277
16. Television Scenery	296
17. Television Make-up	328
18. Television Lighting	337
19. Television Audio Problems	382
20. Remote Pickups	413
Index	465

1 INTRODUCTION

Television programming is built out of three types of program material. First there are the "live" programs ("live" to distinguish them from film), which originate in the television studio; second are the live shows, which originate at remote locations outside the studio; and third are the programs which are projected onto the television system from motion-picture film.

The major purpose of the television studio and all the production paraphernalia that goes with it is the creation of illusion. Sets, props, costumes, and acting all contribute to create an illusion that the action is taking place anywhere but in the television studio itself.

The final product of television drama is very close to that of motion-picture drama—a story about people involved in situations, presented by actors and translated to a screen in terms of long shots, medium shots, close-ups, and reverse angles. It is inevitable that the techniques of the motion picture should be adopted in large measure. With almost any other type of programming than the dramatic show, however, it is a different story. In the comedy show, the revue, the dance, the panel format, the interview show, and many others no illusion is attempted. Such programs are better television when their directors make the most of the effect of immediacy—the feeling on the part of the audience that the action on the screen is at that very moment taking place. Some programs, like the classic "Garroway at Large," create illusions but are happy to destroy them as soon as they have served their purpose, knowing that this very act of destruction is often more entertaining and better television than the illusion itself.

Remote pickups usually make interesting television entertainment because of the actuality of the real backgrounds and the immediacy of the real action which is being transmitted. The television cameras at the remote location may simply report on an event and transmit it directly, as in the case of spot news, such as fires and other disasters; they may

2 TECHNIQUES OF TELEVISION PRODUCTION

pick up a show which has been prepared for a regular audience present at the event, as in the case of sports and parades; or they may pick up a special program which has been created expressly for the television show.

Another type of television programming is provided by motion-picture film. Films are threaded into special projectors and projected directly upon a television pickup tube.

At first there were many television stations which were not connected to the growing television networks and thus could not receive live programs from New York or other points of origination. A method of recording live television programs on film was developed so that these stations might also carry the network programs. A film made by this process is usually called a "kinescope recording." The equipment consists of a motion-picture camera focused upon a television receiver screen.

PRODUCTION IN LARGE AND SMALL STATIONS

It is very difficult to generalize about television production methods. Techniques differ widely between the small station in a community of limited size and the large network origination station in New York or Hollywood. The small-station producer may have to do a local variety show, for example, for \$200, while his colleague on the network may have a budget of \$10,000 with which to produce the same type of show. In addition to this, the network director will have a week or more to prepare his show without other responsibilities, and a day for camera rehearsal, whereas the local producer, responsible for several hours of programming per week, must throw the production together and considers himself very lucky if he is allowed any camera rehearsal time at all.

Studio facilities also vary greatly. A network station in New York will have more than a dozen studios, several converted theaters, and two or three mobile units. The total number of cameras owned by a network station may be as high as 70. Each studio will have three cameras, and some may use four or five. On the other end of the scale, there are several stations which have been operated successfully with no more than one studio camera or none at all, programming entirely through network feed and film.

THE TELEVISION STUDIO

A visitor to a television studio is apt to remark at first glance that it looks very much like a movie set. Then he will note things which remind him of a stage in a theater, and if he has the opportunity to enter the control room, he will feel that the whole thing is, after all, an overgrown radio studio. He will be right in each case. Television has borrowed much from all three of these fields.

Like stage shows, television productions must run continuously

scenes with a minimum of time allowed for changes of
 sets and lighting. All the lights must be properly placed at the beginning
 of the production, they cannot be repositioned. The lighting, the
 position must be planned so that the show can be seen properly
 from any angles of view. In the theater the audience sits in all
 directions, and in the television studio the cameras shoot
 from all angles. Most television studios use a type of scenery which
 is like the theater, flats made of muslin stretched on light wooden
 frames, cycloramas, traveler curtains, and the like.
 Experienced people working in television production say that this
 is like nothing quite so much as summer stock. Everyone
 knows that against time, nothing can be perfect, and the short cut is
 often the "right way" to do a thing, the main difference
 between the two is that there is a new show every night instead of every week.

Television is unlike the stage in one very important way. Television
 is a photographic medium. Nothing reaches the television audience
 which has not entered the eye of a camera. The question has been
 commonly raised: Why cannot the television medium transmit a stage
 play to the home audience, capturing the immediacy of the performance
 instead of attempting to simulate the motion picture? Perhaps if a play
 were televised in one continuous long shot with the proscenium arch of
 the stage constantly visible, the effect of a stage play would be retained.
 As soon as the cameras are brought onto the stage, however, and proceed
 to break the action down into close-ups, two-shots, reverse angles, and so
 forth, the show no longer resembles a play but has become like a motion
 picture. The television medium is a medium of the camera and as such
 has departed almost as far from the live theater as has the medium of film.

The main difference between television and motion-picture studios is
 that the film studio is not a machine. It is only a space, like the photo-
 graphic studio, within which lights, sets, and cameras may be placed and
 pictures made. Very little is built in; practically everything rests on the
 floor. Lights, when they are not mounted on floor stands, are fixed to
 the top of the sets or to scaffold towers or bridges, which in turn rest on
 the floor. This is possible in film production because everything may be
 rearranged between each shot. In television, on the other hand, the
 production cannot stop after each shot, and the entire floor must be free
 for the unrestricted movement of cameras. The salient feature of the
 television studio which is taken directly from radio is the control room.
 Sound-isolated from the rest of the studio, the control room is always
 provided with a large plate-glass window. In radio this window allows
 the actors to see the director and take visual cues from him. In tele-
 vision, cues are never given through this window to anyone; it is usually

4 TECHNIQUES OF TELEVISION PRODUCTION

impossible to see through it from the studio side because of the studio lights. Most stations have installed large sheet reflection material across the glass to cut down the glare from the camera so that the personnel in the control room can see the camera easily. Very often the studio is so crowded with sets that sets are placed against the control-room window, and it becomes a wall instead.

THE ANATOMY OF THE TELEVISION STUDIO

Turning now to the elements which make up a typical television studio, we note first of all that the studio must provide a space or a stage for action. In small studios where there is not enough time to rearrange lights and other equipment between shows, these staging areas will remain pretty well set from one show to the next. In a large-network studio, however, the designer of a set should be able to use any portion of the studio he wishes, provided, of course, it is possible for the director to get his cameras into place to shoot it. The typical dramatic production will be laid out in a series of small two- or three-sided sets placed around the sides of the studio with an area for camera movement left free in the center. Some of the more complicated productions have reversed this procedure and placed their sets in the center of the studio with camera access provided on all sides. In using this method, however, the director must be careful to plan things so that minor errors do not result in the cameras showing each other in the background of their shots.

Some television sets have been two stories high, and indeed in some of the larger studios the ceiling of lights can be raised, permitting background drops as much as 40 feet high to be used.* At the other end of the scale, some very successful productions have been staged without scenery at all, the entire show being done in close-ups of the actors against a background of "limbo" (dark curtains or cyclorama backing which comes out black on the television screen).†

The television camera is at once more complicated in operation and more flexible than motion-picture cameras. It is rather unwieldy, but no more so than a large sound camera of Hollywood when enclosed in a soundproof blimp, and it is certainly less cumbersome than the huge technicolor camera.

The cameraman controls the composition of the picture and the focus of the lens when action is approaching or receding from the camera, and he often rolls the camera across the floor ("dollies it") at the same time.

* ABC-TV Studio 1, 7 West Sixty-sixth Street, New York, N.Y.

† NBC's Cameo Theatre produced by Albert McCleary.

The camera is provided with a small monitor, actually a little receiving set, which constantly shows the cameraman the picture that his camera is putting out. This is called an "electronic view finder."

The cameras are connected by special cable (containing 24 different conductors) to the camera-control units in the control room. The camera, its camera-control unit, and the power supply which feeds it the necessary voltages are known collectively as a "camera chain." A camera cannot operate without its entire chain. A video engineer is necessary to operate the camera controls in the control room, and he might very well be classified along with the rest of the camera crew since the camera will not function properly if he is not on the job. Each camera-control unit contains a monitor on which the picture taken by its particular camera is visible as long as the camera is operating.

The studio audio equipment parallels that of a radio studio very closely. A similar audio console is used in the control room, although extensible boom microphones of the motion-picture type are necessary to follow the sound which must necessarily come from actors in movement. Two turntables are usually provided so that recorded music can be used freely as part of the studio show. Sound effects are usually provided by a sound-effects man who handles records and live effects in the studio just as in the manner of radio broadcasting.

THE STUDIO CONTROL ROOM

The camera monitors already described (part of the camera-control units) are usually lined up in a row in front of the control-room window, permitting the director to preview the picture from each camera at all times.

In addition to the camera monitors there is always a master monitor, or on-the-air monitor, which carries the picture that is leaving the control room. Thus when a switch (or "cut") is effected between two cameras, no change is noted on the respective camera monitors, except for small tally lights which indicate which chain is on. The master monitor always shows the effect of the cut, however, since it carries the program which the director is creating.

An additional monitor is always present for the purpose of previewing pictures which do not come from studio cameras and do not have their own camera monitors in the control room. This is called a "preview monitor." Film and slides from the projection room, pictures from remote locations which are to be integrated with the studio programs, and sometimes pictures from other studios are previewed on this monitor.

Switching from camera to camera is done with a control panel of switches and levers or dials, called the "switching system." Not only straight switching (instantaneous change of scene) but dissolves, fades,

6 TECHNIQUES OF TELEVISION PRODUCTION

superimposures, and sometimes wipes can be done as well. Figure 1-1 shows four different methods of control-room layout. The technical director, who operates the switching system, may sit at the same console with the video engineers (a) or he may sit side by side with the director (b, c, and d). This is the preferred method. Some studios place the video men and camera monitors off to the side of the control room and leave the director and the TD alone in front of the control room window. Only a master monitor and one preview monitor are used in directing a

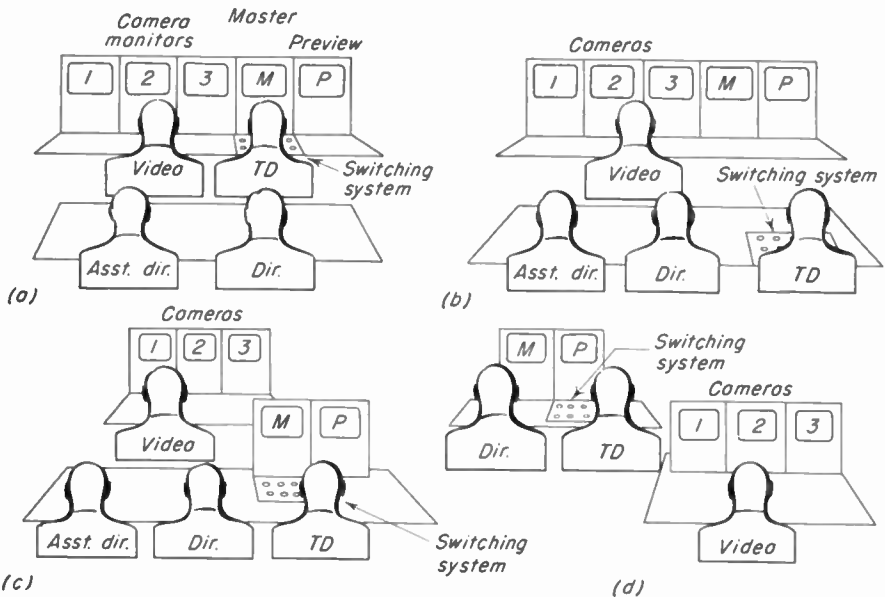


Fig. 1-1. Four typical control-room layouts. (a) All controls and monitors on lower tier; (b) all monitors below, director and technical director side by side at production desk; (c) master monitor and preview monitor (or monitors) mounted on production console; (d) camera monitors removed from director's line of sight—preview monitor switched from camera to camera instead.

show with this control-room layout, each camera having to be specially previewed just before it is used.

Some stations have experimented with using two control rooms instead of one. The engineering and the production functions are thus separated, with, of course, constant intercommunication between. WENR-TV has used this method with considerable success in their Civic Opera Theatre. The director and assistant work in a small control room by the side of the stage, which is equipped with a monitor for each camera, a master, and a preview monitor. All the engineers are located in a second control room backstage. Cues for switching, audio directions, and whatever else is

necessary are given by the director to the engineers in the other control room over the intercom.

Several stations are laid out in still a different manner. All the camera-control units for several studios are placed together in one central

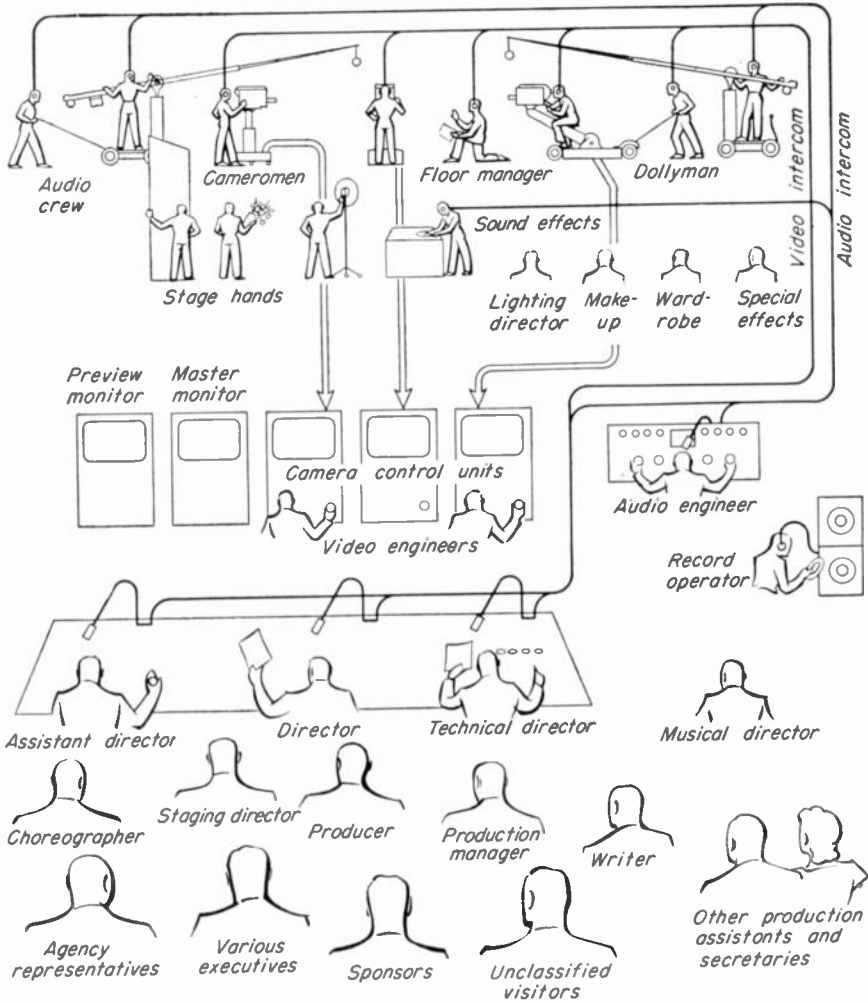


Fig. 1-2. Personnel present during rehearsal of a typical television-network show.

camera control room. Thus the only engineers present in the studio control room are the technical director and the audio engineer. Again intercommunication is essential.

It should be noted that several of the best television directors seldom use the control room in rehearsing a show, preferring to work on the studio floor, watching the picture on the cameramen's view finders or on the floor

8 TECHNIQUES OF TELEVISION PRODUCTION

monitor, and not entering the control room until time for dress rehearsal. It is certainly very rarely that a director can stay long in the control room during rehearsal of a complex show without having to go out onto the floor and untangle some kind of problem.

THE PROJECTION ROOM

Since a large part of the programming of television is motion-picture film, every station must have equipment for the projection and pickup of films. The simplest setup is illustrated in Fig. 1-3, where a specially built projector is focused directly upon the iconoscope tube within the pickup

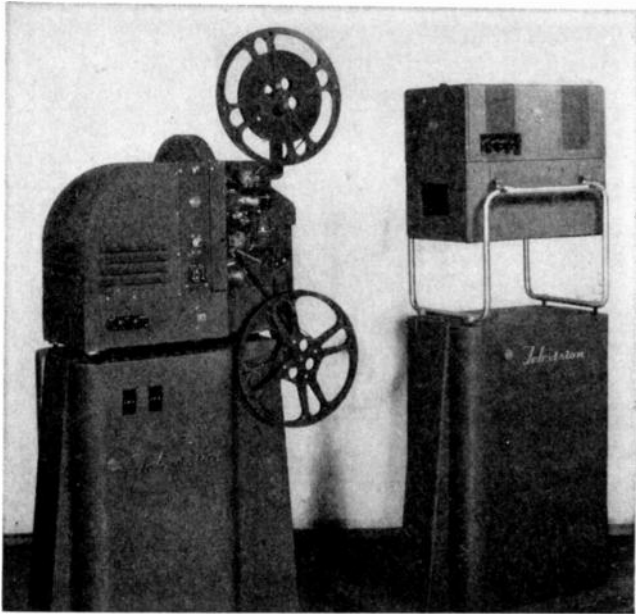


Fig. 1-3. Television film projector and film-pickup camera.

camera. By an arrangement of mirrors as many as seven different projectors have been used on one film pickup camera.

Each film pickup camera must have its camera-control unit just as the studio cameras do. In a network station these are placed in a special film control room, which is generally laid out in very much the same manner as a studio control room, with two levels, a switching system, master monitor, and audio console.

MASTER CONTROL

In a large station or network, studio programs will not go directly to the station transmitter, but to an intermediate switching point which is called the "master control." This also constitutes a central place for the group-

ing of amplifiers, synchronizing pulse generators, and the other technical equipment which is necessary to the television system. Several studios may feed into master control; so may one or more film "studios"; and there may be incoming lines from outside the station, such as feeds from remote pickups and network programs from the telephone company (Fig. 1-4). Master control will in turn feed programs to many different places. Video patchboards are provided, similar in a general way to telephone switchboards, making a great variety and flexibility of circuits possible. Signals from any of the above incoming lines may be patched down to any studio for preview or for integration into that studio's program. In addi-

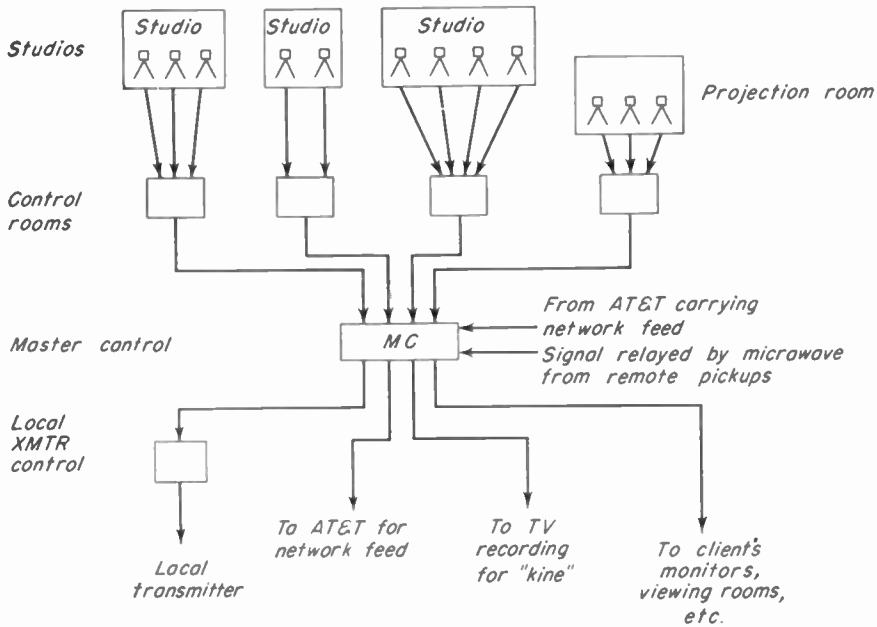


Fig. 1-4. Chart of typical network station.

tion to outgoing lines to each studio, master control may also feed a variety of client and audience monitors about the station, the local station transmitter, and the central offices of the phone company for network feed. Still other outgoing lines will lead to the kinescope recording department, where certain programs will be put on film.

SMALL-STATION LAYOUT

Smaller stations will often combine the various control rooms mentioned above in the interest of economical operation. The usual combination is to include the film-control function in the studio control room. This will add the camera-control units for one or more film chains to the line of

monitors beneath the control-room window. Sometimes film control is combined with master control, and occasionally both these functions are incorporated within the single studio control room. A few small operations have combined all this with the transmitter control room so that one control room performs four functions. An unusual arrangement was observed at one station, where audio for the studio was operated by the transmitter operator, who was far from the studio but took all his cues by phone. This made an audio engineer in the studio control room unnecessary. Furthermore, a video engineer was eliminated by putting the camera-control unit for the film pickup camera in the projection room so that the projectionist could shade film. The only functions left in the studio control room were those of technical director (switching) and video engineer (camera control). By a further simplification and stretching of duties, these two functions were performed by one man. Thus, in this abridged operation, three engineers were sufficient to run an evening's program schedule: TD, projectionist and transmitter operator.

2 THE TELEVISION CAMERAMAN

Television is a medium of the camera. All the techniques of television production are related to the functioning of this instrument. Since the camera is basic, any real understanding of the medium must begin with a thorough familiarity with the television camera and its operation.

In turn, prior to the discussion of cameras and the techniques directly associated with cameras, a general picture of the television cameraman will prove valuable. The following chapters will discuss details of equipment and operating techniques—knowledge which a cameraman must have and which a director would do well to acquire.

The requirements of television production and the unique design of television cameras have developed, in the better television cameramen, operators of unusual skill. Handling the camera is a highly creative job, and there is a tremendous difference between a good and a mediocre cameraman. The ability of a television cameraman depends on certain basic abilities but is also due in large measure to his attitude toward his job. This in turn seems to hinge primarily on the position of the cameraman within the station organization.

The job of cameraman is only one of a group known as operating jobs. Such duties as dolly pushing, mike-boom operating, audio console operating, and the jobs of technical director, projectionist, record spinner, etc., are not strictly *technical* jobs. In none of these positions does the operator have to understand more than the mechanics of operation of his equipment. He is not called upon to repair or redesign, but only to operate, and skill of operation rather than engineering understanding is required. A few television stations, as, for example, WHEN and WTVJ, have classified every one of these jobs under the program department. Since, in an operating job, an understanding of showmanship is of greater value than a technical background, creative contribution is more likely to result in all these aspects of production. This is not to say, of course, that no

engineers have any concept of showmanship. There are many engineers in television who, through particular backgrounds or constant control-room experience in television or radio, have developed an understanding of the elements of showmanship that would qualify them equally well as directors. The best of the technical directors fit this description.

APTITUDES OF THE SUCCESSFUL CAMERAMAN

Whatever the cameraman's classification with in the organization, he will become really good only if he has two essential aptitudes. The first is a sense of composition, and the second is a well-developed manual coordination.

The sense of composition comes only from long familiarity with the picture medium. A man who has been a still- or motion-picture photographer, or perhaps has worked on a picture magazine, has been thinking in terms of pictures and developing this sense. Many books are available on composition, but it is not possible for the television cameraman or director to apply rules for composition while he is making pictures. There just is not enough time. The cameraman must have acquired a feeling for a well-composed picture. He must be able to look at a picture, see what is wrong with its composition, and unerringly make a quick adjustment to improve it.

Manual dexterity and coordination come only to those who are endowed with the necessary aptitude. Just as it is impossible to teach some persons to fly an airplane, so it is impossible to teach such persons the smoothness and dexterity necessary to operate the television camera. A man who lacks the feeling for composition but has coordination may learn the former in time; if he lacks the aptitude for physical coordination, he will never be a good television cameraman, no matter how finely developed his pictorial sense.

RELATIONSHIP BETWEEN CAMERAMAN AND DIRECTOR

Most creative decisions about the use of the cameras are made by the television director. He is even sometimes known as the "camera director" to distinguish him from the "staging director," whose concern is only with the performers, the sets, the costumes, etc.

The usual studio setup puts the director at one end of the studio intercom and the camera crew at the other. He directs the movements of the camera on the air, while at the same time readying his other cameras for the next shots he will use. Then he directs the switching from camera to camera as the show progresses. The director and the cameramen work together as a team. Since the technical director does no more during a show than operate the switching system, this method of operation has been known as the "switcher" system.

In some stations, notably those operated by NBC, the "technical director" system is used in which the TD operates also as a kind of head cameraman. He will be familiar with the show before it comes into the studio, having visited one or more outside rehearsals, and will have had a share in the planning of shots and camera angles. During studio rehearsal he is then in charge of the operation and placement of cameras and is usually the *only* one who gives directions to the cameramen.

Proponents of this system see in it an analogy to the method of Hollywood production, where each film has two directors, one of whom is the "director of photography" and is in charge of all technical aspects of the production, while the other, who carries the title of "director," concerns himself largely with the broader problems of staging and acting. Where this method is in use, however, the job of TD is always an engineering job. The TD must be in charge of the camera and control-room crew and for this reason must be a superior engineer. Men who can fulfill all these requirements are rare, or cannot be found for the salaries that are offered. The TD system breaks down when an inexperienced man is on the job or when an "ad-lib" show is attempted.

During an ad-lib show, camera and cutting instructions must be given very rapidly and acted upon immediately, or action is lost. Sudden instructions to the cameraman cannot originate with the director in these cases, since, by the time they are relayed through the TD, the moment has passed and it is too late to put them into effect. To be sure, the TD himself may make these decisions, but he is acting then in the capacity of director, which very few TD's are able to do or would be allowed to do. A good TD can assist the director by keeping one step ahead of him. He can so engineer the cameras that the director would have a variety of shots to choose from in calling takes, and one camera at least would always have a good shot, well framed, taken from the proper angle to show the action, and ready at the right time. However, there is some question as to whether this could not be done just as well, or more easily, by the director himself. It is a general opinion that for ad-lib shows the TD system does not work. Since most television stations must do the ad-lib type of production (and practically all remote pickups fall into this category), most stations have decided against this method.

A good compromise is achieved in some stations where both the director and the technical director may talk to the cameramen at any time. This makes quick decisions possible and at the same time provides a two-director team for the rehearsal and production of the show. After operating under this joint system many people have observed that the usual method, whereby the TD simply operates the switching system under the director's command, wastes the capabilities of this individual, who could be assisting the director at the same time.

THE CAMERAMAN'S RESPONSIBILITY

Opinion is divided as to how much responsibility should be vested in the cameraman for finding the right shot at the proper time. In the case of the unrehearsed show where there is no set sequence of shots, the cameraman is usually relied upon to "hunt for shots" when he is off the air. The director may look at a shot the cameraman has found and say, "No, I don't want to use that," or "That's good; give it to me again when I tell you," or he may switch it immediately into the program.

At the opposite end of the scale is the method of operation where the cameraman makes no move at all, except the very obvious, without instructions from the control room. It is a generally accepted principle that a cameraman should operate like this while his camera is on the air, but most stations give him greater freedom and more responsibility between shots.

In the case of the scripted and rehearsed show, the cameraman will always be supplied with cues from the control room to remind him of his next shot each time he is switched off the program line. In many studios, however, he is expected to take the major responsibility and will keep a cue sheet on the camera, listing each shot as it becomes established in rehearsal. He will often put numbered chalk or paint marks on the studio floor so that he can immediately find the exact camera position that was established in rehearsal for each shot.

Some of the better cameramen are opposed to this method, however. They feel that the important thing is to get the same *shot* they had in rehearsal, not just the same lens and camera position, and since the performer's positions may vary between rehearsal and air, the camera may easily be on the right mark and not have the proper shot at all.

3 TELEVISION CAMERAS

The four major makes of American TV cameras (Fig. 3-1) have more characteristics in common than they have differences. They are all built around the RCA image-orthicon tube. They all incorporate an "electronic view finder." They all have a turret holding four lenses, which can be rotated from the rear of the camera. They all focus by sliding the tube inside the camera toward or away from the lens.

Some of these cameras are known as "field" units and others as "studio" units. The difference lies not so much in the cameras as in the associated equipment. Field gear, described in detail in Chap. 20, is built into suitcases so that it can be carried about, while studio gear is permanently mounted in consoles, vertical racks, etc. There is no reason why field gear cannot be used in the studio, however, and many stations use this equipment interchangeably.

VIEW FINDERS

Like motion-picture and still cameras, any really useful television camera must have a view finder to show the cameraman what he is doing. In some kinds of camera work, notably fast sports, it is necessary for the cameraman to have a greater freedom and visibility than if his vision were limited to the small area of the scene which the camera is picking up. He then uses an exterior, or *sports*, view finder. This frame type of view finder, mounted on the outside of the camera, is a useful adjunct to the other types of view finder and sometimes has been used exclusively when a station could not afford to purchase the electronic type.

The simplest type of exterior view finder is a frame of wire mounted forward on the camera, with a small ring, or gun sight, near the back of the camera lined up with the center of the frame. If the cameraman puts his eye to this tiny ring, he is sure to see the area of the scene which his camera is seeing.

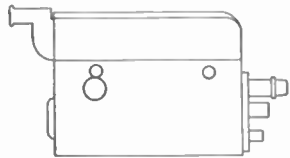
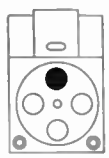
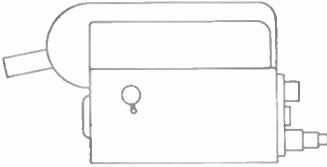
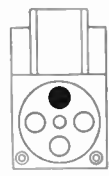
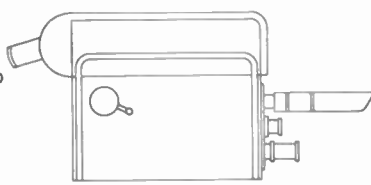
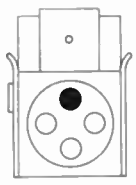
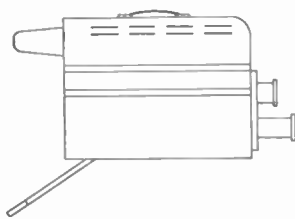
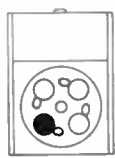
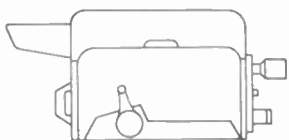
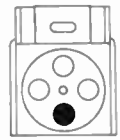
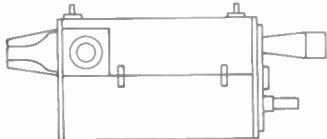
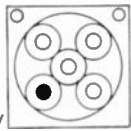
<p>RCA field camera</p>		<p>Special features</p>	
		<p><i>Focusing crank Periscope view- finder hood</i></p>	
		<p><i>Wt. 100 lb</i></p>	
<p>RCA studio camera</p>		<p><i>Adjustable hood Focusing crank</i></p>	
<p>New RCA field-studio camera</p>		<p><i>Supplants both previous models Similar to them except for carrying handles</i></p>	
<p>DuMont field camera</p>		<p><i>Handle bar grip focusing Mechanical lens- iris control from rear of camera</i></p>	
<p>General Electric studio camera</p>		<p><i>Focusing crank</i></p>	
<p>General Precision Laboratory field camera</p>		<p><i>Electrical focus push-button turret change Electrical lens-iris control from rear of camera and on camera-control unit remote control of all camera controls</i></p>	

Fig. 3-1. A comparison of the four major makes of TV cameras.

A wartime gun-sight device, the bull's-eye finder, has been adapted as a sports view finder and can be supplied by some manufacturers with the image-orthicon cameras. This device consists of only one sight (Fig. 3-2), and through it the cameraman sees a series of concentric circles superimposed on the scene. No matter how he may move his head or from what angle he may look through the sight, the bull's-eye will be superimposed on the same place in the scene. This will not show the cameraman his field of view, but only where the lens is centered. Many field cameras are equipped with both the bull's-eye and the electronic finder so that they may be used alternately as circumstances may require.

An inaccuracy is inherent in these view finders since they are mounted on the side or top of the camera. The center of the view finder is thus several inches from the center of the lens, and the view finder is seeing a

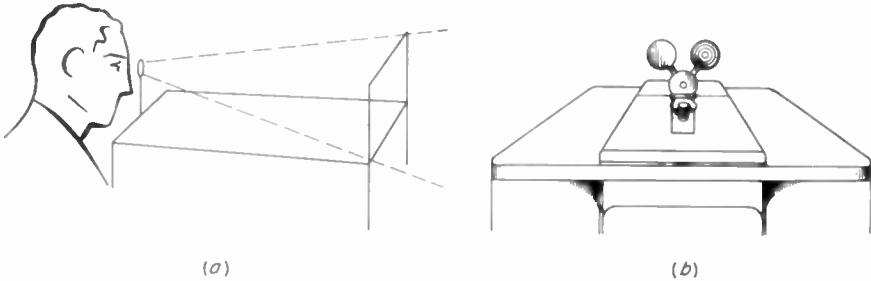


Fig. 3-2. Sports view finders: (a) wire frame with sight, (b) bull's-eye.

portion of the scene 8 inches, let us say, *above* what the lens is seeing. This is known as parallax error. In a distant scene, 8 inches doesn't amount to much, but as the subject comes closer, the parallax error is increased, until in close-up an error of 8 inches may cause entire loss of the picture.

It is interesting to note here that, even in studio camera work, when the cameraman is provided with an electronic view finder and composition of the shot is his prime consideration, he will frequently prefer to move his head away from the camera and work without any view finder at all. To give a simple example, let us say that the cameraman has a close-up of a person seated, showing only head and shoulders and the subject suddenly rises. If the cameraman's eye is glued to the electronic view finder, the action may occur too suddenly for smooth handling. If, however, his head is away from the camera, he will notice other movements of the subject preparatory to the act of rising—uncrossing the legs, placing hands on the arms of the chair, etc.—which will warn him of what is coming.

Optical View Finders. Several types of optical view finders have been used on television cameras. The primary advantages of the optical view finder are:

1. Focusing is quicker and more accurate. A fine ground glass will give better definition than a monitor tube and will inform the cameraman sooner when his camera is going out of focus. Thus he can see the error and correct it before it has become noticeable in the control room or to the audience at home. The cameraman with an electronic view finder, however, has no such advantage.
2. The field of view of the view finder may be made greater than that of the camera. This permits the cameraman to see slightly beyond the frame of the picture on all sides. Thus the boom microphone, dangling close to the top edge of the frame, need never appear by surprise as the cameraman pans slightly upward, and action entering from outside the frame can be anticipated. This is made possible simply by enlarging the size of the ground glass so that it picks up the image of a larger area than does the camera. (An electronic view finder, since it takes its pictures directly from the output of the camera, can see no more than what the camera itself sees.)

In spite of these definite advantages, optical view finders have not found wide acceptance in television, mainly because of the following disadvantages.

1. The optical view finder has a low light level. The brightness of the picture on an optical view finder is dependent upon the brightness of the scene. If the light is dim, as is often the case on field pickups late in the afternoon, an optical view finder is very nearly useless.
2. The optical view finder gives the cameraman no electronic information.

Electronic View Finders. The electronic view finder is the preferred form for studio work. It is essentially a compact television receiver mounted on the camera, which presents to the operator an image of what the camera sees. This image is also reproduced on the monitor screens in the control room and thus serves to coordinate the work of cameraman, video switcher, and director.

By watching an electronic view finder, the cameraman knows what the camera is *actually* sending out, not just what it is *supposed* to be sending. It will show him how the camera is reacting to conditions of high contrast range or light flare; it will show him such things as color response, definition, etc.

Sometimes the cameraman will have occasion to mark the face of his view-finder tube with a wax pencil. This is necessary in some superimposition effects where exact register is required. The sides of the screen may also be marked, about 10 per cent of the width in from each

side, to remind the cameraman not to include anything of importance in the border area lest it will not be seen on many receivers.

View-finder Hoods. The view-finder hood, designed primarily to keep stray light from washing out the image on the kinescope tube, is often used as an important element in camera control. Pressure of the forehead on the hood can be used to dolly the camera, to tilt down, or as a steadying force to control other movements of the camera and ensure smoothness.

The importance of an adjustable hood is that the cameraman does not always have to be directly behind the camera in order to see into the



Fig. 3-3. RCA studio camera with adjustable hood. Cameraman is using forehead pressure on hood as a help in camera control.

view finder. A hood which will pull down to a low angle when the camera is high and pointing down, for example, will allow the cameraman to look directly into the view finder without having to climb up on a chair to do so. The RCA studio camera has such a view-finder hood (Fig. 3-3), and the hood on the General Electric studio camera is also adjustable to a certain extent. As the camera tilts, the view finder must be continuously adjusted to the new angle. In the RCA studio camera, tension screws inside the hood can be adjusted so that the change can be made by pressure of the forehead alone without the cameraman having to touch it with his hand.

Many cameramen prefer to work without a hood at all, using only a cardboard shade above the face of the tube to keep out excess top light. This method increases the cameraman's flexibility since he can see the

view finder from any angle and does not have to be directly behind the camera.

FOCUS

If a camera is to be in focus, the photosensitive plate must be exactly where the image is formed. This means that, to keep sharp focus on a object which is moving toward or away from the camera, an adjustment must be made in the distance between lens and plate. This is known as focusing the camera. Camera designs solve this problem in one of three ways:

1. Standard photographic lenses are equipped with "focusing mounts." By turning a threaded collar on the lens barrel, all or part of the lens is screwed away or toward the plate. This is accurately calibrated so that the photographer can be sure of his focus even though he may have no ground-glass view finder on which to check it. Image-orthicon lenses, since they are largely standard minicamera photographic lenses, are so equipped. It is difficult, however, to utilize this type of focusing from the cameraman's position at the rear of the camera.
2. The lens can be fastened to a movable mount and racked bodily forward or back by a wheel or handle control, in the manner of a portrait-studio bellows camera. This is the method which was used on the old reflex-type* studio iconoscopes. It was necessary, with these cameras, to move both lenses at once so that the view finder would show the same focus as the camera.
3. The tube may be moved back and forth while the lens is stationary. This is the method used on all present-day image-orthicon cameras.

The RCA field camera mounts a knob on the side of the camera which engages a gear train inside. The RCA studio model and the later models of the field camera incorporate an improvement on this by adding a small crank, so that focusing adjustments can be continuous. With the knob control, any large focusing adjustment must be broken up into jumps, since the cameraman's wrist can rotate only so far before he must release his hold and take another grip. The knob is often a better device for field work, however, since it provides a solid grip on the camera where fast and accurate panning is most important. In most field pickups, all the action is so far distant from the camera that very little focusing is necessary.

The engineers at KTTV in Los Angeles improved the RCA field cameras by substituting a 6-inch disk for the focusing-crank control. This allows more delicate adjustment, and since the leverage is greater

* Twin lenses: one for camera, one for view finder.

at the outside of the wheel, the wheel can be moved very easily with only the pressure of the finger tips against the side. In following focus as the camera or subject moves, some cameramen have found it helpful to keep shifting focus constantly, very slightly back and forth. This gives them a fluidity which is necessary for the best control.

In studio work, it is often necessary to set focus on an object which is not yet in the picture. When a person comes through a door, for example, or stands up into the frame, it may be necessary to take the shot just as soon as the subject appears, and there is no time to focus up. Mike Freedman at ABC has developed a method which helps at these times. He notches the camera with a file so that he has a rough type of calibration



Fig. 3-4. General Precision Laboratory camera.

which can be felt by the fingers as the camera is being focused. If the focus is set at the correct calibration, established in rehearsal, the subject will be sharp as soon as it appears.

A smooth continuous focus over a wide range is not possible with the usual methods of operating a "motorcycle-grip" handle, since the wrist can turn only so far before the hand must release and take another grip. One way of getting around this is to put the flat of the hand or the fingers against the rotating grip and roll it down the palm, the wrist, and even the forearm if necessary. An early-model camera had such a control, which was not as sensitive to a light pressure and could not be used in this manner. The cameramen at the Navy studio in Sands Point solved the problem by adding a crank wheel to the end of the focus handle.

On the GPL camera (Fig. 3-4) focusing can be done with either hand.

The focusing knobs are potentiometers (the same as "pots" or fading dials on an audio console), and the actual movement of the tube is achieved by means of an electric motor.

Both the RCA and the GE cameras rack the tube from one end of its travel to the other in about $8\frac{1}{2}$ turns of the crank. The Du Mont motor-cycle grip takes 11 turns for the focusing travel. The GPL camera achieves its entire focus range within less than 1 turn.

THE LENS TURRET

Standard design in most film and television cameras includes the use of several lenses mounted on a rotating turret. Television cameras have been designed so that the cameraman can change lenses quickly by means of a handle on the back of the camera. It is desirable for the cameraman to mark or memorize this turret control so that he can know which lens is in place and which direction to turn to reach the next lens he may want.

The reader will note that there is no handle at the back of the GPL camera. The desired lens is selected by the row of four punch buttons at the bottom of the camera back, and the turret is motor-operated. It takes about $1\frac{1}{2}$ seconds for an adjacent lens to come into place and about 3 seconds if the lens is at the far side of the turret. This is slightly longer than a quick manual change. Another saving in time is accomplished, however. Each time a lens is changed, the camera automatically compensates for the change in focal length by racking the tube forward or back so that the new picture quickly comes into focus. With any of the other cameras a moment of manual focusing is necessary whenever a lens change is made.

THE LENS DIAPHRAGM

Under ordinary circumstances control over exposure (the amount of light entering the lens) is not part of the cameraman's responsibility. Exposure is a part of "picture quality," an engineering term referring to such factors as the accuracy of tonal reproduction, freedom from "noise" (rain or snow in the picture), and clarity of the image. When the cameraman adjusts the lens diaphragm to admit more light to the camera tube, he does it at the direction of the video man, who has found he must have more light for a satisfactory picture.

In the first RCA and the GE cameras this is done by reaching around to the front of the camera and adjusting the diaphragm control on the lens. The Du Mont, GPL, and new RCA cameras allow this operation to be done from the back of the camera. In the Du Mont camera (Fig. 3-5) this is accomplished by a shaft through the camera and a gear on the lens turret which engages the lens collar controlling the diaphragm. Specially adapted lenses are necessary for this type of operation, and

there is some doubt as to whether it is entirely necessary. There are times when it is undoubtedly helpful—as when the sun goes in and out all afternoon during a ball game, or in the late afternoon as the light is failing—but usually the lenses are all set to a standard opening when the cameras are lined up and are not touched during the program. (Studio lenses may be set anywhere between $f/5.6$ and $f/11$ depending on the age of the camera tubes which are in use and the studio illumination.)

The GPL camera controls the iris diaphragm electrically. A pair of “open” and “close” push buttons are provided just above the focusing



Fig. 3-5. Du Mont camera. This photo shows two iris control gear boxes on turret, one of which (at left) is contacting a lens. When this lens is placed in taking position (lower left) the gear box will be in lower center of the turret. The cameraman then pushes a knob at the back of the camera which advances a rod into the turret to contact the gears.

knob. Far more important, the video engineer also has a similar control on the camera-control unit. A small meter on the back of the camera and another on the camera-control unit indicate the diaphragm opening (f stop) at which the lens in taking position is set.

GPL provides a remote control unit (Fig. 3-6) containing focus knob, turret change buttons, and controls for an electrical pan and tilt apparatus. This might be useful if the camera is placed in a dangerous location or on the end of a long boom, where weight is an important factor. Studio boom dollies have been designed which place the cameraman with his view finder and controls on the base of the dolly, leaving the camera alone on the end of the boom arm.

Some stations (such as WHUM-TV Reading) installed GPL remote-control apparatus and eliminated studio cameramen, the director handling the camera controls along with his other duties.*

* Including, in this case, video control, switching, and remote control of film and slide projectors.



Fig. 3-6. GPL remote-control devices. Left: early remote-control unit for pan and tilt apparatus at far right. Center: remote-control box for focus and lens change only.

Control is surprisingly delicate, but camera flexibility is limited and the director is extremely busy. This equipment appears to be practical only for the simplest type of studio production.

LINING UP THE CAMERA

Lining up the camera is strictly a technical operation, and it is performed under the direction of the video engineer. However, it is well for the cameraman to be familiar with the process since his help is usually required. The following discussion is nontechnical and is intended only to assist the student cameraman toward a better performance of his part in the operation:

1. *Alignment.* The first step in the lining-up process is called alignment. If a camera is improperly aligned, this is because the scanning beam is not moving down the center of the tube. There is considerable disagreement among video engineers as to the best procedure in aligning the camera, and the cameraman may be asked to proceed in different ways when working with different engineers. Some will do the entire alignment with the lens capped up. Others will prefer to point the camera at a test chart or a flatly lit dark area. Still others feel that proper alignment cannot be obtained unless the camera is focused on a scene of average brightness and contrast range.

Whichever of these alternatives the engineer will choose, he will proceed to turn up the "orth-focus" control on the camera-control unit so as to bring out one or more tiny white "dynode spots" as close to the center of the picture as possible.

The engineer turns the orth-focus control back and forth to bring the spots in and out of focus. The cameraman, in the studio, listens to the engineer's instructions on the earphones and watches the effect on his

camera monitor. If the camera is not properly aligned a dynode spot will arc back and forth across the screen instead of blinking in and out. It is then the job of the cameraman to rotate his "align" knob in whichever direction is necessary until this arcing is reduced to blinking. The video engineer continues to turn the orth-focus knob back and forth until he is satisfied that the adjustment is correct. If the cameraman cannot stop the spot from arcing by means of the alignment knob, he must open up the side of the camera and make a screw-driver adjustment on the alignment coil inside. He may have to adjust both the knob and the screw-driver control at once to find the exact combination which will properly align the camera.



Fig. 3-7. Cameraman lining up on test chart.

2. *Aspect-ratio Adjustment.* If he has not done so before, the cameraman now focuses the camera on a test pattern or resolution chart (Fig. 3-7). He will not adjust his view finder until the video engineer is satisfied that the height and width of the picture are correctly adjusted.

The cameraman is asked to reduce both height and width until the camera is greatly "overscanned." Almost the entire end of the circular image-orthicon tube is then visible on the camera monitor. The video engineer will now direct the cameraman to pan and tilt, or dolly in or out, until the image of the test pattern fills the correct scanning area on the end of the tube. This should be as large as possible—most engineers scan very slightly onto the curved edges of the tube, knowing that the resultant corner distortion will be cut off in monitors and receivers.

Now the cameraman is asked to expand picture width and occasionally adjust horizontal centering and linearity, until the video engineer "gets

sides." This means that the edge of the test chart just touches the edge of the camera-control monitor screen. The cameraman then adjusts his own view-finder width and centering controls until his sides are also correct. Owing to the difference in blanking signal at the camera and at the control unit, the cameraman should be able to see a slightly wider area than will be visible on the control-room monitor. This same procedure is then followed in respect to height until the video engineer is satisfied that he "has top and bottom."

3. *Shading.* The video engineer will refer to the oscilloscope trace on the camera-control unit for a check on shading. The "grass" on this



Fig. 3-8. Portable TV camera nicknamed "walkee-lookee" or "creepee-peepee" by the press. Built by RCA from a standard industrial model, the Vidicon camera (using the Vidicon tube) has small electronic view finder, focus control, etc., and uses 16-mm camera lenses. Cameraman carries small transmitter on his back which can relay camera signal as far as a mile to control point if line of sight is maintained.

wave-form monitor must be of a uniform height; the cameraman may be asked to rotate the "shading" control on the camera until this is achieved. The effect on the picture is to lighten or darken one side against the other but is too subtle for the cameraman to make the best adjustment by eye alone.

4. *S Distortion.* The engineer will ask the cameraman to pan back and forth across the test pattern to see whether horizontal lines stay horizontal or whether they tend to twist up or down as the camera moves across. If this effect is seen, the "image-accelerator" knob must be adjusted until S distortion disappears.

5. *High-peaker.* For this test the cameraman will be asked to dolly in for a close-up of the two heavy dark bars located below the circle on the

test chart. The high-peaker control is found inside the camera on the right-hand side. As it is turned back and forth, the bars will be found to streak white when it is too far in one direction and to streak black when it is too far in the other. The control must be adjusted so that neither of these effects is visible.

There are other adjustments which the cameraman may be called upon to make, such as adjusting the G-5 control (inside the camera next to the high-peaker), which will change the sharpness in the corners of the picture. Most of the lining-up process, however, is contained in the directions given above. The cameraman will make whatever contrast and brightness adjustment on his view finder he may wish, but he should not change the height, width, centering, or linearity once the lining up has been done.

4 CAMERA HANDLING

There are four different ways of using the camera in television. The first of these is the standard *objective* camera of dramatic films, the presence of which is completely unnoticed by everyone in the scene with it. Camera consciousness in the viewer is to be avoided. Rough camera handling can have the result of calling attention to the camera and destroying the story illusion.

A second use of the camera is the *subjective* technique. Here the camera takes part in the drama, becoming one of the actors. The audience at home, the camera, and the character in the drama are all one. Actors address this character by speaking directly into the camera lens. Rough camerawork may not result in camera consciousness since movements of the camera are interpreted as movements of the identified character.

A third way to use the TV camera is simply as a receiving instrument, like the radio microphone, into which people can talk and look in order to reach the viewing audience. The camera is used in this manner on most nondramatic programs where no illusion is attempted. The camera is like a window, having no importance in itself except that it allows the people on one side of a wall to see through to the other. There is still an element of the formal presentation across the footlights in most shows produced by this technique. Camera consciousness is not fatal but is definitely to be avoided, and so smooth handling is essential.

The fourth camera technique is similar to the third, except that the camera is very much a part of the scene. No attempt is made to hide one camera from the view of another or to preserve the anonymity of the television crew. The performer, the cameraman, the camera, and the audience are more nearly one. This represents the complete loss of theatrical illusion, of aesthetic distance, of the footlights separating audience from stage. Front stage and back stage are the same.

In this television technique, camera consciousness need not be avoided. Rough camera handling—changing lenses on the air, abrupt panning, or bumpy dollying—is not at all the crime it is otherwise held to be. Small hand-held television cameras will soon extend the possibilities of this technique.

Creative camera work must be originally conceived and planned by the director. On a dramatic show this is usually done while the production is still in the paper stage. The director weighs the various possibilities in each case, visualizes the final shot on a receiver screen, and makes his selection. The choices that he must make fall within several categories and can be listed as follows:

1. Choice of field of view. The director must decide how much of the subject should be included in the frame.
2. Choice of camera angle. The director must decide from what direction the camera will view the subject.
3. Choice of camera movement. This will include rotation of the camera on a vertical or horizontal axis, bodily movement of the camera as in dollying and trucking, and vertical movement (*i.e.*, raising or lowering the camera).

STAGING FOR THE TELEVISION CAMERA

A great deal of what the camera is able to do depends on the staging of the action before it. People with stage experience, for example, have had to learn that in a television studio the stage for action is altogether different from what it is in a theater. Instead of being crosswise to the audience, the television stage is lengthwise. It is a long, cone-shaped area, wide at the back and tapering to a point at the camera lens. If a director conceives of this area as his stage, he will stage action in depth, making his important entrances and exits either near the camera or at the far back. He will also remember that every time he cuts to another camera he is creating a new stage. This then means that camera shots and action are best constructed together.

Staging of static scenes is also important. As soon as the camera holds a static shot, pictorial composition becomes important. The director will often try to group his people so that they make as simple a form as possible. Three people standing separately are only three people, but the same three standing together or one before the other so that they overlap on the television screen will make a single form. This is usually a simpler and better composition. Of all the many shapes a form may take, perhaps the pyramid is the strongest. The apex of this form is a compelling spot in the composition and lends dominance to whatever may be placed there. Here again, an early decision in regard to the use of the camera

will in many cases dictate the grouping and composition of the subject itself.

THE CHOICE OF FIELD OF VIEW

On the first reading of the dramatic script a director will begin to make his decisions about field of view. He will decide whether he wants a single or a two-shot (one or two people), a full-length shot, or head and shoulders. The terms "long shot," "medium shot," and "close-up," commonly used to designate various fields of view, have no exact meaning. A shot is long, close, or medium only in relation to the other shots that are used with it. Many TV directors identify the type of shot they want by describing in one word where the lower edge of the frame cuts the actor. The use of such specific terms as "knee shot," "thigh shot," "waist shot," "shoulder shot," etc., will result in pretty nearly the same framing every time.

The cameraman works for a pleasing composition largely by adjustment of the field of view. This is known as "framing." A better composition is sometimes asked for in the simple command "Frame up." The cameraman pans, tilts, or dollies in or back until the composition is pleasing. The framing is considered "tight" when the subject is crowding the sides of the frame and "loose" when there is considerable space around it. A loose composition is always safer since the camera can be ready for broader action, but the tight composition is usually the more pleasing.

The actual physical size of the subject on the television screen is an important dramatic factor. A close-up emphasizes that subject or that part of the subject which is shown. Greater importance is imparted to the larger objects in the scene. A long shot may have dramatic value also, in the opposite way. Sometimes when a character feels lost, rejected, and very small in relation to the world, a long shot which actually shows him small in relation to his surroundings will enhance the dramatic mood.

CHOICE OF CAMERA ANGLE

A good camera angle can often improve composition by introducing variety of size (the principle of subordination). If the camera is placed so that all the people in the picture are the same size, the shot is usually less interesting than when some people are larger on the screen than others. Proper staging in depth can make this possible, or placing the camera to the side of the set instead of shooting everything head on.

Variation in height is another important factor in good composition. From a lower-than-eye-level camera position near persons are high in the

picture and far persons lower. If the camera is higher than eye level, this relationship is reversed.

As for the dramatic values of camera angles, the proper placement of the camera can often enhance the dramatic relationship of one person to another. This is the principle of dominance. A larger object dominates a smaller one, and a person higher in the picture tends to dominate one who is lower down. Furthermore, if one is looking up at an object (like a statue high on a pedestal), it takes on a greater importance than the viewer. We feel that we are figuratively as well as actually "looking up"

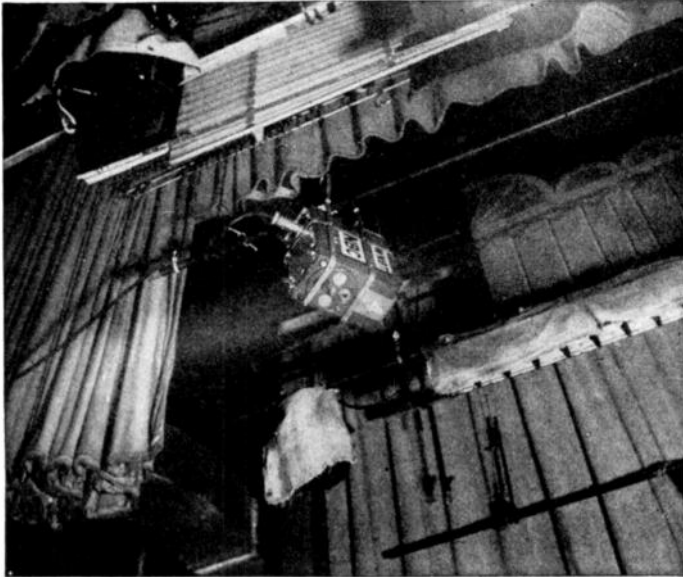


Fig. 4-1. Camera suspended on batten for top shot above stage (35-mm lens in use).

to it. Conversely, if the camera shoots down on someone, he is less important than we are.

Most television cameras are equipped with tripods and tripod dollies which will not allow any change in camera height. Only the larger studios have pedestals and boom dollies which can be raised or lowered. Even there, however, cameras are operated most of the time at eye level. This is a matter of necessity, since no cameraman could be asked to operate for several hours at a stretch in anything but the most comfortable position.

High-angle shots are sometimes obtained by mounting a camera on a lighting catwalk or other vantage point in the studio. This entails taking it off its regular mount and devoting it entirely to that one use. Usually it will mean leaving the camera in its high place during the entire broadcast evening. Such cameras have been left unattended, set up for only one shot.

There are several methods of obtaining a high-angle shot through the use of one or two mirrors. These techniques are explained in detail in Chap. 11 in the section on the use of mirrors.

It is interesting to note that the *effect* of a high- or a low-angle shot can sometimes be achieved although the camera is in reality shooting from a normal angle. On the Du Mont program "Hands of Mystery," a top shot of a man in bed was achieved by standing the bed up vertically and pinning the bed sheets up around the actor, who then stood in bed in front



Fig. 4-2. Camera on stacker at WEWS, Cleveland.

of the camera. Again, on this same imaginative program, a low-angle shot was obtained by building a flat to resemble a ceiling with a cheap electric fixture attached to it and holding this at an angle behind the actor. The actor leaned slightly backward, and the resultant shot looked exactly as if it were taken from a low angle shooting up against the ceiling.

In some studios an industrial machine known as a "stacker" has been experimented with. Station WEWS in Cleveland, for example, keeps one in its studio and uses it occasionally for high-angle shots (Fig. 4-2). It provides an adjustable platform on which the camera and cameramen can

be raised to a high position by manual means. In the case of this particular apparatus the raising or lowering operation is noisy; so it cannot be adjusted during the program, nor can it be moved about while the camera is shooting.

THE CANTED SHOT

When the camera is tilted sideways, vertical lines are no longer vertical and horizontal lines no longer horizontal on the screen (Fig. 4-3). This



Fig. 4-3. Canted shot obtained with a dove prism. (*Off-the-tube photo taken through the courtesy of SRT television studios.*)

movement can be called a “roll,” since it is analogous to the rolling of a boat. The angle shot which results, however, is called a “canted” shot. The composition of such a shot is often quite dramatic owing to the predominance of strong diagonal lines across the screen. A special camera setup must usually be made, however, and, because of the special preparations involved, the canted shot is not often used. None of the regular controls on television cameras will permit this canted effect. Below are listed several ways to achieve the canted shot:

1. A special setup can be made with an unevenly set tripod. This is the method usually employed in films, but it is not very practical for television unless the camera is to serve no other purpose in a production.
2. The tripod head may be set at right angles to its regular position, or if standard tilting cannot be sacrificed, two tripod heads may be mounted one on top of the other, at right angles to each other. Special shopwork is required, however, to fit the tripod heads together, and the camera is raised pretty high.

3. The image-orthicon tube can be twisted with its yoke inside the camera. This again requires special preparation and eliminates the camera for any other use.
4. The image-accelerator control on the camera will tilt the picture slightly to left or right. This is a quick adjustment that the camera-man can make, but it rarely produces as much of an effect as would be desired.
5. A mirror shot has often been resorted to for this effect. The mirror is placed to the side of the subject and slanted a little out of vertical. This is described in greater detail in the section on mirrors in Chap. 11.
6. When the Fearless Panoram dolly is used, still another possibility is open. Beneath the panhead on this dolly are two small leveling screws, one on each side. If these are taken out and wood blocks substituted, the leveling can be greatly changed very quickly by changing the blocks. A large block on one side, for example (Fig. 4-4), and none on the other will cant the camera a considerable amount, which, if combined with the image-accelerator effect, is said to be quite useful.
7. The simplest and most practical method involves a large dove

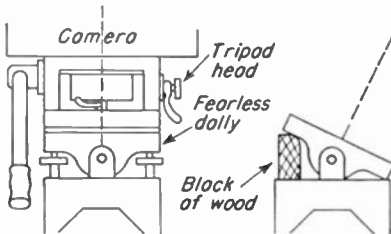


Fig. 4-4. Method of canting the tripod head on the Fearless Panoram dolly.

prism. The prism is placed endwise in front of the lens and is suitably mounted so that it can be rotated. Ninety degrees of rotation will turn the picture upside down. The prism, like the single mirror, will reverse the image from left to right.

CAMERA MOVEMENT—PANNING

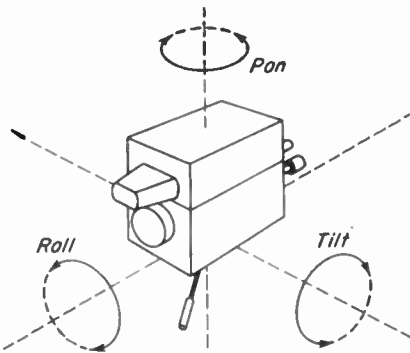


Fig. 4-5. Rotation around three camera axes.

Movement of the camera on its vertical axis (that is, twisting it from one direction to another) is called "panning" (from panorama). Tilting the camera up and down is often combined with the pan shot and is subject to the same considerations (Fig. 4-5). In fact, the "tilt shot" is frequently called a pan in television; the director calls for a "pan up" or "pan down," just as he does for a pan left or right. The following dis-

cussion of panning should be understood, therefore, to include tilting as well.

Panning is the most common camera movement or adjustment, and it is one of the first things that the cameraman must learn to do. He must learn smoothness, control, and how to make his movements definite and deliberate. The best-executed pan shot, however, does not always work. One or more static shots are better in many cases. There are certain qualities that camera movement must have; lacking these, it may be more of a detriment than a help.

Every camera movement (as indeed every device of production) must first be motivated. In other words, the audience must *want* the camera to be moved. Second, each camera movement must retain interest and be continuously gratifying throughout its duration. Finally, camera movement must achieve a purpose and have some value to the production as a whole. Let us examine these various requirements in greater detail, though not necessarily in the order in which they have been mentioned.

The Pan Must Be Smooth. Smoothness is partly a matter of manual dexterity and partly of quality of equipment. A pan shot should not be jerky; if it is following action, it should not lag behind the motion of the subject; and it should start and stop smoothly. Sometimes it is possible to start a pan slowly, gather speed, and then slow down smoothly at the end. If the pan must follow an irregular action, the cameraman must smooth out the motion of the camera and not attempt to follow every jump and jerk exactly.

A camera is panning too fast when the picture is hard to watch on the screen. Normally a pan which follows the motion of a subject can be made at whatever speed the movement requires, as long as the camera can stay with the subject.

If the pan is not following action, the speed of panning must necessarily be much less, because everything is in motion across the face of the screen. If the scene is relatively a plain and simple one, such as quiet sea and sky, the camera can slide over it much faster than it can over complicated and detailed backgrounds. The more there is for the eye to examine, the slower the pan must be.

If, for some reason, the camera must pan fast across a stationary scene, then it should pan *very* fast, so that the eye is not tempted to identify objects in the blur but just lets the whiz go by. This type of shot is sometimes called a *whiz*, or *swish pan*. It has a definite dramatic effect but cannot be used indiscriminately without the danger of calling attention to the camera.

The Pan Must Be Continuously Interesting. The pan shot, like anything else in showmanship, must be continuously interesting to the audi-

ence. It must have a beginning, a middle, and an end. The motivation for the pan gives it a beginning; the ultimate purpose is usually recognizable at its conclusion and gives it an end; but a frequent error in camera-work is to forget about the middle.

It is a mistake, for instance, to pan across large open areas lacking in visual interest. Often the camera must pan between two people, and there is nothing of importance to show in the process of panning (as in the case of two people conversing on a sofa).

Figure 4-6 shows a common problem in camera coverage. By the first method, with the camera perpendicular to the sofa, a relatively long and

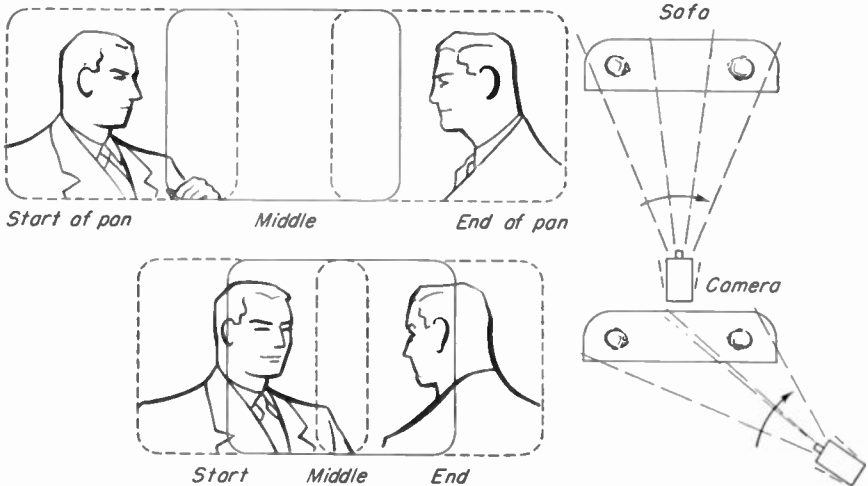


Fig. 4-6. The pan shot with the uninteresting middle. Choice of a side angle reduces the length of the pan. The new subject can start to enter the frame as soon as the camera starts to pan.

uninteresting middle is necessary to link the beginning and end of the pan shot. Unless the two subjects can be moved closer together (and this is sometimes not possible), the camera must find another angle from which a shorter pan can be made. By the second method, the uninteresting middle is eliminated from the pan entirely. The second person enters the frame of the picture before the first has disappeared from sight.

The Pan Must Be Motivated. The audience must *want* the camera to pan. If the camera pans without motivation, the viewer will be, so to speak, dragged away from something he was looking at. He will resent this, if only subconsciously; and his conscious mind may even be called to the camera and away from the subject of the shot. Camera consciousness is always to be avoided when a story illusion is being conveyed, since the illusion is broken when attention is called to the mechanics of production.

EQUIPMENT AND TECHNIQUES FOR PANNING

The action of panning is not performed by the camera, of course, but by the tripod head on which the camera rests. Standard motion-picture equipment is used for this purpose, since the demands of television panning are not very different from those of film.

The standard type of tripod head is the "friction head" (Fig. 4-7). The friction head, as the name implies, provides friction surfaces which slide across each other as the camera pans. Controls on the tripod head

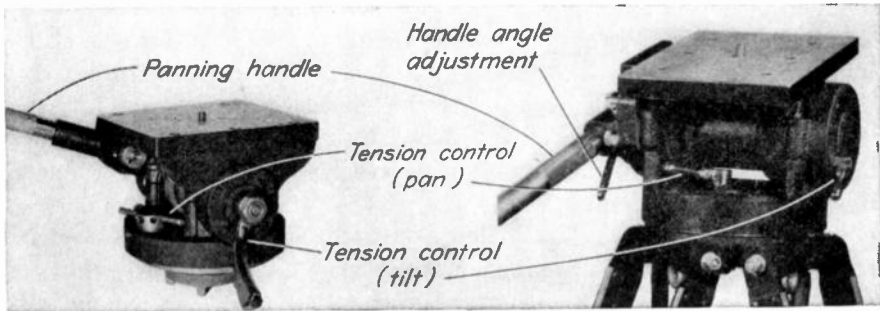


Fig. 4-7. Two of the best tripod heads, Fearless (left) and Camera Equipment Co. (right).

regulate the pressure with which these surfaces press against each other and thus provide varying resistance to movement.

Other types of tripod heads used in motion-picture work have been found unsuitable for television. One of these is the old "gear head," in which the actions of panning and tilting were performed by small hand cranks. Operation of such a mechanism calls for exact rehearsal of every move and a few extra hands to operate the cranks. Another type, the "cradle head," was designed to prevent heavy cameras from overbalancing as they are tilted forward. But this also must be operated with cranks.

The "gyro head" employs a series of gears and flywheels which whirl into motion as the camera is panned, thus smoothing the movement of the camera. This has also been found unsuitable. The gyro can be set for several panning speeds but must be reset if the speed of panning is to change.

Since television cameras are considerably heavier and bulkier than all but the largest studio film equipment, they have a higher center of gravity. As long as this center of gravity is over the base of support, the camera will not be out of balance, but as soon as it is tilted forward so that the center of gravity is beyond the base, the camera acts like a lever, with its weight pushing the head into a steeper and steeper tilt.

To counteract this, heavy springs are coiled around the tilting axis,

so that the farther over the camera tilts, the stronger is the spring tension opposing that movement. A camera mount which allows the camera to be slid back on the tripod head will also help to rebalance the camera.

CAMERA MOVEMENT—DOLLYING

Bodily movement of the camera is similar to panning in its basic requirements. Here again we may say that camera movement must be smooth, continuously interesting, motivated (in the beginning), and purposeful (in the end).

Smoothness is a result of the skill of cameraman and dollyman but is also dependent on the equipment the cameraman is given, the size of his dolly wheels, and the smoothness of the floor. In motion-picture work, absolute smoothness has usually been achieved by laying metal tracks ahead of the dolly. Where this has been attempted in television, more has been lost than gained, because of the resultant inflexibility of camera movement and positioning.

Smoothness of dollying is also dependent on the focal length of the lens in the camera. A long lens magnifies the scene and also the irregularities of camera movement. The shorter the lens (the wider the lens angle), the smoother the dolly movement appears to be. The 50-mm (wide-angle lens) provides the smoothest dolly, but the 90-mm (normal lens) is more commonly used for all purposes and hence for dolly shots as well. The extremely wide-angle 35-mm lens exaggerates the speed of forward or backward motion of the camera and must be used with caution except for special effects. The 135-mm lens is too long for smooth dollying on anything but the smoothest equipment and studio floor. Anything over this length is impossible to handle smoothly on a moving camera.

The zoom lens has been used in some studios to replace dollying (see pages 64 to 68 for an explanation of the variable-focal-length lens). Perfect smoothness is obtained with a zoom lens since the camera does not actually have to move at all.

Motivations for Dollying. Only fast dolly movement has to be motivated. A slow dolly, if smoothly executed, often goes unnoticed, even without special motivation. Thus the slow dolly can be arbitrarily used for a variety of purposes. Some of the best television cameramen keep their studio pedestals almost constantly in motion, achieving a great fluidity and flexibility by this means. Fast dolly movement can be motivated by intense dramatic action or by motion of the subject which the camera is following. Unmotivated fast dollying causes camera consciousness.

A dolly movement which follows action is usually well motivated. A person moves from the back of the set up to a position at the front, and

the camera dollies back in front of him, keeping him always the same size in the frame. This kind of camera work is sometimes called a "follow shot" or a "travel shot." In motion pictures it is usually termed a "trucking shot" because of the method of putting a camera in a truck and trucking up the road in front of the galloping cowboy, keeping always the same distance from the action.

The term trucking shot is used in television more often to mean any kind of camera movement which is not toward or away from the action. Thus the television cameraman is asked to dolly in or pull back but to truck left or truck diagonally in to the right.

The Dramatic Effect of Fast Movement. Man's sixth sense is the kinaesthetic, the sensation of bodily movement perceived through all the nerves of the body and of course accompanied by a strong visual sensation of movement.

Whereas we cannot transport the viewer through space, we can give him the visual sensations of movement by moving the camera, and the faster this movement, the stronger the kinesthetic effect. A fast dolly or a fast zoom with the Zoomar lens will carry the spectator in breathless flight through space and add a strong dramatic emphasis to the action. This has frequently been used in dramatic shows at moments such as a dramatic entrance, a sudden accusation of murder, or a sudden realization of the "awful truth." At all these moments a big close-up of the actor is called for, and a sudden dramatic swoop of the camera can intensify the dramatic effect.

VERTICAL CAMERA MOVEMENT

The ability of the cameraman to move his camera vertically depends on the equipment he is given. Some camera mounts (the counter-weighted crane dollies) can raise and lower the camera so easily that there is a great tendency to overdo the effect and raise or lower the camera without sufficient motivation. Many television studios, on the other hand, are provided with no equipment whatever for vertical camera movement.

Dramatic purpose can sometimes be served by a camera which is in slow vertical movement, changing its camera angle during a scene. For example, imagine a scene in which two people carry on a conversation during which the relation of one to the other is slowly reversed. One person dominates the scene at the beginning, let us say, while at the conclusion the other person is in control. If the dominant person is placed in the background of the shot and the camera is placed somewhat above eye level, he will be higher in the picture than the one in the foreground. This will give him a dominant position in the composition. When, dur-

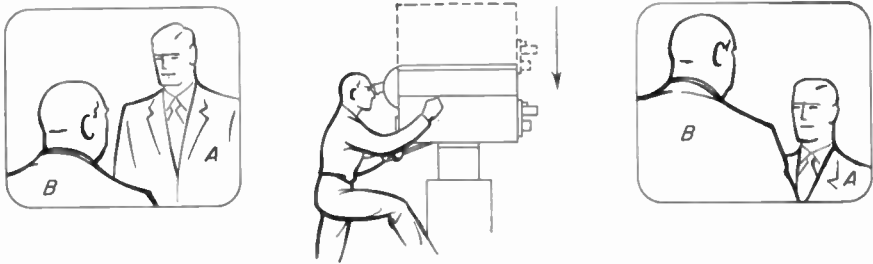


Fig. 4-8. At beginning of scene A is dominant, at end B has become the stronger. Camera contributes to this dramatic change by a slow vertical movement to a lower camera angle.

ing the conversation, the foreground person comes to dominate the scene, the camera slowly lowers its height until it is lower than eye level and the foreground figure becomes the higher of the two and the dominant element in the composition (Fig. 4-8).

CAMERA MOUNTS AND EQUIPMENT FOR MOVEMENT

Camera mounts are of several types. The simplest is the tripod on a three-castered base and the most complex the counterweighted crane. The flexibility and quality of camera movement, as well as freedom in repositioning the cameras between shots, are dependent in large measure on the equipment which the cameraman is given.

Camera movement and camera repositioning are two different things and must not be confused. Camera movement refers to the movement of the camera while it is on the air. Repositioning, however, is done while the camera is off the air, in setting up for its next shot. Some of the dolly equipment mentioned in the following section is well adapted to one of these functions and not the other.

Examples of the principal types of camera mounts are described in detail, and from this discussion the reader should be able to evaluate the equipment available to him and determine the best methods of operating it.

The requirements of good dolly design for repositioning between shots are as follows: (1) Maneuverability. The dolly should be able to move in any desired direction without a lot of backing and steering. (2) Speed. The dolly should be able to reach the next camera position in the shortest possible time. Of course noiseless operation is required, but smoothness is not a consideration. Thus wheels of the castered type are well suited for repositioning.

On-the-air dollying must be smooth, and it must be controlled. Caster wheels have a habit of going in the direction offering the least resistance and will often make the direction of movement hard to control. Locked wheels, on the other hand, are certain to go in a straight line. The larger the wheel, the smoother it will roll in most cases.

TRIPOD DOLLIES

Turning now to camera mounts which will permit both quick repositioning of the camera between shots and camera movement on the air, the first to be considered is the tripod dolly. This is simply a three-wheeled base on which a tripod can be mounted. Many stations have built these themselves at little cost out of a triangular piece of plywood and three large casters (Fig. 4-9). If the casters swivel easily and roll smoothly, this dolly can be used for simple on-the-air moves, at least in straight-line movement, although before a shot a little advance preparation is needed to get the wheels lined up in the right direction. A

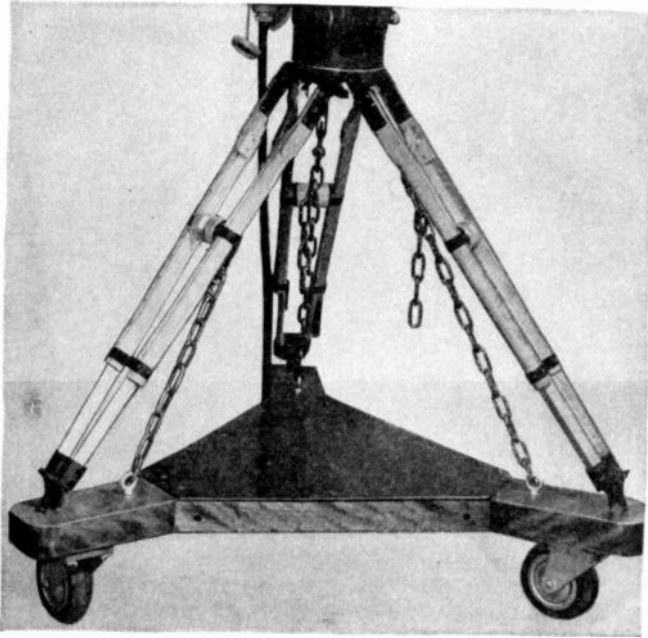


Fig. 4-9. Station-built tripod dolly with caster wheels.

particularly skillful cameraman can control direction to some extent during a movement on one of these better tripod dollies and simulate what can usually be done only with a two-man-operated boom dolly. This is definitely the exception, however, the tripod dolly being primarily a device to provide mobility for the camera between shots while it is off the air.

The RCA tripod dolly (Fig. 4-10) is highly flexible and will permit movement in almost any direction at any time. It is collapsible and may be used on remote work if desired. Large caster wheels ensure smooth movement. The setscrews on each caster work very well as

cable guards since they are always ahead of the caster, no matter in what direction the dolly is moving. They must be dropped to within $\frac{1}{4}$ inch of the floor to function in this manner, but they obviate the need of skirts which must be built around the wheels of most dollies to save the cameraman from worrying about camera cables on the floor. The Television Associates dolly is only 36 inches wide and can pass through most doors. When all three wheels are set for forward motion, they can be locked by a foot lever in the center so that straight-line dollying can be done.

Some television stations have acquired tripod dollies which have only one steerable wheel. This is a very great disadvantage in television

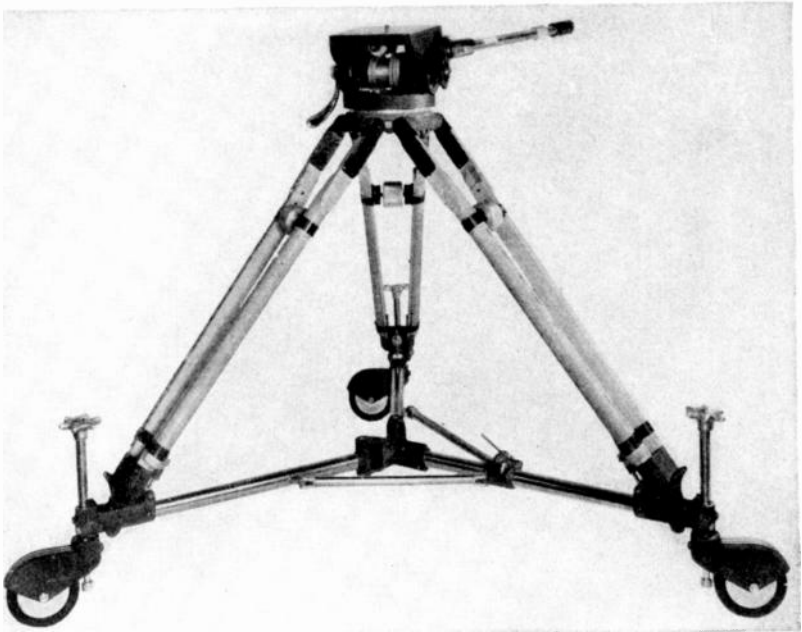


Fig. 4-10. RCA tripod dolly.

studios. No matter what kind of wheeled camera mounts are used, all wheels should be steerable so that backing and turning will not be necessary.

STUDIO PEDESTALS

Many people consider that the nearest thing to a final answer to the maneuverability problems in the television studio is to be found in the studio pedestal type of camera dolly (Fig. 4-11). With this equipment one man can often achieve the same quality of camera movement that two men usually produce with more complicated dollies.

The three wheels on the RCA pedestal are joined with a continuous chain so that they are locked together and must all point the same way. Steering is controlled by a handle which circles the pedestal at about waist height. Motion in any direction is possible as soon as the wheels are correctly aligned. On-the-air movement was not intended by the manufacturers, yet cameramen constantly achieve excellent dolly shots with the studio pedestal.

Steering during on-the-air movements is possible only if the cameraman can release his hold on the focus control to steer the pedestal. Sometimes an assistant can help the cameraman by steering the pedestal for him. However, two-man operation of the pedestal usually is considered only an emergency measure in the event that another camera has failed.

Many cameramen prefer the studio pedestal to one of the larger boom dollies. For one thing it can be started into motion faster. The weight of the larger dollies prevents quick reactions of this sort. Another advantage is the small size of this unit, making it possible to move the camera through tight places, get it behind sets to shoot through doors or windows, and squeeze it between mike boom and other studio equipment for greater maneuverability and choice of camera position. A third factor, which has led some cameramen to request this unit when they could have had a Fearless Panoram dolly

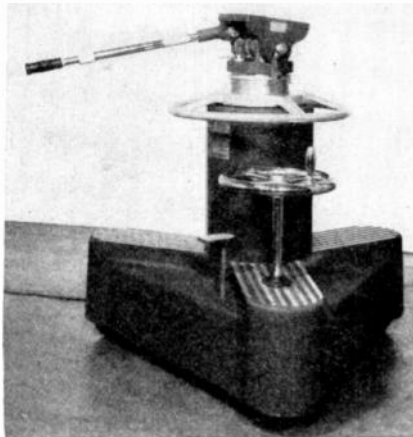
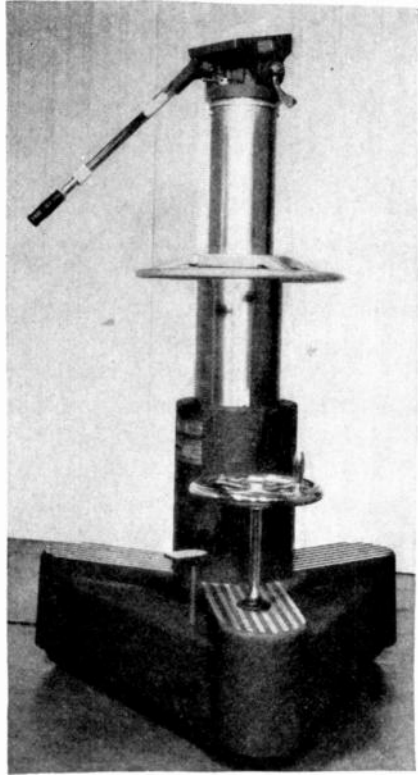


Fig. 4-11. Fearless studio pedestal. Maximum lens height 6 feet above floor. Minimum 3 feet 10 inches.

and dolly pusher for a dramatic show, is that all motions of the camera are under the cameraman's complete control.

When the camera is at minimum pedestal height (lens height 3 feet 10 inches), the handle for steering and movement control is too low to reach properly and moving the pedestal is very difficult. On-the-air moves are much easier at standard height (which is, of course, the height at which the view finder is just at the cameraman's eye level). The pedestal will raise the camera until the lens is at a height of 6 feet from the floor.

The control of height in the studio pedestal is manual; a hand crank projects up from the base of the pedestal for the purpose. This adjustment can be made while the camera is on the air if an assistant can handle the crank. Some of the cameramen who have had considerable experience with this equipment have found that they can operate the hand crank with the foot (Fig. 4-12).

A studio pedestal which is counterweighted and can be raised and lowered by the cameraman without any additional controls is manufactured by Houston-Fearless (Fig. 4-13). The device was designed by Sid Sanner, who also designed a counterweighted boom dolly described on page 54. This pedestal is an excellent solution to the problem, pro-



Fig. 4-12. Pat McBride adjusts pedestal height while his camera is on the air. (Courtesy of Popular Science.)

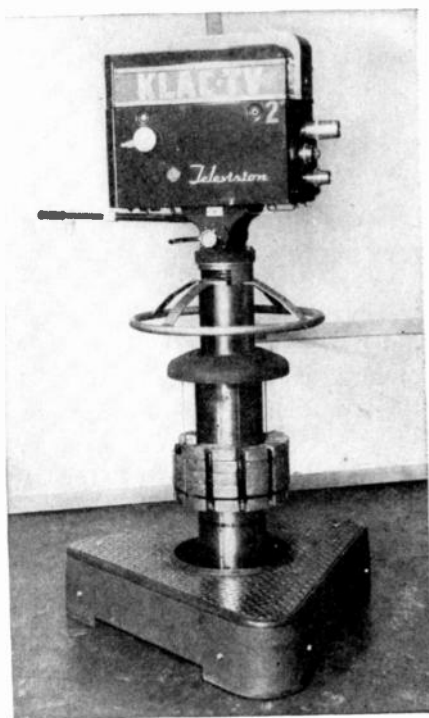


Fig. 4-13. Sanner counterweighted pedestal (with housing removed to show weights).

viding the cameraman with a one-man camera dolly capable of smooth movement in any direction including the vertical.

Another solution to the camera pedestal problem has been worked out by Du Mont on a slightly different basis. For many years the Du Mont key station WABD used a type of four-wheel "tea-wagon" dolly which proved quite flexible for both off-the-air repositioning and on-the-air camera movement. The original models were steerable only by virtue of two caster wheels placed at the front. It was possible to point the dolly quickly in any desired direction simply by rotating it on its fixed back wheels. Two steering handles projected out on either side of the cameraman, and a strap was put across between them, both in front of and behind the cameraman. Forward or backward movement could be achieved by bodily pressure on the straps.

A version of these original tea-carts is offered by Du Mont with a number of added features (Fig. 4-14). For one thing, the camera pedestal is counterweighted. As in the Houston-Fearless-manufactured Samner pedestal the cameraman lifts the camera as he would a window sash. All four wheels of this dolly can be synchronized. The cameraman has his left hand on the steering handle. If, however, the cameraman should prefer to have the front wheels caster, he can disconnect them from the synchronous steering by means of a foot pedal, but this change can only be made while the camera is off the air. The two handles at the back are most inconvenient since they prevent the cameraman from moving around to the side of the pedestal if he pans the camera 90 degrees to the side. Du Mont has subsequently put out a three-wheel pedestal similar to the counterweighted Houston-Fearless with the added feature of a pneumatic counterbalancing device.



Fig. 4-14. Du Mont pedestal dolly.

CRANE OR BOOM DOLLIES

A boom dolly requires two- and sometimes three-man operation and is thus too expensive to operate for the great majority of small stations.

Most models are almost a direct transplantation of motion-picture equipment, to which a few new wrinkles have been added to adapt them to the different requirements of television use.

The Fearless Panoram Dolly. Nearly every station which attempts dramatic shows is equipped with a Panoram dolly (Fig. 4-15). This boom dolly permits many kinds of camera movement and a large choice of camera angles, both of which are of great importance in creative camera work. The cameraman may ride the boom on this dolly, he may stand on the platform below, or he may pull the boom over to the side and stand on the studio floor. A good cameraman or cameraman-dollyman team, working with this equipment for a year or so, will develop such



Fig. 4-15. Fearless Panoram dolly.

skill and precision they may be operating far beyond the methods for which the instrument was designed or the ways in which it was ever used in the motion-picture field.

Since the dolly pusher on this team has no view finder, he is in a sense working blind, largely on orders from others, either the director or the cameraman himself. The cameramen at WPIX rigged up a small push-button and light system, so that red and green lights controlled by the cameraman on his pan handle would cue the dollyman for forward and backward movements. Thus the cameraman was able to signal without having to take his hands off the camera controls. As he becomes more experienced, the dollyman will develop the ability to keep a constant visualization of the shot the camera is taking, assisted by an occasional glance at the floor monitor or into the camera view finder over the cameraman's shoulder.

This dolly comes equipped with two seats. One of these is on an extended arm and is intended for the assistant camera operator during motion-picture shooting. This is immediately discarded by every television studio. The other, attached to a small arm part way up the boom, is usually retained. Howard Hayes, top cameraman at WCBS-TV, used the seat for two years and subsequently abandoned it entirely. He felt he had doubled the flexibility of the instrument by removing this limitation.

It is undoubtedly true that a cameraman who is fastened to a seat is limited to the angles he can shoot from that single position. He is limited in how far to the side he can pan without losing good control or a

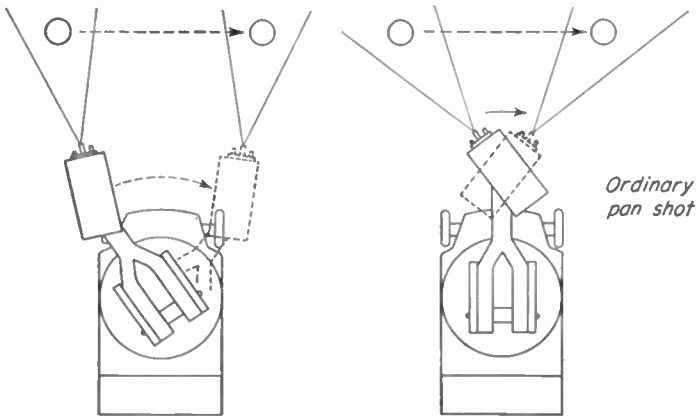


Fig. 4-16. Tonguing to follow action vs. panning the camera.

good view into the view finder. He is limited to one height and to only a narrow lateral range of camera angles. One Western station went so far as to put stirrups on the boom to further increase the comfort of the cameraman but admitted they were rather useless when it came to real operation.

The boom, or "tongue," of this dolly is mounted on a turntable in its base. When the seat is used as an operating position, rotation of the turntable is sometimes used as a means of panning. The cameraman holds his camera more or less stationary and swings the boom across the set by cranking the small turntable control wheel. This is often called "tonguing" left or right. It is useful in following action, since it provides at once a panning shot, which keeps the actors in frame, and a transverse camera move, which keeps the relation of camera and actor more nearly the same (Fig. 4-16).

A cameraman will often prefer to achieve a dolly-in effect by moving the boom rather than by rolling the wheels of the dolly. Many cameramen prefer to work with the boom out crosswise from the dolly, their feet on

the floor, dollying by walking forward or backward with the camera. The movement is in an arc rather than a straight line, but this makes very little difference. The important thing is that all movements of the camera are under one man's control. If he pushes forward, he can correct focus at the same time; his hands need not leave the controls even for brief signals to the dollyman. A completely coordinated move is the result.

If the dolly is placed almost crosswise to the set (at a slight angle as indicated in Figure 4-17), the camera can be quickly placed at any point within the working space indicated. Only two moves are necessary, one

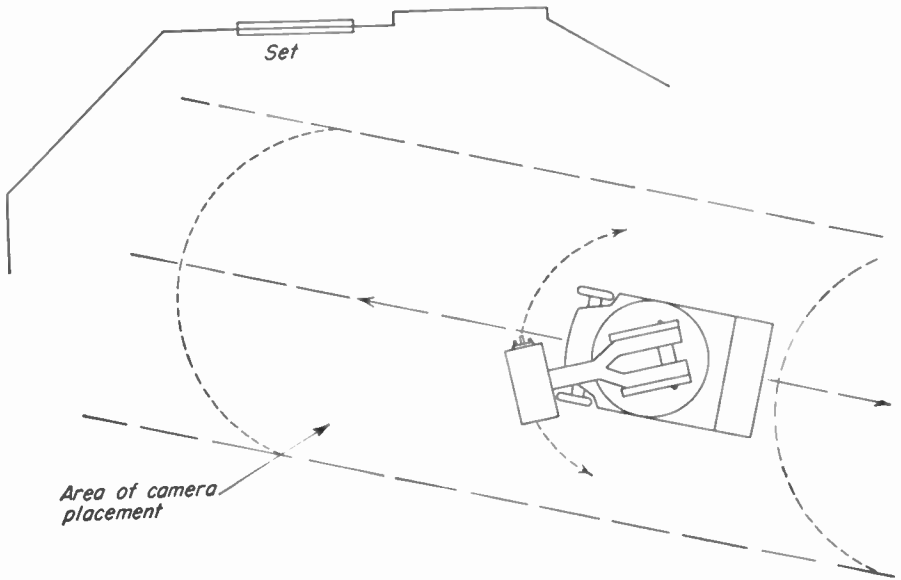


Fig. 4-17. A more flexible method of using the Panoram dolly. Camera has great freedom of positioning, and cameraman has freedom of forward and back movement.

by the cameraman (pushing the camera in or out) and one by the dollyman (pushing the dolly forward or backward along the set).

Even without movement of the dolly the cameraman can place his camera in a great variety of positions by utilizing the full possibilities of the camera boom. Speaking three-dimensionally, he can put the camera anywhere on the periphery of a hemisphere which is about 6 feet across and rises to maximum boom height, about 7 feet, in the center (Fig. 4-18). In combination with the choice of lenses instantly available, this provides a great variety of shots without moving the wheels of the dolly at all. One of the Panoram dollies at CBS-TV was made more flexible for this kind of use by the addition of a 3-foot extension to the boom. The

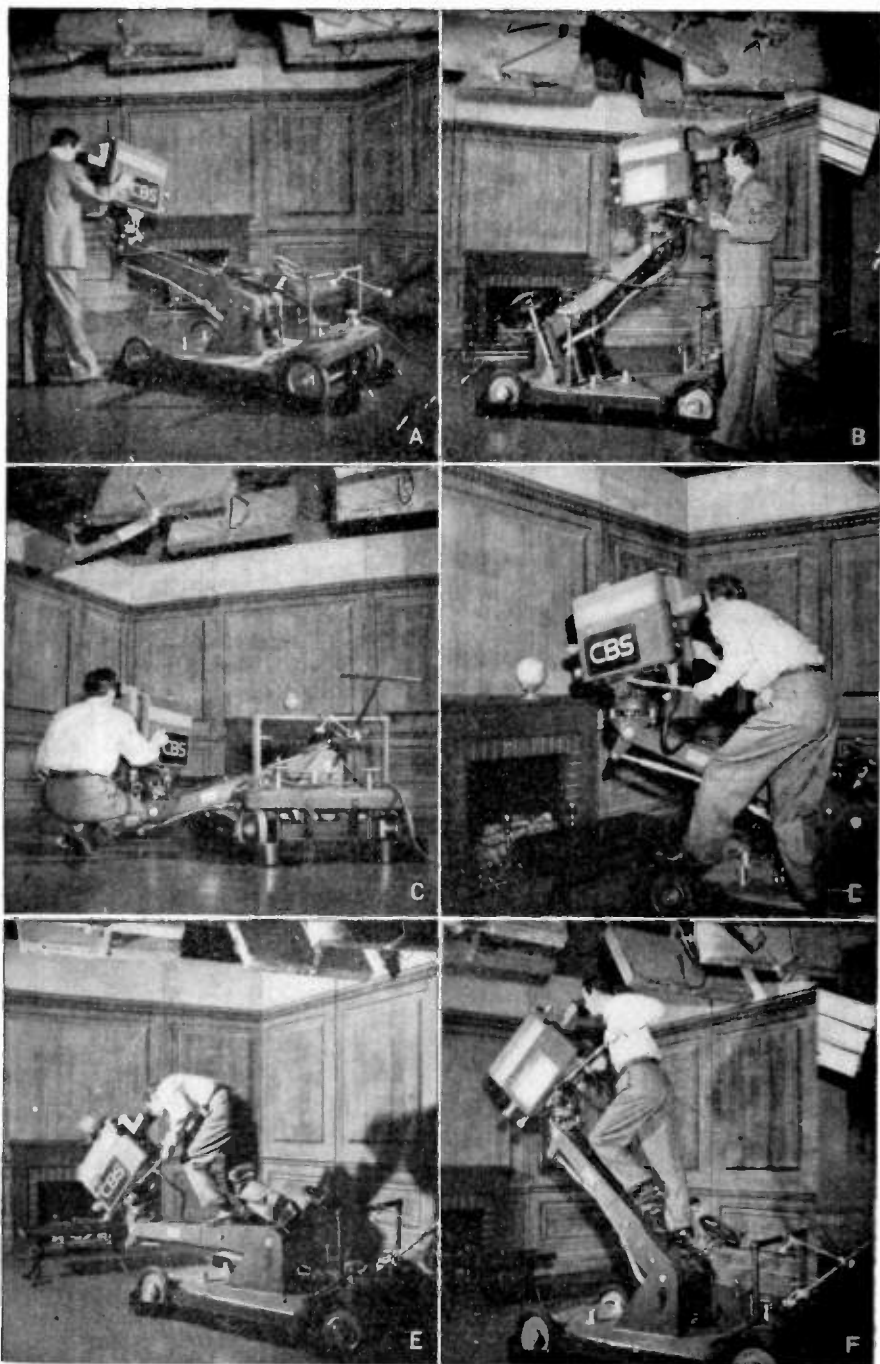


Fig. 4-1B. Howard Hayes, top CBS cameraman, demonstrates the flexibility of the camera when mounted on the Panoram dolly. Hayes never sits astride the boom.

additional weight was counterbalanced by a concrete weight just on the opposite side of the point of support (Fig. 4-19).

Adjustments in camera height are almost always off-the-air moves, although for special reasons it is sometimes desirable to make a vertical move during a shot. This can be done very easily going down; the cameraman can often control the move himself by reaching back with his foot and spinning the vertical control wheel. Under the weight of the camera—and cameraman—the wheel will spin freely until he again brakes it with his foot, giving him accurate control over the speed and length of the vertical move.

An on-the-air vertical move from low to high must be done by the dollyman since the wheel must be cranked continuously to make the boom rise. If the cameraman is riding the boom, the cranking becomes very difficult; so these moves are usually made with the cameraman standing beside the boom. After the camera is up to the highest point at which he can still control it, he will carefully climb onto the boom. His weight is now less of a factor because the boom is more nearly vertical, and he can easily be cranked up to full height if necessary. Minimum lens height is 28 inches from the floor, obtained when the boom projects from the side of the dolly. Maximum lens height is 7 feet.



Fig. 4-19. Fearless dolly adapted by CBS with 3-foot extension on boom counterbalanced by large weight (foreground) and auto steering wheel at back.

The standard Fearless dolly provides for back-wheel steering only, controllable by a handle bar which is lowered to a height most convenient for the dollyman. Pulling the handle to the side will turn the rear wheels. CBS installed an automobile steering wheel on one of its dollies in place of the handle and found it very useful (Fig. 4-19). The dolly could be steered from the side, as well as from behind, and could back up close against sets or the studio wall. Side operation is very important, since from that position the dollyman is able to reach all the boom controls. Very delicate camera movements or adjustments are best made by handling one of the front wheels. Marshall Diskin, who, before he became a director, was one of the best dollymen in the industry, always wore gloves so that he could roll the dolly or at least start it into motion with the wheel.

Formerly the front wheels on the Panoram dolly were individually mounted on swivels so that they could be unlocked from the forward direction and one by one locked into a transverse position. The move took too long for television, however, and so was never used, the cameramen preferring to pull the dolly back and go in again on a different line to find a new position. The later models of this dolly have an additional control to turn both front wheels at once, located toward the back of the machine, where the dolly pusher can reach it easily. At the same time that the front wheels turn, a caster is lowered at the rear of the dolly, lifting the back wheels. The dolly can then be immediately pushed sideways without any further steering. Men at some stations use this freely and find it a valuable addition, since it makes sideways movement a practical thing, but other cameramen use it very rarely. It is far from noiseless in operation and must be very carefully handled.

COUNTERWEIGHTED CRANE DOLLIES

Recently, several studios have invested in a larger and more elaborate type of dolly with a counterweighted crane. In the Fearless dolly which has just been described, the weight of cameraman and camera at the end of the boom are balanced by strong coil springs underneath the boom (Fig. 4-20). In the case of the counterweighted crane, this weight is balanced by another weight at the other side of the point of suspension of the

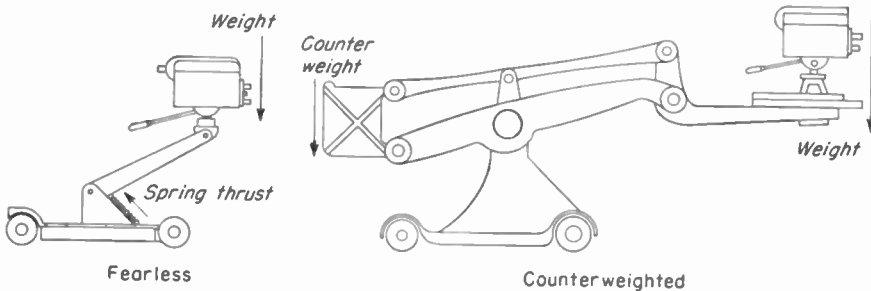


Fig. 4-20.

boom. This weight is adjustable and can be increased or decreased to balance exactly the weight of any particular cameraman. Raising or lowering of the boom can be accomplished with very little effort, and no cranking is necessary. The camera platform, the boom, and the counterweight are all provided with handles so that the boom man can operate from almost any position.

The Houston-Fearless Counterweighted Crane. The Houston crane (Fig. 4-21) is standard motion-picture equipment which has been adapted for television by the addition of cable guards around the dolly base.

The Houston crane is a three-man operation since the dollyman operates from so far behind the machine that he cannot reach the boom. It is referred to as "the monster" in every TV studio where it is used. Steering is controlled by a handle similar to that of the Panoram dolly, and the dolly is motor-driven, under the dollyman's control. The central pedestal of the dolly can be hydraulically raised or lowered 15 inches by a handle at the side of the base. Sometimes it has been found necessary to make more delicate dolly movements than the motor can handle (as when the camera is on a close-up and a slight movement makes a large difference in the picture). It has been found that it is possible to push

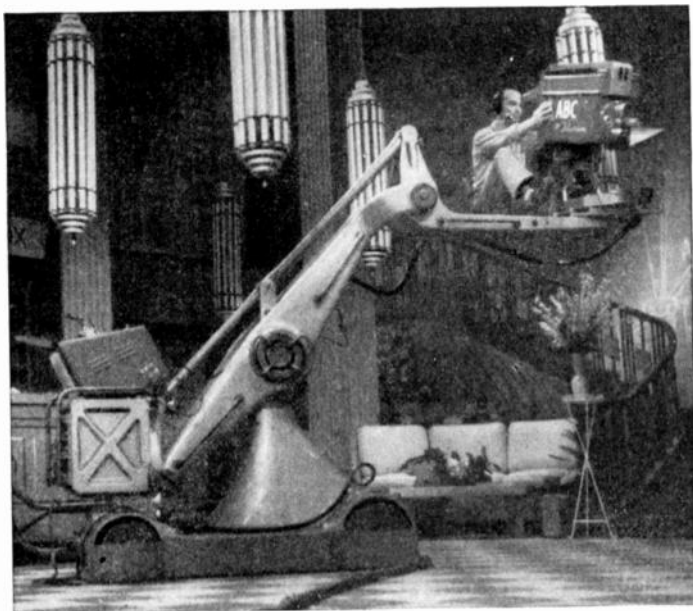


Fig. 4-21. Houston crane in use at ABC-TV, New York.

the machine manually if it is put in gear but power is not applied. This gives a slow and regulated movement which is not possible with the use of the motor.

In recognition of the very real need of the dollyman for a view finder, both CBS and ABC have installed monitors on the back of the counter-weight boom. (The monitor is fed from the camera view finder through a stabilizing amplifier.) With a view finder for the dollyman, and the boom man too, if he works from behind the dolly, it has been found possible on complicated shows to achieve a smooth flow of movement, in time with the music, and coordinated with the actors or dancers in a way which would never be possible if the dollyman had to wait for directions from the cameraman or the control room. On the Paul Whiteman revue, a particularly intricate dance and musical production, the camera on the

Houston crane has sometimes carried the entire show alone for as long as four minutes at a time, moving in and out, up and down.

The camera platform ("turret head") on the Houston crane rotates around a point of support directly under the camera and carries the cameraman's seat around with it so that he is always directly behind the camera. Foot-pedal control operates this, pressure on the right pedal panning the camera left, and pressure on the left pedal panning it to the right (Fig. 4-22). The panning head on the camera is usually left free also, for smaller adjustments, while the cameraman executes the larger

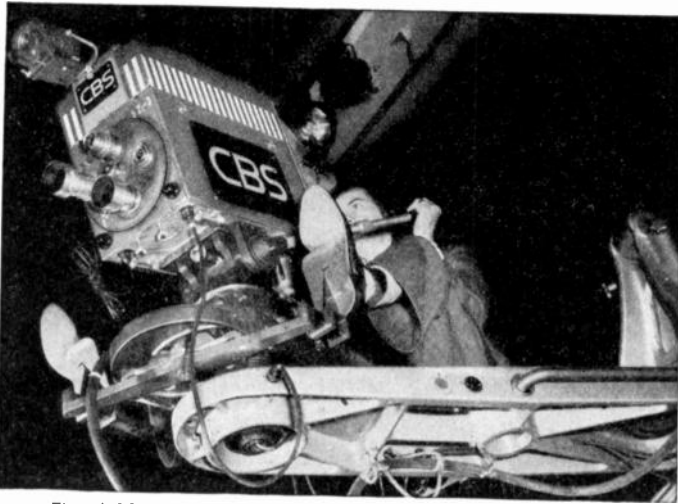


Fig. 4-22. Cameraman on turret table of Houston crane.

movements of panning with his feet. The turret table can be rotated through 180 degrees, and it can be set for any degree of friction by a control within the cameraman's reach.

The boom is capable of carrying the camera lens to a height of 10 feet from the floor and lowering it (when the central pedestal is down) to a height of only 2 feet above the floor. It will rotate around a 360-degree

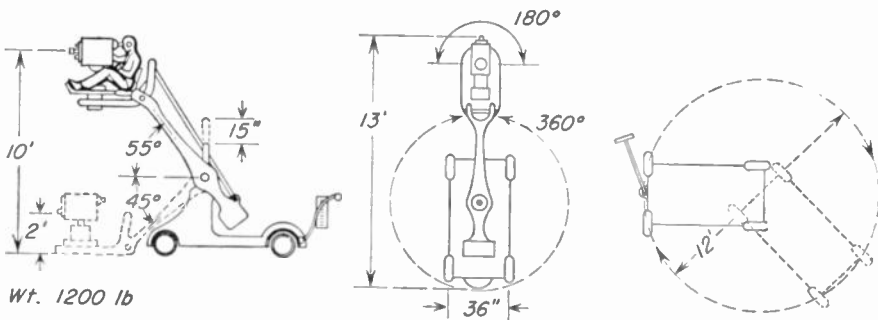


Fig. 4-23. Dimensions and range of movement of Houston crane.

arc, and both panning and tilting of the boom can be set for any desired amount of friction. The entire crane weighs about 1,200 pounds and will pass through a doorway 3 feet wide and 6 feet high. CBS in New York regularly transfers its Houston crane from one studio to another, rolling it through doors, down ramps, and along the street.

The Sanner Dolly. Another type of counterweighted crane dolly was designed and built by Sid Sanner, a cameraman at KTTV in Hollywood



Fig. 4-24. Sanner dolly (Sid Sanner behind camera).

and a design engineer with considerable motion-picture background. Although somewhat smaller than the Houston crane, this dolly is more practical for most television studios and is receiving a wider acceptance in the field. This is largely because it is specially designed for the television studio and is not an adaptation of motion-picture equipment (Fig. 4-24).

The most important aspect of the Sanner dolly is the method of steering. Whereas all other two-man dollies are steered only by the back wheels, the Sanner dolly steers with all four. A steering wheel is used instead of a handle, and next to the wheel is a lever which will shift between two types of steering.

The first type of steering is *synchronous*, *i.e.*, all four wheels change direction at once. This makes it possible to move the dolly in any direc-

tion without changing its orientation. The same flexibility of movement which characterizes the studio pedestal is here incorporated into a crane dolly.

The second type is *differential steering*. The back wheels turn in a direction opposite to the front wheels and follow exactly in their tracks. Thus the dolly is able to rotate in a wide or narrow circle or even to rotate on its own length, turning completely around in a circle with a 9-foot diameter. These two methods of steering are a very great advan-

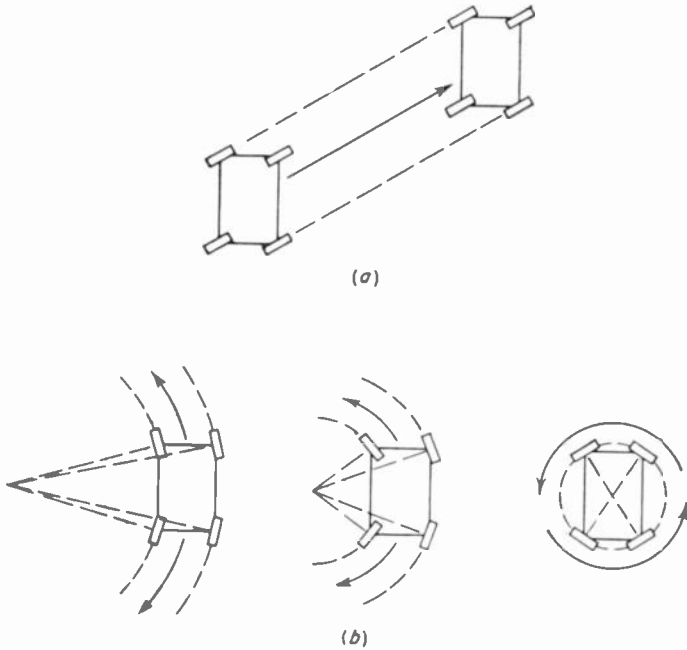


Fig. 4-25. (a) Synchronous steering. (b) Differential steering.

tage in the usual television studio, where maneuverability is so highly important.

In a small studio, where a great amount of dolly movement is not necessary, the original Sanner dolly was operated by only two men. Since the steering controls can be reached from the side of the dolly, the dollyman could easily take his position where he could handle the boom. Two men who have worked together for a month or two could operate this dolly all day without rehearsal. The usual practice at a small station which does not allow rehearsal time is for the director to turn over the show for certain periods to the cameraman-dollyman team. On a piano number, for instance, the director may say to the crew, "Take over; the next three minutes are yours" (Fig. 4-26).

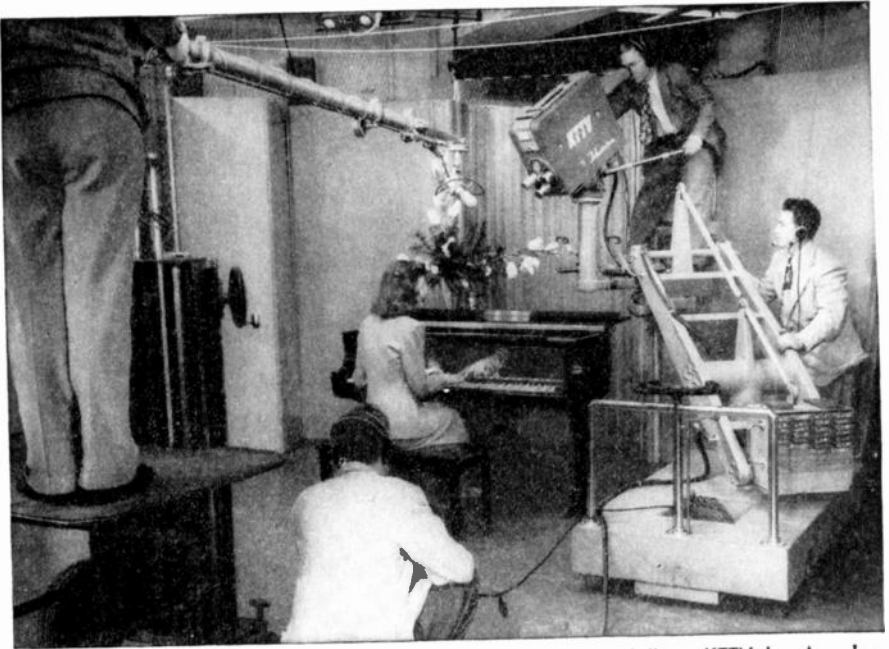


Fig. 4-26. Dolly-cameraman team working the original Sanner dolly at KTTV, Los Angeles.

One serious drawback to the Sanner dolly, however, is its lack of a motor. Its heavy weight makes it very difficult to start into motion rapidly, and fast moves, either for repositioning between shots, or on the air, are a constant requirement in every complex show. Several studios have found it best to assign four men to this dolly: cameraman, boom operator, and two dolly pushers—the strongest and heaviest boys on staff. The excess weight is caused by the fact that the dolly base and other large parts were made of heavy castings. In the original Sanner prototype models all parts were made from plate metal. The change to castings for economy in manufacture added 1,000 pounds to the weight.

The camera platform rotates 180 degrees under control of the cameraman's feet just as in the Houston crane, except that the cameraman may, after reaching the limit of rotation, reach down, release the pedals and reverse them, then engage them again for another 180 degrees of rotation. If the cameraman should want to stand on his feet, as he often has to for high-angle shots, he can stand on running boards which are fastened to the same shafts as the foot pedals and continue to control the camera in the same fashion.

5 TELEVISION LENSES

A complete familiarity with television lenses is essential to both the director and the cameraman; yet among directors there is a wide variation in methods of working with lenses. Some directors don't try to keep track of each lens during rehearsal, simply asking the cameraman for a "wider" or a "tighter" shot and leaving the choice of lens and the responsibility for getting the same lens again on the air show entirely up

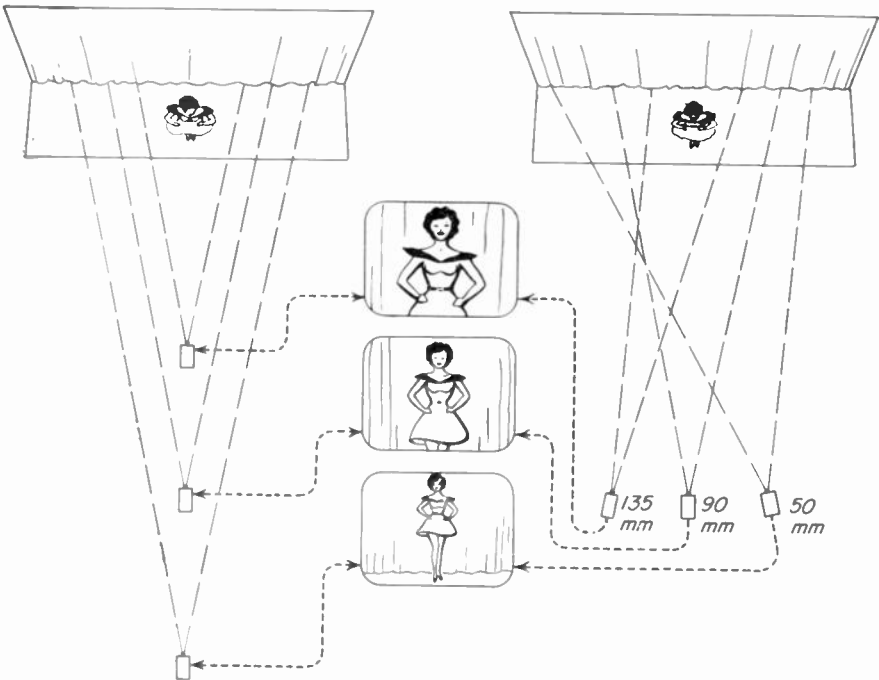


Fig. 5-1. Three standard shots, long shot, medium shot, and close-up taken by (A) a camera (with the 90-mm lens), in three positions; and (B) three lenses on a stationary camera.

to him. Others, and these are usually the better directors, come to rehearsal with a very exact idea of which lens will be used on each shot, ask the cameraman to "change to the 135" or "try the 50," and can often tell by looking at the picture which lens is on the camera.

Almost anyone who has worked at all in television production becomes familiar with the fact that a change of lens means a change in angle of view. A "wide-angle" lens takes in more of the scene than a "long" lens. Of course, when a larger area of the studio is included, everything becomes smaller in size. Conversely, since the narrow-angle lens takes in less of the studio, objects appear relatively larger. Narrow-angle lenses are ordinarily used for close-ups, wide-angle lenses for long shots.

It should be noted here that a shot made with a narrow-angle lens far from the subject and a shot made with a wide-angle lens close to the subject will not be identical. They will be similar only in field of view. There are other differences in the picture, described later.

THE PARTS OF A LENS

Let us look more closely at a lens now and see what we can discover about it. We notice:

1. The lens is built inside a metal cylinder (called the lens barrel).
2. The lens itself is made of several pieces of glass, and the surfaces of the glass are curved.
3. There are two sets of calibrations marked around the barrel or rim on the front of the lens, and the lens can be adjusted to these calibrations by turning portions of the lens barrel. These are:
 - a. The focusing scale. Settings for distance to subject marked off in feet (or meters in the case of European lenses).
 - b. The diaphragm scale. An iris diaphragm is included in standard lenses, which can be closed down to a tiny pin point under brilliant lighting conditions or, when the light level is low, opened up to a circle as wide in diameter as the lens itself. The diaphragm scale is marked in *f* stops (described later). The larger the *f*-stop number, the smaller the diameter of the diaphragm opening. Lenses are often described in terms of their largest *f* stop. A lens capable of opening up to *f*/1.9, for instance, lets in a great deal of light and can take pictures under low-light conditions. It is known as a "fast" lens. A lens which cannot be opened wider than *f*/8, for example, is known as a relatively slow lens.
4. The lens is fastened to the lens turret by means of a screw base. Some of the longer lenses are fixed with a "bayonet" mount, which makes it possible to change lenses quickly and without the danger

of damaging threads. The bayonet mount requires only one twist to secure it. The lens turret on television cameras is made to take threaded lenses; so an adapter for the bayonet-mount lenses is first screwed into the regular lens position.

STANDARD TELEVISION LENSES

To give a broad picture of the variety of lenses available for television, the most common lenses found on television cameras are listed below. Lenses are usually known by their focal length (a term which will be explained later in this section). Focal length bears a close relation to angle of view; long-focal-length lenses take in a narrow angle; short-focal-length lenses, a wide angle. The most common lenses are the 50-mm,



Fig. 5-2. Camera with standard complement of studio lenses. In taking position, top, $8\frac{1}{2}$ -inches; bottom, 50-mm; left, 90-mm; right, 135-mm.

90-mm, and 135-mm, sometimes referred to as the 2-inch, 4-inch, and 6-inch (Fig. 5-2).

These three lenses are used on almost every studio camera. An extremely wide-angle lens, the 35-mm, is used in studios which are very small and on programs which take advantage of the exaggerated effects which this lens is able to achieve. The 8- or $8\frac{1}{2}$ -inch lens is also commonly seen in studios. The use of this long a lens enables the cameraman to get extreme close-ups without having to move his camera in so close that he might enter the field of the other cameras. There is a wide gap between the field of the 50-mm lens and that of the next longest lens, the 90-mm. Some studios have added an intermediate lens, the 75-mm or 3-inch, to bridge this gap. Unless the producer specifically requests these additional lenses for his show, however, the assignment of studio facilities generally includes the use of only the 50-, 90-, and 135-mm.

	<i>Focal Length</i>	<i>Maximum f Stop</i>	<i>Horizontal Angle of View</i>
Standard lenses for studio use:			
Ektar or Ektanon	35 mm	<i>f/3.3</i>	51°
Ektar or Ektanon	50 mm (2-in.)	<i>f/1.9</i>	34°
Ektar or Ektanon	75 mm (3 in.)	<i>f/2.5</i>	22°
	90 mm (4 in.)	<i>f/3.5</i>	19°
Ektar or Ektanon	135 mm (6 in.)	<i>f/3.8</i>	13°
	8½ in.	<i>f/3.9</i>	8°
	13 in.	<i>f/3.5</i>	5°
Long lenses for field use:			
RCA	13 in.	<i>f/5</i>	5°
RCA	15 in.	<i>f/5</i>	1.5°
RCA	17 in.	<i>f/5</i>	4°
RCA	25 in.	<i>f/5</i>	2.75°

The following additional lenses are supplied with Du Mont cameras: 10 in *f/4.5*; 12 in *f/5.6*; 14 in *f/4.5*; 20 in *f/5.6*.

The standard lenses supplied with General Electric cameras are Baltar 3-, 4-, 6-, and 10-inch. The 6-inch is *f/2.7*.

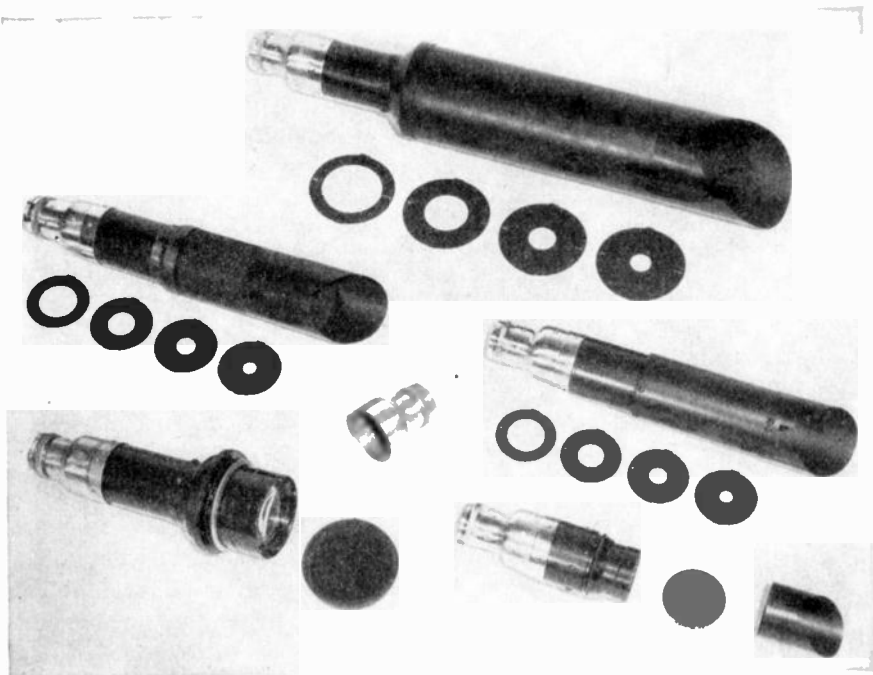


Fig. 5-3. Field-camera lenses supplied by RCA. Lower right, 8½-inch lens with lens cap and sunshade; lower left 13 in *f/3.5*; center right, 15-inch; center left, 17-inch; top, 25-inch. Water-house stops (described on page 78) accompany the three largest lenses in stops of *f/8*, *f/11*, *f/16*, and *f/22*. Center, lens turret adapter for additional lenses.

The General Precision camera is equipped with Dahlmeyer lenses (English make) in the following selection: 39 mm $f/2.0$; $1\frac{3}{4}$ in $f/1.9$; 2 in $f/1.9$; $2\frac{1}{2}$ in $f/1.9$; 3 in $f/1.9$; 4 in $f/1.9$; 4 in $f/3.5$; 5 in $f/1.9$; 6 in $f/1.9$; 6 in $f/2.9$; 6 in $f/3.5$; 8 in $f/2.9$; 9 in $f/5.6$; 12 in $f/4.5$; 12 in $f/5.6$; 17 in $f/5.6$; 20 in $f/5.6$; 24 in $f/6.5$. The reader will note a wide selection of extremely fast ($f/1.9$) lenses listed here

<i>Special Lenses</i>	<i>Focal Length</i>	<i>Maximum f Stop</i>	<i>Horizontal Angle of View</i>
Television Zoomar with tele-front lens	Varifocal 5-22 in.	$f/8$ (or 5.6 if not used at over 12 in. focal length)	13° - 3°
Television Zoomar with wide-angle front lens	Varifocal 3-13 in.	$f/8$ or $f/5.6$ as above	22° - 5°
Television Balowstar	7 in.	$f/1.3$	10°
Television Reflector	40 in.	$f/8$	Less than 2°
Electra-Zoom	Varifocal $2\frac{5}{8}$ -7 in.	$f/2.8$	26° - 10°

The 50-, 90-, 135-mm Ektar series are modifications of standard photographic lenses, originally designed for the Eastman Ektar and other 35-mm minicameras. This use is possible because the size of the photocathode in the image-orthicon tube is very close to the size of the 35-mm double frame (the film used in minicameras).

There is a simple formula for arriving at the lens angle of any given focal length which, although not mathematically accurate, is close enough for any production purposes.

$$1. \text{ Horizontal angle of view} = \frac{1700}{\text{focal length in millimeters}}$$

or

$$2. \text{ Horizontal angle of view} = \frac{68}{\text{focal length in inches}}$$

With the application of this simple formula it is possible to find the horizontal lens angle of any lens of known focal length. The vertical angle of view is always three-quarters of the horizontal angle, since the height of the picture is three-quarters the width.

The actual angle of view that the camera is transmitting is not always exactly that listed above, however. Electronic adjustments within the camera can alter it somewhat. If the video operator happens to adjust his horizontal width to scan a picture slightly under the full photocathode size, then the picture which appears full-screen on the monitor will be less than the entire picture that the lens has produced. The effective angle of view of the lens is thus reduced.

In addition to the standard photographic lenses which are furnished for

television cameras, several special lenses are on the market which deserve individual discussion.

THE BALOWSTAR LENS

The Balowstar lens (Fig. 5-4) is particularly valuable for field pickups where the light levels are below what the ordinary lenses can handle. The Balowstar is rated as a $f/1.3$ lens, which makes it the fastest of all the television lenses, and, in addition, it is a relatively long lens (7-inch). Whereas the 50-mm, which can open up to $f/1.9$, can handle low light levels, it produces such a wide angle of view that it cannot be used on most remote work, where the cameras have to be quite a distance from the action. The Balowstar opened up new program possibilities. At the



Fig. 5-4. The Video Balowstar, an extremely fast long lens.

opening of the Metropolitan Opera in 1950, ABC used several of these lenses to obtain remarkable close shots of the dimly lighted action.

THE REFLECTAR LENS

The Reflectar is a lens of radically different design. Instead of using lens elements to form the image, the Reflectar uses a concave (focusing) mirror. Although only 16 inches in over-all length, the Reflectar produces a picture equivalent to that produced by a 40-inch lens; thus its focal length is almost twice that of the next longest television lens. Figure 5-5 shows the Reflectar mounted on the lens turret of a WFBM-TV camera. It will be noted that the shortest-focal-length lenses can be used on the same turret without danger of the Reflectar showing in their pictures.



Fig. 5-5. Video Reflector lens in use. Camera is one of 11 at WFBM-TV, Indianapolis, which were designed and built by Harold S. Holland, chief engineer (shown operating camera).

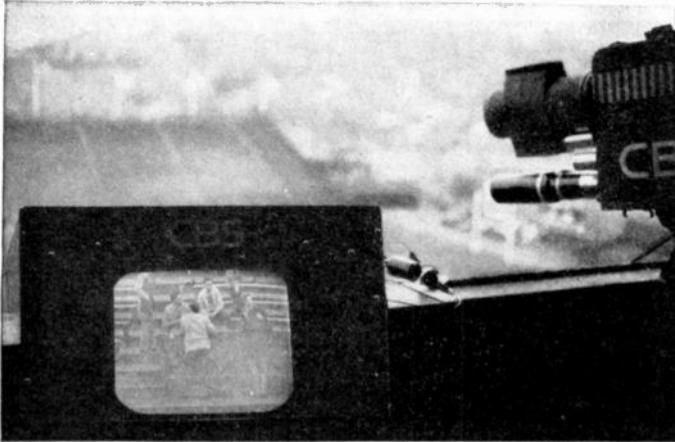


Fig. 5-6. Video Reflector lens (early model) focused on people in the stands across a football field. The camera's picture is visible on the monitor in the foreground.

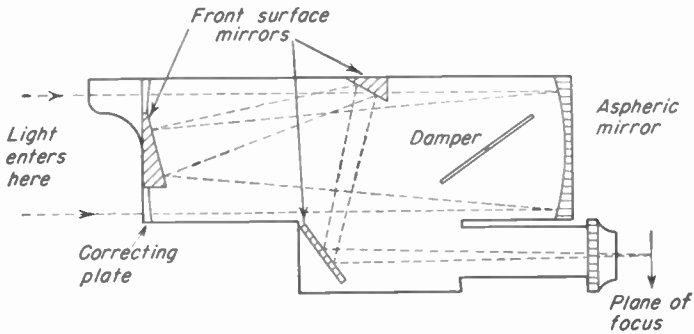


Fig. 5-7. Sketch of interior of Video Reflector lens. Exposure control is accomplished by means of a simple damper. When this is horizontal, the lens is rated at $f. 8.$

THE ZOOMAR LENS

This unusual lens is probably the most important accessory to be added to standard TV equipment. It is a varifocal lens: the focal length can be changed within certain limits while the camera is in operation. As focal length changes, of course, so does angle of view; and the picture which this lens is taking can be smoothly changed, either rapidly or very slowly, from a long shot to a close-up or back again.

(Other varifocal lenses have been available, (such as the Taylor-Hobson zoom lens), but they are very complicated in design, with complex gear movements and no assurance of keeping a sharp focus throughout the zooming movement. The Zoomar lens effects the change in focal length



Fig. 5-8. Television Zoomar lens. Control handle is visible at rear of camera.

by simply sliding one movable barrel (carrying 3 lens groups) within the main lens barrel (which holds stationary the rest of the 28 lens elements).

Since each lens element is a separate piece of glass, this means 56 surfaces; and when it is considered that each one reflects and loses up to 10 per cent of the light that falls on it, one wonders how any light reaches the plate at all. By coating the lenses with magnesium fluoride, however, this reflection can be cut down to $1\frac{1}{2}$ per cent at each surface. Only since the development of antireflection coatings has such a lens design been made possible.

The Zoomar is adapted for field or for studio use by interchangeable front units which can make the zoom cover a higher or lower range of focal length. In the field, using the tele front lens, the range is from a 5-inch focal length to a focal length of 22 inches. This means that in zooming, the width of scene taken in by the lens will decrease to less than one-fourth or expand to over four times its former size. With the wide-

angle front lens for studio use, the range is from a 3-inch focal length to a focal length of 13 inches (Fig. 5-10).



Fig. 5-9. Studio Zoomar lens ($f/2.8$; range: 58 to 175 mm), mounted on General Electric color camera. Manually controlled by operating rod through camera.

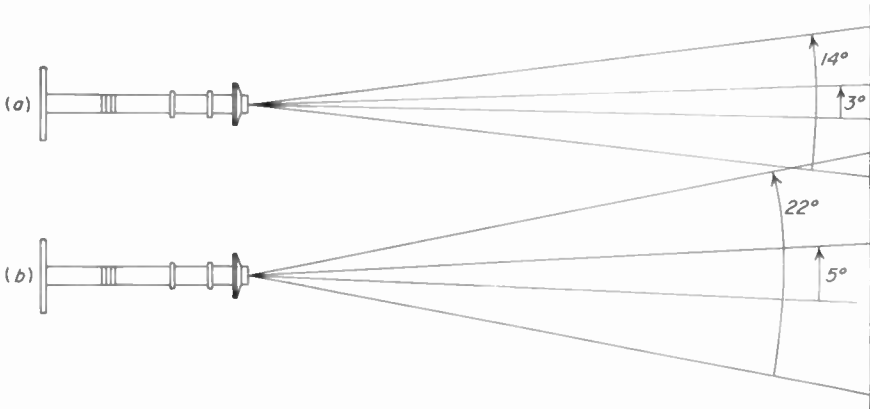


Fig. 5-10. Horizontal angles of view for Zoomar lens. (A) with tele front lens for field use; range of focal length, 5 to 22 inches. (B) with wide-angle front lens for studio use, range of focal length, 3 to 13 inches.

Control over the zooming section is exercised by means of a long plunger which is extended through the camera to the back, where it emerges in the center of the turret-control handle. A simple pulling or pushing motion is sufficient to achieve the zooming effect. The Zoomar lens keeps in focus during the zoom, except when the subject itself approaches or recedes from the camera. When following an end run in football, for instance, the cameraman must be able to follow focus as he zooms the lens; and, of course, he must also pan and tilt the camera to follow the action at the same time. Since the cameraman must operate the zoom plunger with one hand while he is panning and tilting the camera with the other, it might seem that keeping the camera in focus would be a difficult task.

Anticipating great difficulty in finding three-handed cameramen for this job, Dr. Frank G. Back, the designer, incorporated the focusing as well as the zooming function into one control. The plunger can be rotated to change focus. This is achieved by fitting the forward end of the plunger with a long spline, which engages a collar gear at the front of the lens. Rotating the plunger will turn the collar; and focus is maintained by controlling the lens, not by the usual method of racking the tube toward or away from the lens.

If the gear on the end of the plunger were of the usual cogwheel type, moving the plunger in or out would quickly cause it to lose contact with the gear around the lens. This is avoided by making the plunger gear a long spline instead, with teeth running its entire length, so that no matter how the plunger is moved, the teeth are still in contact and lens focus can be controlled.

Roughly half of all television stations have purchased these lenses. They are particularly valuable in coverage of such games as baseball and football, where the action is very fast and the usual method of switching from one lens to another can easily confuse the audience. A more detailed discussion of the use of the Zoomar on sports pickups will be found in Chap. 20 on Remote Pickups.

Many stations utilize zoom lenses in the studio. Used in the studio, the zoom lens constitutes an alternative to dollying the camera, although a totally different effect is achieved. When the camera is *dollied* forward, not only does the subject get larger in the frame—it also changes in perspective. Near objects move in relation to farther objects; the view through a doorway, for example, will widen out and more of the room behind can be seen.

The only similarity between the dolly and the zoom effect, however, is that the subject grows larger in the frame. Since the camera equipped with the zoom lens stays the same distance away, the *perspective* remains the same. An object in the background which is obscured by a foreground object, will remain obscured even in the close-up view. It is

usually possible to distinguish very quickly between the zoom and the dolly effect (Fig. 5-11).

There is a great advantage in using the Zoomar in the studio, especially when zoom effects are needed on very small subjects. For one thing the big problem of following focus is eliminated. In the ABC production *Stop the Music* it was desired to have a very fast zoom shot to a telephone at the moments when incoming calls interrupted the program. A cameraman could not have done this by dollying and still have held focus. The phone had to be too close to the camera, and the speed was too great. Moving the telephone on a track toward a stationary camera would still have required a very fast follow focus. The solution was found in the use of a Zoomar lens. No focusing was necessary, since the telephone remained the same distance from the camera during the zoom.

Another advantage of zooming over dollying is that the movement is



Fig. 5-11. Comparison of dolly and zoom. Starting with the center picture, the dolly effect, left, alters the perspective in the shot. As the camera approaches the door, it can see around the sides of the man and he becomes smaller in relation to the door frame. During the movement the sides of the door frame move outward against the background. In the zoom effect, right, the same perspective is maintained throughout the shot, and the man still fills the doorway. There is no movement of the door frame against the background.

always rock-steady, whereas dollying always involves a certain amount of jiggle due to irregularities in the floor.

THE ELECTRA-ZOOM LENS

Another zoom lens with a more limited range of focal lengths is finding considerable use in television stations. This is called the Electra-Zoom lens because the zooming action is electrically controlled by a toggle switch mounted on the camera panning handle. Manual control may also be added. The designer was Joseph Walker, Hollywood cameraman, who originally built this type of lens for motion-picture cameras. The range of the Electra-Zoom is from $2\frac{5}{8}$ to 7 inches. This makes it possible for one of these lenses to almost replace the entire normal complement of studio lenses on the camera turret. The horizontal angle of view will vary from 27 degrees, not quite as wide as the 50-mm lens, to about 10 degrees, nearly the same as the 8-inch lens. Wide open this lens is rated at $f/2.8$. It is particularly valuable for night and indoor remote

pickups, where the Television Zoomar is inclined to give a rather soft picture. A big advantage of the Electra-Zoom over the Zoomar lens is its size (Fig. 5-12). The camera can be handled more freely and moved about the studio with greater ease.

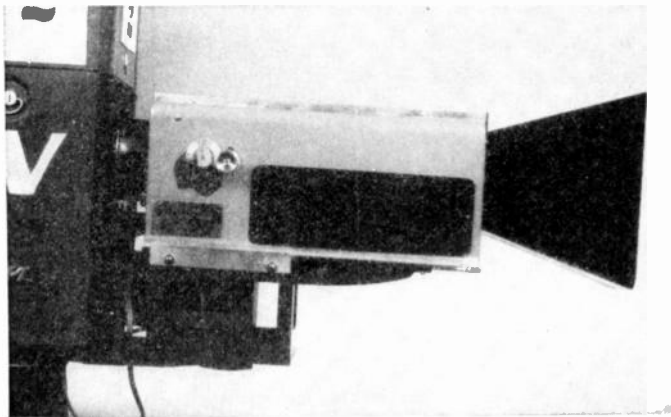


Fig. 5-12. The Electra-Zoom lens on camera at KOTV, Tulsa. Speed $f/2.8$; range of focal lengths, $2\frac{3}{8}$ to 7 inches. (Courtesy of Radio Optical Research Co., Hollywood, Calif.)

PERSPECTIVE IN LONG AND SHORT LENSES

It has been said before that the shot taken by a long-lens camera far from the subject is a different picture from that taken by the wide-angle lens closer to the subject. This is true, in spite of the fact that each may take in the same actual area of the scene. The difference is in the perspective in the picture—the way in which the camera registers the dimension of depth. If the scene had no depth, there would be no difference between the two shots. The image of a title card, for instance, if it fills the screen in each case, will look the same no matter what length of lens is used. But a scene in which some objects are close and others far away will look quite different. A wide-angle lens exaggerates the depth dimension. A long lens, on the other hand, will squeeze the near objects up against the farther ones, so that they are all about the same size, and decrease the dimension of depth.

To understand this more clearly, consider a very simple illustration. Two actors are in a studio set, one about 4 feet in front of the other. A set of off-the-tube pictures is shown in Fig. 5-13 illustrating the shots obtainable with the three standard lenses from the same camera position. There is no difference in perspective; the relative size of man and girl is the same in each shot. In the second series of shots (Fig. 5-14) the same field of view has been maintained. This of course required repositioning the camera each time the lens was changed.

By changing the position of the camera we have changed the *relative* distance from the camera to the two subjects. In the bottom picture, taken with a 50-mm lens, the camera is 5 feet from the man and 9 feet from the girl. She is almost twice as far away, hence half the size. In the top picture, taken with the 135, the camera is 10 feet from the man and 14 feet from the girl. This is a ratio of 2 to 3 rather than 1 to 2. Less relative difference in distance from the camera, hence less difference in size. If the camera had gone even farther back, using longer and longer lenses to keep the field of view the same, the 4-foot difference between the two people would count for less and less in relation to the camera distance and they would even more closely approach the same size.

Another series of pictures (Fig. 5-15) serves to illustrate how this same thing affects the shots we take in remote pickups outside the studio. The camera is set up to shoot through an archway at a fountain beyond. Three shots are included, taken by the three standard lenses, and since the arches are the same size, it is obvious that the camera has repositioned each time a new lens was used. It will be noted that the relative size of the fountain has changed considerably.*

It is not the choice of lens which has made the difference in perspective between these shots, but the repositioning of the camera which had to be done to keep the arches the same size in the frame. The size relationship between arch and fountain shown in the 135-mm shot (No. 3), for example, is due not to the fact that a long lens was used but to the fact that the camera was placed farther back from the subject. This same size relationship would exist in the shot taken by any lens, even the 50-mm (No. 4), as long as it were from this same camera position. This is the perspective which exists; it is not something created by the long lens; it is the same relationship which an observer would see if he were standing next to the camera. A long lens simply takes a small portion of the distant scene (with its distant perspective) and enlarges this to full-screen size, giving the viewer the illusion of a closer camera position. If perspective then looks distorted, it is because the viewer assumes from the size of the objects that the viewpoint is closer and cannot reconcile a close viewpoint with a distant perspective.

A common shot in television is the piano keyboard, from the side looking down the keys. If this shot is taken with the 135-mm lens, the perspective looks very strange. The keyboard looks abnormally short, simply because the camera is far away. The second picture (Fig. 5-16) illustrates the same piano keyboard taken from a closer camera position

* The author used an Exakta 35-mm camera in taking these pictures. Since the area of the 35-mm double frame used in minicameras of this design is practically the same as the area of the image-orthicon photocathode, the results of the three lenses used above are substantially the same as though they were used on television cameras.



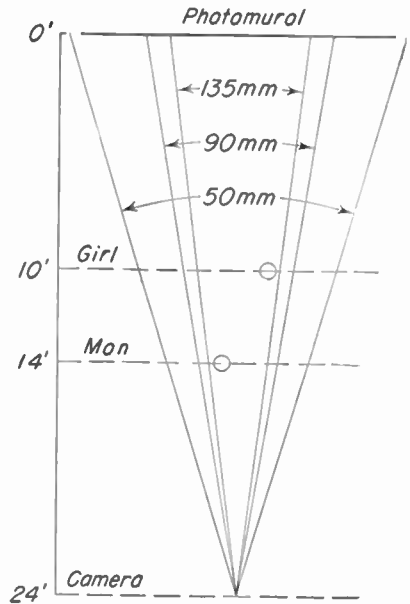
135-mm lens



90-mm lens



50-mm lens



Depth of focus problem
*You can get better
depth of focus by chong-
ing to a wider lens if
you are willing to accept
a wider shot*

Fig. 5-13. Three shots taken from one camera position with three different lenses. Note that relative size of man, girl, and building remains the same. Only the field of view changes. Note also the improved depth of field in the wide-angle shot (all lenses were opened up to $f/3.8$ to exaggerate this difference in depth of field.)



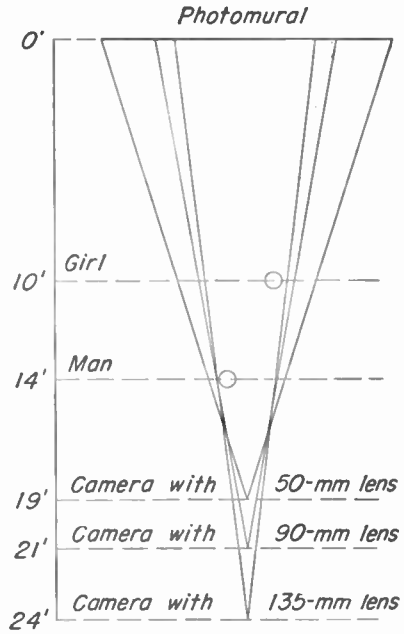
135-mm lens



90-mm lens



50-mm lens



If, however, you want to keep the same field of view, the camera must dolly in when a wider lens is used. This results in practically the same depth of focus as before

Fig. 5-14. Three shots with three lenses from three different camera positions maintaining the same approximate field of view. Man in foreground has been kept the same size. Note difference in relative size of girl and building in the three shots. Note also that there is very little difference in depth of field.

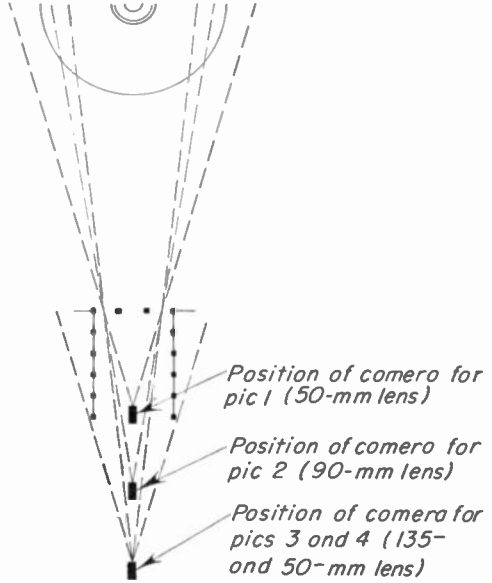


Fig. 5-15. Three shots, Nos. 1, 2, and 3, made from different camera positions with different lenses, keeping the arches the same size. Note that wide-angle shot (4) from same camera position as (3) shows the same relative size of fountain and arch.



Fig. 5-16. Piano keyboard taken with (a) 135-mm lens from a distance, (b) 50-mm lens up close, and (c) 90-mm lens from intermediate position.

with a wide-angle (50-mm) lens. Here it has the perspective of a near object. Provided it is viewed from a normal distance, it will look more natural.

THE NORMAL LENS

The term "normal" (normal-length) lens has been used heretofore without any exact definition. If we understand now what is meant by a normal lens, we can better understand why long or wide-angle lenses give their unusual effects. When we stand in front of a scene and draw, paint, or photograph an area of it into a two-dimensional picture, we intend that picture to be viewed from a certain distance. The area of the scene itself is seen within a certain angle of view from the eye. If we draw or photograph that scene so that the final picture is looked at with this same angle of view, as far as perspective is concerned we have come as close as we can to creating in two dimensions the effect of reality.

The angle of view with which a picture will be seen determines the angle of view with which it should be taken, if it is to have correct perspective. In motion pictures, an angle considerably narrower than 50 degrees is considered a normal angle of view, since the viewer usually watches the movie screen from a relatively greater distance than that from which he looks at a photograph or a painting. Between 20 and 25 degrees is used as a normal angle of view in 16-mm and 35-mm motion pictures. The 1-inch lens is considered normal for the 16-mm camera, and the 2-inch lens is normal for the 35-mm.

Generally speaking, the televiewer sitting in front of his set is 4 to 8 feet from the screen. If the screen is 18 inches wide and the viewing distance $6\frac{3}{4}$ feet away, then the angle of view is some 11 degrees. The normal lens for this viewer is 135-mm.

When fewer people are around a set, they generally prefer to sit somewhat closer, say about $4\frac{1}{2}$ feet away. The angle of view is about 19 degrees from such a position for a 18-inch screen.

If the normal angle of view for television viewing is 19 degrees, then the normal-length lens should have an angle of view of 19 degrees also.

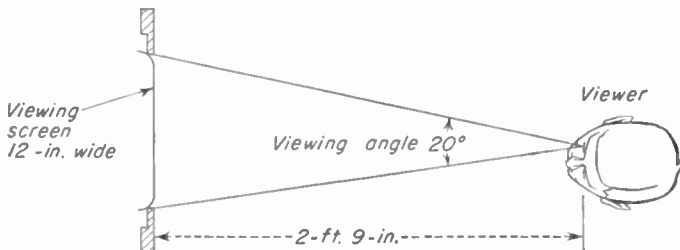


Fig. 5-17. Proper viewing distance for shots taken with the 90-mm (normal) lens.

The 90-mm lens fits this description. As long as television viewing screens were, on the average, rather small and the distance between viewer and screen proportionately large, the lenses longer than 90 mm could be used without seeming to distort perspective too much. However, with the larger screens becoming more popular, unless people sit farther back, the screen will subtend a greater angle at the eye and the long-lens effects will, of course, be more noticeable.

WIDE-ANGLE LENSES

The exaggeration of depth in a wide-angle shot makes the studio look much larger than it really is and exaggerates the speed of movement



Too close with the 50-mm lens

Fig. 5-18. Distortion of close-up taken with wide-angle lens.

toward or away from the camera. Dancers loom up very rapidly or dwindle quickly as they go away.

Caution must be exercised, however, in using wide-angle lenses. If the cameras get too close to a person's face, a very undesirable type of distortion will result. This is noticeable in the 50-mm lens when the camera is so close that the person's head is half the height of the screen. With the 35-mm the effect is perceived even sooner, when the head is one-third of screen height.* Since the nose is the closest thing to the camera, and considerably closer than the ears, it takes on an exaggerated size. The rest of the face then curves away from the nose like the sides of a ball (Fig. 5-18).

* This is between $3\frac{1}{2}$ and 4 feet from the camera in both cases.

Barrel distortion is another difficulty encountered with the wide-angle lenses, especially the 35-mm. Vertical or horizontal lines near the edges of the screen seem to curve outward. This may not be noticeable in a static shot, especially if there are no definite lines to appear distorted. When the camera moves, however, and particularly when it pans, objects move from distorted to nondistorted portions of the screen and can be seen to change their shape and bend around.

HOW TO CHOOSE LENSES

When a remote pickup is to be made from a new location, a preliminary survey is always made; and usually a member of the program department accompanies the engineer who makes it. He is primarily concerned with camera positions and the kind of shot he can get. Standing where the cameras are to be, he must be able to visualize exactly what each of his lenses will cover.

There are portable view finders on the market which can serve this end. The adjustable finder for the Leica camera, for example, carries view finders for at least the three standard lenses. It is not necessary to go to that expense, however, for a simple shoe box can be adapted very easily to serve the purpose.

Cut a peephole in one end of the box; in the other, a window just wide enough to show you the angle of view of, say, the 135-mm lens. To

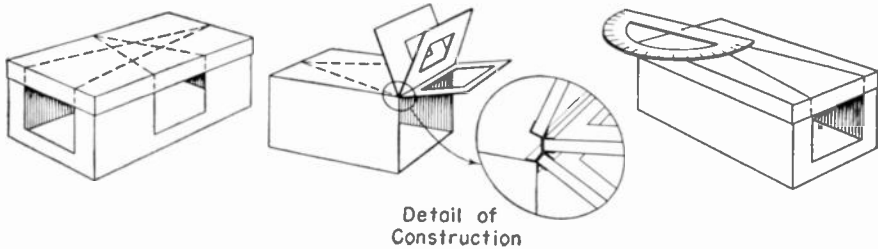


Fig. 5-19. Simple viewing boxes.

determine the size of this window, lay out the lens angle (13 degrees) with a protractor on the top of the box. If the box is too long for this, turn it sideways. Just be sure you can get your eye right up against the peep hole. Otherwise the angle of view that you see will be too narrow. Directors have at times made these viewing boxes with only one peep hole and a number of flaps that hinge down in front of one window.

An even more practical type is a simple cube box, conceived by the author and known as the "Bretz box," which has windows on all sides. The window for one lens serves as the peep hole for another, when you turn the box around.

This is very easy to make. Simply cut six pieces of cardboard, each

about 6 inches square. Lay out all the lens angles on one of them, as if it were the top of the box. Using this for a gauge, mark out a different window in each of the other pieces. The lens angles given are horizontal angles. To find the height of each window, figure three-quarters of the width, since the screen aspect ratio in television is 3 to 4 (three units high, four wide). After the holes are cut with a razor blade, fasten the sides together with scotch tape. Mark the lens numbers on the windows, so there can be no confusion. A good place is on the inside of the box before you put the pieces together. If the interior of the box is black, it is easier to visualize the window as a television screen.

This box will show you everything that the camera and lens itself will show you. In it you can see the effect of distortion of depth with wide-angle lenses and long lenses. You can take it in your hand and walk up

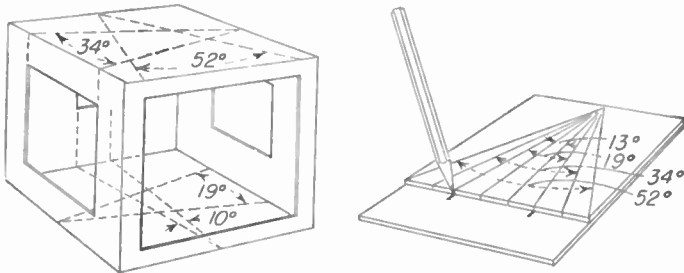


Fig. 5-20. "Bretz box," with method of laying out windows.

to or away from the arch, in our recent example, and determine ahead of time just what camera position is necessary for the desired size relation between arch and distant fountain. The only thing the box will *not* do is to show you these pictures full-screen. You have to look through a large window for a wide-angle shot and through a small window for a long-lens picture. This is where your imagination must help. You must visualize each of these various-sized windows as a full-screen picture on the television monitor, and if you can't do that, the box will help you learn.

FOCAL LENGTH

When the lens is focused at infinity and the image-orthicon tube is as close as it will ever be, the distance between what is known as the "optical center" of the lens and the photosensitive plate is measured; this is known as the "focal length." Focal length is not the same as the distance between the back of the lens and the tube; that is known as "back focus." Nor is the focal length the same as the length of the lens barrel itself.

TELEPHOTO LENSES

The telephoto is a lens which is actually much shorter than its focal length. It is not correct to call any long lens a telephoto. To be sure,

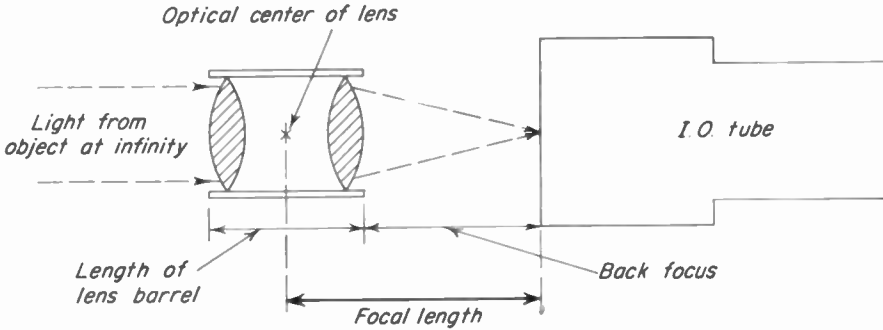


Fig. 5-21. Focal length is the distance from the optical center of the lens to the focal plane when the lens is focused on infinity. It is not to be confused with back focus or the length of the lens barrel.

they all produce the effect of a telescope—a great enlargement of a small area of the scene. But that is not the full meaning of the term. A 20-inch regular lens would have to be somewhat over 20 inches in actual length; whereas a 20-inch telephoto lens, owing to its different design, could be less than 15 inches in length. Both 20-inch lenses would have the same focal length, angle of view, etc., and would function, to all intents and purposes, identically. This is such a great advantage in photography that most long lenses today are made in the telephoto design. This has given rise, of course, to the confusion in terms.

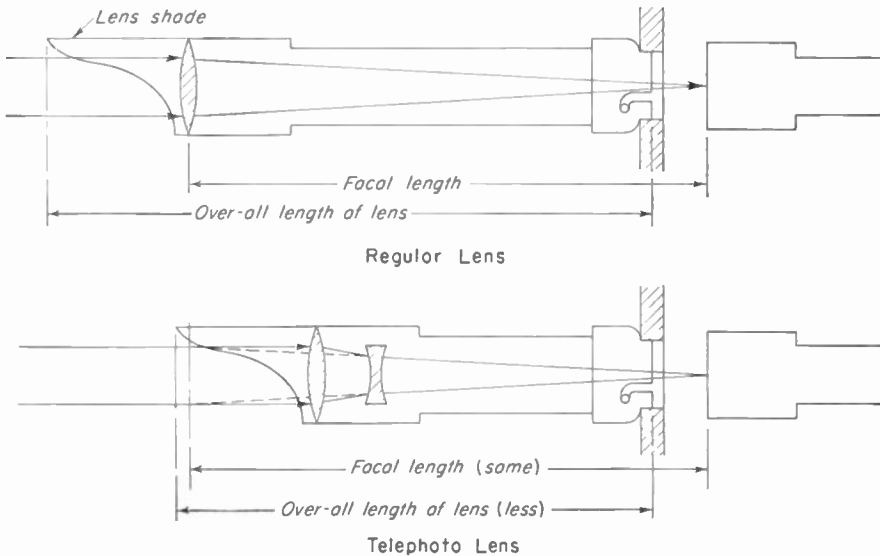


Fig. 5-22. Comparison of regular lens with telephoto lens of same focal length. Both produce the same picture.

The telephoto principle, very simply, is this: an additional *negative* lens element is added behind a regular short-focal-length lens. The effect of a negative lens is to diverge the rays of light. This causes them to converge to a focus farther back than they otherwise would. They converge, however, at such an angle that were they coming from a regular lens, that lens would have to be much farther away. The optical center of the lens, the point at which the rays are bent to converge into an image, is, in the case of the telephoto, actually outside and ahead of the lens. Of course, the rays are not *actually* bent there; they are *effectively* bent there. As far as the television tube is concerned, the rays of light that fall upon it through a 20-inch telephoto lens are converging at the same angle they would from a 20-inch regular lens. Figure 5-22 explains this.

DIAPHRAGM OPENINGS

The iris diaphragm in most lenses is adjustable. It is made of a great many small leaves which overlap each other in a circular fashion and which can be made to open up to allow a large amount of light into the lens or to close down to a small opening so that only a minimum of light can enter (Fig. 5-23).

Some lenses are not so equipped. To cut down the amount of light which can enter such lenses, pieces of cardboard or metal, with holes of different sizes, are inserted in the lens barrel. These are known as "water-house stops." Some of the long lenses used in the field make use of this simple method of controlling the lens opening (Fig. 5-3).

The size of the lens opening is calibrated in stops. To open the lens one stop means to allow twice as much light to enter. Two stops will quadruple the light; three stops will multiply it by eight. Conversely, closing the lens one stop will cut the light down by one-half; two stops, by one-fourth; three, by one-eighth.

Stops have, until recently, been designated almost exclusively by *f* numbers. The *f*-number calibration for a lens is calculated by dividing the focal length by the diameter of the lens opening.

$$f = \frac{\text{focal length}}{\text{diameter}}$$

Thus, if a lens has a 2-inch focal length and can be opened to a diameter of 1 inch, we call it an *f/2* lens. Such a lens can take pictures under very low light conditions. Closed, or "stopped," down one stop, to *f/2.8*, it admits half the light. The lens diameter is then about $\frac{3}{4}$ inch. Stopped down two stops, to *f/4*, one-quarter of the light now passes the lens, and the diameter is $\frac{1}{2}$ inch.

All lenses, when set to the same *f* stop, produce about the same illumination on the plate of the tube. This is the reason the *f*-stop method of

calibration was devised, so that a photographer might use several lenses on the same scene and put them all on the same setting. The reader may have noticed from the chart of lenses, however, that only the shortest lenses open up to large stops, the longest ones being relatively slow. We have said that

$$f = \frac{\text{focal length}}{\text{diameter}}$$

and that

$$f/2 = \frac{2\text{-in. lens}}{1\text{-in. diameter}}$$

What diameter would a 20-inch lens need in order to achieve an $f/2$ rating? It is easy to see that a lens of that bulk would be impractical. The 20-inch lens for the television camera opens up only to $f/5.6$, which means its diameter need be only about $3\frac{1}{2}$ inches.

The usual range of stops marked on television lenses is as follows: $f/2.8$, $f/4$, $f/5.6$, $f/8$, $f/11$, $f/16$, and $f/22$. Each of these is a full stop different from the next.

The particular diaphragm opening which will produce the best picture will vary according to the sensitivity of the camera tube, the amount of light incident on the scene, and also the reflectance of the scene (dark objects need more exposure). The best practice in determining the correct lens setting is to open the lens one stop beyond the point at which the highlights begin to compress. The engineer will determine this point by watching his waveform monitor as the lens is opened.

When the 5820 image orthicon is used outdoors, very brilliant illumination is frequently encountered. Bright sunlight may register as high as 10,000 foot-candles—100 times as bright as the usual studio illumination. This would require stopping the lenses down as much as six or seven stops from their studio openings. Since the smallest stop on most lenses is $f/22$ (only one or two stops smaller), neutral-density filters which cut out at least nine-tenths of the light must be used.

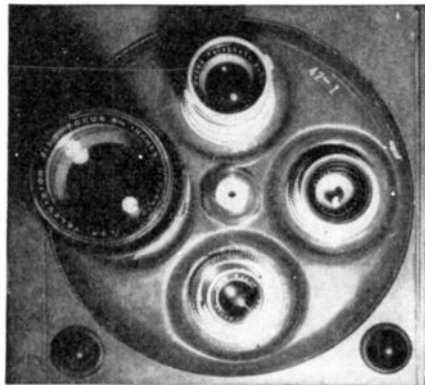


Fig. 5-23. Four standard studio lenses. The iris diaphragm can be seen within each lens, partially stopping it down. Top, 135-mm; left, $8\frac{1}{2}$ -inch; right, 50-mm; bottom, 90-mm. All these lenses are set at the same f stop. Notice that the longer the lens, the larger the diameter of the opening which is necessary to produce the same image brightness on the face of the tube. Note that the 50-mm (right), being a faster lens than the others, is far from wide open.

The use of a 10 per cent transmission is equivalent to stopping down the lens three stops. $f/16$ can be effectively changed to $f/45$. When more stopping down than this is necessary, filters of only 1 per cent transmission have been used.

Occasionally it is possible in some stations for program people to have a word in a few of these technical matters. Some directors, for instance, like to see larger lens openings used. Less light is necessary, for one thing, and subtler nuances of light can be achieved at lower levels. Another reason is that the depth of focus is reduced at larger lens openings. It is not always desirable to have everything in the picture in sharp focus. A great depth of focus is particularly unwelcome to set designers, who notice all the wrinkles, cracks, and blemishes showing up clearly on their scenery in the background.

T Stops. The system of rating the light transmission of lenses in terms of their focal length and diameter was never too accurate. There were many factors which this formula did not take into account. Most lenses today are antireflection-coated and transmit more light as a result. But their f -number calibrations remain the same. To improve this condition, a new method of rating lenses, which calibrates them according to their actual transmission of light, is becoming popular. The emergence of this " t -stop" method of calibration is of greater importance to photography than to television. The photographer cannot see the result of his work until after he has developed his films, and accurate exposure is his main control over picture quality. In television, it would be possible to do without any lens calibrations at all, since you can see the picture as you are taking it, and making the proper lens setting is only a matter of adjusting the lens until the picture is the way you want it. The value of lens calibrations is not to be forgotten, however. Standardized diaphragm stops make it possible to set all lenses quickly to transmit the same amount of light and to reproduce accurately the conditions of a previous pickup.

FOCUS

Anyone who has operated a camera of any kind understands the problem of focus. The lens must be set for the right distance, or the image will be soft and fuzzy. If the subject moves toward or away from the camera, it will go out of focus unless the lens is readjusted. The larger the size of film or photosensitive plate in the camera, the more focusing adjustments must be made. A camera with a small-size film, say 16 mm, can hold focus through a much greater depth without adjustment than can a 35-mm camera or a television camera. The smallest movie camera, the 8-mm, needs no focusing adjustments at all under ordinary conditions. The lens for this camera is made "fixed-focus" without a focus scale.

Everything from 2 or 3 feet to infinity is in focus at once, since the lens is set at the proper intermediate point (called the hyperfocal distance).*

TV-studio lenses are usually set at infinity, but there is a difference in practice here between one studio and the next. Some studios set all lenses at 15 feet. This is done in an attempt to reduce the amount of refocusing which is necessary, especially at close distances, after switching from one lens to another. If all four of a camera's lenses are set on infinity and the camera is focused on this distance, lenses can be changed without readjusting focus. However, when the camera focuses on a closer subject, each lens requires a different amount of tube travel. With the RCA camera, for instance, to focus down from infinity to, say, 2 feet, with the 50-mm lens requires less than two counterclockwise turns of the crank. With the 135-mm, on the other hand, six turns are necessary to focus on the same subject. In other words, in changing from the 50 to the 135 while focused on 2 feet, the crank handle must be turned counterclockwise about four turns to readjust focus.

The GPL camera as described before has solved this problem in a unique way. As the turret is changed in this camera and a new lens comes into position, the tube automatically slides forward or backward the necessary amount so that the new lens is immediately in focus.

DEPTH OF FOCUS

When the rays of light emitted by a single point, such as we have been discussing, are brought to a focus, they form a cone of light behind the lens. After they have come together, they cross and proceed to diverge again in another cone. It is only when the photocathode is placed exactly in the focal plane that the image of the point is actually a small point itself. As the tube is moved away from this plane, the point becomes a small circle which gradually increases in size, the farther the tube is moved. When all the points which go to make up an image register as circles, the image becomes soft and indistinguishable. There is a short distance within which the tube can be moved, however, without making any noticeable difference in the sharpness of the picture. This is because there is a certain maximum size of circle below which it is, to all appearances, still a point. This maximum size will, of course, vary according to the final size in which the picture will be seen. For television it is of the order of $\frac{1}{200}$ inch (0.005 inch).† For those who want a clearer defi-

* The hyperfocal distance is the nearest point at which objects are in approximately sharp focus, when the lens is focused on infinity. When the focus is fixed on the hyperfocal distance, everything from half that distance to infinity will be sharp. The hyperfocal distance depends on diaphragm opening and focal length of the lens: the longer the lens and the wider the opening, the greater the hyperfocal distance.

† Box cameras, $\frac{1}{60}$; folding Kodaks in low-price range, $\frac{1}{200}$; 35-mm cameras, $\frac{1}{500}$; 16-mm, 1/1,000; Leica Summar lens, 1/1,500.

nition, it might be added that this is called the "circle of confusion."

Inside the camera, then, the distance within which the plate can move

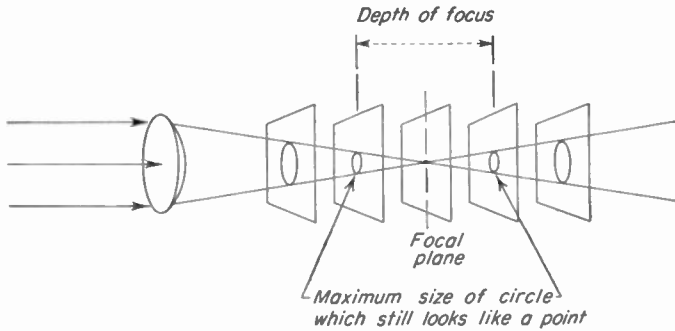


Fig. 5-24. Depth of focus.

toward and away from the lens without throwing the image out of focus is called the depth of focus.

DEPTH OF FIELD

Assuming no camera adjustment, the depth within which a *subject* can move toward or away from the camera without going out of focus is called the depth of *field*. To put it another way, depth of field is the distance between the nearest sharp object and the farthest sharp object. Depth of field is often erroneously called "depth of focus." This misnomer has become so widespread that it has almost become general usage.

Depth of field depends on three factors: (1) the distance from the camera, (2) the diaphragm opening used, and (3) the focal length of the lens.

Any cameraman can tell you how hard it is to keep in focus when

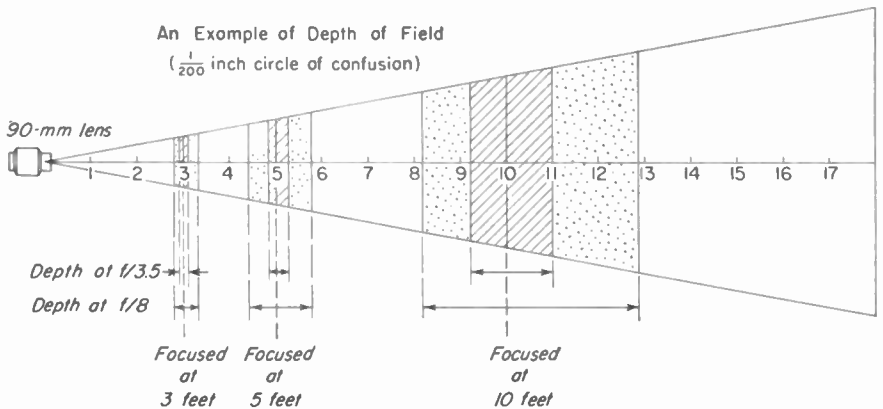


Fig. 5-25. Depth of field with the 90-mm lens. Depth of field is greater, the farther the point of focus is from the camera. Depth of field is increased by stopping down the lens.

he is holding a large close-up. He has a much shallower depth of field when focused close, and even a slight movement may exceed it.

Figure 5-25 is a diagram of the depth of field which a 90-mm lens can hold when focused at different distances.

Diaphragm Opening and Depth of Field. The diagram in Fig. 5-26 also indicates the difference that diaphragm opening makes in the depth of focus. When this particular lens is used wide open ($f/3.5$), the depth is very shallow. As it is stopped down to a smaller and smaller opening, the depth of focus constantly increases.

Consider again the light from a single point, gathered together by a lens and concentrated into one spot to form an image. It is clear from the diagram that a smaller lens opening, producing a narrower cone of

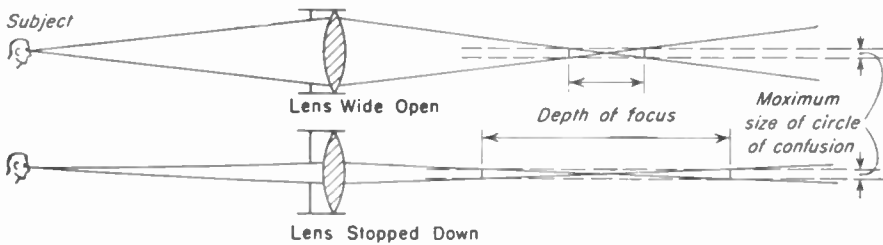


Fig. 5-26. Why depth of focus is improved by stopping down the lens.

rays, will cause the maximum tolerable circle of confusion to fall farther from the plane of exact focus, both ahead and behind. Thus the depth of focus is increased by stopping down the lens.

It should be pointed out that when the lens is stopped down, fewer rays of light enter it and the image loses brilliance. More light is necessary on the subject to give the same illumination on the photosensitive plate.

Figure 5-27 explains what stopping down the lens means in terms of depth of *field*. In drawing (a) the depth of focus is not sufficiently great to hold two objects, *A* and *B*, sharp at the same time.

The end of the tube could be placed anywhere between positions 1 and 2, and the image of the distant point, *A*, would be in focus. Critical focus would exist only at *A'*, where all the rays from *A* join to form a point of light. Between positions 1 and 2, however, the circle which these out-of-focus rays cast is within the tolerable limits and still looks like a point. The rays from point *B*, however, are forming too large a circle in this region, and *B* is definitely out of focus. *B* will be in focus only if the end of the tube is placed between position 4 and position 5. But these two regions where *A* and *B* are in focus do not overlap, and any attempt to "split focus" by focusing on a point midway between *A* and *B*

(position 3 with the tube) results only in both points being out of focus.

Figure 5-27*b* illustrates the effect of stopping down the lens in solving this problem. Point *A* is now in focus from tube position 0 to position 3; point *B* is sharp from position 3 back to position 6. By splitting focus and placing the tube at 3 we can now get both *A* and *B* sharply defined

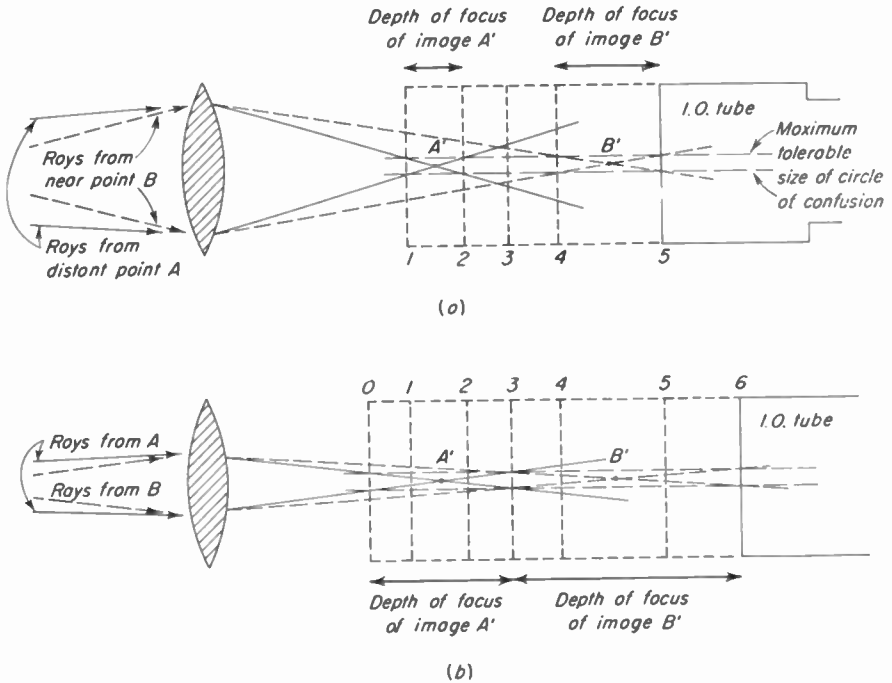


Fig. 5-27. Attempt to split focus between two objects unsuccessful in (A), when lens is wide open; but succeeds in (B), when lens is stopped down. Note: Amount of movement of the tube is exaggerated for purposes of illustration. The possible length of travel is only a little over 2 inches.

at the same time. In front of the camera the depth of field has been increased until it is now as great as the distance from point *A* to point *B*.

Focal Length of Lens and Depth of Field. The second factor which determines depth of field (and depth of focus) is the focal length of the lens. A short lens has a greater depth of field than a long lens, when both are set at the same diaphragm stop and *focused for the same distance*. Figure 5-28 is a comparison between the depth of field of three standard lenses. All three are open to the same *f* stop and are focused on a subject 10 feet away. The shorter the focal length, the greater the depth of field. Cameras which use smaller sizes of film need relatively shorter-focal-length

lenses to cover the same angles of view. This is why these small cameras have a greater depth of field, why the 8-mm movie camera never needs to be focused at all. The standard lens on these cameras is only $\frac{1}{2}$ inch focal length. The three photographs in Fig. 5-13 demonstrate the improvement in depth of field with the use of a wider lens.

It should be noted, however, that you cannot get something for nothing.

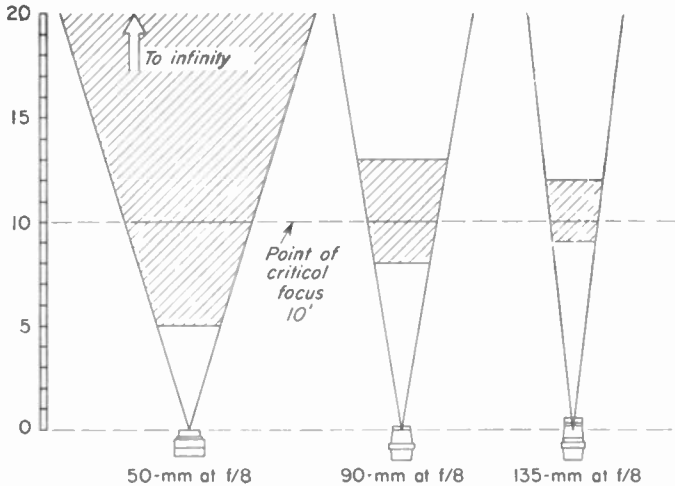


Fig. 5-28. Comparison between depth of field in three standard lenses focused on a point 10 feet distant.

In changing to a shorter-focal-length lens to increase the depth of focus, you have also greatly increased your angle of view. If this is undesirable, the next move will be to dolly the camera in closer to the subject. But as the distance to the subject decreases, so does the depth of focus. When the camera is in close enough to cover the same width of stage as it did before with a long-focal-length lens, the depth of field achieved with the wide-angle lens is not very different (Fig. 5-29).

Depth of field at a given distance depends on the diaphragm opening and the focal length of the lens. All lenses of the same focal length have the same depth of focus, no matter what cameras they are used on. If you want to look up the depth of focus of a particular lens you plan to use, you can consult photographic tables concerning lenses used on any size camera. The best source for such information is the "American Cinematographer Handbook." Bear in mind, however, that different depth-of-field tables are calculated around different maximum circles of confusion. If the maximum tolerable circle size is only $1/1,000$ inch, for example, the depth of field of a lens at any particular lens opening will be a lot less than it would be for a television camera, where the circle size can be $\frac{1}{500}$ inch or less. Look then for tables calculated at

this size circle, such as the table for 35-mm-film camera lenses in the handbook mentioned.

NOTES ON THE CARE OF LENSES

Lenses should of course be kept clean. Don't polish a lens with anything, however, until the dust has first been blown or brushed away, or tiny bits of grit in the dust will scratch the lens as you clean it. One

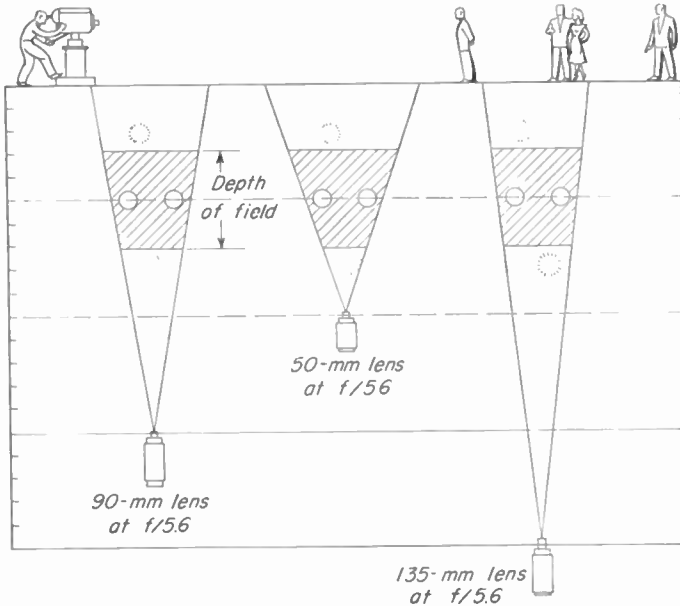


Fig. 5-29. Comparison between depth of field when same width of scene is maintained in shots taken by three standard lenses. You cannot improve depth of field by changing lenses unless you accept a wider angle of view.

scratch more or less will make very little difference, but after a lens is covered with tiny scratches, these will diffuse the light that comes through it and the focus of the lens will be perceptibly softened. Fingerprints and especially grease marks will do the same. Grit particles may be bound by grease; so look very carefully at the lens surface after it has been brushed and before it is polished to make sure that no more grit remains. If grease is present and holding grit, it may be removed by a brush dipped in industrial alcohol. Polish with a soft linen cloth which is lint-free, or a clean piece of chamois leather, or with special lens paper. The latter should always be kept on hand. To keep dust off the lens, it should always be capped when not in use. If the lens turret is removed from the camera, it should be stored in a dust-free case to prevent dust from settling on the back of the lenses.

6 TELEVISION CUTTING

In motion pictures a change from one scene to another is accomplished by cutting the unwanted portions off the end of one scene and the beginning of the next and then joining the two together with a splice. This process is called "cutting." To "cut" a film does not mean simply to reduce it in length by taking out unwanted portions. It is the whole process of putting a film together; choosing which shot shall follow which, and determining the precise length of each and the exact frame on which each cut shall be made.

The cutter is the one who does the physical work of handling the film. The creative decisions are usually made by a "film editor," who may sometimes do his own cutting. Motion-picture cutting is recognized as a vitally important aspect of the film art. It is a profession in itself. Some film makers have gone so far as to say that in the technique of cutting lies the entire process of creative film art.

In television a change in the scene is made with a switch, not with the scissors and splicer. Strictly speaking, we should call it "switching" instead of cutting. But the word "cut" has come to mean an instantaneous change of scene; and since that is what we produce by pushing buttons, it is still correct to call the process cutting. The two terms will be used interchangeably hereafter: "cutting" when the creative aspects of the process are being considered, "switching" when the discussion is on the technical side.

The process of cutting television is very similar to that of cutting motion pictures in end result, but the method is entirely different. A film editor may take weeks to cut a show, deliberating over each decision. A television director has to do his job during the show itself. He must rely on fast thinking, quick reaction time, and thorough preparation. In some cases he relies on his script or on his assistant, who follows the script. The sight of the television director excitedly calling shots ("Take

Two!" "Take One!") has led some to think that shot calling is all there is to television directing. Some directors actually do forget to make full use of their cameras because they are so occupied with just the problem of cutting.

In creative production a good director plans his cuts, just as he plans his camera shots—on paper. If he has had enough experience, he can visualize the effect of a cut, even between two shots which also exist only in his mind or as thumbnail sketches on the margin of the script. He will not limit himself to what he has planned, however, once he has produced the shots with cameras and watched the effect of the cut on the master monitor. He may change the camera shots to improve the cut, or he may change the timing of the cut itself.

By far the greatest number of television shows, however, are produced with little or no rehearsal; and the cutting cannot be planned in advance. Even if camera shots are set in rehearsal, the cutting is often not the same on the final air show. This is because the timing of the cut or the choice of camera depends mainly on the performers. If they deviate from the rehearsed routine or go through actions which have not been rehearsed at all, the director must be on his toes to adapt his cutting to their performance. This is called "off-the-cuff" shooting, "ad lib" cutting, or "winging" the show.

METHODS OF CONTROL-ROOM OPERATION

Under both the "technical-director" and the "switcher" systems of control-room operation (described in Chap. 2) an engineer known as the TD (technical director) operates the switching system and actually punches the buttons. He may take the cues directly from his own script or the action on the screen, or he may, as in most cases, wait for the director to call the shot before he punches the button.

Another method of control-room operating which is used in many of the small stations could be called the "director-switching" system. Under this method the director has the switching system before him and operates the buttons and faders himself. Some stations have adopted this method for reasons of economy and because there was no union jurisdiction over the job. Others have chosen it because they believe it to be the best method of operation. The exact moment when a switch is made is very important, and a split second's delay can often mean the difference between a good and a bad cut. In baseball pickups a bad cut is much worse than that—it is a lost play. A majority of the stations have adopted the director-switching system at least for baseball and other sports remotes.

In the remote truck that WBKB has designed and built (one of the best designed trucks in the industry), there are two sets of buttons: one below

at the technical director's desk, and one on the upper desk for the producer. It is possible for the technical director to punch a "remote-control" button and throw the switching operation entirely to the director of the program, who then operates from his own set of buttons. A few have carried this policy of operation over into studio operation. WCAU-TV and WPTZ in Philadelphia are good examples. Making a comparison with the TD system, they say at WPTZ that "It is easier to train a director to punch a few buttons than it is to teach an engineer showmanship."

This method of operation works out fairly well in small stations and on programs which are not too complicated. However, in the production of dramatic shows, it is well that the director can dispose of the burden of handling the dials and switches.

It is very important for the switcher or TD who punches buttons to know ahead of time which camera is to be taken next. His reaction time is faster then. He has only to punch the button. He doesn't have to decide first which button to punch. KLAC-TV in Hollywood once established a rule requiring directors to call the camera number first before they call the take. If they say, "Two—take Two," this gives the TD time to get ready and a well-timed cut results. In spontaneous cutting, however, the director may not know the camera he wants until the moment he wants it. Many director's orders at this studio sounded more like "Two-taketwo," which was no great advantage and just gave the director more to say.

The director's best method is to give a "ready" cue whenever possible. This is appreciated also by the cameraman, who is not so likely to be caught changing lenses or adjusting focus at the moment of the cut. "Ready Two" can be said almost automatically while you are watching the action on camera 2. Where the cut must be precise, a further "Take—" will keep the TD poised. Then the number can be thrown very quickly, accompanied if desired by a hand signal, and the reaction is almost as fast as though the director himself pushed the button.

PRINCIPLES OF CUTTING

The principles of cutting outlined here are the same that have governed film editing in all but the most esoteric types of film or film sequences. These are the techniques which achieve a "smooth cut" and assure a visual continuity. Good cutting, by this criterion, is unnoticeable. Two shots are joined in such a way that the audience is completely satisfied by the result; and attention can properly remain with the action, rather than the method of production. Subject is more important than form in this type of production.

Basically, the responsibility of the television director is to satisfy the

viewer. When something is going on and the director is making pictures of it, he must show it properly or the viewer will be dissatisfied. He must show the viewer what he wants to see. Forty years of an ever-improving motion-picture art have educated the viewer to expect a lot. He wants close-ups on essential action; and he wants them quickly, just as he is used to getting them in the films. He wants to look around and know where he is, and he expects good orientation. Above all, he doesn't want to miss anything that happens, and he doesn't want to be confused.

The director must show the viewer what he wants to see, when he wants to see it, and cause him no confusion in the process. If the television director can achieve even so much as this, he will be a good director. Fancy angles, subjective camera, montage cutting—these have their place too, but they can never substitute for these basic requirements.

Showing the viewer what he wants to see might better be classified under camera handling than under cutting. But showing it to him when he wants to see it is definitely a principle of cutting. The timing of the cut is perhaps the most important single thing about it, and the one thing which is most likely to be a little off in television. Film-editing procedures take account of this and usually include a "rough-cut" stage where all the scenes are overlong. When the film is projected and studied in this condition, better decisions can be made as to the exact timing of the cuts. In television such a thing is impossible. A long shot and a medium shot which are to be cut together exist side by side on two monitors. A switch between them is instantaneous and irrevocable.

Within a sequence of shots taking place in one scene, the actual length of an action cannot be changed. An actor crosses the room, and we cut to a close-up when he reaches the other side. In film editing there is a possibility of shortening the actual time of the cross. If the actor walks out of frame on the first shot and into frame on the second, the entire intervening time can be eliminated. This is known as creating "filmic time." In television we can condense time in this way only between sequences or by special devices, but not in the regular run of cutting. We are limited to actual time, since television is basically an art of actuality. The choice, by the director, of the best segment of this actuality, at the best time, is the process of artistic selection, which is a good part of what might be called the creative art of television.

Dependence on actual time, however, simplifies television cutting as compared with cutting film; there is no need to worry about matching of action. In film shooting it is always a constant worry to be sure the action is the same when you shoot a close-up as it was when you shot the medium shot just before. If an actor sits down, he must do it at the same speed each time, hold the chair with the same hand, cross his legs in the same direction, etc.; or joining the two pieces of film will be a great prob-

lem. Then (in film cutting), even when you have two shots with identical action in them, there is the problem of cutting between them, so that the action, which begins in one shot and ends in the other, will be smooth and continuous. There must be no overlapping or anything missing. This also we are spared in television.

CUTTING ON ACTION

The principle of cutting on action is just as important in television as it is in films. There is nothing that will so disguise the fact that a cut has been made as a strong and positive action to carry across from one shot to the next. The cut should be made during the action itself, not just before it, and not after it. As a director you must watch your monitors very closely, have the second camera ready, call the first half of your order, "Take—," and, just at the moment of the move, call the camera number. If it is a short movement, like a dancer's leap, for instance, and there is any delay at all, the cut will come after the leap is over.

Cutting on action is possible, however, only if the attention of the audience is definitely centered on the action through which you intend to

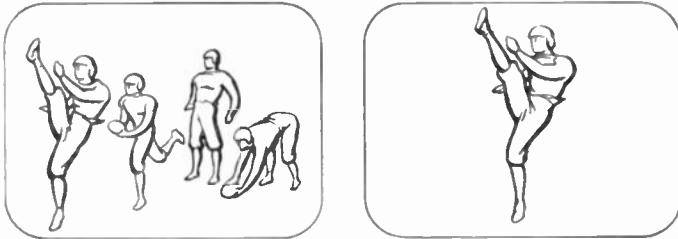


Fig. 6-1. Cutting on action is an unsure method in this case because there is no way of knowing which action the audience may be watching.

bridge the two shots. If you start with a long shot which includes several actions, the audience is as likely to be watching one as another. If the shot, let us say, shows four football players warming up before a game by kicking punts and the director should wish to cut to a close-up of one of them, he cannot do this on the action of the kick. There is a 3-to-1 chance that the viewer may not be watching the same player that the director is looking at. If the viewer's attention happens to be on the wrong player, the new shot will suddenly be upon him in the midst of an action. It would be best in this case to cut before the kick, so that the complete action would be included in the close-up shot, just as one would do in cutting to another scene, when matching of action is unnecessary.

CUTTING ON REACTION

One of the most powerful motivations for a cut is to have someone in the picture look outside the frame. Immediately the audience wants to

see what he is looking at. A shot of another subject—anything under the sun—is accepted, at least momentarily, by the eager viewer. The viewer has been given what he wanted to see. More than that, the director has contrived, by the device of having someone look, to make the viewer *want* to see the thing he is going to show him next. He can cut to almost anything at all and make a good cut. For a joke, he can even put in something ridiculous. If the shot is entirely impossible and incongruous, the viewer will laugh at himself for having accepted it, but only after a smooth and natural cut has been foisted upon him. The same general principle applies in the case of an actor pointing a camera or a gun. The audience wants to see what the actor is pointing at.

Such a device can be used to motivate a cut to a very big close-up, from a medium or long shot. Usually it is best not to make the change of shot too extreme. Long shot to medium shot, medium to close-up, close-up to big close-up is the normal progression. But if a person picks up a picture or a letter or obviously concentrates his attention on a very small portion of the scene in front of him, a cut to that small area is perfectly motivated.

Cutting is often motivated when the audience wants to see someone's reaction to what has just been said or done. In the audience-participation show, a contestant may be blindfolded and put through some silly stunt. A shot of his wife's reaction to his asininity is completely motivated (provided she is reacting at all). In the dramatic show, when two people are in conversation, it is often desirable to cut to a close-up of the person who is not talking, in order to watch his reaction to what is being said. Standard procedure under other circumstances, in covering a conversation, is to show the person who is talking, at all times, and to cut back and forth on every speech. You have to show the viewer what he wants to see, and he is interested primarily in the source of sound. Noises off screen, the opening of a door, or a voice will make the viewer want to see where the sound is coming from.

THE CUT-IN, OR INTERCUT, SHOT

Sometimes during an event or a performance it may enrich the show to cut away from the event and interpose a shot of something else. A spectator reacting to a sports event or not reacting, as the case may be, is a good example. The newsreels frequently intercut a close-up of screaming fans just after a good play, or show a long shot of the stands if the preceding action has not been too exciting. But in films this serves a practical purpose, which does not hold true in television.

An intercut shot in a film can be used to separate two shots that do not match and cannot be cut together. A smooth continuity results. More-

over, the film audience does not mind being taken away momentarily from the primary action because it knows the film editor has included the rest of the scene in the reel and that it is not going to miss anything. The television viewer, on the other hand, feels no such certainty. He is afraid, while he is watching the frenzied fans jumping in the stands, that he is missing something going on down on the field. The same is true of audience-participation shows, comedy shows, variety shows, and many other kinds of spontaneous programs. If intercut shots are to be used at all, they must be used at a time when nothing of importance is likely to happen elsewhere or they will not be what the viewer wants to see.

The television dramatic show, on the other hand, is closely akin to the dramatic motion picture in this as well as most of its other aspects. All the cinematic techniques are applicable to television dramatic shows if they can be physically accomplished at all. Intercutting of extraneous shots for purposes of contrast, irony, flash back, etc., can be accomplished as well in television as in the film medium. The reader is referred to such books as Rudolf Arnheim's "Film," Raymond Spottiswood's "A Grammar of the Film," and Ernest Lindgren's "The Art of the Film" for full analysis of these techniques.

LENGTH OF SHOT

Some people hold the theory that a lot of cutting increases the tempo of a production. This is carried so far that statements like this have been heard: "There should be a cut at least every 20 seconds in order to keep audience interest." This is by no means always true. A shot should be as long as the proverbial piece of string. Tempo is not controlled only by the rate of cutting, except perhaps in newsreels or documentary films. In the newsreels or in the "March of Time" films which are built from a series of more or less disconnected shots, scenes of three or four seconds in length are standard. A shot containing action should be continued as long as necessary to complete the action, or cut as short as possible, one might rather say, without *losing* any of the action. "The True Glory," a war film made from thousands of stock shots taken by a great number of Signal Corps cameramen, was cut to a very rapid pace. The shots were, straight through the film, less than two seconds in length. This resulted in a picture which was very hard to watch.

Cutting, in this type of film, does control tempo because it controls the speed at which the film progresses from subject to subject. Television production, however, is not like this at all. Cutting, in television, is generally not from one subject to another, but from long shot to medium shot to close-up, etc., all parts of the same scene or subject. The speed at which the performers progress from action to action is what determines tempo. All the frantic cutting in the world can't speed up the show.

I remember once, as a young director, being given a sports interview show to direct. The MC and the interviewee sat together on a sofa and talked. Here was my great opportunity to do a real production. I dollied the cameras in and out. I cut from one angle to another—big close-ups, high two-shots, timing each cut accurately with the phrasing of the conversation, building up what I thought must be a terrific pace. But I succeeded only in sweating up the camera crew and making it hard for the audience to relax and pay attention to the interview. The show remained nothing more than two people sitting on a sofa and talking.

“What is the absolute minimum length of shot?” is a question that is sometimes asked. Four frames of film are enough to give the audience a glimpse of a subject; there are shots of this length in some of the montage sequences in Hollywood films. It is amazing how quickly the eye can take in a picture. Back in the Keystone Comedy days they found they could get a better laugh if they cut in close-ups of action. If the action was only a pie hitting a face or a quick change of expression on a comedian’s countenance, it was included in a few frames of film and there was no need to run the shot even as long as one second to show what had happened.

Fast cutting is very rarely desirable in television, and hardly ever possible. For one thing, you run out of shots too fast. You only have two or three cameras, and you have to allow time between takes for the cameramen to line up new shots or you will be repeating yourself.

Furthermore, television doesn’t call for the pace of the motion picture. The two media are different in this respect. Since the viewers are watching reality in the case of television, they are content to let events take their own natural time. It is hard to imagine a group of people sitting through a 2½-hour film of a football game in the way that they will watch a full-game telecast. In a motion picture they are used to a condensation of time and a tempo of production which is purely filmic.

CUTTING VS. CAMERA MOVEMENT

Since the film is a construction made out of shots spliced together, it is natural that the cut would be accepted as the normal thing. Television, on the other hand, is an electrical pickup of reality. The television camera makes pictures continuously, as long as it is turned on and the beam control is up. Theoretically, the long continuous shot is more natural to the television medium. Furthermore, a television pickup is usually less of a construction than it is reality itself. The television viewer feels toward the receiver as though it were a kind of window through which he can see distant events. The more real this view, the stronger his feeling. These theoretical considerations seem to indicate that cutting is something to be avoided in television.

Camera movement is, of course, the alternative. Instead of cutting to a closer shot, why not dolly in? Is it not better to use a Zoomar lens on a baseball game than to cut from camera to camera? By and large, this is true. Willys Cooper in his "Volume I," "Escape" and "Stage 13" series has done some very fine dramatic shows with only one camera. There are times, however, when the advantage of a cut over camera movement is very great. Several such advantages can be listed:

1. One practical consideration is time. It takes time to dolly in to a close-up and back again. The action must be slowed down for the camera. It is much better to cut to a close-up and cut away from it again in a matter of seconds and get along with the show.

2. Rehearsal time is also involved. A dramatic show can be planned with a great deal of actor and camera movement, or it can be done by cutting between a series of static shots. A lot more rehearsal time is needed to produce a show with camera movement. The movement, the positions of the actors, and the coordination of the camera—all have to be carefully worked out and well rehearsed if they are to work at all. Simple cutting from one shot to another can be worked out in much less time.

3. Reaction shots, also, cannot often be done by panning or dollying the camera. When the viewer sees someone look at something, he wants to see immediately what the actor is looking at. The viewer is seldom content to wait through a long pan shot across unimportant background to see it.

4. Another consideration is the dramatic value of the cut itself. The sudden appearance of a new picture on the screen can be put to good use sometimes, entirely for its shock value. This is particularly possible if cuts have been used sparingly in the sequence just before. A sudden dramatic moment can be enhanced by sharp cuts. A cut is useful for punctuation, something that is more difficult to accomplish with camera movement.

MATCHING CENTER OF INTEREST

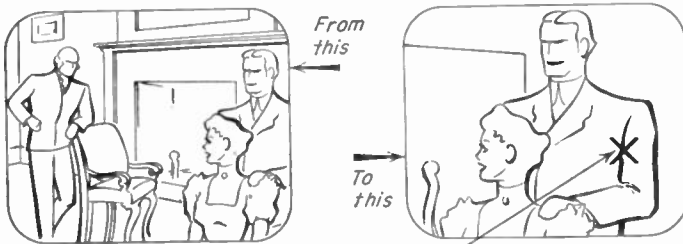
The composition of the two shots involved has a definite effect on the smoothness of cutting between them.

When a cut is made, the eye must quickly adjust itself to a new composition. The easier the readjustment, the less noticeable and the smoother is the cut. One factor which determines this smoothness is the composition of the two shots and the relative position in the frame of the center of interest in each case. In the first shot in Fig. 6-2 the center of interest is the woman talking, in the lower right-hand corner of the screen. If a cut is made to a close-up of the same subject, but composed so that the

woman is then to the left of the screen, a readjustment of the eye is necessary. The eye remains focused on the lower right-hand corner after the cut, with nothing particular to look at. It must travel across the picture to find the center of interest again in its new position on the screen.

This is really a minor point in television, since there are usually so many other more important things to be desired. Where greater perfection is necessary, however, it is something to consider. An example is in the pickup of sports. The smoothest possible cutting is necessary in covering sports because even momentary confusion is enough to cause the viewer to lose track of a play, particularly in a fast game. Naturally it is not possible to order the cameramen to place the ball in any particular corner of the screen (although methods for doing this very rapidly have been suggested). It is about all you can hope for if each camera merely centers on the action. If each camera centers the ball, at the moment of the cut the ball will remain in the same place on the screen.

When you cut



The eye is left on point X and must travel across the screen to find the center of interest again

Fig. 6-2. The importance of matching center of interest.

The series of pictures in Fig. 6-3 illustrate a common error in composition made by television students. Sometimes a framing may be very good in and of itself but lead to confusion when cut into a sequence of other shots. A sequence of three shots is shown, a covering two-shot and two waist shots of individuals. When these two single shots (shot 2 and shot 3) are cut together, the two people do not seem to be looking at each other but, instead, seem to be back to back looking in opposite directions. Each one is looking out of the frame, away from the place where the other man's head will be after the cut is made. In order to make these shots usable in this succession, good balance must be sacrificed and both shots framed up so the people are looking into the frame and at each other (shots 4 and 5).

Another common fault is the sequence of shots which are composed in such a way that the subject appears first in one part of the frame and then in another. The sequence of shots in Fig. 6-4 illustrates this.

Whereas the composition of the individual shots may be entirely adequate, when they are used in succession the character A seems to jump from one part of the picture to another. This is made particularly noticeable by the fact that he is the same size in both pictures.

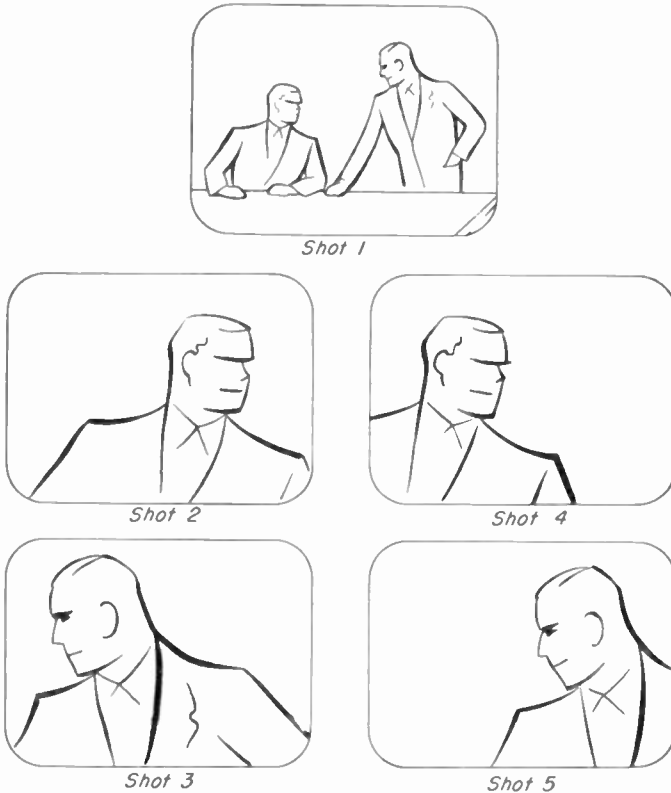


Fig. 6-3. A simple switching sequence involving a two-shot and two close-ups. If the close-ups are composed as in shots 2 and 3, a smooth cut between them is impossible. Shots 4 and 5 cut together well. Note that shot 4 cuts after shot 1 better than shot 2 does because there is less change in the center of interest.

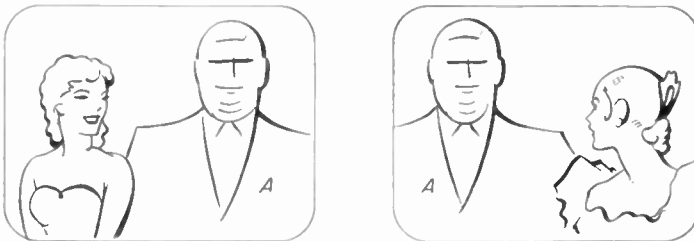


Fig. 6-4. Two-shots that cut very badly together. Character A appears to jump from one place to another on the screen.

CUTTING TO THE AUDIO

Sometimes, the phrasing of sounds will provide a natural place to cut. For instance, all else being equal, it is smoother to cut at the end of a sentence rather than in the middle of one. The phrasing of music forms a very compelling pattern for cutting, especially when the music plays an important role. The music is reinforced if the visual change follows the changes of tone color, chorus, and verse. Clark Jones, one of the best directors in this field, is known for his accurate cutting in musical shows. His shots will be 8 bars, 4 bars, sometimes only 2 bars in length depending on the change in tone color of the music, and the cut is always made precisely on the beat, showing the new musician just as he begins to play. When tone color changes every 2 bars, so do the cameras; when a vocalist sings 32 bars without a break, the camera rests quietly with the subject.

WHAT NOT TO DO IN CUTTING

To the tyro director who has had little experience in the film or television medium I would direct the following words of caution:

1. *Don't cut too much.* You are likely to make the show harder to watch or to irritate your audience. If you have time to work it out, camera movement or actor movement is smoother. Use the cut for dramatic punctuation or to get a shot on the air quickly. Don't go crazy with "brilliant" cutting unless you know what you are doing.

2. *Don't cut blindly.* Some directors seem to close their eyes and say, "Take Two." They are afraid to take their eyes off the master monitor. Keep looking back and forth; try to watch all the monitors at once. And look at the camera monitor just before you call the take. You'll get fewer lens changes and out-of-focus shots on the air if you do.

3. *Don't cut from one shot to another one just like it.* A cut from a two-shot to a two-shot adds nothing. To be sure, the second one may be from a different angle, but does it show the audience anything more? The only exception to this is in the case of "reverse-angle" shots, where the first camera looks over one man's shoulder to see the other full face and the second camera does the opposite from the other side (Fig. 6-5).

Never let two cameras give you the same shot. See that one of them changes lenses or repositions. Otherwise you might as well not have it out there. Sometimes a director may get stuck and have to cut between two identical shots, bad as such a cut may be. He may find, for example, that he has to release the camera which is on the air for some sudden need. He must cut to another camera. His only possibility is an identical shot, and he hasn't time to change it to something else. The viewer doesn't know these problems, however, or hear the director's excuses.

A cut between two similar shots will often give the effect of a sudden jump in action. There is a certain shift of position on the screen which blends in the eye like stages of an animation to give the effect of motion. This is similar to the familiar jump cut, in unedited films, caused by the camera being turned off and then on again.

The worst example the author can recall of cutting between similar shots occurred on a variety show. There were three cameras; one presenting a full face of the girl singer, one a three-quarters left profile the same size, and the third a right profile, also the same size. During the song the director changed shots often. There might have been some reason for this because of the variety obtained by the change of angle,

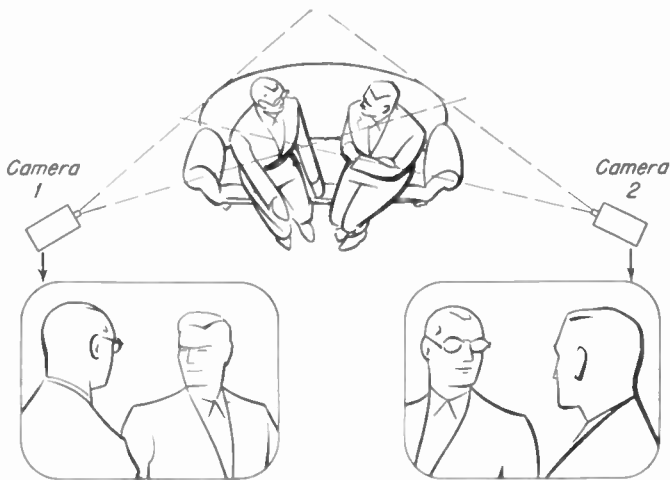


Fig. 6-5. Reverse-angle two-shots. This is an exception to the general rule against cutting between similar shots.

except that the performer was too smart for them. She was on to television. As soon as the camera changed, she spotted the red lights out of the corner of her eye and turned to face the new camera. Thus wherever the director shot from, he always got a full-face close-up. The singer continued to chase the cameras around for the rest of the number.

4. *Don't cut to an extremely different angle.* What constitutes too great a change in angle is hard to define. The main thing is to be sure the subject is immediately recognizable and doesn't look like something else in the new shot. A shot from an angle that is so far different that an altogether different background is seen behind the subject will cause confusion. Sometimes a change of angle will make a great difference in the lighting. What is contrasty side light from one angle may be flat front light from another. The difference may be so great as to make the subject unrecognizable, at least for a moment. The author has seen a profile shot

of a news commentator cut in suddenly after a full-face shot, with the result that the profile shot looked momentarily like someone else sitting across the room watching. The viewers have no way of knowing that the new shot is taken from a different camera angle until they have seen the shot and comprehended it. The natural assumption is that it is taken from the same place, but looking in a different direction, just as an observer on the scene would turn and take in another view. The problem of camera placement in the pickup of baseball and other sporting events is directly tied in with this. A further discussion of the relation between cutting and camera angle is to be found in Chap. 20 in the section on baseball. One point should be made here, however. When an action takes place *between* two cameras, so that they see the subject from opposite sides, the direction of the action will be completely reversed when a cut is made. Nothing can be so utterly confusing (Fig. 6-6). It is usually

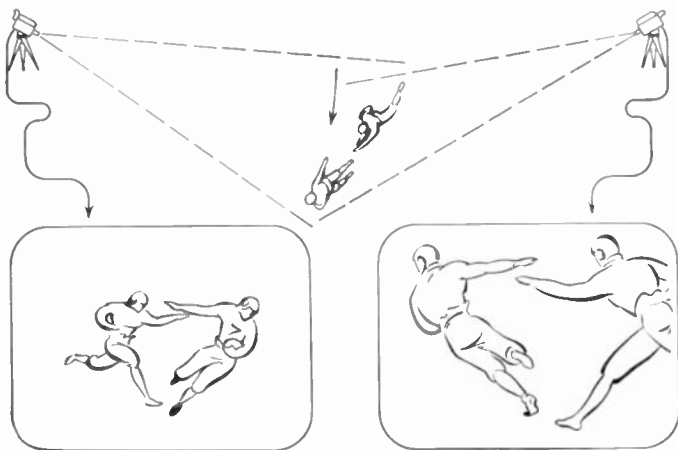


Fig. 6-6. If cameras are placed on opposite sides of the field, a cut will reverse the direction of action taking place between them.

best to keep at least the main two or three cameras as close together as possible on most sports pickups.

5. *Don't cut on a pan.* Don't cut from a camera that is panning to one that is static or from a static camera to one that is panning. Try it once, and you will see what I mean; it just can't be done. You *can* cut from pan to pan very nicely, provided they are both going in the same direction and at the same speed. When two cameras are following the same action, for example, the cut is usually quite smooth. At a football game, if both cameras center the ball as they follow a runner, it is perfectly possible to cut from medium shot to close-up without the slightest confusion, since both cameras will be panning, and in the same direction.

6. *Don't spoil exits.* As far as the audience is concerned, once an actor has left the frame of the picture, he has made his exit. Don't rediscover him and exit him again in the background of the next shot. The same thing goes also for entrances. Don't make an actor enter twice.

THE DISSOLVE

The dissolve, lap dissolve, or cross fade is the method of transition in which the first picture becomes steadily weaker while the second becomes stronger on the screen. It is really a fade-out simultaneous with a fade-in. If the dissolving process is stopped at the mid-point, a superimposure is the result—each picture at half strength.

In films, the dissolve has been used with a certain connotation. By unwritten agreement, all film makers found it best to reserve the dissolve for a particular purpose. (The expense of having dissolves made assisted toward this end.) The meaning of a dissolve in dramatic films is transition in time or, occasionally, transition to another place at the *same* time. You dissolve between sequences—to a later time or to another place, or both. Dissolves within a sequence where no change of time or place is intended are rarely done in films, unless it may be by an amateur fascinated with the dissolve mechanism on his camera, who dissolves between the long shot of a garden and the close-up of a flower.

In television, unfortunately, a dissolve is no harder to do than a cut and costs no more. Instead of going to another day's work, as you do in films (taking out the proper negatives, sending them out for opticals, splicing back the dupe negatives into the reel), in television you simply turn a dial or move a handle, as the case may be. With the Du Mont equipment (described in Chap. 7) you punch the same button you ordinarily punch for a cut, and a dissolve is automatically effected.

The result is a very free use of dissolves, often in places where a cut is really preferable. Dissolving within a sequence is often done on television. This is not generally true of dramatic shows, because in this type of production we follow the motion-picture technique rather closely. In musical productions, variety shows, and the like, however, a director feels less confined to the motion-picture tradition. The result is that in television we have a new connotation (or a loss of any connotation at all) for the dissolve.

Dissolves are commonly used in nondramatic television shows for their own sake, or their decorative value, not for any meaning they may carry. In a fashion show, for instance, with lovely models, smooth music, slow movement, a dissolve from long shot to close-up, as the model turns, is more in keeping with the mood than a sharp cut. Similarly, in shooting a smooth dance number, dissolves may help retain the continuity of movement. In dissolving, as in cutting, the midst of an action is the best time

to make this transition, except that, in the case of the dissolve, a longer action is needed. The dissolve on a twirl or turn is particularly smooth. The length of the dissolve depends on the mood at the time, the length of the action behind it, and the pace of the show. Very fast dissolves which are almost like a cut are sometimes seen. Don't forget that the audience is temporarily confused during a dissolve. Whether that is to be a pleasant lingering confusion or as short as possible so you can get on with the story is up to your creative judgment.

Don't go dissolve-happy. Don't use a dissolve where a cut would be better. Don't use a dissolve or a cut when camera movement would be better.

THE FADE-OUT AND FADE-IN

The motion-picture connotation of the fade-out has been retained in television. The fade-out is sometimes called the "dissolve to black" in television because of the way it is done with the dissolve control. It has a connotation of finality; it indicates an end to something. It may be used in place of a dissolve to link sequences together where there is a greater change in time or place than is usually indicated by a dissolve. A dissolve retains continuity; a fade-out-fade-in breaks the sequence. It is not good, for instance, to fade in and fade out a series of titles, since the audience will think with each fade-out that they have seen the last of the series. Similarly, a play divided into a number of short scenes with fades between will lack the unity it might have had if other devices had been used. If the fade-out-fade-in is done rapidly (in less than two seconds all told), it does not end continuity so completely and can be used for many of the same purposes as the dissolve.

The most dangerous aspect of using fade-outs in television is that the length of blank screen between fade-out and fade-in may be too long. Audience interest drops very rapidly when there is nothing on the screen. There may be exceptions to this rule: certainly when sound or music carries through, the wait is not so bad. However, the timing of the fade-out, the blank screen, and the fade-in should always be carefully planned and rehearsed. The shortest possible blank screen is particularly important when the fade-out comes at the end of a program or spot announcement. Every second's delay in bringing up the next picture means an increasing loss of audience. Dial turning on television is a much greater problem than radio ever had to contend with. In stations where the same control-room crew must do one show right after another there is a great tendency on the part of directors and technical directors to fail to look ahead past the conclusion of one program and plan the moves that must be made to begin the next. They wait until the final fade-out, heave a big sigh, and then start hunting frantically through their sched-

ules and routine sheets for the next move while the screen remains patiently blank. This problem became so acute during the early months of operation at WPIX that a rule was made against any fade-outs at all. All transitions were to be made by dissolves.

There are other ways of doing fade-outs in a program than by simply turning down the gain, or dissolving to black. Fade-outs can be done with the lights on stage; the old familiar blackout. This is easier if the number happens to be lighted by one spotlight, which is all that needs to be cut. The light can be moved off the subject, or the subject can move out of the beam of the light. If the motivation is carefully planned, the camera can be panned off into a dark area or moved behind a dark object. This device was used by Olivier in the film "Hamlet." Another variation on this is to have an actor walk directly into the camera until he blocks out all the light. Whichever of these devices is used to effect the fade, it is usually effective to use the same thing in reverse for the fade-in of the following scene.

THE DEFOCUS TRANSITION

The defocus transition is akin to a dissolve and is used for somewhat the same purposes. The effect is simply that the picture becomes blurred, then clears up again, and a new picture is revealed. Some directors reserve the defocus for a transition backward through time and signify a flash-black by this means, while an ordinary dissolve is used for time lapses in the forward direction. This device is particularly useful when the sequence it introduces is led up to by an actor thinking, or falling asleep, or passing out. It is not necessary to use the full transition; simply a defocus and a dissolve to the next picture are often just as effective, and there is a shorter period of eyestrain for the viewer.

Making a defocus transition requires a little coordination between TD and cameramen. First you ready the camera which is not yet on the air with the order "Ready Two out of focus." When the moment arrives for the transition, give the next three cues in rapid succession: "Out of focus One. Dissolve to Two. Into focus Two." It is assumed that the cameraman on No. 1 will refocus his camera again without being told, as soon as you are through with the effect.

VISUAL CONFUSION OR INTERFERENCE

Almost anything which fuzzes up or confuses the picture can be used very nicely as an alternative to the dissolve. It is best, of course, if the first appearance of the effect is motivated in some way. People walking in front of the camera, fire, smoke, water, etc. in front of the lens—whatever is at hand will do. Distortion glass or erinkled cellophane in front of the lens might be used. These special transitions are rarely utilized

because they take time to rehearse and execute properly. But remember that the transition device may arise directly from the special effects within the show. Anything which confuses the picture will find its use somewhere as a transitional effect.

THE WIPE

The wipe is a cinematic transition in which the new picture starts as a small area and grows until it covers the entire screen. Film wipes can be made in a great variety of patterns, and new ones can easily be devised to suit special purposes. The simplest is the plain horizontal wipe. Several types of simple wipes can be done optically by shutters and masks in front of the camera. These will be discussed in Chap. 13. A wipe transition between, for example, two title cards, is not to be confused with a pull-off or slide-through, which is a bodily movement of the title in front of the camera. In the true wipe, two cameras are used (or two stages of an effects machine), and everything is stationary. The only thing that moves on the screen is the line of demarcation between the two pictures as the area of one grows larger and the other smaller.

No standard connotation was ever found for the wipe in motion pictures. It is very rarely used in dramatic films, finding its greatest value as a decorative device to dress up industrial films, film commercials, and the like, which depend on surface devices for their visual interest. A wipe is sometimes used to lead into a split screen effect. A man starts a phone conversation. On the opposite side of the screen a wipe begins, which proceeds far enough to reveal the party at the other end of the phone. When the call is over, the second picture wipes back out again.

The variety of transitions and effects which can be produced without special technical preparation depends on the flexibility of the available switching equipment. The following chapter will describe the standard switching systems which are to be found in most of the television studios and will indicate the usual things that a switching system will be called upon to do.

7 TELEVISION SWITCHING EQUIPMENT

There is considerable variation in design between the different switching systems put out by manufacturers of television equipment. General engineering departments of the major networks, and many independent stations, have designed and built their own systems. All these permit the operator to fade to black, lap-dissolve, and superimpose. Not all switching systems, however, will permit complicated effects such as cutting to a superimposure or cutting away from a superimposure to a shot on another camera. Not all will permit the operator to preview a superimposure before he puts it on the air. Before discussing specific equipment, however, let us consider the standard requirements of the studio switching system.

INCOMING PICTURE SIGNALS

A studio switching system must be designed to handle more incoming picture signals than merely those emanating from the cameras in the studio. Projection equipment is often used for titles or film portions of studio shows, and the film channels must also be controlled from the studio switching system. In small stations, the studio control room functions also as the film control room, sometimes actually containing the projection equipment in a back corner. In such cases, the film channel or channels normally feed through the studio switching system.

BYPASSING THE STUDIO SWITCHING SYSTEM

When a film or test-pattern slide is on the air and feeding through the studio switching system, the studio cannot be used for camera rehearsal. Any switching would disturb the program on the air. For this reason, there is always some means provided for bypassing the studio switching system and feeding directly from film camera to transmitter. The same

bypassing is provided for other incoming signals, such as network programs or a picture from another studio or a remote location. A series of master switching buttons is often installed for this bypassing purpose in the circuits between the studio switching system and the transmitter. Sound, of course, must be handled identically, but audio is a parallel system and not the concern of this chapter. Figure 7-1 shows a master switching panel for bypassing the studio switching system. Buttons shown in black are on. The film camera is feeding through the bypass

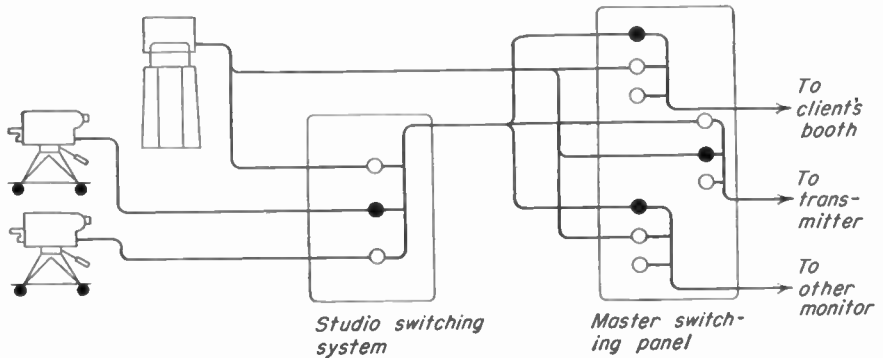


Fig. 7-1. Method of bypassing the studio switching system through the use of a master switching panel.

circuit directly to the transmitter, while the switching system is feeding only the client's booth and monitors.

PREVIEW SWITCHING

It is always a great risk to put anything on the air without being able to watch it right up to the moment of the switch. Every picture must be previewed somewhere before being switched onto the air. Not all picture sources which go to make up a program have their individual monitors in the control room. Incoming lines from projection rooms, remote locations, network feed, etc., are regularly used. A preview monitor is generally provided on which any of these may be shown. A special switching system controlling only the preview monitor (a single row of buttons) is necessary.

Some switching systems make it possible to use the master monitor for previewing these incoming lines. This is a poor practice, however, since it sacrifices the master monitor during the time another channel is being previewed. It results in a type of previewing which amounts to only a quick glance at the next picture, and it certainly is not desirable for best programming results.

DISSOLVES

A switching system must also be designed to fade channels or cross-fade them so that dissolves, fades, and superimpositions can be accomplished. There are three common ways to design a switching system to do these things.

1. *The Mixer Type of Switching System.* The first system provides each channel with a separate gain control and runs them all together into a mixer, just as the outputs of many microphones are mixed in an audio console. The signal from each source is collected by a common "bus," or copper bar, and this then feeds the program line. This kind of switching system may have separate switches, as well as separate fading controls. The old Mt. Lee studio of KTSL had such a switching system, built to the studio's own design. It had seven positions for fading, but no switches. Instantaneous cuts had to be approximated by very quick dissolves. The Du Mont "mixer" is a switching system of this general type, which provides for only four channels but has switches and a number of additional features and refinements.

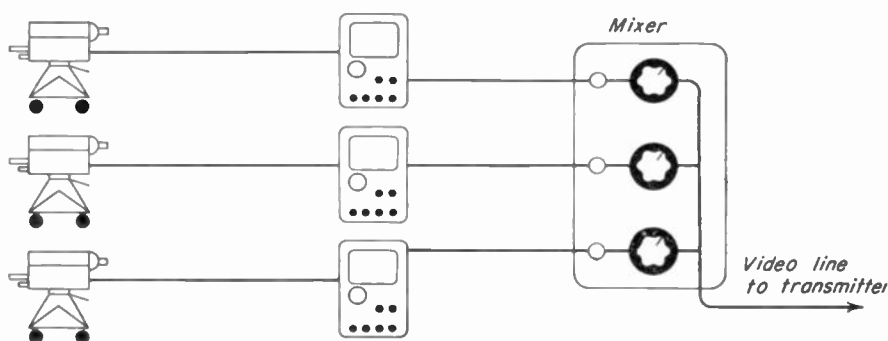


Fig. 7-2. Mixer type of switching system.

2. *The Dual Fading-bus Type of Switching System.* The second type of switching system provides two basic master channels, which feed through two fader controls. They are usually termed "channel" or "fading bus" *A* and *B*, and all the video channels which feed into the switching system can be punched up on either one.

Only one of these two channels is used when straight switching is desired: the fader control for the channel being used is left open, and the fader control for the other is closed. If you have been using bus *A*, for example, and wish to make a dissolve, first punch up the camera you will dissolve to on bus *B*, then simultaneously fade out bus *A* and fade in bus *B*.

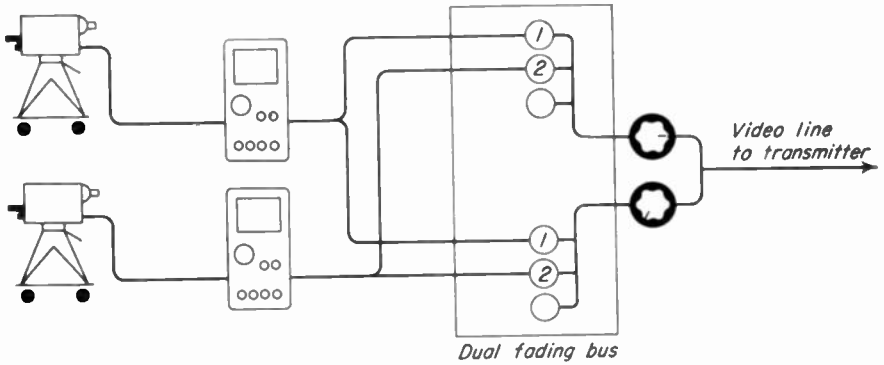


Fig. 7-3. Dual fading-bus type of switching system.

3. *The Three-bus Type.* The third system has three master channels, two of which are for fading and dissolving, as just described, while the third is intended for straight switching. The program-switching bus has an extra button marked *E* for *effects*, through which the combined output of the two fading busses must feed. Whenever dissolves or superimposures are desired, this button is pressed and the two fading busses are operated exactly like a two-bus system. The three-bus method permits switching to a superimposure or switching away from a superimposure to a single camera.

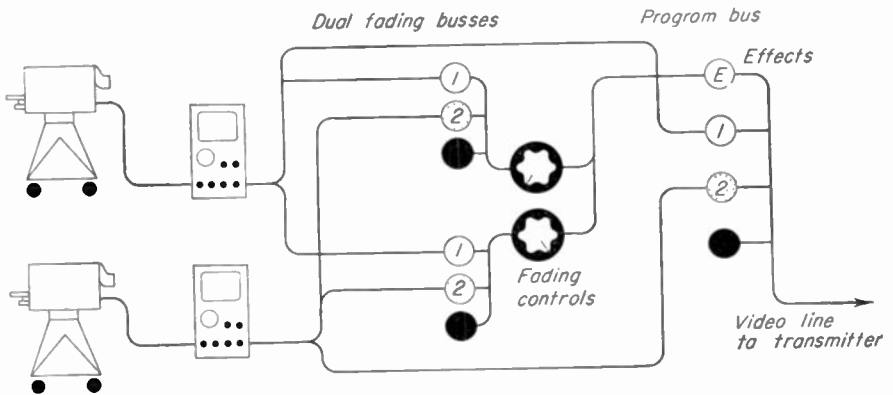


Fig. 7-4. Three-bus type of switching system.

THE RCA FIELD SWITCHING SYSTEM

This switching system contains only a single program bus (bottom row of buttons) with a row of tally lights just above. (The top row of buttons is for monitor switching.) The top third of this control panel

contains 13 toggle switches controlling a very complicated and flexible intercom system rarely used in its entirety. The middle third contains jacks for plugging in headsets.

Dissolves. When this equipment was designed in 1945 no one anticipated making dissolves in the field. Today an auxiliary switching system (Fig. 7-8) is available for use in making dissolves and superimposures. Lacking this, however, many stations have adapted the field switching system so that dissolves could be made (Fig. 7-7). Those who have not been able to alter the equipment still have managed to make dissolves by the following procedure (Fig. 7-6):

To dissolve from cam 1 to cam 2, first fade down the gain on the cam 2 control unit so that the picture is black. Then add it to the program line by punching No. 2 button, holding No. 1 button down so that it will not fly up. No effect is noticed on the air since the added signal is black. Dissolve by simultaneously turning down the gain on the cam 1 control unit and turning up the gain on the cam 2 control unit. The cam 1 picture is now black. It must be dropped from the program line and faded back up again. Hold No. 2 button in, and depress another button halfway, just enough to release button 1.



Fig. 7-5. RCA field switching system.

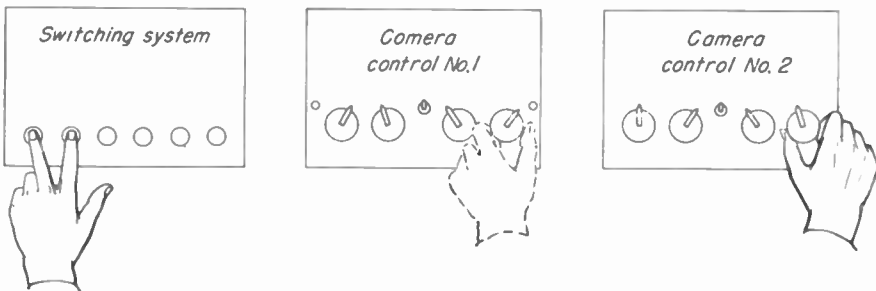


Fig. 7-6. Method of making dissolves with RCA field equipment.

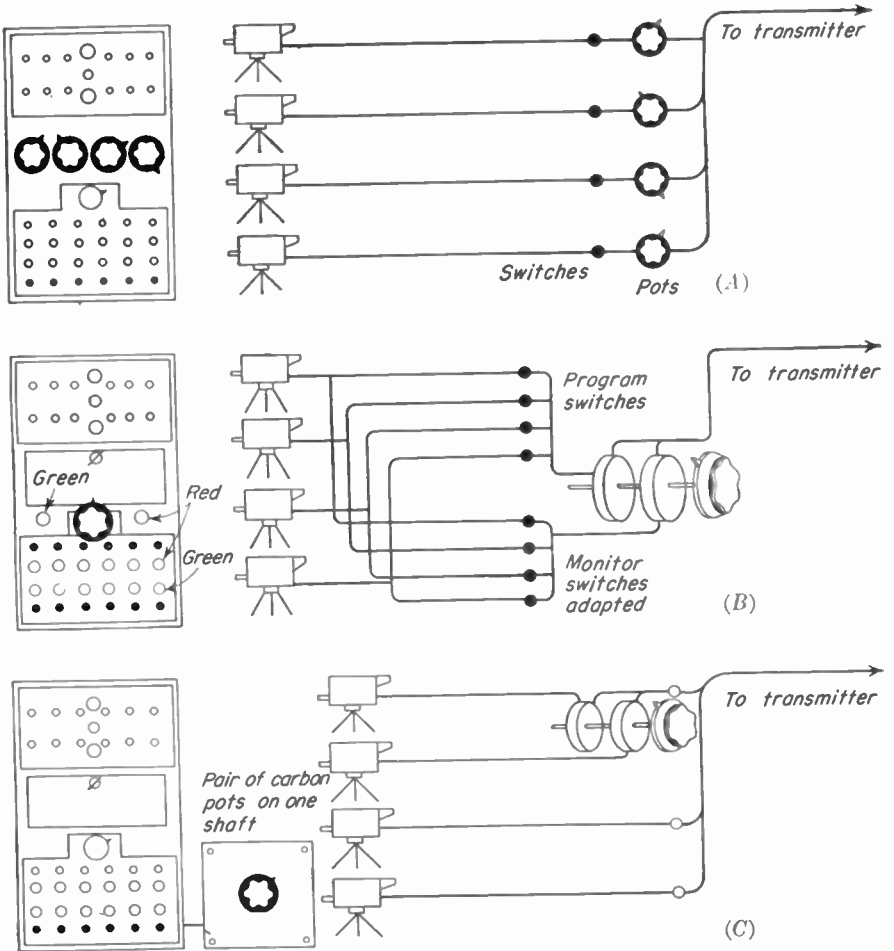


Fig. 7-7. Three adaptations of the RCA field switching system to make effects easier to achieve. (A) A pot added to each channel. This eliminates need to use gain control on camera-control unit and coordination with video engineer. (B) Monitor switching buttons converted into a second bus. Two carbon pots back to back on the same shaft operate opposite to each other, one fading out as the other fades in. (C) Dissolve box with two pots on one shaft as above. Takes output of two cameras and feeds into one switching position. Dissolving limited to only two channels.

THE RCA STUDIO SWITCHING SYSTEM

This is a dual-fading-bus system with two banks of push buttons each controlled by a fading handle. The combined output of the two fading busses is the program line. The two fading levers can either work separately to fade out one bus and fade in the other or, clipped together, will operate simultaneously for lap dissolves.

In Fig. 7-9, the two rows of buttons are connected to the two fading busses. The white row may be faded by the white handle, the black row by the black handle. Above the two rows of switches is a row of tally lights that show which channel is on the air.

Straight switching between cameras can be done with either bank of push buttons, provided that the fading control for that particular bank is open. The signal from camera 1, in other words, is carried to *both* white button 1 on the white row of buttons and to black button 1 on the black row. When white button 1 is punched, the signal goes onto the white bus and through the white fader control, if that control is open. If a dissolve is desired to, say, camera 2, button 2 must be preset on the black row (since the black fading control is closed, nothing happens to the program line). When the moment for the dissolve comes, the white bus is faded out and the black bus is faded in. The two

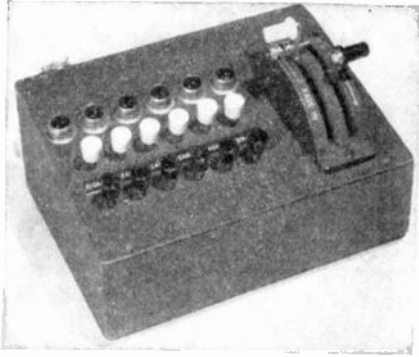


Fig. 7-8. Auxiliary field switching control (RCA). This operates exactly as the RCA studio switching system described in the text. It feeds into one of the six positions on the field switching system, making the combined unit capable of handling 11 camera signals.

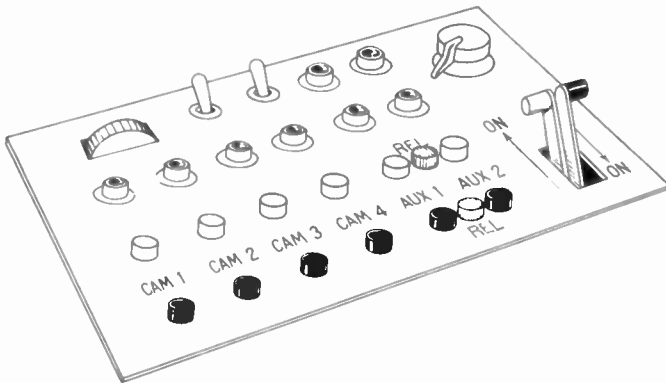


Fig. 7-9. RCA studio switching system.

fading levers work in opposite directions; that is, the "on" position for the white handle is at the top, and the "on" position for the black handle is at the bottom. Thus, at the beginning of the dissolve, both levers will be at the top, and so it is possible to work them with one hand and simultaneously fade one picture out and fade the other in (there is a spring clip with which the levers can be fastened together).

Fades. The fade-out-fade-in effect can be done in two ways. The first is "dissolving to black." Punch up the "rel" (release) button on the opposite bus and bring both handles down (or up) together. Then punch up the next camera on the original bus and move the handles back again.

The second method involves separating the handles. If the white bus is carrying the signal, bring only the white handle down for the fade-out. Fade in when ready by bringing the black handle down. This method is considered better practice because all buttons can be preset; only the handles are used at the time of the effect.

Superimposures. The halfway position in a dissolve is a superimposure, and the handles may be left in the midway position if desired. Each camera is then at half brilliance. This does not always make the best superimposure, however. Sometimes it may be necessary to superimpose a ghost onto a scene, for example, without making any change in the tone of the scene itself. In this case the two handles are separated, and the second one is faded up to the desired brilliance without changing the first.

Cutting to or from a Superimposure. It is not intended to be possible, in a switching system composed of two fading busses, to tie up both in a superimposure and then switch to another shot. There is nothing left to switch to; everything is in use. If another camera were punched up on either of the fading busses, the new picture would simply take the place of one of the other camera signals within the superimposure. One of the cameras must be lost from the superimposure before straight switching can be done. The same is true in getting into the superimposure. A straight shot must be taken first and the superimposed picture added; the two cannot appear at once. Technical directors with skill and ingenuity have discovered ways, however, to operate this equipment and effect a cut to a superimposure or away from a superimposure to a single shot.

A practical problem like this sometimes arises. A girl enters a room, sees a ghost, and speaks to it. But the ghost must be *in* the room as soon as we see it. We must then cut away from the room-and-ghost shot to a single shot of the girl as she speaks.

One method of doing this is as follows: Camera 1 takes the girl as she enters the door, camera 2, the room, and camera 3, the ghost (an actor in another set, brightly lighted against a black background). Camera 1 is on the air. If No. 1 is punched up on, say, the top row of buttons, punch it up also on the bottom row and set the handles halfway. Half the camera 1 signal is then coming through one fading bus and half

through the other. Now place one finger on button 2 in the top row and a second finger on button 3 in the bottom row, and press them both at once.

This produces a super which is the mid-point of a dissolve. To cut away from this superimposure back to camera 1 again as the girl speaks, simply press both camera 1 buttons at once.

A second method allows one signal to be made stronger than the other. Preset the black row of buttons with no signal. (This means punching up either the "rel" button or a dead channel.) Set the black lever to whatever position was found to be best in rehearsal. When the time comes, simultaneously punch camera 2 on the white bus and camera 3 on the black. To cut back to camera 1 from this, simply punch both camera 1 on the white bus and the "off" button on the black bus.

Dissolving to or from a Super. The only way this effect can be accomplished is to punch up two cameras on one of the busses. This results in half strength for each picture, but a dissolve can then be made to the other bus, either to a third channel or to another pair of channels (dissolve from super to super).

Note that when No. 1, for example, is on the white-bus, feeding program line, and No. 1 is preset on the black bus, there is no effect. If No. 1 and No. 2, however, are preset on the black bus, the level of the program picture drops. If No. 2 and No. 3 are preset on the black, there is no effect.

THREE-BUS SWITCHING SYSTEMS

The three-bus type of switching system is more common than any other in network studios. Figure 7-10 shows a three-bus switching system built by CBS. Instead of having a row of tally lights above every

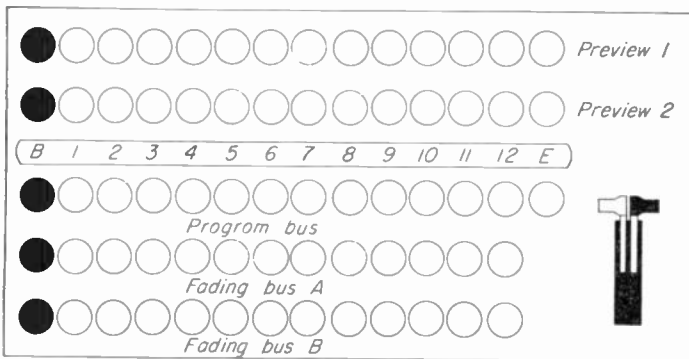


Fig. 7-10. CBS three-bus panel used with RCA director's console. "Off" or "black" buttons at far left of each row are used for "dissolving to black."

row of buttons. CBS used a plastic button which was in itself a light, going on as soon as it was punched. This was a practical simplification, and the manufacturers soon followed suit.

The advantage of having three busses in the switching system is that you can cut to or from a superimposed effect. The last button on the program bus is a special button labeled *E* for effects. A glance at Fig. 7-4 will reveal that when the *E* button is punched, the output of the fading busses goes out the program line exactly as if it were a two-bus switching system. Like any other punch button in the straight switching line, the *E* button flies out as soon as another button is punched, thereby cutting out the two effects busses entirely. In this condition the switching system is operating like a single-bus type, with no fading or dissolving facilities. Although the effects busses are not feeding the program line, their combined output can still be *previewed* by punching up a similar *E* button controlling a preview monitor. Two separate single-bus switching systems controlling each of two preview monitors are provided at the top of the panel. Thus it is possible to preset a superimposure, look at the effect, get just the right adjustment of strength from each signal, correct each cameraman's framing, all just before the effect is used. To cut to a superimposure, simply press the *E* button in the program bus. To cut away from it again, punch another button on that same top line, and the *E* button will fly out.

The usual method of operating this type of switching system is to use it like a two-bus system most of the time. Straight cutting is done on one of the fading busses so that a dissolve can be quickly preset and made with little advance warning.

It is only in the case of a special requirement such as a cut to a superimposure or the need to preview a super that the straight-switching bus is brought into operation.

If the TD is operating on the program bus when the director suddenly calls for a dissolve, he must go through several motions to make ready. To begin with, he must bring the fading busses into operation. To do this, he presets the same channel that is on the air on one of the fading busses, sets the correct handle in the "on" position, and punches the *E* button. No effect will be seen, and he is now ready to preset the other fading bus for the channel he will dissolve into.

THE DU MONT MIXER

The Du Mont switching system, though built for field use, is also well adapted to studio purposes. It is a mixer type of switching system, with separate fading dials for each channel. The manufacturer labels it "Mixer, Amplifier and Monitor," in recognition of the other functions incorporated into the same suitcase unit.

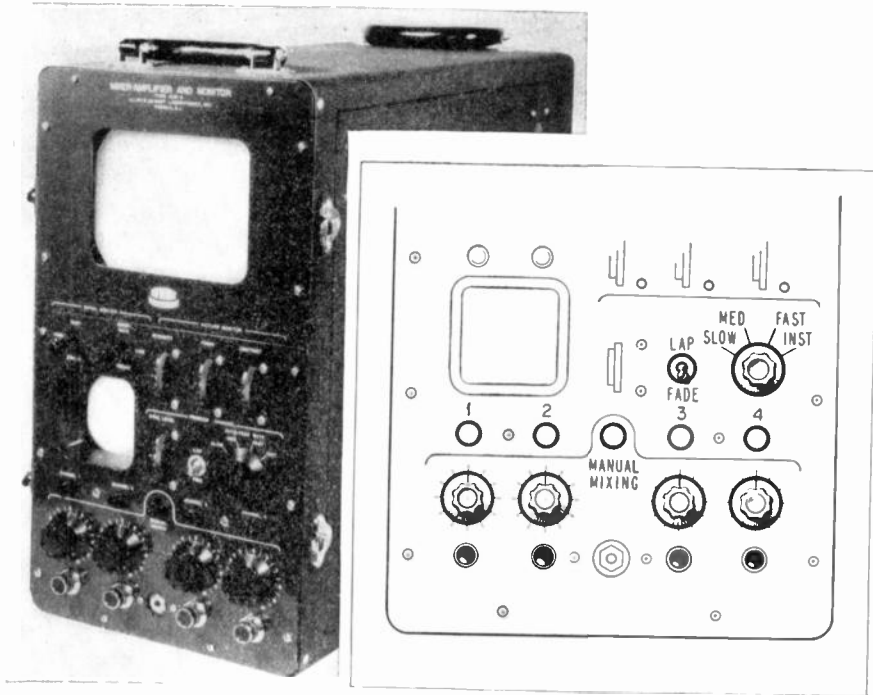


Fig. 7-11. Du Mont mixer.

Starting at the bottom of the mixer control panel, there is, first, a series of four tally lights for the four channels this equipment can handle. In the center of this row is an input socket for plugging in the TD's earphones and talk-back circuit. Just above are the four fading dials, and above each of these is a push-button switch. These four switches are mechanically interlocked like any group of switching buttons, and when all the faders are left open, straight switching can be done.

An unusual feature of this switching system is an automatic fade and dissolve, which can be actuated by these same buttons. Above the fourth push button is a dial marked "Auto Fade Rate." If this dial is set at "inst" (instantaneous), pushing the channel buttons results in straight switching.

If the automatic fade dial is set on any of the other three positions (slow, medium, or fast), a lap dissolve or a fade-out-fade-in will be made. A small toggle switch to the left of this dial selects either the dissolve or the fade effect. The only manual control necessary is punching the button for the new channel; the dissolve or fade then proceeds automatically at the selected speed. A fast lap is completed in $1\frac{1}{2}$ seconds; medium speed is 3 seconds; and a slow dissolve takes 5 seconds. The

fade-out-fade-in proceeds at about the same speed as the dissolve. Many TD's dislike the automatic feature because it robs them of exact control of timing.

Manual Operation. Since the automatic dissolve cannot be halted at a halfway point for a superimposure effect, another method of operation has been provided. In the middle of the row of camera switching buttons, divided from them by a white line, is a button marked "Manual Mixing." Punching this button has the effect of throwing all the other buttons into the "on" position. Control is then exercised only by means of the fading dials.

During automatic switching all the faders must be open, but the switching buttons are interlocked, and only one channel at a time is switched into the mixer. When the manual button is punched, however, all the channels are switched into the mixer and will all go out at once as one big superimposition, unless their fading dials are first turned to the "off" position.

The transition from automatic to manual operation is usually made in this fashion: All the faders are turned down except the one controlling the channel which is on the air. The manual mixing button is then punched. There is no effect on the program picture, since all that the manual button has done is to turn on the other three switches. It is now possible to fade, lap, or superimpose to any extent and at any speed, since everything is under manual control. If at any time a cut is desired, automatic cutting must be restored by punching the switching button of the channel that is on the air. No effect is seen, but all the other switches are automatically turned off. However, the other faders have been turned off and must first be turned up before a switch between channels can be achieved.

A super can be done automatically as follows. While No. 2 is on the line and before touching the manual button, turn all pots down except No. 3, which is left at the proper point for the superimposure. The automatic dial is now set for slow (or medium or fast) and the toggle switch on "lap." When the manual button is pressed, the mixer automatically dissolves from No. 2 to No. 2 plus No. 3, which results in a gradual superimposure. To lose No. 3, simply punch button 2, and the superimposure will slowly disappear.

The method of operating this equipment usually is as follows: The right hand is kept on the auto-fade-rate control, ready to turn it to "inst" if the director calls for a take or back to one of the other settings according to the director's ready cue. The left hand is used for punching buttons and working dials on the first two channels. The right hand generally handles the third and fourth channels.

Cutting to or from a Superimposure. The simplest method of cutting to a super is to punch two buttons simultaneously. The TD must mark the position of each fading dial during rehearsal and set them thus before the switch so that the balance between them will be correct. It is often found desirable, when two channels are punched up at the same time, to leave the fading dials full open and regulate the balance between the two pictures by riding the pedestal controls on the camera-control units. This requires either very close coordination between the TD and the video engineer or close proximity of mixer and camera-control units so that the TD can operate both. Cutting *from* a superimposure to another camera is very simple when this method is used; punching up the new camera will automatically release the previous two.

A second method makes use of the manual button (which throws all switches into the "on" position at once). The TD opens the two fading dials that control the cameras which are to be superimposed and then punches the manual button. The cameras will go on the line simultaneously. Automatic switching is no longer in effect, however, and the first switch will not automatically snap off. Unless the first camera is quickly faded down when the switch is made, there will be three picture signals on the air.

To cut from the two superimposed cameras back to the single shot again, the TD simultaneously punches the button that controls this camera and turns up its dial. Punching the camera button throws the system into automatic switching, and both the superimposed cameras are dropped from the line as the new camera is switched in. Since the fading dial for this camera had been closed before, it must now be quickly opened so that the signal can feed through.

To Delay a Fade-in. Sometimes a program will require a longer fade-out-fade-in than the automatic slow rate of five seconds. In this case, the TD may punch the fade-out and quickly turn down the dial of the new channel so that the automatic fade-in will have no result. Then, when ready, he will fade in that channel manually by turning up the dial. Another way to do this is to make an automatic fade to black. Since the automatic fade effect always includes a fade-in after the fade-out, if the picture is to stay black the new channel must be a dead channel. The TD will turn down the fading dial on a channel which is not in use, set the auto-fade dial and switch, and punch the button for that dead channel. The live channel will fade out, the dead channel "fade in," and the screen will remain black. Then, when he is ready to fade in the next picture, he will punch the appropriate button. The mechanism then makes a second automatic fade; the dead channel automatically "fades out," and the new picture fades in.

Dissolving to a Superimposure. At the mid-point of a dissolve to a super three cameras must be on the air at once. When the system is set for manual mixing, it is possible to fade down a dial with one hand and fade up two more simultaneously with the other. This can be done automatically, however, simply by punching two buttons at the same time. To dissolve from 1 to a super of 2 and 3, for example, set for lap and the desired rate, and punch buttons 2 and 3 together.

GENERAL ELECTRIC SWITCHING SYSTEMS

The small switching panel shown in Fig. 7-12 is a single-bus type quite similar in operation to the Du Mont mixer. A row of buttons at the

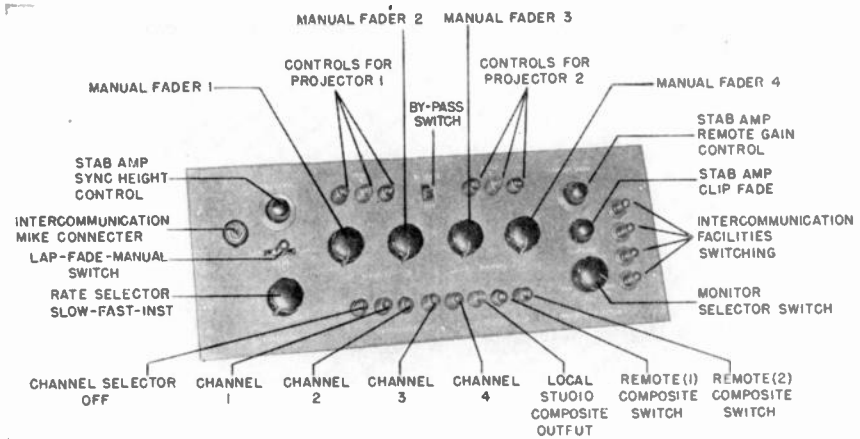


Fig. 7-12. General Electric TC 21 switching control panel.

bottom will handle four studio cameras and two exterior sources of picture signal. An "off" button is added to facilitate dissolving to black.

The four camera channels have individual fader controls. Instead of a manual *button* as in the Du Mont mixer, to throw all four switches on at once, the same manual control is combined with the lap or fade selector switch. A rate selector knob just below the lap or fade switch will choose between fast, slow, or instantaneous (for straight switching).

The other controls on this panel do not strictly control program switching. The monitor selector switch in the lower right will switch whatever channel is desired onto a preview monitor. Remote controls for two film projectors are added at the top. Most stations find they have to install such controls at the switching desk, and it is good to have them built into the switching panel. The three controls related to the stabilizing amplifier (Stab amp) are of engineering concern only.

A more complex switching system is shown in Fig. 7-13. This is a three-bus switching system with a row of buttons at the top to control a preview monitor. Automatic fades and dissolves are used in this switching system in connection with the straight-switching bus (second row from the top). Fade or lap and the desired rate of either are selected by a series of buttons at the left. The "direct" switch is the same as the instantaneous position on the Du Mont auto-fade-rate selector.

When a superimposure is desired or a specially timed lap or fade is necessary, the manual busses and fading handles can be employed. They are brought into operation by punching the "manual" button at the bottom left. This is similar to punching the *E* button on a standard three-bus switching system and renders the entire straight-switching

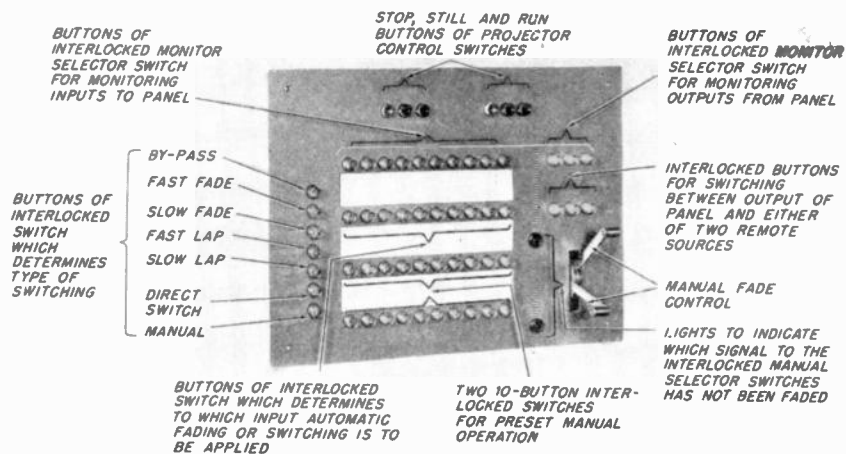


Fig. 7-13. General Electric TC 31 switching control panel.

bus inoperative. Pushing any of the other buttons in the left-hand line takes the system back out of manual.

A FIVE-BUS SWITCHING SYSTEM

There are some effects which are occasionally very useful, especially in musical shows, which cannot be achieved readily on any of the switching systems described so far. None will allow you to set up a superimposure, preview and check it, and then *dissolve* into it. Only the single-bus mixer type will allow you to dissolve *within* a superimposure so that one of the two pictures gradually changes. Only the mixer type will allow a triple superimposure, or allow a TD to dissolve from one super to another.

To give a few examples, in a song about memories the director may

want to superimpose a man's thoughts in one portion of the frame. If he can dissolve within the superimposure, the memories can slowly change during the song. A much more common example is the case where the director will dissolve between title cards which are superimposed on a live scene. A dissolve to or from a super is a natural transition and would be found useful in a great many instances.

A switching system capable of all these effects was specially built in the CBS studio in New York for the "Fred Waring Show." It was designed by Bob Banner, the director, and Al DeCaprio, the TD of the show and was built by General Electric.

This switching system contains five busses, one for straight switching and four for effects busses, in two pairs, each with its two fading handles (Fig. 7-14). The output of each pair of fading handles goes to one of a pair of master fading handles, which in turn feed to a master *E* button on the straight-switching bus. Each of the effects pairs has its own subsidiary *E* button so that the master faders can be bypassed if desired. In normal operation one of the effects busses is used for direct cuts and the other in the same pair for dissolves. The second pair of effects busses is used only when a dissolve to a super or another of the special effects mentioned above is desired. In this case one super can be on the air and another set up and previewed at the same time. If a dissolve from super to super is desired, this can be done with the master fading handles, fading out one pair of busses and fading in the other. The straight-switching bus is used when a cut to or from a super or other effect is desired. Another advantage of this type of switching system is that a superimposure can be faded out through the use of only one fading handle.

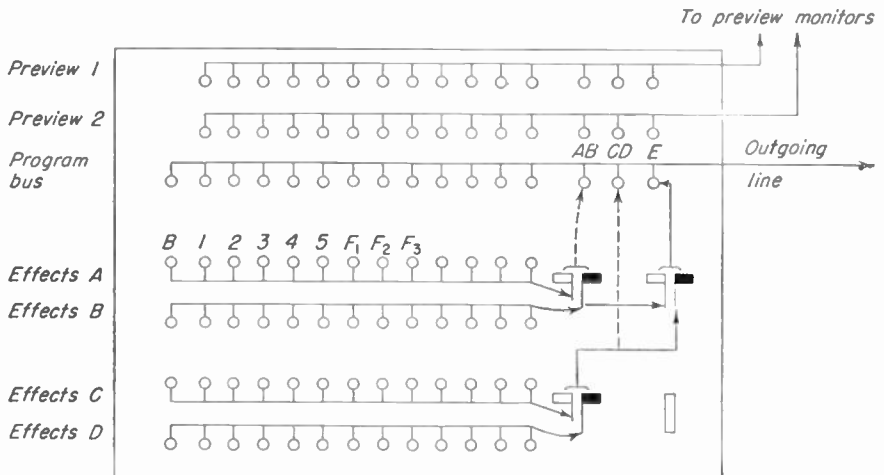


Fig. 7-14. Special five-bus switching system built for the "Fred Waring Show."

(With the two- or the three-bus type two controls must be used.) The extra space at the lower right of the panel is left for the future addition of vertical and horizontal wipe controls.

Electronic wipe controls have been built into many switching systems and operate very much like dissolve control handles. For further details on the operation of electronic wipes and switching panels for the control of montage effects see Chap. 15.

8 TECHNICAL LIMITATIONS AND THE PRODUCTION PROBLEMS INVOLVED

DEFECTS AND SPURIOUS EFFECTS IN THE IMAGE-ORTHICON TUBE

When the conditions of subject or lighting cause contrast range to be extreme, today's image-orthicon tube will exhibit certain strange effects. The viewer may see a black halo around bright objects, for instance, or streaks across the picture in line with the slats on venetian blinds, or a ghostly repetition of a bright object just beside it on the screen. These are called spurious effects and are due to "secondary emission"—uncontrolled electrons flying around inside the camera tube and landing in strange places on the target plate. Some other effects are functional defects within the particular tube and may show up worse as a tube becomes older. These will be discussed first.

DYNODE SPOTS

Sometimes tiny spots of light are visible which stay in the same place on the screen even when the camera pans, and disappear only when another camera is switched onto the line. These are called dynode spots, because they originate in the multiplier section of the IO tube, toward the back where the returning beam jumps from dynode to dynode, increasing in strength. Dynode spots are present in all tubes but are considerably worse in some. If the scanning beam is thrown slightly out of focus, these spots can be made to disappear, but at the expense of good resolution over the rest of the picture as well.

IMAGE RETENTION

The image-orthicon tube has an unfortunate tendency to retain an image that has been held on it too long, especially if the scene has con-

siderable contrast. A cameraman who has held his camera poised on a title for a few moments at the opening of a show often finds the lettering remaining on his picture long after he has left the title. This is particularly noticeable in an older tube.

Sometimes strange effects result from image retention. An actor will move in front of a background, for example, which has become "burned into" the television tube; and both the image of the actor and the background behind him will be seen. One can see through him like a ghost. The author once used a very old tube for rehearsal purposes which had such a bad case of image retention that it remembered everything it saw. When an actor who had been seated was asked to stand, there were two actors on the screen, one sitting, and one standing. Then, if the actor moved again, there were three.

To avoid burn-in, cameramen usually keep their cameras in constant gentle movement from side to side while they are waiting for the director to switch them onto the air. Holding the camera slightly out of focus will accomplish the same end, since an image must be sharp as well as constrasty to cause a noticeable burn-in.

When a tube has developed a burnt-in image, it can be erased by exposing the camera to an even, bright surface. Sometimes a cameraman will pan his camera back and forth across a bank of fluorescent lights. Accepted procedure is to illuminate a blank card or sheet of white paper and let the camera rest on it for an hour or more depending on the severity of the condition. A small flashlight can be used directly on the photocathode for this purpose and is standard equipment in many mobile units.

HALO

A particularly bright highlight will cause a black flare to develop just around it (Fig. 8-1). The greater the contrast between highlight and background, the darker and more extensive this halo will be. Unfortunate effects sometimes result from this defect, though sometimes the results are pleasing. Halo can be minimized to a certain extent by careful camera adjustment, but only a very close control of highlights and brightness range within the scene can eliminate it.

IMAGE-ORTHICON GHOST (IMO GHOST)

When a particularly bright object is seen against a dark background, not only is halo visible around the edges of the light area, but a ghostly repetition of the object is visible, displaced slightly on the screen. A title with white lettering on a black background will often display this effect. The farther the object is to the right of the screen, the farther the ghost is displaced upward to the left. Toward the left of the screen the



Fig. 8-1. The effect of halo around an extremely bright highlight. A small image-orthicon ghost is visible just beside the candle flame. (*Off-the-tube photo taken with facilities and through the courtesy of SRT television studios.*)

ghost image is displaced progressively farther downward and to the right. In the center of the screen, however, there is no displacement, and hence no visible ghost. Placing such a bright object in exact center screen, then, is one solution to the problem of imo ghost. A reduction in contrast range, either by darkening the object or lightening the background, is a better measure.

CLOUDING

Another spurious effect is noticeable when large, dark areas are included in the same scene with white areas of high intensity. The dark area does not stay dark but clouds up in the center in a manner which resembles lens flare in a film camera. If the light tone is kept down to no more than five times the shadow intensity, clouding will not be a serious problem.

STREAKING

This effect is noticed when strong horizontal lines appear in the scene, especially if they contrast strongly with the rest of the scene. A white or a dark streak appears across the picture in line with these horizontal shapes. This is due to the line in the scene falling exactly along the scanning lines of the tube (Fig. 8-2). If the camera angle is changed so the contrasty lines in the scene fall at even a very slight angle to the horizontal, no one scanning line will be following them very far and no streaking will



Fig. 8-2. Streaking caused by white venetian blinds. (Off-the-tube photo taken through the courtesy of SRT.)

result. A better solution is to note beforehand any horizontal set elements which may cause streaking and make sure these do not contrast too greatly with the rest of the scene. A tan venetian blind, for example, will look the same as a white one on the screen and will be much less likely to cause streaking, even when perfectly horizontal in the picture.

THE PRODUCTION PROBLEMS ASSOCIATED WITH COLOR RESPONSE

A bright color carries a strong hue to the eye because it reflects one predominant wave length of light, whereas a dull or in-between color is often a composite of many wave lengths distributed throughout the spectrum. If this predominant wave length is in the blue or in the red (at either end of the spectrum), it will sometimes elicit a different response from different camera tubes. A red dress has looked dark in one camera's picture but has come out a perfect flesh tone in another, providing a startling undressed effect. Designers have usually avoided reds and blues; and some have painted their sets in monochrome, either in shades of some single color or only in tones of gray. When this was done, there could be no possible difference in color response, even between badly matched cameras, and the designer could always know exactly how the set would look on camera. Even though current tubes have a panchromatic response, this is still a good method of working. Very few designers or scene painters, however, derive much enjoyment from working in monochrome.

Systems of color analysis always recognize three qualities to every color: hue, intensity, and tone (or value). Hue is what we usually mean when we say "color," *i.e.*, red, green, blue, etc. Intensity is the brightness of the color (bright red, red, dull red, etc.). For each intensity of each hue there is then a full scale of tones ranging from the lightest tint to the deepest shade (pink, red, maroon, etc.). There is an almost infinite variety of colors which the eye can detect and which an artist or designer might decide to use in front of a television camera.

In black-and-white television we must ignore the hue. Whether a color happens to classify as a green or a red will make very little difference since the television tube will turn them all into monochrome anyhow, in the same shades as they appear to the eye. The intensity of the color can also be ignored. If all other factors are constant, a bright red will look exactly the same as a dull red on the television screen. This leaves only tone to be considered. If we can determine by looking at a color just what its tone is, we shall know how it will look on the television system.

Colors can sometimes be deceptive. An artist may use two colors which contrast with each other, not in tone, but only because of their difference in hue. On camera he may be surprised to find both colors registering with the same tone of the gray scale, so that any pattern or picture which depends on a contrast between them disappears entirely. Oranges and grapefruit are of different hue but very close to the same tone, and the oranges must often be made up with a darkened wax to give them a contrasting shade. Sometimes the colored labels and wrappers of commercial products register poorly when seen on camera. Some studios make photostatic reproductions of them. Whatever the color response of the photostat paper may be, at least the producer can see the effect in black and white beforehand and retouch if necessary, knowing that the black-and-white photostat will not suffer any great alteration of tones when it is seen on camera.

It is difficult to look at a color, forget its hue and intensity, and see only its tone. Squinting at it will help. Perhaps the best way is compare it with a scale of gray tones (Fig. 8-4) and see which it most closely resembles. Lay the scale against the color, and you will find that you can eliminate very quickly the grays which are lighter or darker in tone. This will leave one or two grays which are doubtful. As you squint at the gray scale, the boundary between your color and one of the grays will appear less distinct. The two will seem to "run together." This means they have the same tone. Calibrate your color according to the gray-scale number. This is the shade it will probably appear on the television system (provided, of course, that the camera tube is giving standard panchromatic response).

CONTRAST RANGE AND THE GRAY SCALE

There is a much more serious limitation to perfect performance of the television system than unbalanced color response, lack of sensitivity, or any of the spurious effects. How a performer will look on television, how a fabric or a paint will show up depend more on the tonal response of the television camera than any other factor. When the camera is pointed at a scale of grays, it will not register the same series of tones as are seen by the eye. There is a distortion of the gray scale. Briefly, it may be said that the lighter tones of the scale are condensed together and the lower tones also are compressed. Light tones all seem to go white, while dark tones tend to appear black. It is a rare camera indeed which can register all 10 tones of the gray scale. More often only 7 are visible, the other 3 looking like their adjacent tones. It has been found that tones from the central portion of the gray scale are reproduced more or less faithfully, and the best studio lighting and set design is directed toward keeping the important tones of the scene within this middle range. Lots of fill light is necessary on the set so that the shadow tones will not be too black. Film made specially for television use is photographed with rather even lighting and printed soft so that there is not too great a contrast range for the television system to handle. Night scenes on film are notoriously bad: all the shadows go pure black (with iconoscope edge flare to complicate the problem), and an exaggerated contrast results.

The limited tonal range is further reduced by the characteristics of the home receiver. The great majority of television receiver tubes are not capable of showing a greater range of contrast than 20 to 1. The tone of the screen when the receiver is turned off is the darkest black that the receiver can show. The brightest tone is usually twenty times brighter than this. Under ideal room-lighting and operating conditions a television receiver tube will show a range of 40 to 1, which is the range usually encountered in 35-mm projection on the theater screen. The human eye, however, is capable of seeing at least a 100-to-1 contrast range in an actual scene. It is evident, therefore, that certain tones (details within a shadow area or variations within a light area), although visible as distinct tones to the eye, and possibly also to the camera tube, will exceed the contrast range of the receiver tubes and go either pure white (the lightest receiver tone) or pure black (the darkest tone). If every tone in the original scene falls within a 20-to-1 range, however, the scene will be more faithfully reproduced on the receiver screen.

THE GRAY SCALE

Figure 8-3 is a 10-step scale of gray tones varying within a 20-to-1 contrast range. This represents the range of tones which ordinarily can

be used on television. Tone 1 is not pure white, but it will appear pure white on the television screen. Likewise tone 10 is not a black, but it will appear black on television. The full range from tone 1 to tone 10 can be used if the lightest and the darkest of these tones are confined to

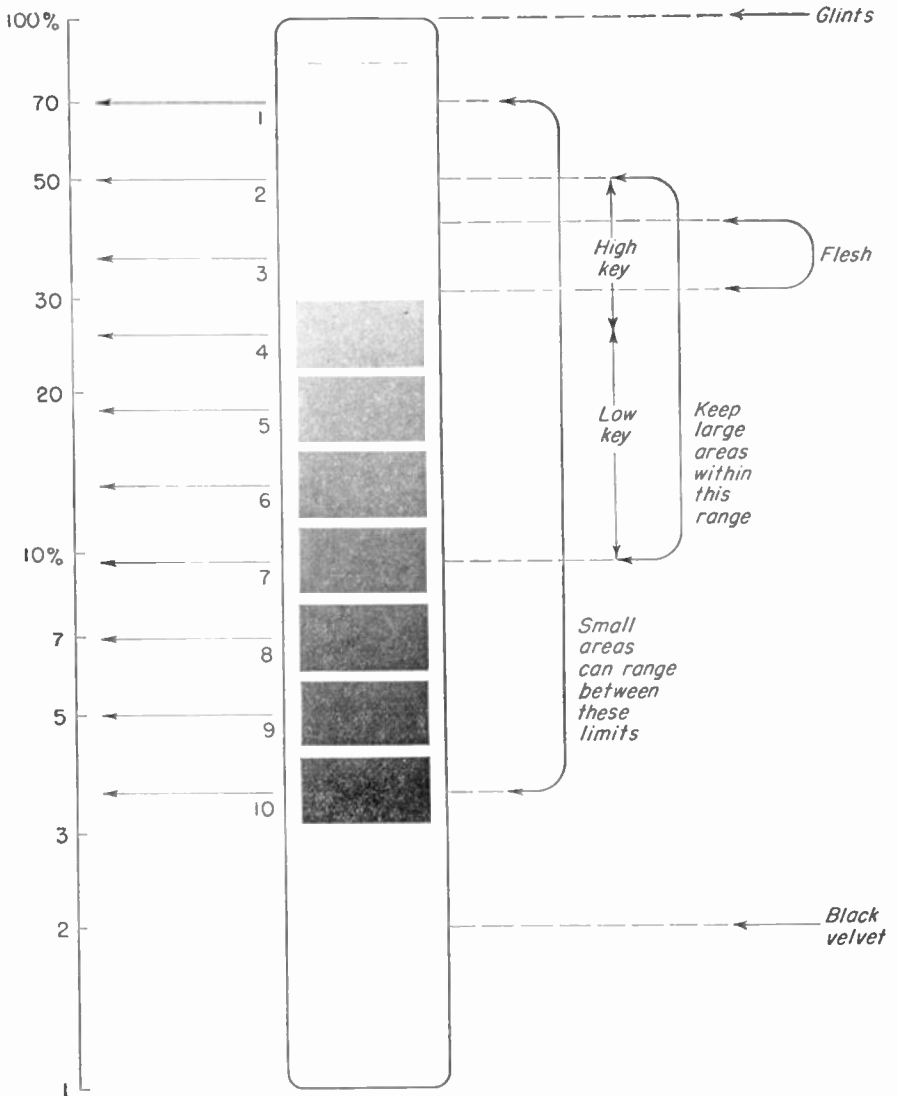


Fig. 8-3. Ten-tone gray scale calibrated in per cent of reflectance. Note that the reflectance scale is logarithmic (10 per cent is the halfway point). This is due to the human eye. A small increase in light will make the difference between two dark tones (just as a single candle will illuminate a dark room), whereas it takes a much greater increase in light to make the difference between two light tones. (Information for above chart from Richard S. O'Brien, CBS.)

small areas. Any large area of the screen, however, must be kept within a more limited range. It should be borne in mind, of course, that a close-up will enlarge an otherwise small area. Clothing worn by performers will often fill a large area of the screen in close-up or medium close-up and should be considered in the same light as large painted areas of the set.

Tones are measured here in terms of per cent of reflectance (scale at left side of chart). Merely a measure of the reflected light from a tone is not enough, since the brighter the illumination on the tone, the higher this measurement would be. Per cent of reflectance, however, will be the same in any light. A comparison of these per cents of reflectance figures will provide a quick measurement of the contrast range between any two tones. Tone 7, for example, at about 10 per cent reflectance, is one-fifth the value of tone 2, which is measured at 50 per cent reflectance. The contrast range between them, therefore, is 50 to 10, or 5 to 1.

A SIMPLIFIED GRAY SCALE

Although the 10 tones described above might be resolved by a good television system operating under optimum conditions, most television systems are incapable of this range. As tubes age, they tend to have a shorter gray scale. The control-room picture will often show no more than 7 or 8 tones, including black and white. Two or three of the tones on a 10-tone scale may look the same as the next lighter or the next darker tones beside them. This will be most likely to happen at the top or the bottom of the scale.

If this shortening of the gray scale is visible on control-room monitors, what will be the ultimate effect on the home receiver? It is not likely that the picture will be improved after transmission and reception; if it is changed in gray scale, it will certainly be for the worse. Many viewers set their contrast controls too high and inadvertently shorten their receiver's gray scale. The tendency to do this is particularly strong when there are other lights in the room which wash out the dark tones on the receiver screen. Furthermore, it is logical to assume that almost any home receiver will produce a poorer picture than a control-room monitor, even in top working order. A \$200 set cannot be expected to perform like a \$2,000 monitor which is serviced daily by expert technicians.

Accordingly, if seven or eight tones are visible on the control-room monitor, five or six may be all that a large percentage of home sets will show. In order to be perfectly safe, a five-tone scale can be chosen. An off-white, an off-black, and three grays are used: dark gray, medium gray, and light gray. If the television artist restricts himself to the use of these five tones, he will be perfectly sure that the tones he uses will be distinguishable on every receiver screen. If he tries to use more

tones than this, a pattern or lettering composed of two adjacent tones is likely to disappear completely.

Another type of gray scale, devised by the author, is shown in Fig. 8-4. This scale is arranged in two rows of five tones each. This makes it into two five-tone scales, one a step lighter than the other. The TV artist may choose either of these scales and, as long as he stays within it, will run little risk of losing one tone against another.

This scale may also be used in checking the tone of a fabric or a prop to determine whether or not it will be visible against the background with which it will be used. So long as the two tones are separated by two or

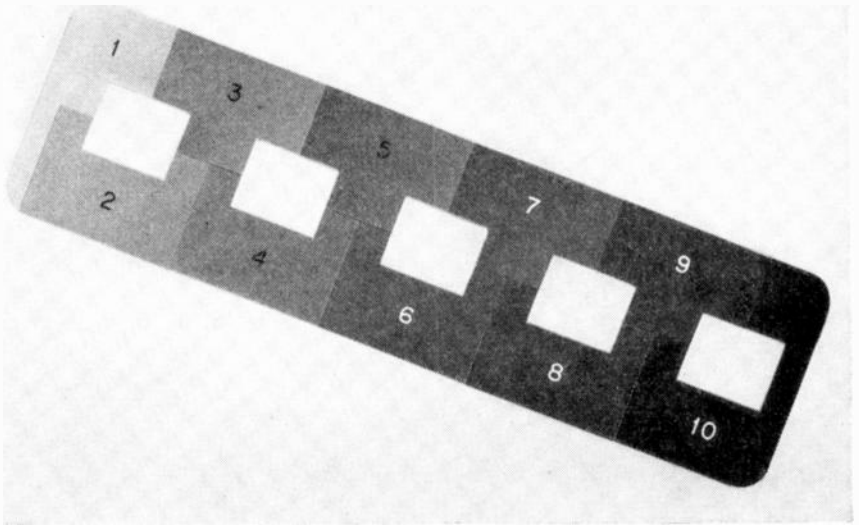


Fig. 8-4. Five-tone gray scale (10 tones are arranged in two scales of 5 each).

more steps on the scale, they are sure to show a contrast between them. One should be careful, however, about using No. 7 drapes against a No. 6 wall, for example, or a No. 2 bathing suit on a No. 3 model.

PRODUCTION PROBLEMS CONCERNED WITH TONAL RESPONSE

Technical men in Hollywood say that 90 per cent of the motion-picture business is concerned with the actor's face. Make the face look right, and the picture is acceptable. Miss out on proper rendition of the flesh tones, however, and no matter how perfect every other detail may be, the picture is rejected. This is just as true of television as well. The reflectance of the human skin is in the neighborhood of 30 to 40 per cent. This is seen by the eye as a relatively light tone which under proper illumination can show highlight areas of considerably higher value. The

variations of tone in the face, however, are subtle. The lighting man tries to keep these tones as close together as possible, knowing that beauty and glamour are easily lost if there is too much contrast between high-light and shadow. Any rendition of the face which exaggerates the tonal range will bring out wrinkles, undesirable forms, harsh edges, etc., which make any woman look ten years older. This is the effect that has given television the reputation of being merciless to the human female. (The same effect is not so damaging to the male visage, since a little added harshness often brings out lines of strength and virility.)

The important thing to note, however, is that the ability of the television camera tube to resolve the subtle face tones and reproduce them without exaggeration depends on *the other tones within the same picture*. If the performer wears a white dress or even a white collar and tie, the face can suffer. A recent television show was rehearsed without all the props; it looked fine in rehearsal, but when the show went on, it appeared that one of the acts involved drawing pictures on an easel. The easel was brought on stage complete with a large pad of white drawing paper, and when the performers stepped in front of this, their faces went pure black. To avoid experiences of this nature, the engineering staffs of the networks have worked out rules for staging practice as a guide to the producers and directors of the shows.

According to CBS, large areas of the set or of any particular picture (such as the dress or the background in a head-and-shoulders close-up) should be kept within a limited range. Small areas can exceed this range and appear as maximum black or up to as high as 70 per cent of total reflectance (off-white). Large areas should be kept within a middle range. From step 2 to step 4 (Fig. 8-3) is a wide enough range for the usual high-key scene. In the case of a low-key scene (dimly lighted interiors or exteriors at night) the reflectance of large areas should be between step 4 and step 7. If the scenery for a low-key scene is painted these dark tones to begin with, the low-key effect can be achieved without having to cut down on the studio light (with consequent deterioration of the camera signal).

In respect to small areas of the scene, these may range the entire length of the 10-tone gray scale (from $3\frac{1}{2}$ per cent maximum black, to 70 per cent, maximum white). They may not exceed this range without causing spurious effects, but since they are small and not likely to become a very large portion of a close-up scene, they do not have to be kept within the limited range which is allowed for large areas. White shirts and handkerchiefs are small areas of even a close-up scene, but these must be specially treated, or they will reflect too much light. Starched white cloth reflects 90 per cent of the incident illumination, which puts it way above step 1 on the gray scale. Not only will it come out pure white, but it will bloom

and cause halos and affect the tones of the face nearby. If the performer wears a colored shirt or a white shirt dyed a light blue or yellow, it will have a lower reflectance (equal to tone 1 in the television gray scale) and still look pure white on the television screen.

If dark clothing *must* be worn, the only thing to do is to keep the background low in tone. This will reduce the contrast range by holding everything else down to accord with the one thing (clothing) which cannot be altered.

The highlights caused by shiny or white props on the television set are a frequent problem. White refrigerators and kitchen equipment, shiny metals or polished surfaces are encountered every day. If these objects are not treated, halo will result, as well as other undesirable effects. A shiny black object is worse than a shiny light one, since the range between highlight and body tone is greater. Automobile advertisers usually prefer to display light-colored cars for this reason. Aside from this choice of the tone of the object, highlights can be handled either by cutting down the reflectance or by softening the light. Softening the light means eliminating all spots, open floods, sometimes even fluorescent tubes from the studio lighting.

Lowering the reflectance of a highlight can be achieved by one of several means. When the object itself is white and its regular reflectance irrespective of highlights is already too much for the television gray scale, it must be repainted. Refrigerators and other white kitchen and laundry appliances have commonly been painted with a light gray or yellow water-color paint which is washed off again if necessary. The interiors of these subjects are sometimes shown but do not have to be painted, since they usually receive so much less light. CBS uses a canary-yellow mixture of clear shellac colored with dry pigment for this purpose. This can then be washed off with alcohol and will hold up a little better than water-color paint. A permanent coat of flat paint is of course best.

HIGHLY REFLECTANT OBJECTS

When the surface of an object is shiny, light sources reflect almost as they would in a mirror; an image of each light is seen. This is called *specular* reflection. Usually this can be overcome by dulling the surface, by spraying on wax, soap, or some similar coating. Shiny oilcloth has been sprayed with a solution of shaving lotion for this purpose. A solution of epsom salts and stale beer is a standard (one tablespoon of epsom salts to one cup of stale beer). Mirrors are treated in this fashion so that they will still look like mirrors but will do a poor job of reflecting objects or lights. The solution is sprayed on thinly while the mirror is lying flat, and it is then allowed to dry before the mirror is used. Clear liquid wax is often sprayed onto shiny objects to cut down specular reflection.

White china teacups have been rubbed with lipstick on a rag. Spirits of camphor and sour milk have also been used to take down shine.

Occasionally one will encounter the need to televise shiny objects which cannot be specially prepared to reduce reflectance. Jewelry and musical instruments appear in many shows; sometimes silverware must be shown in close-up. Silverware is an almost impossible subject to light by ordinary methods. At CBS a method was worked out in connection with the live commercials for "Silver Theatre" which involved the use of a method known to film production but rarely used on television, the method of tenting. A canopy of silk or muslin is built entirely around the subject with the exception of an opening for the camera on one side, and all lights are directed at the tent from the outside (Fig. 8-5). This produces the ultimate in soft, diffuse lighting, since the whole interior of the tent acts as the light source. The silverware does not lose its gleam, but there are no brilliant highlights to cause halo and tonal distortion.

The proper lighting is a very important factor in keeping the contrast range of the picture within the necessary limits. Subject contrast can be controlled by keeping the reflectance of objects and surfaces within the proper range of the gray scale, but lighting contrast can upset this if not properly employed. If dark objects are dimly lighted and light objects brightly lighted, for instance, the range of tones can be easily increased far beyond the television gray scale.

Because of the limited tonal response of the television system, engineers early insisted on the absolute minimum of lighting contrast. All portions of the set were illuminated equally from every possible angle. This was flat lighting and gave us rather uninteresting pictures (no modeling, no separation of actors from background, no highlights), but it was entirely necessary for good tonal rendition. The television concept of *basic light*, something new to the photographic field, developed from this need. Television producers with film or photographic backgrounds fought against this concept, knowing that the only way to achieve good lighting was through the artistic use of highlight and shadow.

During the last few years it has been found that it is possible to retain

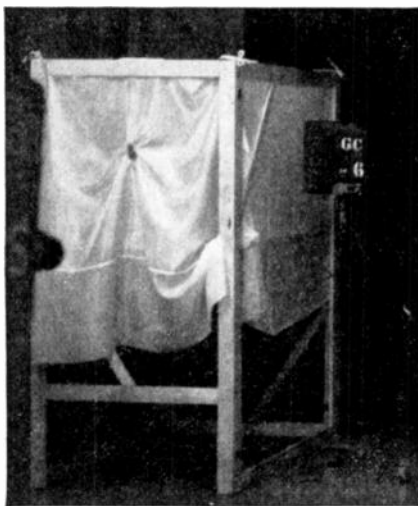


Fig. 8-5. Tent for lighting silverware. Used for commercials on CBS program "Silver Theatre." (Courtesy of CBS.)

the engineer's basic light and build a creative use of lights around it. Once the basic light is established over all portions of the set and from all possible camera angles, then a certain amount of lighting contrast can be permitted for purposes of snapping up the picture, bringing out the form of objects with modeling light, back lighting to help foreground objects stand out from the background, etc.

LIMITATIONS OF THE PICTURE AREA

Another serious limitation of television transmission is the loss of picture area around the top, bottom, and sides of the screen.

The height, width, and centering controls on a television receiver are usually adjusted only by a more or less competent serviceman, but on many sets they are not too well hidden, and the owner of the set may alter them from time to time. The result is that a certain proportion of sets are out of adjustment in regard to picture size. This maladjustment is usually made in the direction of overscanning of the receiver tube, since the results of underscanning are much more noticeable (Fig. 8-6).

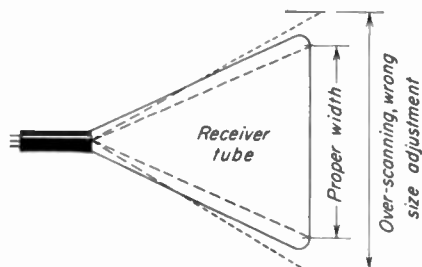


Fig. 8-6. When the height and width controls on a receiver are set for too wide a sweep, the beam will strike the sides of the tube and only the center of the broadcast picture will be seen.

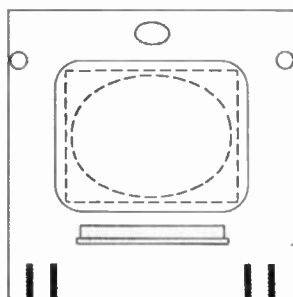


Fig. 8-7. CBS monitor overlay indicating areas of picture loss.

Several formulas have been worked out for determining the area of the picture which will always be visible, even on poorly adjusted or circular screen receivers. This area will be referred to as the "copy area." Subject matter which is considered absolutely essential (such as the commercial message or an object of importance to the plot) must be kept within this area. The total original picture is called the "camera field."* The border area within, which when added to the copy area makes the camera field, may be called the "supplementary area." Information supplementary but not essential to the picture may be included in this region.

* The camera field is also called picture area, scanned area, transmitted area, or exposed area. The copy area is known in some stations as the essential area, lettering area, safe area, or usable area.

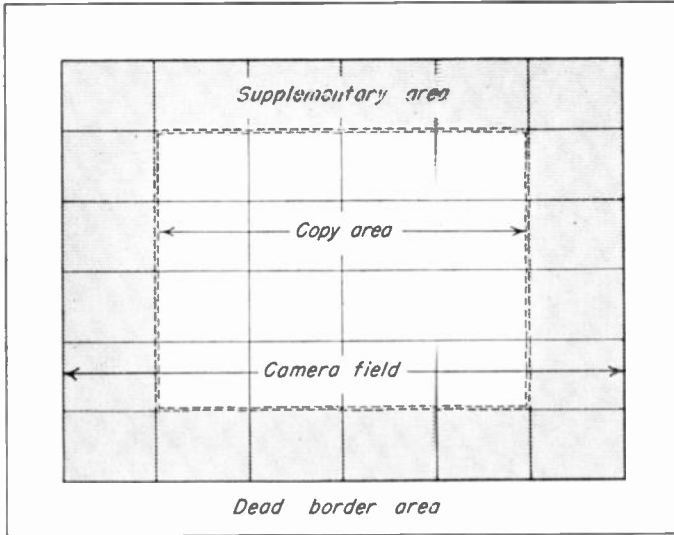


Fig. 8-8. The rule of one-sixth. A good method of establishing copy area. One-sixth of the width on each side and one-sixth of the height, at top and at bottom, is considered only supplementary area.

CBS television has approached the problem in a logical way. A celluloid sheet, outlined in an oval shape, is laid across every monitor and camera view-finder screen. The cameramen call this the "ellipse of essential information" (Fig. 8-7).

All the formulas for determining the essential area seem to agree on one thing: The copy area should be no larger than half the total size of the camera field. The surest formula involves dividing both height and width into six subdivisions. Thus 36 rectangles are formed, each with a 3 by 4 aspect ratio (Fig. 8-8). The central 16 rectangles, then, constitute an essential area of a little less than half the total picture area, but of the correct 3 by 4 aspect ratio. A simple method of applying this formula is suggested for the graphic artist in the following chapter.

9 GRAPHIC MATERIALS

Anyone who produces television shows will find sooner or later that he must have a rather intimate knowledge of the many contributory fields. One of these is graphic art. Every show uses some kind of graphic materials, if it be no more than opening title cards. Some news programs and documentary shows have built the major part of their programs around such things as maps, graphs, charts, drawings, still pictures, and various kinds of simple animations. Commercials, particularly those which are produced on film, lean heavily on graphics for this visual material.

The simplest and most common graphic element is the title card. It is traditional to begin a film with a series of titles, and until rather recently Hollywood producers have tried to outdo each other in lavish production of this opening title sequence. Many of the early television productions tried to follow this tradition, but the rehearsal of complicated openings took entirely too much time. Sometimes half a director's rehearsal would be devoted to his opening and closing sequences—out of all proportion to their importance to the show as a whole. The simplest, quickest, and most straightforward entrance into a show has come to be accepted as best in television. Within practical limits, however, a great deal can be done to enrich a show through the opening titles. Style and design of lettering, for example, can do much to set the mood.

There are two basic ways of using a title, and of course innumerable variations within each and between the two. The first method is to show the title as a card, frankly, and nothing more. This is as far as possible from the motion-picture tradition. The most striking example was the opening of the "Garroway at Large" show, where a hand simply hung the title cards on the wall.

The other method is to disguise the method of production so that the title becomes, not a title card picked up by the camera, but only lettering

appearing on the screen. When the letters are superimposed on a background scene, this method is most effective. When the titles are changed by dissolving, either between cameras or between two stages on a projection machine, rather than leafed over or slid bodily in front of the camera, the edges of the cards are not seen and there is no clue as to their actual size.

Sometimes the titles can be integrated with the live action of the opening scene, in which case they may not be title *cards* at all. Byron Paul opened his CBS production of "Carmen" in this way, with titles in the form of bill posters on the walls of the exterior set. Figure 9-1 illustrates an unusual method of handling closing credits on the CBS-TV show "Big Top."

When it comes to still pictures, either art work or photographs, it is



Fig. 9-1. Some productions have found unusual ways of handling their titles.

much more difficult to use them frankly as pictures on cards. There is an element of illusion about a picture. There is much less, of course, in the case of a still picture than in the case of a film, but some illusion is still there. Perhaps you have seen a shot where a camera dollyed up on a painting in a frame: while the picture frame is visible, the picture is only a painting; but when the camera comes close enough to lose the frame, the picture (if the technique is a realistic one) suddenly imparts an illusion. It begins to have depth. Objects assume their full and natural size. One almost expects them to move.

This illusion of reality is further enhanced if the camera then dollies in on the picture or pans across it, or both. Carl Beier first demonstrated this magical effect at CBS in 1945 when he set up large Breughel prints and explored them with the camera. As the camera dollies in, it seems to pass foreground objects and to go beyond them, actually carrying the audience into the scene. Some very excellent motion-picture shorts have been based largely or entirely on still pictures brought alive through camera motion. Actually there is no perceptible difference between a pan shot across a still picture and a motion-picture pan shot across a static scene. Nothing moves but the camera in either case. When your still

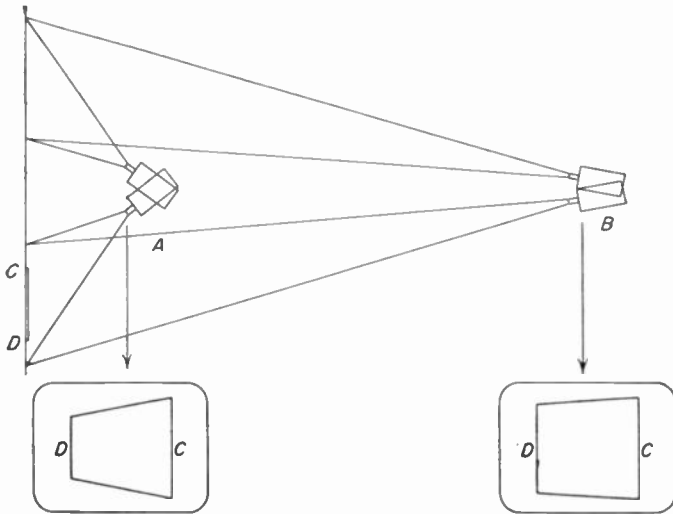


Fig. 9-2. (A) Camera in near position with wide-angle lens. Effect of "keystoning" is noticeable (square or rectangular area takes a keystone shape). (B) Camera in more distant position with long lens. Less keystoning because camera covers the sides of the picture from more nearly a perpendicular angle.

picture contains obviously arrested action, however, it is very difficult to make it look like anything more than a still.

Rather large blowups are necessary if the camera is to move around on them. The cameraman will be happier the larger these prints can be made. This will relieve him of the difficult focusing problem when a subject is very close to the lens. An 11- by 14-inch picture is about the smallest that a camera can easily pan around on. Prints 18 by 24 inches or larger are better for this purpose. The cameraman will prefer a long lens (narrow angle) with a distant camera position, rather than a wide angle, with the camera close to the print. From the distant position he can pan across a wider arc without introducing distortion (Fig. 9-2).

Still pictures can be cut into live scenes to give the effect of greater

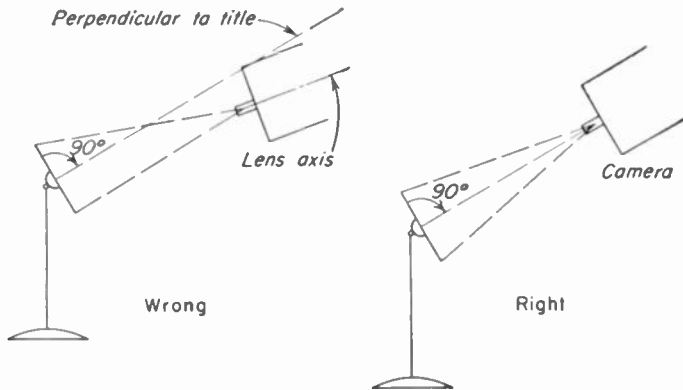


Fig. 9-3. Lens axis must be perpendicular to the center of the title, or title will be distorted.

space. In a recent production a couple walked through a zoo pointing at the animals in the general direction of the camera. Each time the actors pointed, a still picture of an animal was cut in briefly, giving the impression that the animals were actually in the set.

If a live shot is to contain no action or camera movement, it can as well be a photograph. Considerable saving on cost and studio space can be achieved if objects (such as furniture, household items, etc.) which are for static display are photographed first and the picture used instead of the live shot.

METHODS OF HANDLING GRAPHIC MATERIALS

It will depend on the studio and the operating procedure of the station whether it is more desirable to use titles on cards in front of the studio camera or on slides or halop prints in the projection room. Many New York studios are adapted from legitimate theaters and do not have projection equipment associated with them. To use film or slides in connection with programs originating in these theaters, a second technical and production crew would be necessary to man a film control room in another part of the city.

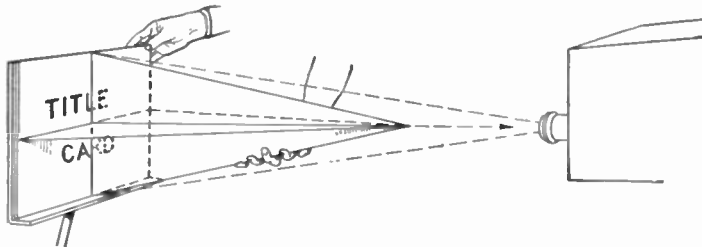


Fig. 9-4. Double T-square device to aid in lining up titles. Known as "Bretzaligner." Can be built of two pieces of cardboard, each notched halfway like dividers in an egg crate.

The main advantage of putting graphic materials in projected form is that the cameras are freed from the restrictions of easels, drums, and effects machines on the studio floor. There is more room for camera movement, and the cameras are available for live shooting. They do not have to be taken out of action when graphics are to be used. This is more important in a small studio with only two cameras than it is where there is plenty of room and three or four cameras are available.

Those who favor the use of cards and effects in the studio point out that coordination between operators is much easier and there is less margin for error when all concerned with the production of a show are in the same room. Thus the graphics operator can see or hear everything that is going on, understand his integration with the show better than he could in a distant projection room, and keep alert to his job during rehearsals. The floor manager is often the one who operates the titles

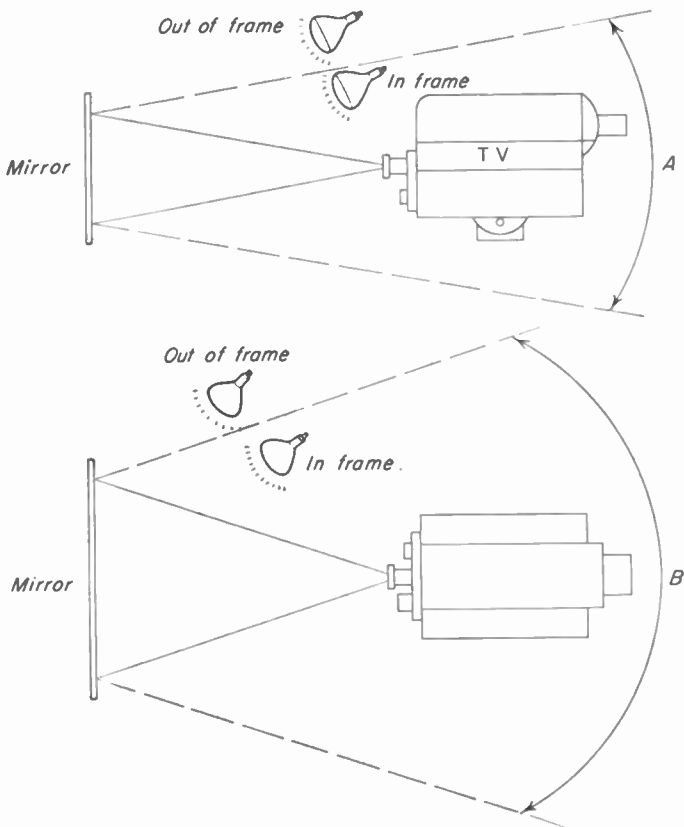


Fig. 9-5. Will lights glare off the title card? Imagine that the title is a mirror instead, and determine whether or not the lights would be in the mirror's field of view. (A) Vertical field of view, (B) horizontal field of view.

and effects machines on the studio floor. In areas where stage hands have union jurisdiction, this falls within their province.

Often one camera is kept busy on nothing but graphics. At ABC's Ritz Theatre in New York a special-effects studio is operated back stage, where one camera equipped with a Zoomar lens is surrounded by title devices, small objects, and whatever effects the show may require.

GLARE

In studios where floor lights must be used to illuminate the easels, it is often a problem to eliminate glare from the face of the card. Glare is reflected light which follows the regular laws of reflection (such as the second law, which states: The angle of reflection is equal to the angle of incidence).

Apply this to a camera and title card just as though the card were a mirror instead. If it were a mirror, would the camera see the light source in it (Fig. 9-5)?

If all light is kept out of this field of view, pictures framed under glass can be used, but this is impossible in the ordinary television studio. There is bound to be some light behind the camera somewhere, which will reflect in the glass. Glossy prints act like glass in this respect, and it is mandatory to use matte-surface pictures and title cards in the studio. In good opaque projection machines stray light is pretty well eliminated, and any surface may be used. Sheets of celluloid which don't lie flat, however, cause trouble anywhere. Wherever you put the light, if the celluloid bulges enough it will reflect the light somewhere along the surface of the bulge.

TITLE-CHANGE DEVICES

Studio Graphics. The dissolve or the cut are natural ways to join titles together but are not too practical for studio use. Two cameras must be tied up on titles, and many studios do not have a third camera which can be readied on the opening live shot. Some method of changing titles in front of a single camera or with a single film chain is more practical for most studios. Listed below are some of the most common means of doing this:

Fade to Black (or dissolve to black). The title is changed during the dark period. Not recommended, because of the feeling of finality in the black fade. Continuity is lost.

Fade to White. This can be done only in coordination with the video engineer, who controls the gain on the camera, and is rarely considered worth the trouble involved. The feeling of finality is avoided, however.

Blackout. Some 2- by 2-inch slide projectors include a shutter which momentarily blacks out the light as the slide is changing. The SVE projector model AK is of this type. This is quicker and hence more desirable than the fade-out.

Defocus. Crank the camera out of focus, pull the card, and crank it in again. This is all right if it can be done quickly, but too long an out-of-focus period is very hard on the eyes. An alternative method to cranking the camera is to zoom the title up to the lens either by hand or on a track, slide the new one in behind the first before you pull it out, and zoom back.

The Drop-in and Drop-out. Drop titles are generally punched with two or three holes and work vertically on a large ring binder. Drop-in

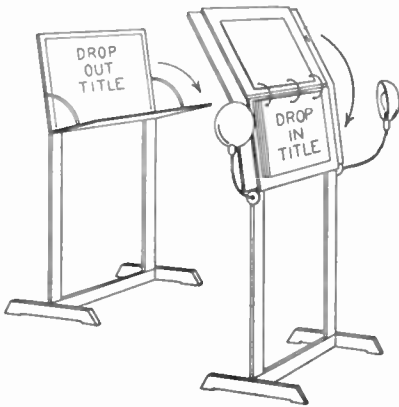


Fig. 9-6. Drop-out title in special stand; drop-in title on "hod." The hod may be equipped with its own lighting such as the gooseneck lamp shown.

titles have the holes at the top and are allowed to fall into position in front of the camera. Drop-out titles work the opposite way; the holes are on the bottom, and the cards are flicked away so that they drop out of sight, revealing the next card behind. This method may be a little slow and irregular on the beginning of the movement if the operator is not too deft. The drop-in title, also, commonly exhibits an irregularity of motion just at the end of the movement when the eye is trying to comprehend the new title.

The drop-in title has been used by NBC as a standard device in lieu of a better method. Every studio is equipped with special stands called "hods." The hod design provides a sloping top to hold the cards (Fig. 9-6) securely, and the operator moves each one forward on the rings and drops it on cue. The ring binding is superior to the separate-card method since it assures that cards will not be mixed up in order between rehearsal and air. It is routine practice for a director to check the order of his titles just before air time; the author can remember more than once finding separate cards out of order in the last few moments before the start of a show. The drop-card board should be lighted from in front, from the sides, or from below, but not from above or the shadow of dropping cards will precede them. Some hods have their own built-in gooseneck lights.

The drop-in title has been used by NBC as a standard device in lieu of a

An engineer at WLWT, in Cincinnati, designed and built a drop-title device which could be mechanically controlled. A large screw with very deep threads holds the top of the cards and slides them forward as it is turned. They are pushed forward at the bottom by springs. As each card comes to the end of the auger threads, it falls out of the shot, revealing the card behind.

Calendar leaves are made to drop off the wall, one by one, by mounting the entire pad on two knitting needles which can be withdrawn from the back of the set. As the needles are pulled back, the front leaf, unsupported, falls off. This could probably be applied to title cards as well except that the device is precarious and too fast a pull could easily send two cards falling instead of one. This principle of threading the object on a wire and pulling the wire to release it has been applied also to petals or leaves which must fall from a plant on cue.

Titles which turn like the pages in a book can also be fixed up with wires—in this case, however, wires of a heavier kind. Each “page” is fastened to a separate wire which protrudes through the back of the card. Moving these wires one by one on the back side will leaf over the pages in front (Fig. 9-7).

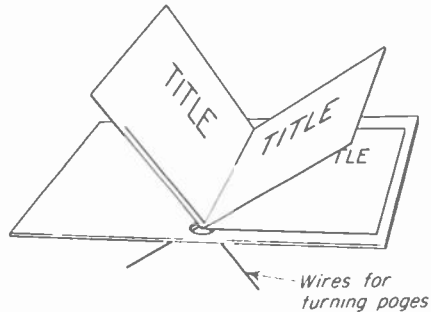


Fig. 9-7. Turning pages. Each page is attached to a stiff wire which is operated from the back.

The Pull-off. The pull-off is perhaps the simplest of all title-change devices. You just pull one title off to reveal the next one behind. Both cards must be the same size, however, and in perfect register. Without the ring binder to assure this, something must hold the cards in one place on the easel, or the action of pulling cards off the face may disturb the position of the others beneath. The author developed a card box for this purpose at CBS, deep enough to hold two dozen cards, open at the top and one side. A phosphor-bronze spring at the back of the box pressed the titles up against the front, where they were held by a half-inch rim around all sides. There was enough spring in the phosphor bronze to keep even the last card flat against the front, where it was in the same plane of focus as all those which had gone before (Fig. 9-8). When this device was adopted in the small studio at WPIX we even eliminated the supporting easel and fastened the card box directly to the wall of the studio.

The pull-off method is used in certain types of opaque projectors, such as the Multiscope and Projectall, where the slides are placed in the machine in a pack. Since the cards must usually go into these machines

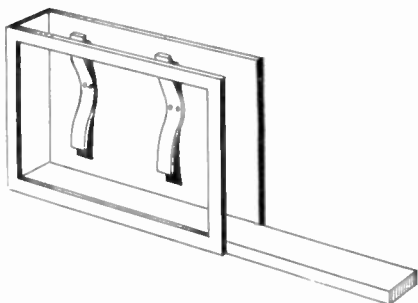


Fig. 9-8. Card box. Springs at the back force cards against face of box. Extension of bottom prevents wiggle as the cards are drawn out.

upside down and are pulled up, the pull-off gives the effect of the title sliding down off the screen.

In mounting pictures to be pulled off in this manner, be sure that the picture extends to the trailing edge. It is undesirable to see an expanse of white border slide by as the card is removed.

The Slide-through. The slide-through is familiar to all who have watched stereopticon slides. One slide seemingly pushes the other off the screen. The slide carrier usually puts a lot of dark area between the two pictures, however. There are slide-through methods for opaque slides and camera cards which can eliminate the border so that one picture is in contact with the next.

We once used long slide boards at CBS, 6 feet or longer, which could be pushed across an easel. Luckily we had a large studio, or the length of boards sticking out at each side of the easel would have used up most of the studio room. Pictures were mounted to the boards, the camera lined up properly on the first one, and then the board was pushed through and marks established according to the cameraman's direction for each succeeding picture. The slide-through is a simple method of title change, when balop slides are mounted on long strips (described later on page 166).

Most of the 2- by 2-inch slide projectors have a standard slide holder that works from side to side. When slides are changed on the air with these devices, however, it looks like nothing more or less than a lantern-slide projector changing slides. That is enough to disqualify it from use. No worse criticism can be leveled at any brilliantly conceived special effect. "What do you think of this idea?" the production assistant asks. "Well," says the director, "you know what it will look like, don't you? It'll look like just exactly what it is." That's all that needs to be said; the idea is dead. But if you ever need the effect of a lantern-slide projector changing slides, you know how it can be achieved.

Drum (for separate titles). Round, square, and octagonal drums have been used in studios for quick title change. The round drum must be relatively large in comparison with the framed area, or the curve of the surface will be noticeable. Drums are always used vertically, since the

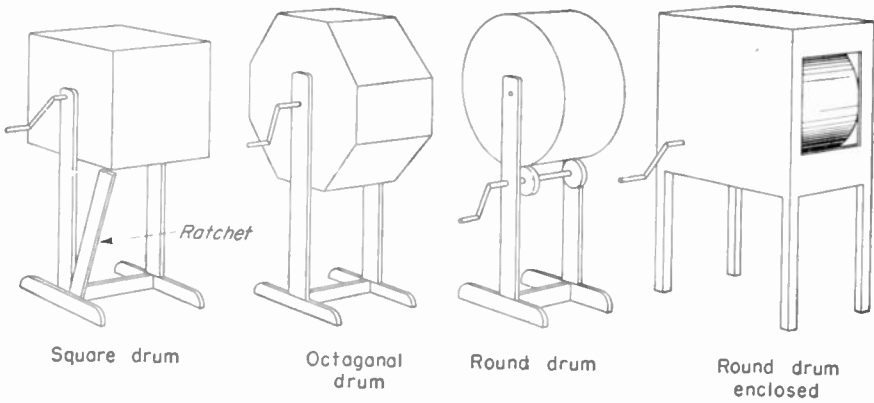


Fig. 9-9. Title drums.

vertical dimension of the frame is shorter and more pictures can be put on the drum when they run this way (Fig. 9-9).

A square drum eliminates the problem of the curve, but only four surfaces are available for cards. Hexagonal or octagonal drums have been built to make space for more titles per drum. These machines are bulky things at best and call for rather careful operation to start and stop them smoothly and accurately. Some kind of indexing device must be devised to stop a drum at the exact point where the next picture is squarely in the frame. A ratchet device which prevents the drum from turning too far until it is released is a good solution. If you try to do it by marks alone, you may find the operator going too far and having to back up to the proper point.

The Windmill. This is a variation on the square drum and gives much the same effect. Only four titles can be mounted on the windmill; but, with the proper design, titles can be changed during its operation on the stages which are not before the camera (Fig. 9-10).

Live-hand Change. The subject of title-change devices would be incomplete without a description of the device known as the human hand, appearing before the camera. Some of the most interesting title changes are done by this method. Titles are even written by hand before the camera when all that is necessary is a quick

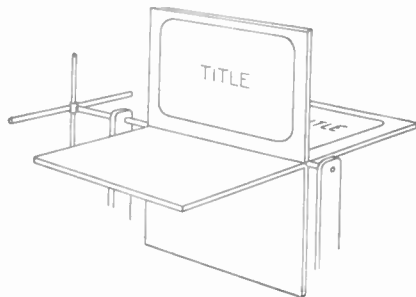


Fig. 9-10. Windmill.

scribble on a memo pad or a scrawl on a blackboard. Any kind of careful lettering, however, will seem to take an interminable length of time on the air.

Bert Gold devised a very clever method of lettering quick titles by working with a single-stroke brush on the back side of a sheet of glass. The formation of a title or a commercial message took a relatively long time at best, however; and it was mostly the fascination of watching the title take shape that made the technique interesting. (Sometimes key letters were left until the last so that the title remained a mystery until the end.)

One of the best title devices in the author's memory was used by Dick Rose to open the Gloria Swanson show at WPIX. Titles were in elegant script on large cards that looked like engraved invitations. They were pictured lying casually on a silver tray, with a gardenia nearby, and a delicate hand reached in with each new card and laid it on the others.

Flipper. This is a derivation of the drum and windmill device but holds only two cards. It is a two-sided drum. A flipper can be rotated

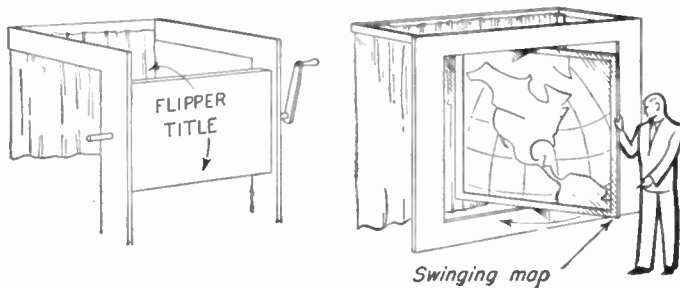


Fig. 9-11. Vertical and horizontal flippers.

either on its vertical or on its horizontal axis. The author has used the flipper principle for large news maps which could be swung around to show a second map, sometimes a close-up of the first, on the reverse side (Fig. 9-11). In the case of both the 11- by 14-inch flipper and the swinging map, a change could be made on the back side if time were allowed, and a series of pictures could be run. However, at the halfway point of the flip, the cards are edgewise to the camera and don't occupy the entire screen, so that whatever stray studio equipment, stagehands, etc., happen to be standing behind the machine will be seen, if only for the briefest moment, and registered on the eye. A special backing is necessary for these machines; usually a simple curtain will suffice, hung as close to the machine as possible without interfering with the movement of the flipper.

Venetian Blind. Titles have been lettered on venetian blinds or specially built gadgets of the same design. A quick change to another title is effected by reversing the blind; and there is a third, though less legible condition, where the blind is left open and a card behind shows through. It is very difficult to disguise the cracks between the vanes, even in a carefully constructed machine; so don't use this device where there is any reason for not wanting it to look like a venetian blind. WSPD put this device to good use in a commercial for selling blinds. KLAC have such a device; after doing two titles, they roll the blind up and have another behind for two more titles. A blind with three-sided vanes has been used in display advertising—a field from which many valuable television techniques have been drawn.

The Disk. A title or still picture has sometimes been mounted to a disk so that it can be spun around for a special transition. Here, as in all movement, evenness is essential. It will not do, for example, if the operator of the disk can reach only a part of it to turn it and must alternately push and let go for a new grip. There must be either a crank for continuous driving or, what is even better, a heavy grindstone behind the disk to give it weight and balance. The flywheel will keep the movement smooth.

Crawl Titles. Titles that crawl slowly up the screen (up because the eye reads down) are familiar in television. Very often an entire series of titles will be lettered on a long strip, which is then fastened to a drum. The crawl is a method of title change similar to the push-through in horizontal movement, but easier to follow, since the eye naturally progresses down.

When a drum is used for this purpose, it must be constructed so that it can be turned evenly. The best drums are motor-driven. If the drum must be manually controlled, gear it down so that it takes several turns of the hand crank to move the drum the height of the camera frame. In this way starting and stopping can be smooth, and irregularities of movement are greatly reduced on the screen. NBC has standardized on



Fig. 9-12. NBC crawl-title device. Aperture in box, $7\frac{1}{2}$ by 10 inches. Camera field 6 by 8 inches. NBC suggest using a copy area (essential area) of 5 by 6 inches.

the title drum (which they call the "crawl") and equipped all studios with this device (Fig. 9-12). The crawl and the hod have been the only standard devices this network has used.

Several of the opaque projectors on the market include devices for crawling long strips of paper or celluloid through the projector stage. Several stations use these means for running continuous news sheets up the screen. Sometimes a crawl title is run behind a mask and seen through a window in a stationary title just above it. WRGB used to do this with a news sheet. Only four lines of copy were visible at once,

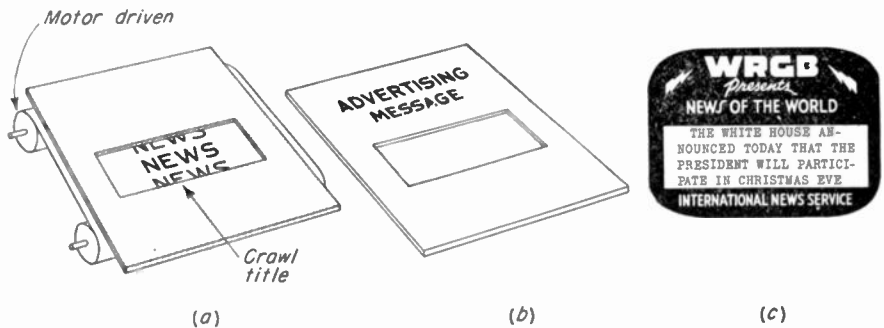


Fig. 9-13. WRGB newsheet crawl. (a) New copy on stage 1 of balop projector. (b) Advertising message on stage 2 of projector. (c) Effect of the optical superimposition of a and b.

the rest of the screen being devoted to a commercial message. Instead of running the crawl behind the title in one balop stage, it was run behind a black mask of the same size and shape as the title, which was then superimposed from another stage. Thus the border title or advertisement could be faded out and changed without disturbing the continuously running news sheet (Fig. 9-13).

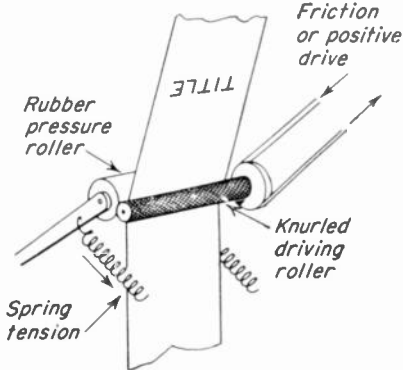


Fig. 9-14. Crawl-title drive mechanism used in several types of opaque projectors.

The mechanism for operating these crawl devices differs slightly in each make of machine but is based on one essential principle: a knurled roller which is turned very slowly by a geared-down motor, and a pressure roller, usually rubber, which is not driven but simply holds the paper against the other roller (Fig. 9-14). The paper may unroll from a spool and roll up again after passing the stage, or it may run into a basket below. WOR-TV uses a continuous loop of news sheet on its Multiscope machine,

which runs all afternoon. The loop can be broken into without program interruption, new stories added, and old ones taken out.

An advantage of the projector crawl devices over the studio drum is that the title moves in one flat plane up the screen; it doesn't curve away, as it would on a drum. At CBS in 1945, Chuck Holden built a device he called the guillotine, which made this possible on the studio floor. It was a long, thin board, to which a title could be mounted, with a gear train along each edge, so that it could be cranked smoothly up in front of the camera (Fig. 9-15). A guillotine strip would have to be over 6 feet long, however, to contain as much title as a 2-foot drum. A long, vertical board curved so that every part is equidistant from the camera will give the same result as the camera pans from top to bottom.

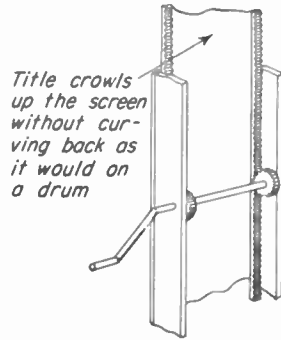


Fig. 9-15. Guillotine.

PREPARATION OF GRAPHIC MATERIALS FOR TELEVISION

Every station has slightly different requirements from the next, both in the manner of preparation of the material, and in the sizes of art work which its particular slide and opaque projectors can handle. The artist should make himself familiar with the requirements of the station (and sometimes even the particular studio of the station) where his work will be used so that these requirements can be met.

FRAMING

When any piece of graphic art is prepared for television use, it is essential for the artist to know the area on which the cameraman will frame, and also the inner area which is sure to be visible on every receiver screen. This problem has been explored in detail in the previous chapter; this section will suggest only a simple way in which the artist can quickly determine the copy area (the inner area which is sure to be seen on all receivers).

Titles and other art work are usually prepared on 11- by 14-inch cards. A border area an inch wide is allowed around the edges of the card to take care of fingerprints and damage from handling, and the camera field is established as 9 by 12 inches. The artist draws a line around this area and expects the cameraman to frame up just within this line.

The first step in determining the copy area is to divide the camera field into six segments (Fig. 9-16). To make sure the inner area is the

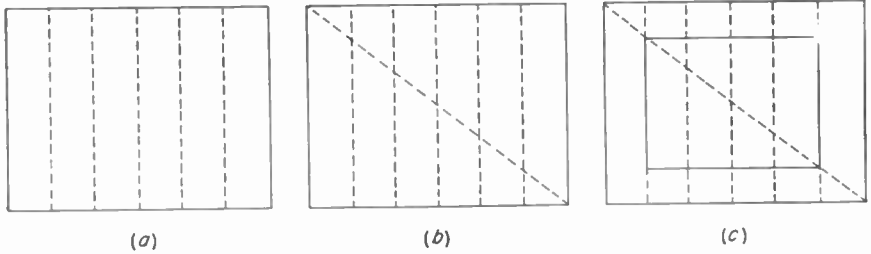


Fig. 9-16. Sherwin method of determining copy (essential) area. (A) Total picture area (dead-border area may surround this). Picture area (camera field) is divided into six vertical segments. (B) Diagonal is drawn from corner to corner to locate corners of the copy area. (C) Top and bottom of copy area are drawn.

same proportion as the picture area that has been laid out, a diagonal line is drawn from one corner of the picture area to the other. Where this diagonal line intersects the two outer divisions establishes the corners of the copy area. The next step is to draw the top and bottom of the copy area to meet these corners. Some artists have prepared framing guides of cardboard or heavy acetate to lay over their work. Whatever size the art work is, however, this same method of establishing the copy area can be used: a sixth of the width on each side, and a sixth of the height down from the top and up from the bottom.*



Fig. 9-17. Station title by Tom Nagaele, WATV. This composition is acceptable in a variety of framings. (A) Picture on control-room monitor; (B) framing seen on average receiver; (C) framing on poorly adjusted receiver—essential area only.

DETAIL

The question of the amount of detail which can be made visible on the receiver screen is an important consideration in television art work. It determines, first of all, the minimum size of lettering. Legibility is not always a matter of size, however. The design of the letters and the tonal relationship between them and the background are fully as important. Furthermore, it is possible to make out details on the screen by close examination which would strain the eyes to continue to look at for

* This method of determining the essential area was developed by Ray Sherwin when he was art director at Young and Rubicam.

any great length of time. The face of a performer is usually the important detail upon which close attention is centered, and one feels a welcome relief when a close-up is taken. No artist would like his work to strain the audience; he wants it to be easy on the eyes. He is obliged, then, to lay out his work in close-ups.

These are the factors that tend to confuse details in television pictures:

1. Soft focus—either optical (on the camera) or electronic (behind the camera) or in the home receiver.
2. Exaggeration of tonal contrast. Spotty pictures are hard to see anyway but are worse when the spots are exaggerated in contrast.
3. The small size of the TV screen in relation to motion pictures. Screens are slowly getting larger. For some time to come, however, a large part of the television audience will be watching on relatively small screens.

Determining the degree of detail is a matter of angles. A viewer 6 feet from a 12-inch screen takes in the width of the screen with an angle of view of about 10 degrees. A viewing angle of 10 degrees projected from the eye onto this book at normal reading distance would cover a width of less than 2 inches—almost postage-stamp size. We are working in thumbnail art. Try it some time, when there are visitors at home and you are sitting in the back row of chairs. Hold your thumbnail up to what seems like a comfortable scrutinizing distance, and see if it doesn't just about cover the television screen. This example is not the average; neither is it the extreme. It represents a certain portion of the television audience, a portion which must also read our titles and understand our commercial messages.

Some television artists prefer to sketch things out first in the 2-inch size. In designing a symbol, for instance, which is to appear on a map, it is first drawn on a 2-inch map, in the correct size relationship. Naturally, this is working in microscopic proportions. But it prevents the design from getting too detailed. If it can be seen on the sketch, it will come across the screen. Some artists use a reducing glass for this purpose; others just hang the work on the wall and step back across the room.

This is one test for clarity: look at it small. Taken alone, however, this is not enough. Because of the extremely good definition obtainable in steel engraving it is possible to see great detail in a postage stamp without the aid of a magnifying glass. But television does not have that definition. Occasionally a particular camera tube or a perfectly operating system will put out pictures of razor-sharp clarity. But as yet such picture quality cannot be sustained all the time, even by the networks.

The second test for clarity, then, in television art work, is to squint through your eyelashes at the picture.

This is a very valuable test. You can get a rough idea of how anything will look on television if you just step back and squint at it. This applies to film, sets, props, even people. Filtering the light through the eyelashes seems to cut down the brightness range that the eye can see. Detail is lost in the shadows; dark tones all go black; fine lines and small print are blurred or lost entirely. If you squint at the picture and still can see it clearly, grasp its meaning, read the lettering easily, then you can be sure the television audience will too.

TONALITY

Closely associated with the limitation on detail which the television system imposes on the artist is the limitation on the range of tone. Sometimes called "values" or "shades," tones range from black to white in what is commonly called a scale of grays. The tone which the television camera sees is not necessarily the tone which the artist intended, however. Several factors may operate to alter it. If facilities are available, the artist should prepare a series of tones of the paints he wishes to use and look at these on the television system at several times and with several different cameras. A detailed discussion of the response of the television system to the tones of the gray scale, plus the pros and cons of using color instead of monochrome in art work, is to be found in the preceding chapter. In a simple way, however, this is what the artist is likely to find when he puts a scale of tones in front of the television camera:

First of all, the number of tones between white and black which the camera can distinguish is limited. The eye can see many variations in tones between black and white. The television system can rarely see more than seven or eight. This range is further reduced by poor reception, so that it is safe to say that a maximum of five tones (including black and white) are sure to be distinguished on all television sets. Any attempt to use an in-between tone involves the risk of its coming out the same as the tone just adjacent to it on the tone scale. If these six tones (black and white and four grays) are standardized on to begin with, the artist can be certain that any effect he creates will look very much the same to the television viewer as it does to his eye. On the other hand, if he uses a great variety of tones, or hues and intensities of colors, he will be creating many effects which either will not be visible or may come out entirely wrong when the art work is seen on the television system.

Figure 9-18, a program title, is done in six tones. Note that black and white are used very sparingly, the former only for certain letters and



Fig. 9-18. Program title done in six tones. (By Tom Nagaele, WATV.)

small shadow areas, the latter only for highlights on the clown's face and sleeve and for decoration in the letters.

Edge Flare. Art work which is to be used in slides or opaque projectors will probably be picked up with an iconoscope tube. Studio title cards, on the other hand, will go before image orthicons. The iconoscope has a characteristic called edge flare which the artist should understand. Black areas near the edges of the picture will not stay black. The best procedure is to eliminate dark areas from the edges of the picture or break them up in some manner. A dark gray (Miller No. 5) is about the darkest you can use around the edges of the picture, according to Georg Olden.* For art work which is to be used in front of image-orthicon cameras, however, avoiding edge flare is not a problem.

In the case of superimposition of white letters over a live picture, the edge-flare problem is greatly minimized. When the slide picked up by the iconoscope camera is a pure black with white letters (a dark gray will do as well for a pure black and give the engineers less trouble), it can be shaded up without edge flare because there are no subtle tonal relations which might be distorted in the process. The black can safely go pure black, the white pure white, and when the slide is superimposed over a live scene, only the letters will be seen.

MATERIALS AND MEDIA

The television artist works in all media, but tempera is probably the most common. The airbrush is an essential tool in a well-equipped art department. Water color, black-and-white line, and sometimes the

* CBS-TV Art Director.

medium of collage is used (pasting up a composite picture). Quite often the artist is called upon to make three-dimensional models, retouch photographs, and make props such as book jackets, posters, etc., for use on the set.

Versatility is important in the television artist; few stations have hired specialists. Most small stations can afford only one man, and often he has other duties as well. He must be able to do everything; but most important of all he must have speed. The ability to do things quickly (and reasonably well at the same time) is a quality which is not new in television. From the producer and director on down, no one ever has what he considers adequate time to do a good job. The entire job of planning, laying out, and finished rendering of a series of drawings must be accomplished in a few hours' time.

STYLE AND TECHNIQUE

Television art is closest to poster art in technique. The poster must be seen and understood from a distance; tones and details are designed for their carrying power. The poster must be basically simple and clear, but it may have further subtleties and finish which reward a closer look.

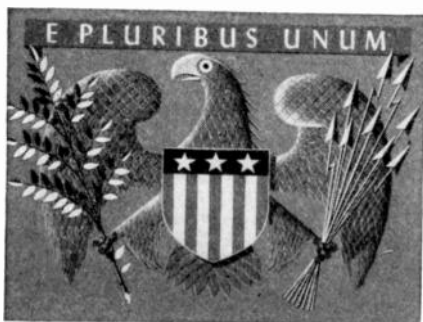


Fig. 9-19. Effective television art work. Upper left, station closing title used during playing of "Star-Spangled Banner." (By Tom Nagaele, WATV.) Upper right, program title (same artist). Lower left, program title by Arthur Rankin, WJZ-TV. Lower right, program title by Georg Olden, CBS.

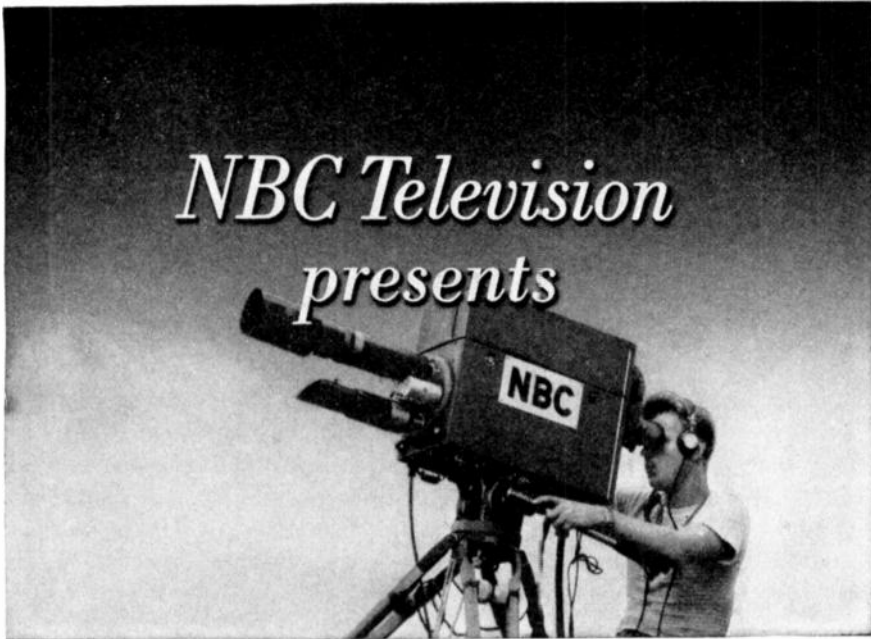


Fig. 9-20. Photographically rendered title. (By Martin Webber, New York.)

This is pretty much the same problem as television. "Carrying power" is necessary because of the small screen. Simplification in line, in detail, and in tonality is essential. Simple gradations of tone made with the airbrush are pleasing. A simplified cartoon or poster style of drawing figures and faces lends itself better to television than an attempt to be more realistic (Fig. 9-19).

Some of the best titles used by the network stations are finish-rendered entirely by photography. A photographer specializing in trick effects* can take the necessary lettering and, following a sketch of the desired result, produce shadows, tones, gradations, beams of light, etc., which are the same sort of thing that a renderer with an airbrush would do, but smoother and cleaner in appearance (Fig. 9-20).

LETTERING

Lettering is usually a problem in the television station. Although a staff artist can do good lettering, it is probably not his specialty, and it takes him a long time to do. More complicated alphabets and script are often entirely out of his line. The network stations in New York often farm out difficult lettering jobs to free-lance artists who specialize in this field.

* Martin Webber, 171 Madison Ave., New York.

There are a number of short cuts to lettering available on the market today, and one or another of these is to be found in use in every television station. Lettering aids are of several kinds: (1) the mechanical guide with which the artist draws the letter, (2) the ready-made letters (on paper or celluloid) which the artist assembles and fixes to his work; (3) the simplified printing-press devices, with fonts of metal type; (4) the movable type, which are set up and photostated, and (5) the three-dimensional movable letters. These will each be described in detail.

Some other methods of lettering have been used and deserve brief mention before a description of the five types of mechanical aids listed above.

Show-card Lettering. If the artist has had experience in show-card painting, he will classify as a lightning letterer. His style of lettering, however, will be very simple and not too accurate, but good enough for many purposes. He will choose a thin, flat brush called a single-stroke brush, the width of the letter he wants to paint, and without going back over his work will turn out signs at the rate of two or more words a minute. If an artist has not had show-card experience, however, he will fuss over his lettering and spend 15 or more minutes per word. The result may be much better, but it takes too long. It is much more economical to give him a mechanical aid.

Printer's Type. Television stations associated with newspapers have experimented with having their lettering set up by hand in the various type faces available and printed off on a good-quality paper that is usable in their work. This is all right when no particular rush is involved, but it would be a headache for the printers to try to do this on a regular basis. Don Figlozzi at WPIX has found that a file of names of various towns and geographical features is very helpful in the quick preparation of news maps (Fig. 9-21). This applies to lettering in small sizes; large type faces



Fig. 9-21. Printer's type set up in names which may be necessary on news maps. (A) Original, (B) negative photostat reduced in size.

at a newspaper are only upper-case and rather reminiscent of headline print.

Typewriter. A typewriter with oversize capitals (bulletin), another thing which is often found in a large newspaper office, can be put to good use in the direct preparation of titles. The style of type is much the same as that of teletype or news type, which is commonly used in television, and is suitable for purposes associated with news. If the station uses an opaque projector with a 3- by 4-inch stage, even standard typewriter titles can sometimes be used for special purposes or in an emergency. This is pretty small print, however, even in that size, and only the upper-case is clearly legible.

Spaghetti Board. This is a derogatory name that production men have given to the black cloth board with movable plastic letters that is used in restaurants for displaying the day's menu. The letters fit into horizontal grooves in the face of the board. WPIX found this very useful in their remotes work when covering harness racing. Before each race it was necessary to give a run-down of the entries, and this could be made much clearer if a list were visible to the audience. Entries were not known far enough ahead of time to allow an artist to prepare titles; so the production men set up the list on the spaghetti board. It is a quick, simple, and not very elegant method, but it gets a title on the air, even though it may have a cafeteria look.

Lettering Guides. Engineering supply firms like Keuffel and Esser sell lettering guides which consist of a long template with cutout letters within which the artist can trace his letter with a special vertical pen point called a LeRoy stylus. These are a little clumsy to use, some require two positions of the template to form one letter, and the variety of styles of lettering is limited.

A new development in this line has been found quite valuable by the television stations that have adopted it. It is called Varigraph and works on the same template principle, except that an adjustable pantograph machine is involved between the tracing of the letters and the drawing of the stylus (Fig. 9-22). The hand guides a stylus over the template, and the pen point forms the letters on the other side of the machine. A great variety of shapes and sizes can be produced from one template at the rate of about four letters a minute, and many attractive lettering styles are available. It is not possible to produce a letter any larger than it appears on the template, except with a special pen point, but it can be made one-seventh the height, or one-seventh the width, or any combination of width and height desired. It is possible for almost anyone to make good letter-

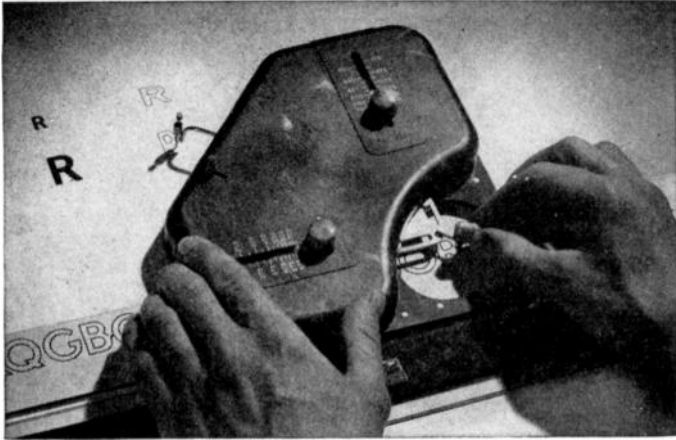


Fig. 9-22. Varigraph machine.

ing with this machine; the only need for artistic judgment is in the spacing of words and letters. The greatest disadvantage is the cost, which might make it impractical for the smaller stations. The Varigraph itself is around \$80, and the templates run from \$6.50 to \$14.50 each.

Ready-made Letters. Several makes of these ready-made letters are available, some on celluloid, some on paper. It is impossible to describe more than one or two principal brands.

Art Type—Acetate. These letters are printed onto a thin acetate and backed with a layer of wax, so that they can be firmly fixed to a drawing by burnishing the upper surface. The wax will not hold tight, however, under any great amount of heat; so you cannot use them directly in most opaque projectors. The work is usually reproduced in some way after art type has been used. This allows for retouching the small traces that the edges of the acetate may cause.

Fototype: Cardboard or Acetate. These letters are set up on a composing stick, face down (duplicate letters are printed on the back of each piece). Once they are set in perfect alignment, scotch tape is pressed across them and they can be lifted out in a body, turned over, and affixed to the work. This is all right if the art work has a plain white background. Fototype also makes transparent letters which are set up the same way on a composing stick and can be used on top of any background. Transparent letters are very useful in reproduction. Ozalid, Apeco, and several other machines can make a contact print through this transparent lettering. The manufacturer claims a composing rate of 15 characters per minute for

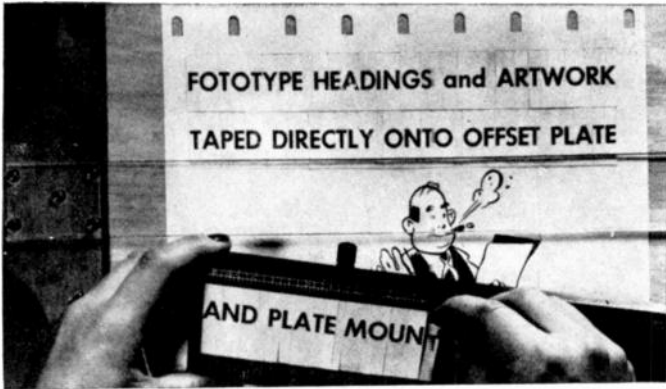


Fig. 9-23. Fototype and composing stick.

the Fototype composing-stick method, but this does not include the job of spacing and fixing them to the layout. One hundred and fifty styles and sizes of letters are available; sets contain 1,750 letters and sell for an average of \$10 a set (Fig. 9-23).

Embossograph. An example of the simplified printing-press devices with movable metal type, this is perhaps the simplest of these to operate and is found quite often in television studios. Metal type is set up on a flat surface, lined up, and spaced by judgment and with the help of a centering guide. A sheet of waxed paper of the desired color or tone is then laid face down across the type, and the background card is laid face down on top of that. Now the whole table on which this has been done is slid into a press, and a long handle is brought down to press card and type together. When the card is lifted off, the unnecessary background pieces of waxed paper can be pulled off, the centers of O's and P's removed, and

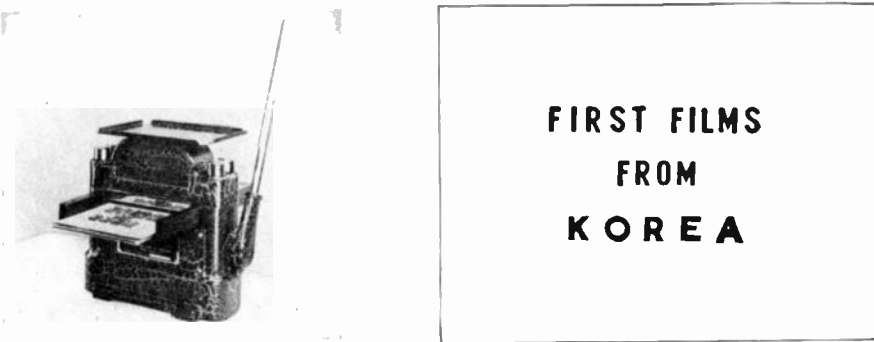


Fig. 9-24. Embossograph machine, 8-inch size. At right: Three- by four-inch balop title made on Embossograph.

the title has been made. Embossograph type is available in a variety of sizes but in rather ordinary styles. Wherever this machine is used, people complain of the style of titles it makes; yet they go right on using it, because it is so quick and easy for anyone to handle. Background cards of special material are available in a great many loud colors and also in shades of gray, certain textures, and imitation wood.

Embossograph machines are made in three sizes; the largest will make a title 14 inches high, the most useful size will handle a title 8 inches high, and a small desk model is built which is limited to cards no higher than 4 inches. An example of a balop title prepared in this size is shown in Fig. 9-24.

Hot Press. The hot-press machine uses regular type in a chase. The type is heated and forms a title in much the same way as the Embossograph, except that the heat sticks the wax firmly without the deep embossing of the edges which is necessary in the former machine, and consequently smaller type faces can be used. This is the best and most expensive method of making titles; it is used widely in film production and has been found well worth the expense in network-television art departments, where a great many titles must be turned out (Fig. 9-25).

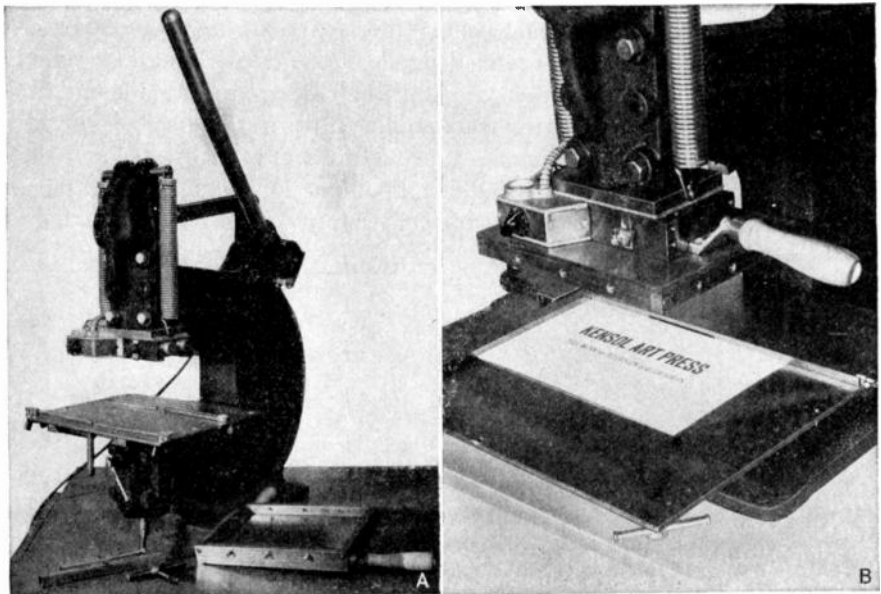


Fig. 9-25. Kensol hot-press machine. Standard lead type is locked into chase at right which is attached to head, heated, and brought down onto the card by manual pressure. Opaque roll leaf is laid on top of card and pressed in by the type.

Movable Type Set Up and Photostated. Bernhard Magnet type is the best example of this method of lettering.* Letters are printed on thin pieces of metal and are laid out to form the desired words on a magnetic board. The magnet holds the letters firmly so that they can be lined up and spaced by eye (something that is not so easily done with the kinds of letters which must be stuck down once and for all). Now the board must be photographed or photostated. Since the types are white on black, black-on-white letters result from one shot on the photostat machine. For white-on-black letters, this negative photostat must be printed—a second shot. If care is taken not to jar the board, the letters will hold where you place them until the shot is made, but it is safer to run a strip of scotch tape across the top and bottom of each row of letters. Slight retouching is necessary on the final print where the edges of the metal pieces may have caught highlights in the photography. Comparatively few alphabets are available, but they are very distinctive and legible. Bernhard leases but does not sell this equipment (Fig. 9-26).



Fig. 9-26. Bernhard magnet type.

Three-dimensional Letters (with pins at the back).

Mittens letters are the best example of this type. The letters are made of white plaster in very simple block design and can be pinned or cemented to a board. The pins which are built into the back of the letters give a false sense of security, however; many of these letters have fallen off and broken from careless handling. The advantage of the three-dimensional letter is that lighting can be used to cast shadows, highlight the edges of the letters, etc. They should be photographed before they can be used, however; it is not safe to send them into the studio to be used directly on camera; titles may turn up at air time with letters missing.

STILL PHOTOGRAPHS

In selecting still pictures for television, the following considerations must be kept in mind: (1) Is the picture instantly recognizable? (2) Is

* Karl Bernhard, 1 East Fifty-third Street, New York 22, N.Y.

the subject large enough in the picture? (3) Is the picture pleasing in composition?

The first consideration is mostly a matter of pattern and tone. Hold the picture at a distance, squint at it, or both, and see if it is going to be confusing on the screen. Sometimes a little retouching or simplifying of the background will make a confusing picture immediately clear. On a matte-surface print a darker tone can be shaded in with a pencil, but, on a glossy one, paint must be used, and considerable skill and experience is required.

The second two considerations are matters of framing. As applied to still pictures, this is called "cropping." First of all, you attempt to crop the print down as far as possible without losing any of its essential parts. You make the subject itself as large as possible in the frame. Of course this can be done only if the picture is to be reproduced to a standard projector size before being used. If the halop size is 8 by 10 inches and the picture comes 8 by 10 inches, there is nothing that can be done in the way of cropping, framing, or altering the composition. You have to trust to the judgment of the printer who has made the enlargements. Luckily the requirements for newspaper reproduction are in most of these respects similar to the needs of television, and good news photos generally make good television stills.

The ability to crop pictures effectively calls for a knowledge of the framing requirements of television and a well-developed sense of composition. A help in cropping is a couple of L-shaped masks which are laid one over the other above the still and can be adjusted to frame a picture in almost any size (Fig. 9-27). However, care must be taken to see that the proportion of the picture stays 3 by 4. Calibrations can be marked on the lower mask: numbered inches on the horizontal, and similarly numbered $\frac{3}{4}$ inches on the vertical.

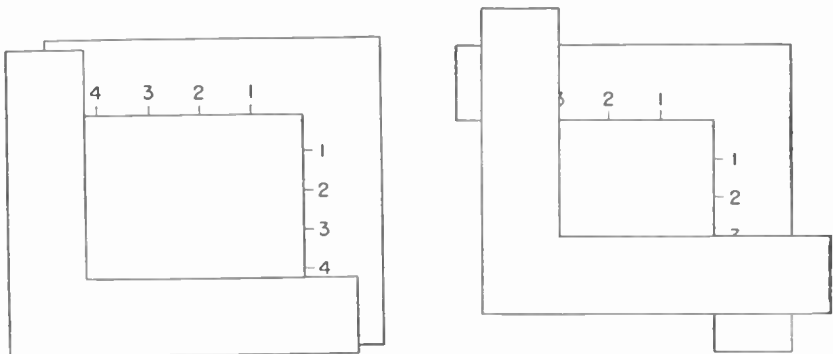


Fig. 9-27. L-shaped framing guides.

The author has devised a sliding frame which can be made small or large and will retain the 3 by 4 proportion at all times. It consists of two cardboard pieces which slide past each other along the diagonal of the frame. Figure 9-28 will serve to illustrate how this device (which has been known as the Bretziframe) can be easily produced with a little cardboard and scotch tape.

REPRODUCTION METHODS (OPAQUES)

The photograph and the photostat are the methods of reproduction most frequently used. Both require equipment that is usually not to be found in a television station; so the work is sent out. This is at very best a matter of hours, more often of days, unless the station has obtained particularly good cooperation. In the interests of time, therefore, much original art work is used on television, especially in the case of news programs. The artist must work to the projector size, however, and he will be happier if the station has a larger size balop. But if the graphics are to be used before the studio camera, they are usually made in an 11- by 14-inch size. The artist will usually prefer to work in this size whenever possible and reproduce small balop prints from this size original.

Photostats are less expensive than photographs but have very definite limitations. The photostat machine is a photographic enlarger which handles opaques instead of transparencies. Whereas, in photographic reproduction, a transparent negative must first be made, developed, and dried before prints can be turned out, the photostat machine makes a paper negative and prints from that by reflected instead of transmitted light. It is a good idea to find out the enlarging capacity of the photostat machine you will be using. If it can enlarge only two diameters, for example, it may take several steps to blow up a small original to a large size print. If the original is 4 inches wide, for example, such a machine could make a negative 8 inches wide and a print 16 inches. Another negative would have to be made from this if a larger print were desired.

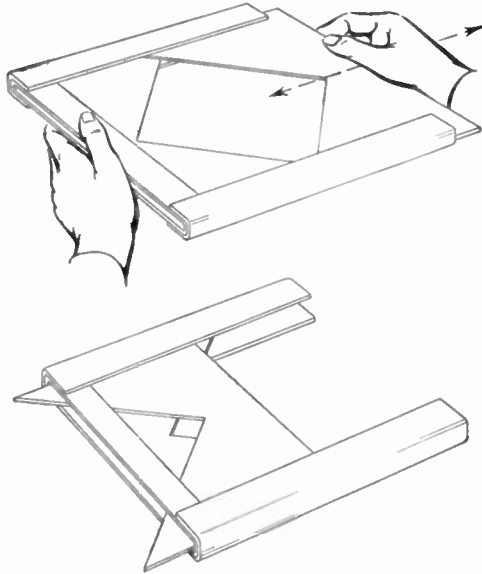


Fig. 9-28. Bretziframe sliding framing guide. Retains 3 by 4 aspect ratio.

Pure black and white is the proper material for the photostat, but tones of gray can be reproduced fairly well if they are not too subtle and are confined to the middle range.

Ozalid. The Ozalid machine is a dry-printing contact device, incapable of enlarging, but very useful for some particular purposes in television. It makes positive prints from positive transparencies. The transparent art work and the unexposed paper are fed together into the machine like sheets into a mangle. Developing is done in a few moments by the action of ammonia fumes within the machine, and the finished result is ready immediately.

Apeco. Some stations have used a small machine similar to the Ozalid for the purpose of reproducing art-type titles. The Apeco uses transparencies only and a negative-to-positive process (not positive-to-positive like the Ozalid) so that white on black letters result from the reproduction of art type. It has been used primarily for titles that were to be superimposed.

METHODS OF MOUNTING OPAQUES

Still photographs, photostats, and some art work may not be prepared on heavy enough stock to withstand ordinary handling or even to lie flat in front of the camera or in a projector. This material must be mounted in some way before it can be used.

Stapling. Every television studio has a "staple gun," a machine which drives heavy staples without clinching them on the back side. When pictures are to be mounted on the walls of a set, on particularly heavy board or wood, this type of stapler can be used. For mounting on regular cardboard, an office stapler is best because it clinches its own staples. The "throat" of such a device is limited, however; and it cannot reach very far in from the edge when mounting a small picture on a large board. At CBS we once adapted one of these staplers with an extra-long extension, so that it could reach about 12 inches in. The stapler method of mounting is very crude and may leave bulges and wrinkles which will catch light. It is used only when there is no time for anything else.

Scotch Tape. Without the various types of pressure-sensitive tape it is doubtful that the average television studio could function. The author once had 14 kinds of tape in regular use at CBS. For the mounting of pictures, both the single- and the double-faced tape can be used. The scotch cellulose tape has about the strongest pull. There are some paper-base masking tapes that are very useful, including black ones. Black tape is best around the edges of a picture because if the camera inadvert-

ently shows edges, they are not nearly so noticeable in black as they would be in white.

The double-faced tapes are particularly valuable for mounting, since they do not show at all. It takes a bit of skill to use them without getting all stuck up, but if you turn the picture over and run this tape around the edges and then apply the picture to the board, it will do a pretty good job. Bulging paper will, however, still bulge, since only the edges are firmly held down. If a title must be slid into a machine or pass other titles and obstructions, the double-faced tape is superior to the single type or to stapling, since there is nothing on the face of the card to catch or gum up the motion. Mounting with scotch tape must still be regarded as a short cut, but, after all, short cuts are what television production is made of.

Rubber Cement. This is a good method of mounting if used correctly. Putting the two pieces together while the cement is wet makes a temporary bond which can be peeled off again—and which probably *will* peel off of its own accord just about air time. For a solid bond, both surfaces must be covered and the cement allowed to dry on both before the mounting is done. A better job can be done with rubber cement than with any other kind of cement, glue, or paste, and it leaves less of a mess around when it is not handled too carefully. Under great heat, however (and some opaque projectors are not too well cooled), rubber cement will soften and peel off. Scotch cellulose tape is stronger, but for real security there is nothing like stapling.

Dry Mounting. This is probably the best method of mounting. It is done in a hot press with a sheet of heat-seal adhesive sandwiched in between paper and board. Sheets of dry mounting tissue are also sold

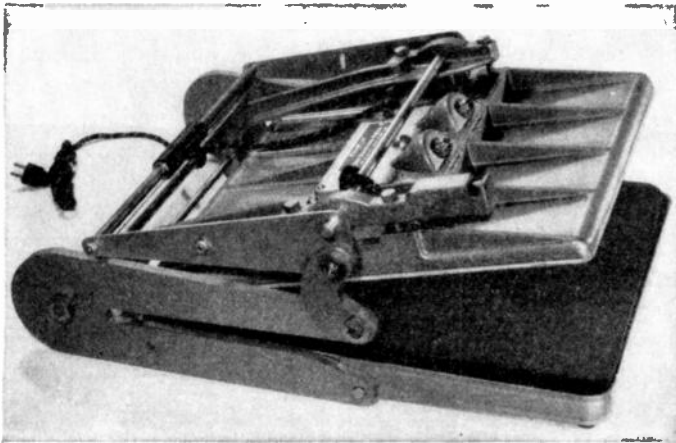


Fig. 9-29. Fotoflat dry-mounting press.

separately, and one is supposed to apply the heat by ironing the picture on with an electric iron; but this is slow and rather difficult. The Fotoflat dry-mounting press is in use in several television studios. It heats up to around 225°F and makes a quick and perfect job. The Fotoflat heat-seal adhesive will soften if heat is applied again; so it is easy to remove mounted pictures by putting them back into the press. The same thing may happen under the hot lights of a balop, however; if your balop operates at a high temperature, none of the mounting processes so far described can be recommended (Fig. 9-29).

Metal Mounts. This category includes the septum, the sheave, the holder, and any other methods of mounting without adhesive. The 8- by 10-inch opaque projector that Paul Adanti built years ago at WRGB used

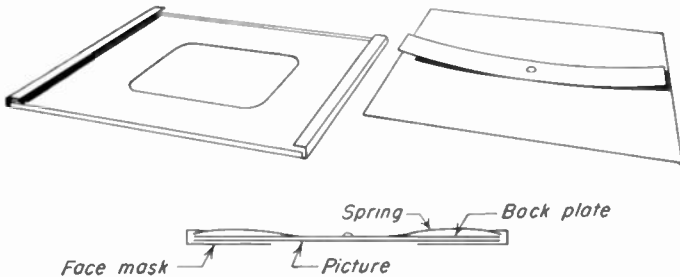


Fig. 9-30. Septum mounting.

lightweight sheaves with a rolled-over edge, into which the 8- by 10-inch glossies could be slid with a little effort and a lot of finger pressure on the face of the paper. It would not have been good for original art work. The advantage was, however, that the print was held firmly by each edge and, in its metal mount, could be handled easily by a machine.

CBS-TV uses telop opaque projectors which employ 3- by 4-inch pictures mounted on a long metal strip. The strip is cut out as a face mask, and backing plates are fastened behind each opening. The plates do not come off the strip, however; when released, they spring back just far enough to allow a picture to be slipped in easily and when held down again are then clamped securely by a small turn button at the edge (Fig. 9-31).

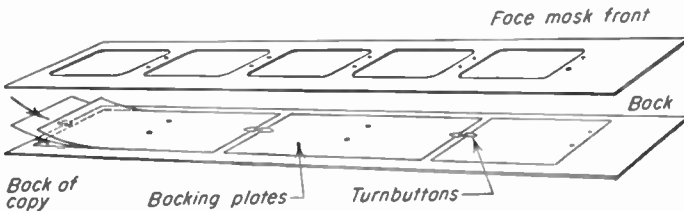


Fig. 9-31. Telop strip mounting.

REPRODUCTION METHODS FOR TRANSPARENCIES

The standard transparencies in television are the 2- by 2-inch slides adapted from school and home use to the television projection room. Some stations are equipped to project only the larger $3\frac{1}{4}$ - by 4-inch slides, which have been standard lantern slides for auditorium use for many years. A few stations can handle both.

3 $\frac{1}{4}$ - by 4-inch Slides. For projection onto a large screen as in rear projection these slides are best. Because of their larger area, more light can be transmitted, and a bright picture can be produced over a larger area. This advantage is of no particular value in the television projection room, since the light must be concentrated onto the mosaic of an iconoscope tube about the size of the slide, and relatively little is needed. However, the larger size slides fit more accurately into the machine and are more likely to come out consistently straight on the screen. Slides $3\frac{1}{4}$ by 4 inches are invariably made on sensitized glass, faced with a cover glass, and bound along the edges. The standard camera field on a $3\frac{1}{4}$ - by 4-inch slide is $2\frac{1}{4}$ by 3 inches. Accordingly the copy area should be about $1\frac{1}{2}$ by 2 inches.

2- by 2-inch Slides. The 2- by 2-inch dimension of these slides is the outside dimension. The camera field is considerably inside this. The aspect ratio of standard 2 by 2 slides is not the 3 by 4 aspect ratio of the television picture (the picture area on the slide is wider in proportion to its height), and a certain amount of picture area must be lost on each side when such a slide is projected on television (Fig. 9-32).

The advantages of the use of slides over strip film (described below) is that titles can be used in any order. A station usually

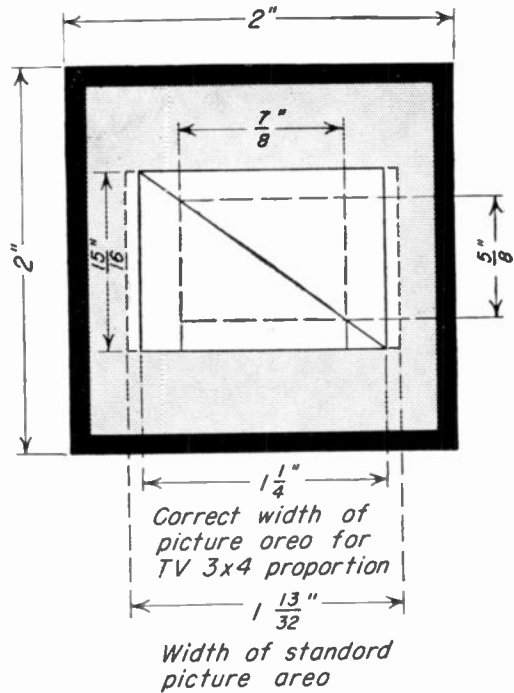


Fig. 9-32. Standard 2- by 2-inch slide with framing dimensions.

keeps a filing box of slides, assigns each slide a number, and refers to it by number on the daily routine sheet. The same feature may be a disadvantage also. There is room for human error in keeping the order right.

The biggest disadvantage of 2- by 2-inch slides is the inaccuracy and variation in their size and shape. A slide which is bound a little too loosely or with a slightly heavier edging tape will ride higher in the projector than the slide just before. Very tiny irregularities will cause it to set at an angle and come out crooked on the screen. This is such a problem that some stations make it a regular routine to check the set of each slide in the few seconds before it is used and relay quick instructions to the projection man to "raise it on the left," "push it a little farther in," or whatever adjustment must be made. It is because the over-all size of the slide is so small that these minor bumps and thick places in the binding make such a noticeable difference. Each irregularity is enlarged greatly on the screen. The same bumps are not nearly so noticeable in the larger size slide because they are much smaller in proportion to the slide.

Slides 2 by 2 inches are made in two ways: (1) photographed horizontally on 35-mm film and bound in metal or cardboard holders called "ready-mounts" or in paper holders which are bound between cover glasses; (2) photographed on glass plates and bound with cover glasses like the larger lantern slides. Metal holders for 35-mm film such as those made by Brumberger which simply snap together over the film are fairly accurate and are affected very little by heat.

It is very troublesome for a projectionist to try to use both types interchangeably. They differ in thickness, which is hard on some projectors. One type of slide may rest in a slightly different plane from the other, with the emulsion either a little closer or a little farther from the lens, and this may require refocusing of the projector.

A photographer with limited darkroom facilities may turn out satisfactory 2 by 2 slides if he approaches the problem as a precision job and devotes great care to centering the picture on the slide and binding the cover glasses together smoothly. There are a number of short cuts to slide making on the market, metal holders, cardboard mounts, etc., which should be looked on only as emergency possibilities. These devices will mount and center 35-mm minicamera film, and slides can be made with any type of 35-mm minicamera. These mounts are relatively inaccurate, however, and the film may curl; so the best way to make a slide is to photograph the picture on a 2- by 2-inch glass plate and bind a cover glass to it. There are many kinds of binding tape on the market, some of which are likely to soften when hot. This leaves a sticky deposit in the projector gate, which makes slides work badly, especially in automatic projectors. Since it is very difficult to distinguish the sticky from the nonsticky tape, manufacturers recommend the use of Slide-ease. This is

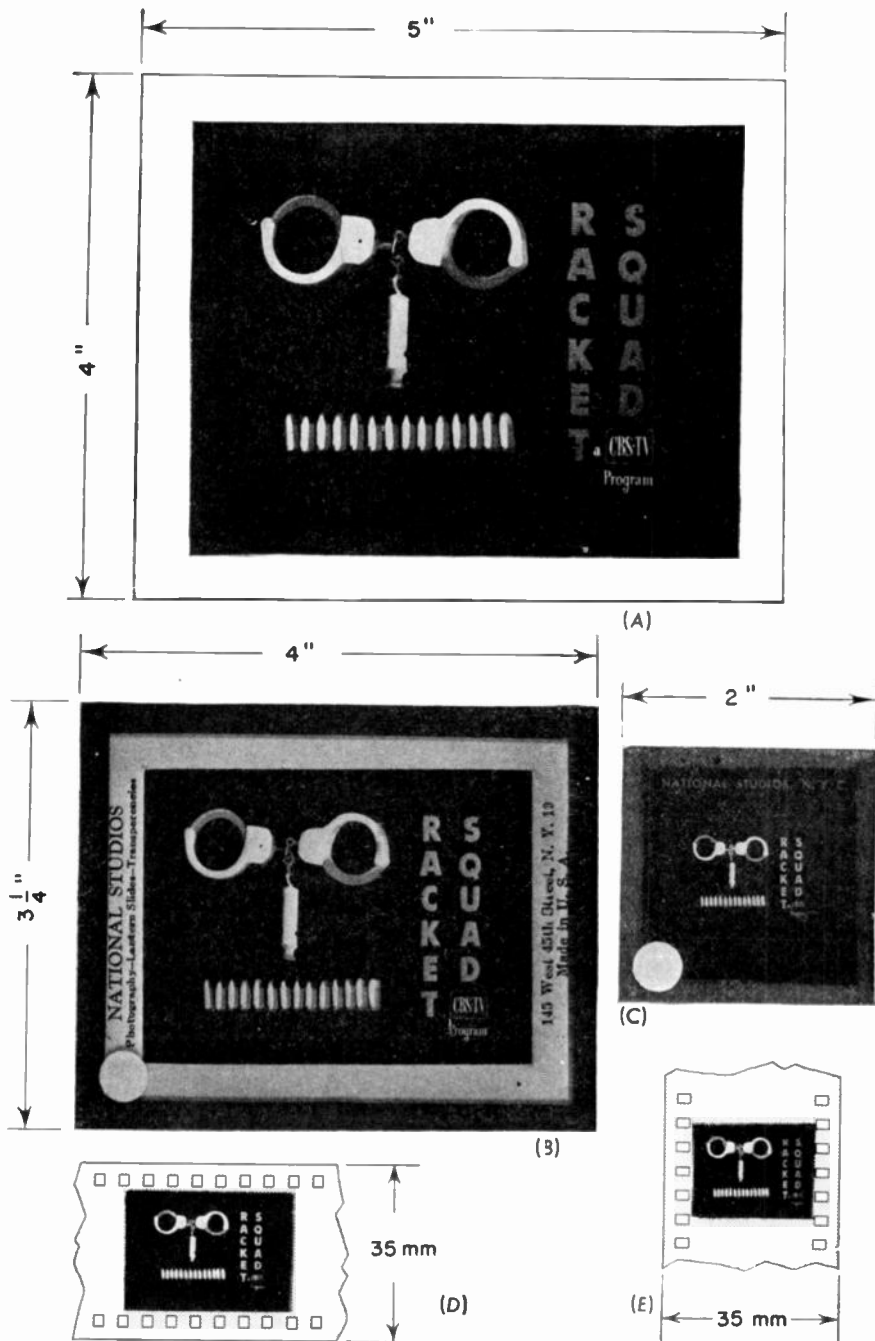


Fig. 9-33. Program promotion title prepared by National Studios. (A) 3-by 4-inch opaque slide for telop, (B) 3 1/4-by 4-inch glass slide, (C) 2-by 2-inch glass slide, (D) 35-mm film for ready-mount, (E) 35-mm film for filmstrip.

a sealer compound which does not become tacky or sticky under heat, stiffens any material which is treated with it, and seals the slide against dust and damage. A thorough discussion of the techniques of slide making is to be found in the "Kodak Data Book on Slides."

35-mm Filmstrip. Filmstrip projectors, long in standard use as visual aids in education and selling, have found a place in television also. The film strip is made on 35-mm motion-picture film, but the film runs vertically through the projector, not horizontally, as it does in 35-mm miniature cameras. Thus the camera field is smaller than it is on the 2- by 2-inch glass slide (approximately $\frac{5}{8}$ by $1\frac{3}{16}$ inches).

The great advantage in the use of filmstrips is that the pictures cannot

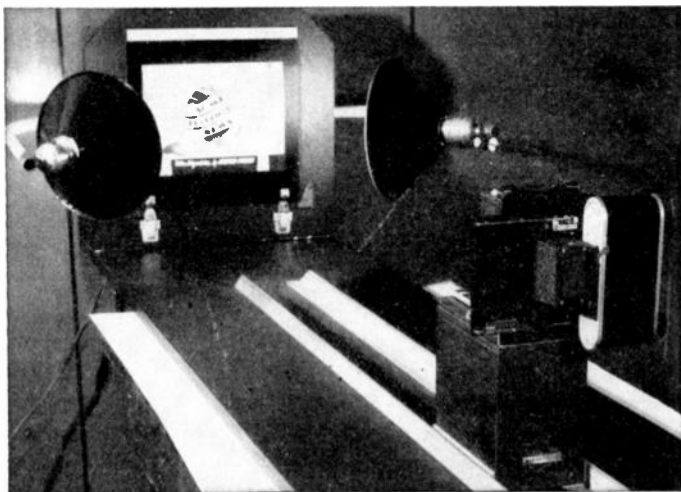


Fig. 9-34. Acme copying camera for 35-mm filmstrip.

get out of order. Of course, the order cannot be shifted either, short of cutting and splicing the film; and splices are likely to catch in a strip-film projector unless they are very carefully made. Picture change is by a rapid pulldown to the director's cue "Flip it." This is not unnoticeable on the screen, but neither is it particularly objectionable. WPIX has been doing a still-picture news show twice daily by this means, since the station first went on the air.

16-mm Filmstrip. The Dunning Animatic is a very precise machine which makes the pulldown so quickly that it appears to be instantaneous. This has been found to be of great value both in the projection room and for studio use. Some stations have acquired the equipment for making the 16-mm filmstrips which this projector uses.

10 PROJECTION EQUIPMENT

In the present chapter the reader will find a description of the particular makes of projectors which are found most commonly in television stations. Most of these are standard models, manufactured for home and auditorium, and they require little adaptation to fit them for television. The only lens system involved in such projection, incidentally, is the projector lens itself. Instead of being focused on a distant screen several feet wide, however, a television projector is focused on the mosaic plate within the iconoscope tube, usually a matter of 20 or 30 inches away and only about 4 inches wide. In order to bring this close image into sharp focus the projector lens must be focused *out* away from the slide. Most projectors do not allow for very much forward focusing, and on the first attempt to get the picture sharp on the tiny mosaic in the iconoscope, the experimenter will find that he is holding the lens in mid-air several inches in front of the projector. Extension tubes have to be made, therefore, to hold the lenses in the correct position for focus on these projectors. A 100-watt bulb is usually bright enough behind a 2- by 2-inch slide.

THE 2- BY 2-INCH SLIDE PROJECTOR

Eastman Kodaslide Projector Model 2A. This model is the most widely used, largely because it is furnished by RCA along with the rest of an order of projection-room equipment. It is smaller and more compact than other projectors of the same quality, and two of them are frequently mounted side by side, projecting into the same iconoscope film camera. They are placed just far enough apart so that the slide carriers will work without hitting each other and are invariably mounted above the two mirrors on top of a pedestal, a combination which is known as the "multiplexer." This means that each projector is shooting down and a little sideways to the screen. The angle is not enough, however, to make any noticeable difference in the projected picture (Fig. 10-1).

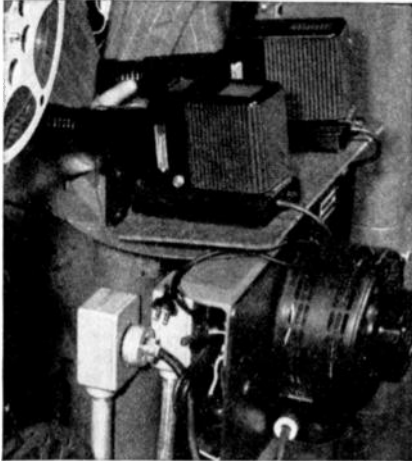


Fig. 10-1. Two Eastman 2- by 2-inch projectors with a Variac dimmer control for dissolving between them.

When two such projectors are used, a dissolve-control outfit can be obtained from Eastman, which allows the projectionist to fade out one projector as he simultaneously fades in the other. This is actually a double-acting transformer; some stations have installed their own Variacs or Powerstats for the purpose. The entire device—controls, switches, and all—should be mounted as close to the projectors as possible, so that the projectionist can change slides and operate the dissolve control without having to move around the room. He may watch the results of his operating on a monitor in the projection

room or keep his eye on the projected picture on the mosaic of the tube itself. A convenient space must be allowed for stacking the used and the unused slides near the projectors. Some stations even mount the slide file box on the multiplexer and use the slides directly from it in regular operation.

A semiautomatic slide changer is available for use on these projectors. A cable release enables the operator to change slides from a short distance away. This is no great advantage, but the fact that one can stack a dozen or more slides in the magazine of the slide changer is often a help. However, this device will only take slides in “ready-mounts” (cardboard holders) and will not handle glass slides.

Provision must be made for last-minute checking, rearrangements, insertion, or elimination of slides. It is very rarely possible to set up all the materials for an evening of television transmission and go straight through without altering the routine. It must be possible, for example, to put such a thing as a “please stand by” slide on the air immediately at any time. If the slide projector is of the automatic type and takes a load of slides at one time, these slides should still be accessible in case they must be changed or new slides added. The

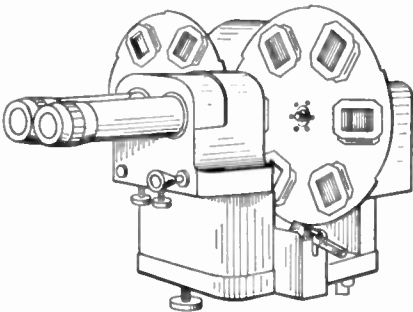


Fig. 10-2. Gray Telojector, dual 2- X 2-inch slide projector.

projectionist should be able to check the slide which is in position to make sure it is the correct slide and right side up.

Some ingenious devices have been built to make it possible to load up a series of slides, and still have them all accessible. The Gray Teljector is an example. Each of the twin projectors can take six slides (Fig. 10-2) and these can be changed during operation simply by slipping them out of the grooves where they are held by pressure springs.

*La Belle Automatic (Model 301).** This machine is considerably larger and more expensive than any of the others, but it has certain very good features. It can be stacked up with 75 slides in Eastman ready-mounts or 35 glass-mounted slides. It can be controlled by a remote push button, which can be mounted in the control room if desired. Changing of slides throughout an entire evening's programming, then, becomes nothing more than a push-button operation. The projector is equipped with a shutter, which automatically blacks out the picture while the slide is changing.



Fig. 10-3. Automatic projectors. (A) La Belle. Slides stack in vertical magazine. (B) SVE entertainer. Slides stack in horizontal magazine above lens. (C) Selectoslide Jr.

Some stations have installed these machines in pairs side by side in front of a single ike and dissolve between them by means of a Variac. Standard bulb in the 301 is 300 watts, which is too bright and must be replaced by a 100-watt bulb for television use.

Perhaps the most useful automatic machine is the Selectoslide (manufactured by Spindler and Sauppe, Los Angeles). This machine handles 16 slides in a rotary manner, any one of which is immediately accessible, even the one which is in projecting position. Figure 10-3C shows one of these projectors in use at KNBH in Hollywood.

3¼- BY 4-INCH SLIDE PROJECTORS

Standard transparent projectors in this size have been adapted to television use by various stations, but no particular makes are common enough to call for specific description. Camera field is usually 2¼ by 3 inches. The General Electric slide projector (described below) is specially built for television and handles 3¼- by 4-inch slides interchangeably

* La Belle Industries, Oconomowoc, Wis.

with opaques of the same size. Some stations equipped with this machine, such as WFIL-TV in Philadelphia, have standardized on the large slide to the exclusion of the 2- by 2-inch size. This has certain advantages, but the cost of making slides is not one of them.

General Electric (PFC-3) (Fig. 10-4). This projector has two stages $3\frac{1}{4}$ by 4 inches in size ($2\frac{1}{4}$ - by 3-inch picture area), each illuminated either from above for opaques or from below for transparencies. Two lenses were used in the original model, projecting each stage onto the iconoscope mosaic. The lamps were lighted on both stages at once and dissolves made by shuttering the light beams just behind the lens. (Controlled by a handle at the back of the machine, Fig. 10-5 at the top.) The later model utilizes only one lens for both stages, providing for dissolves by the addition of dimmers on the lights. It has been found that a fade-out made by shuttering the lens is less desirable than a fade made by dimming the light. When the lens is closed down, dark parts of the picture disappear first and the highlights are left for last. When the light is dimmed, on the other hand, the entire picture fades evenly.

By and large this double-stage machine has worked out very well. An



Fig. 10-4. General Electric opaque and transparent projector (model PFC-3).



Fig. 10-5. Crawl title used in GE opaque projector.

adequate means of stacking slides which are to be used and disposing of slides that come out of the projector is lacking. Small auxiliary tables are sometimes placed nearby, and so the slides may at least be arranged in handy piles. The problem of opaque slides is the same as that of transparencies in this respect.

A manually operated crawl device (Fig. 10-5) is supplied for use with opaque paper. Rubber rollers drive a lightweight paper across the stage. Supply and take-up rollers are not provided; so the length of crawl is dependent on the size of strip that can be managed at both ends by hand.

The problem of changing slides rapidly and accurately is met in one way or another in every good projector. Figure 10-6 shows a four-slide rotary magazine in place on the right-hand stage of the GE machine. It

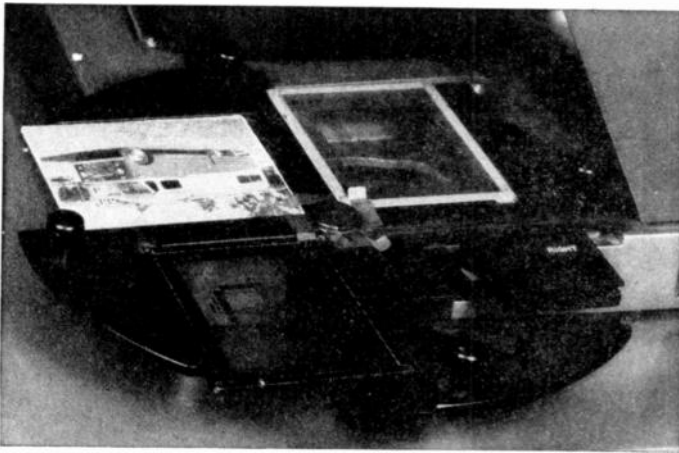


Fig. 10-6. Four-way rotary slide change on right-hand stage of GE balop. Top right-hand slide is in projection position.

is loaded with two transparent slides and one opaque. A similar magazine can be placed on the second stage, and thus eight slides can be loaded into the machine at a time. Any of these slides is accessible for checking or last-minute changing without disturbing any of the others.

Some valuable additions to this machine have been made by the various stations using it. Two examples from WSYR-TV in Syracuse will indicate the kind of improvements which day-to-day operation has brought out. For one thing, it has been found very difficult, especially when opaque slides are being used, to look directly at the illuminated slide, since the light on it is extremely bright. Temporary blindness (for a moment or two) frequently results from this kind of checking, making it difficult for the operator to make his next move. This station's solution was to mount semitransparent mirrors at an angle above the stages to act in the manner of sunglasses and cut down the glare.

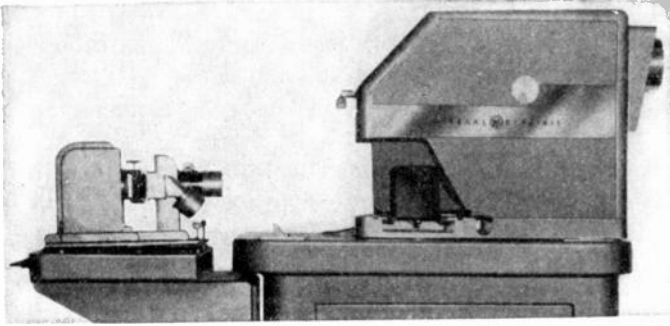


Fig. 10-7. Accessory 2- by 2-inch slide or strip-film projector for GE slide projector.

Another addition made by this same station is a wipe device, making it possible to wipe from one slide to another (but not back to a third; two is the limit). This device fits above both stages (Fig. 10-8) and contains a sliding shutter which moves across the focal plane, blocking off one picture as it reveals the other.

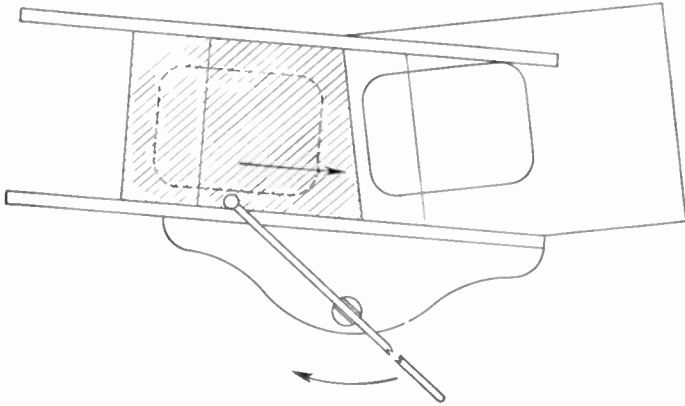


Fig. 10-8. Wipe device designed and built at WSYR-TV, Syracuse.

FILMSTRIP PROJECTORS

There are several makes of filmstrip projectors on the market, many of which are capable of handling 2- by 2-inch slides in addition to strip film, but the two cannot be used interchangeably in television. When the projection is changed from slides to filmstrips, a second aperture is used a different distance from the lens. This requires a focus adjustment and a repositioning of the projector itself. Since these television projectors must be set up solidly and accurately, this kind of adjustment is not possible without a rather complicated adaptation.

OPAQUE PROJECTORS

The simple name "balop" has come into general use in referring to any of the various types of opaque projectors or to the slides and art work prepared for them. It derived from a standard Balopticon (initials BAL for Bausch and Lomb) which CBS had adapted for television use in 1939. Just as all cameras are not Kodaks, all opaque projectors are not balops unless usage makes them so.

Many television stations have built their own balops with stages of various sizes. Even if a station has no use for opaque projection of titles and pictures, it will often have to devise some means of projecting a live Bulova or Benrus clock. Since this must be a working clock, it can be picked up only by a studio camera or in an opaque projector, and many stations have built special devices just for this purpose. A clock in the studio requires a cameraman on duty every time it goes on the air, and in some cases additional members of the studio crew. It ties up a camera between shows and often causes a mad scramble to get the camera on it in time. In the projection room, however, it can be used practically any time. Almost every station has devised a different method for picking up a picture of this clock. Tommy O'Toole at WWJ-TV put a lens in the wall between the projection room and the film-pickup camera, a mirror behind the lens, and the clock 10 feet down along the other side of the wall. WJBK used two mirrors in front of its iconoscope and reflected an image of the clock from a vertical position *underneath* the iconoscope. Some stations build a small clock into an enclosed unit with lights and a lens included and fasten it just above or below the opening to the film pickup camera. When the clock is needed, the projectionist swings a mirror in place in front of it.

All these devices are essentially balops. A balop consists of two parts, a stage suitably illuminated, and a lens in such a position that it can project an image of the stage on the tube in the pickup camera. Most balops

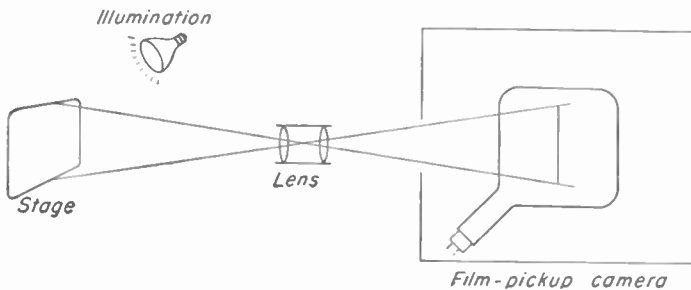


Fig. 10-9. Simple balop.

include at least one mirror somewhere in the system, usually just before or behind the lens. This saves space, since the balop stage does not have to be vertical and in a direct line from the camera (Fig. 10-9). When the mirror reflects a horizontal stage, there is an added convenience in operation since cards and objects will be held on it by gravity and it can be used for many purposes that a vertical stage cannot.

One of the best of the simple balops is to be found at WTMJ-TV in

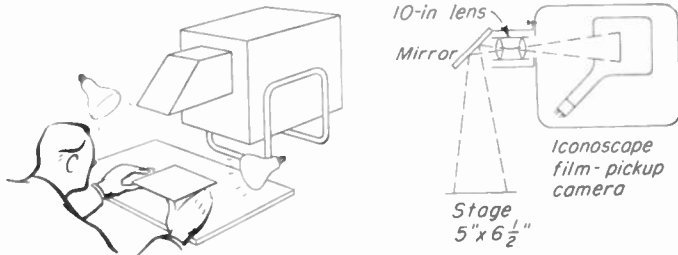


Fig. 10-10. WTMJ-TV balop.

Milwaukee. It is the single-mirror type illustrated above, but the stage is at table-top height and open, not built into a box as most such projectors are. This allows an operator to sit before the stage and work a very complicated and ingenious type of animation which will be described in the succeeding chapter (Fig. 10-10). This device was designed for a 10-in.-focal-length lens. It will take a 5- by 6½-inch card. The size and shape of homemade balops will depend on the focal length of the lens which is used and the size of the stage that is to be projected.

Any opaque projector is likely to generate quite a lot of heat. In order to project 10 to 15 foot-candles of illumination on the iconoscope mosaic, at least 300 watts is usually required on each stage of the machine. This is in marked contrast to transparency projection, where only 100 watts is required behind the slide for the same result. Consequently, blowers must be installed to cool the stages by forced-draft ventilation. The larger the size of stage around which the projector is designed, the more light is needed for it, and the more heat is generated.

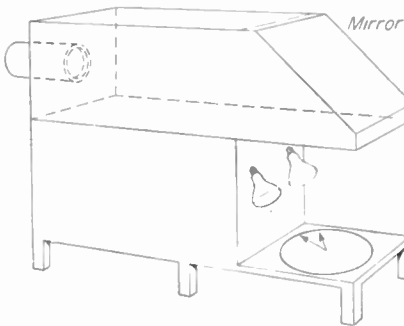


Fig. 10-11. KSD-TV balop.

SINGLE-STAGE BALOPS ADAPTED FROM STANDARD EQUIPMENT

There are several types of opaque projectors on the market which have been adapted for use as single-stage balops. The Bausch and Lomb Balopticon is one of these; the Spencer Lens Co. Delineoscope is occasionally seen, as well as the Charles Beseler opaque projectors, the OA2 and OA3. With all these a very great lens extension is necessary (Fig. 10-12).

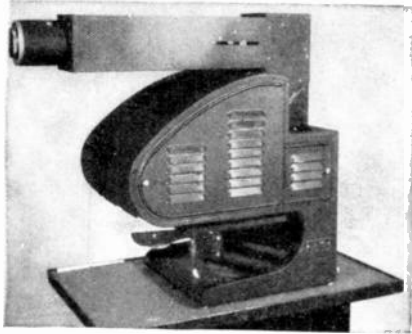


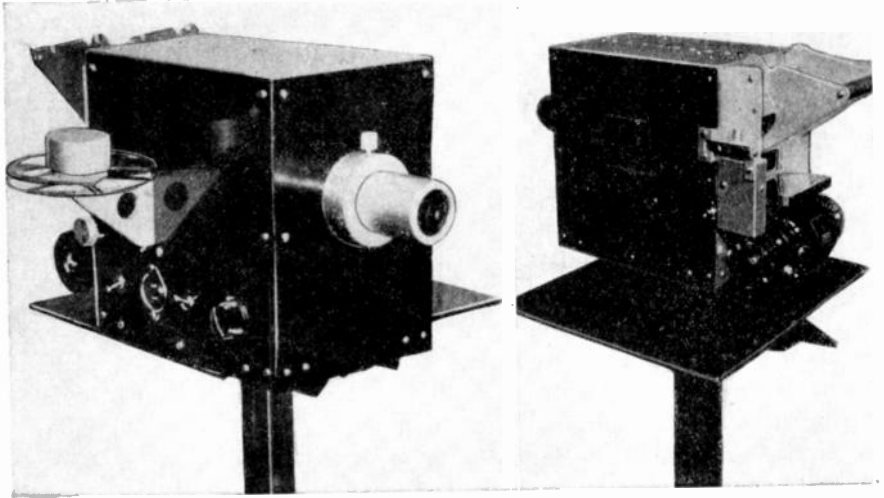
Fig. 10-12. Beseler OA4 opaque projector adapted for television. Optical system has been doubled back on itself to conserve space. Picture size, 8 by 10 inches.

With only one balop stage, production is as limited. WBEN-TV in Buffalo has devised a card-change method for a single balop so that a series of titles or still pictures can be run without interruption. This machine is an adapted Beseler OA3 which has an 8- by 10-inch stage. The regular stage was removed and two sets of tracks put in its place, running at right angles to each other. A card can be inserted in the top

set of tracks, then pulled out to reveal a second card just below it in the second level. A third card can then be pushed in above and the bottom card changed behind it. When the third card is removed, a fourth is revealed, etc. When clocks and three-dimensional gadgets are used, they must work in the bottom stage. This is only a crude approximation of what can be done, however, when a multiple-stage balop is used.

Projectall (a machine specially built for television) (Figs. 10-13, 10-14). The first model of the *Projectall* was a one-stage opaque projector with a number of added accessories which enabled it to serve many purposes in the television projection room. It took a 2 $\frac{1}{4}$ - by 3-inch card, and 30 could be stacked in a cartridge. Titles were changed by the simple pull-off; as the front card was pulled out of the magazine, it appeared to be moving down off the screen.

A simple and practical crawl device is incorporated in this *Projectall*. A roll of paper 4 inches wide is driven vertically by a variable-speed motor. There is no take-up spool. If the station should want to run ticker tape across the screen, this feature is also incorporated; the tape is driven by the same motor. A small revolving stage (which must work in the inverted position) is included for purposes such as product display.



Figs. 10-13, 10-14. Projectall, designed and built by George Tressel.

MULTI-STAGE BALOPS

Opaque projectors with more than one stage are designed primarily to achieve dissolves by optical means so that only one camera is necessary. They provide other possibilities as well, such as superimposition and simple animation, and these have been exploited in a few cases, first, in the way the various stages are projected onto the same iconoscope, and, second, in the way the intensity of these images is controlled.

Some of the multi-stage balops use a separate lens for each stage. The early model GE PFC-3 slide projector used two lenses. The five-stage Multiscope (described later) is equipped with five lenses. The attempt is made to keep these lenses all as close as possible to the optical axis (perpendicular to the center of the iconoscope mosaic) so that they do not have to shoot in from such a great angle that "keystoning"* will result.

Other multi-stage balops utilize only one lens. In a two-stage balop that CBS constructed from two Beseler OA2's (Fig. 10-15) the images from both stages were mirrored through a single lens; the top half of the lens formed the image of the top stage, and the bottom half of the lens projected the other. Another method of multiple-stage projection through a single lens utilizes image splitters. An image splitter is a transparent mirror which can both transmit and reflect. If you hold such a mirror up to the light, you will find that you can see lighted objects through it, but if you hold it against a dark background, it appears to be

* This is the type of distortion which will result from projecting on a wall from an angle. The far side of the image is enlarged, and it is no longer rectangular, but more in the shape of a keystone.

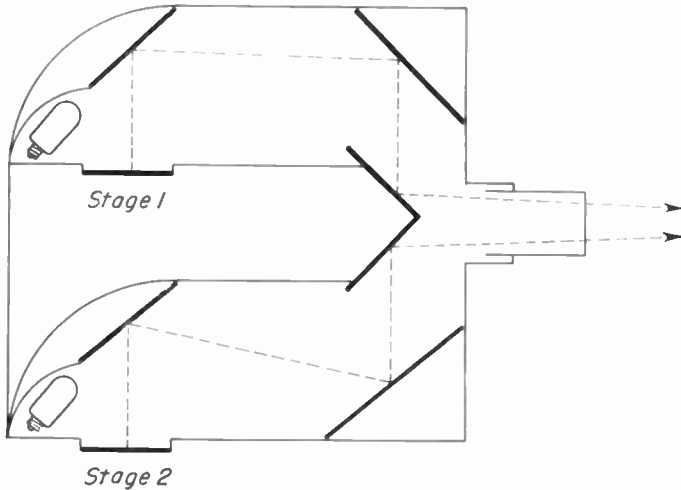


Fig. 10-15. CBS two-stage balop built from two standard Beseler OA2's.

a regular mirror with reflective properties only. Partially silvered mirrors can be produced to general specifications at rather low cost, by any mirror manufacturer, but they have a very high absorption factor. About 30 per cent of the light that strikes such a mirror is neither reflected nor transmitted but is absorbed by the reflective coating and the glass. Much more efficient image splitters can be obtained which absorb only a tiny percentage of the light and can be made to very exact specifications.*

Two methods of light control are in use on multi-stage projection: dimmer control of the lights on each stage, and shutter control over the projected light beam. Where light dimming is used, care must be taken in the design of the projector to see that spill light from the illuminated stages does not get over onto stages that are supposed to be dark. When shutters are used instead, all stages are left constantly illuminated. The multiscope lights five stages with one set of lamps and controls the light beam from each with a shutter behind each lens.

WAVE-TV Specially Built Two-stage Balop. Another type of balop was constructed by the staff of WAVE-TV, built on the image-splitter principle. Both stages are horizontal (Fig. 10-16) and open on three sides, making it possible to reach in and operate animations if desired. Each stage is reflected by one mirror and passes through one lens, so that it comes out correct on the screen just as it would in a simple balop.

Multiscope (specially made for television) (Fig. 10-17). This machine was originated at WBKB by George Tressel and Frank Tracy, who are

* Fish-Scherman, New York.

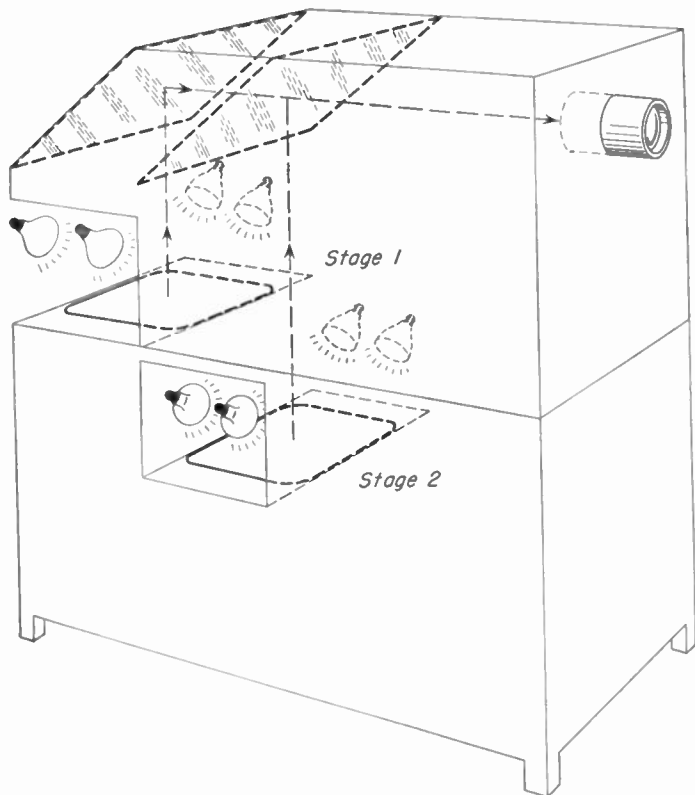


Fig. 10-16. WAVE-TV specially built balop with transparent mirror.

now the makers of the Projectall. The pilot model was a two-stage balop; now the machine is manufactured by Acme Teletronix in a five-stage version. The interior of the machine (Fig. 10-18) is an open box allowing the light from two mercury-vapor lamps to fall on all five stages. Light control between stages is accomplished with shutters which are manipulated by controls on the top of the machine. Each of the five stages has its own lens.

Only the middle stage, however, is exactly on the optical axis; the others all shoot in from a slight angle, but not enough to show keystoneing. You can superimpose all five stages at once or dissolve between them in any order. Stations rarely use all five stages in quick succession; many have never opened up the fifth (center) stage at all.

Frame size is generally $2\frac{1}{4}$ by 3 inches on a card of 3 by 4 inches outside dimension. Thirty cards can be loaded in the machine in two cartridges, so that dissolves are possible between them. A semiautomatic ejector pulls the cards off the face of the cartridge. To create the com-

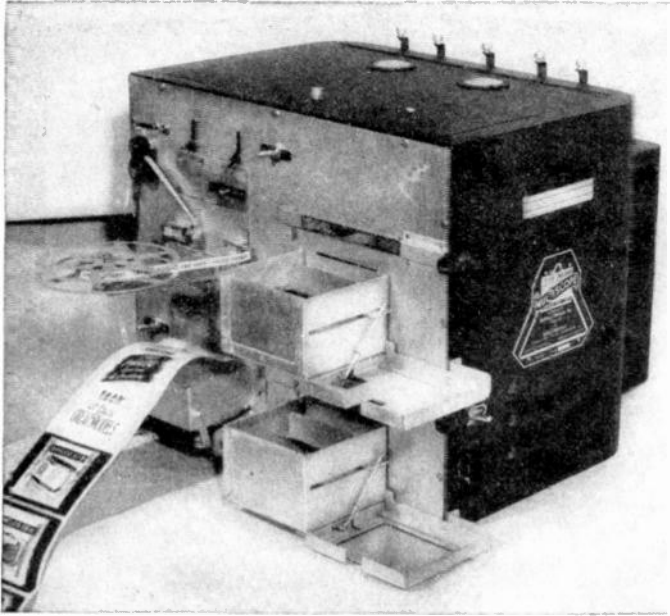


Fig. 10-17. Multiscope opaque projector.

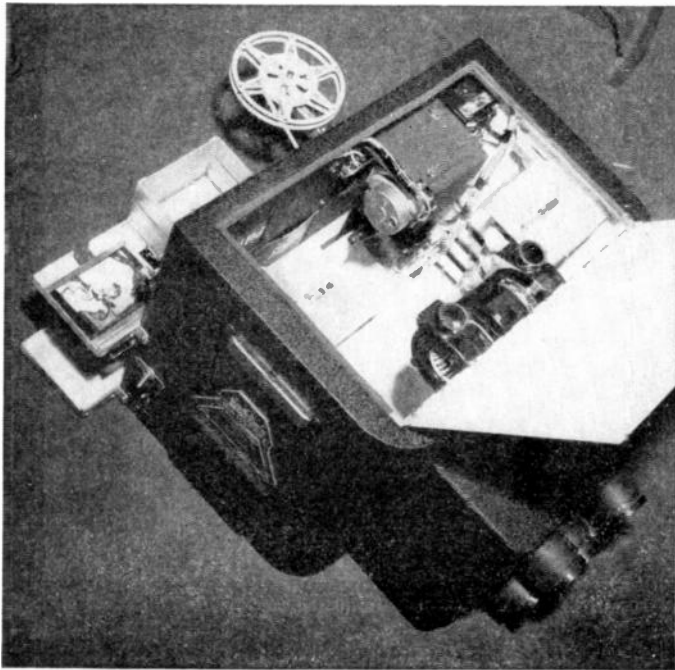


Fig. 10-18. Interior of Multiscope.

posite of advertising slide, weather, time, and news, the Multiscope divides it as follows: Time, weather, and news tape are projected from stage 1 (upper left, Fig. 10-17). The clock is permanently fixed behind the stage, a few words on the weather can be slid into an aperture so they appear in a corner of the screen, and ticker tape moves across the bottom. The rest of this stage is painted dull black and is thereby masked and not projected. Advertising messages or station cards are placed in stage 2 or 3 (the title stages) on the right. Stage 4 is used for the crawl title, and stage 5 is available for any other use that may develop. Focal length of the lenses is 28 inches, which provides considerable leeway in the placement of other projection equipment around the film pickup camera.

The Telop (specially made for television) (Fig. 10-19). This is the largest and most complex of the opaque projectors offered for television use. It was developed by the Gray Company in association with the general engineering department at CBS and is built to the CBS requirements. It projects a picture area of 3 by 4 inches. Pictures or titles are prepared on 4- by 5-inch paper and mounted in metal strip holders.

Four stages are incorporated in this machine, all on the optical axis. Following the optical paths back from the lens (Fig. 10-20), we encounter first of all a semitransparent mirror which either reflects one of the upper stages or transmits one of the lower stages, depending on which are

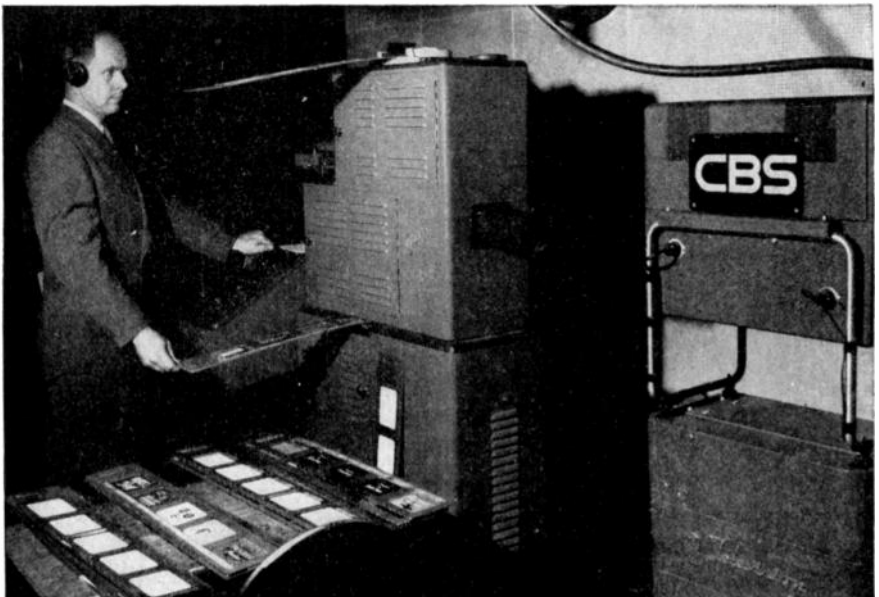


Fig. 10-19. Gray Telop. Four-stage opaque projector.

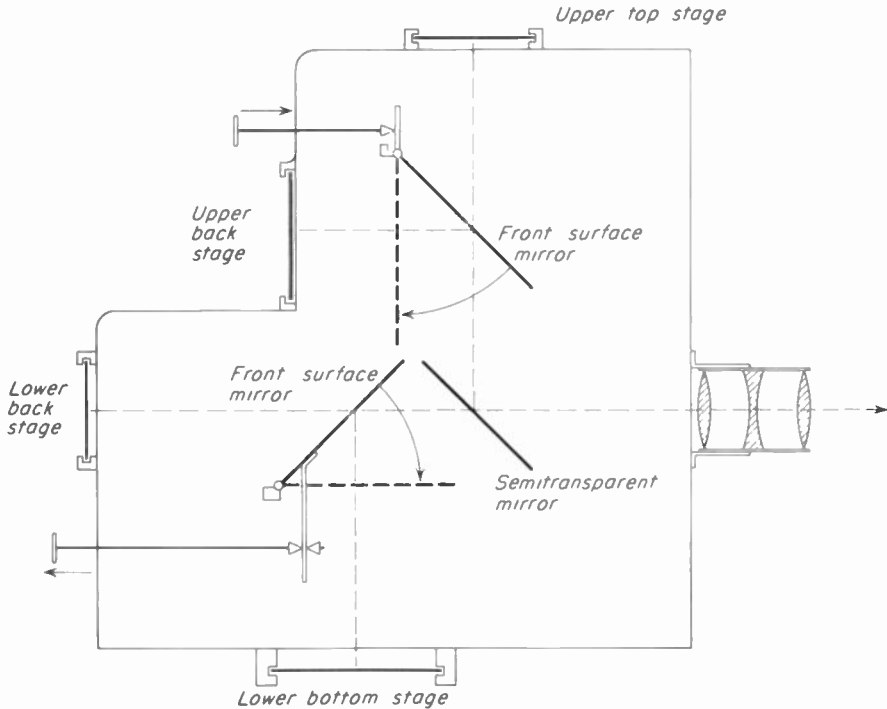


Fig. 10-20. Telop diagram.

lighted. If two stages are lighted, a superimposure results. All four stages cannot be superimposed at once, however. An adjustable mirror between the two top stages can be set manually either to reflect the back stage or, when hinged out of the way, to allow a direct view of the top stage. A mirror between the two lower stages operates in the same manner. When the control is pushed in, the mirror reflects the bottom stage (as shown in the diagram). When the plunger is out, the mirror is out of the way and the back stage can be seen.

Two dimmers are incorporated in the control panel, with reversing switches so that they can dim in or out in either direction. One dimmer controls either the top or the back stage of the upper pair, and a selector switch is provided for this choice; the other dimmer controls either the bottom or the back stage of the lower pair.

Many stations have installed telops in their projection rooms, but few have put all four stages into regular operation. This is because two of the stages are reversed in projection (either both back stages, or top and bottom stages, depending on whether scanning has been reversed in the ike). Gray now puts out a smaller two-stage machine for which no titles need be lettered in reverse.

TELEVISION FILM PROJECTION EQUIPMENT

All television stations use 16-mm-film projection equipment, and most of them have installed at least two 16-mm projectors to make operations easier and permit long feature films to be run without intermission for rethreading. Very few of the stations have also provided 35-mm (standard theatrical film) projectors. Whereas there is general agreement that 35-mm film, by and large, gives a better result, there are other factors of greater importance which have led to the use of 16-mm film instead.

For one thing, very little theatrical film (35-mm) is available for television use, and what can be used on television is easily reduction-printed in the 16-mm size. There is a vast field of nontheatrical film, however, originally made in 16 mm, which can be drawn upon for television use. A station which operates both 16- and 35-mm projectors finds that the 16-mm equipment is put to far greater use.

Until only recently, 35-mm film was made of cellulose nitrate, a highly flammable (almost explosive) material. All 35-mm film had to be stored in fireproof vaults, handled in special fireproof rooms, and could not be carried by messenger on bus or subway. Sixteen-millimeter film, on the other hand, can be handled anywhere, since its cellulose acetate base is no more flammable than paper.

Another factor was that a certain number of stations wanted to set up their own newsreel departments, or at least to use news film produced by other television stations, and the cost of 16-mm cameras, editing equipment, and projectors was much below the cost of standard professional 35-mm equipment.

Most of the film producers who make commercial spots or other films for television use produce these in 35-mm to begin with, make a few 35-mm prints for stations which have the equipment, and then turn out most of their prints by optical reduction in the 16-mm size.

THE SYNCHRONIZING PROBLEM

In the design of motion-picture projectors for television use the problem of synchronizing the 24 frame per second motion-picture film with the 30 frame per second television system had to be solved. Some early projectors begged the question by settling on a 15 frame per second speed (which fitted in perfectly with the television scanning rate—each movie frame was scanned twice), but they could not be used for sound film. The only film available for these projectors was amateur film shot at the silent rate of 16 frames per second. (The 1 frame per second slowdown was not noticeable.)

Perfect synchrony is not absolutely necessary—it is *possible* to project

a picture with an ordinary 24 per second sound projector onto a screen, focus the television camera on the screen, and get a picture. It will flicker somewhat—there will be dark bars moving up and down the screen—but the picture will not be entirely unusable. To avoid this effect, television projectors are specially designed so that their lighted and shuttered periods will coincide with the blanking periods of the television system.

There are several methods of designing television projectors each of which utilizes the ability of the iconoscope tube to store an image and “remember” for a split second what it has seen. Thus if an image is flashed only briefly, maybe for only a thousandth of a second, on the camera tube, then the tube can be left dark for the duration of the following field and it will scan the picture that has been stored.

A good time to flash a picture onto the tube is between fields when the beam is blanked out and doing no scanning. This is what television projectors do. Figure 10-21 illustrates this point. Line A is the television scanning system, and line B is the series of light flashes which the projector throws onto the television tube. Each flash of light is slightly shorter

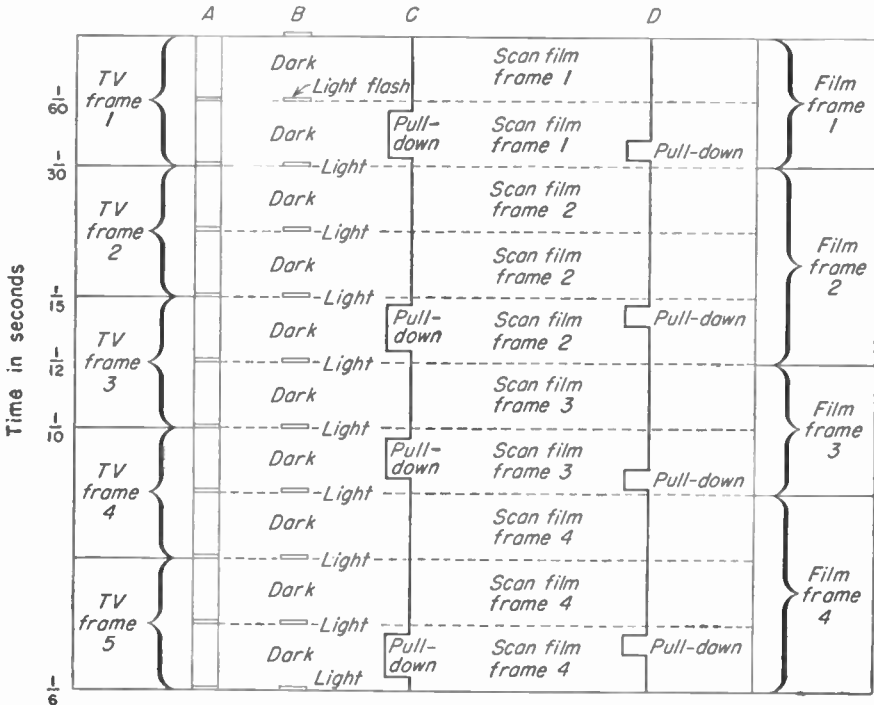


Fig. 10-21. Two methods of fitting 24 film frames into 30 television frames. (The above chart shows 4 film frames and 5 TV frames, since $\frac{1}{6}$ second is covered.)

than the TV blanking and retrace time (blanking time $\frac{1}{750}$ second; light flash $\frac{1}{1,200}$ second).

Now the next problem is: "How many times will each frame of film be flashed onto the TV tube?" We can't pull down the film between each light flash, or the film would be passing through the projector at the rate of 60 frames per second, and standard speed is 24. Exactly two frames of film must pass through the projector in a twelfth of a second, the elapsed time of five television fields. The simple answer is to flash one frame twice and the next three times. After the second light flash the film must be pulled down so that the second film frame is in the gate, and after the next three flashes it must be pulled down again. This means the pulldown must be irregular. Line *C* of the chart illustrates how the pulldown periods of a projector can be placed. This calls for a special design of the projector intermittent. The RCA 35-mm projector is built on this principle.

There is another design which does without the trick intermittent and pulls the film down at a regular rate. In a 16-mm projector the pulldown can be made somewhat faster, since the weight of the film it must move is less and there is less danger of tearing sprocket holes. If the pulldown occupies a shorter time span, it can be fitted in just after a light flash or just before one, so that every other frame of film gets two light flashes and the rest get three, yet the pulldowns are all equally spaced (Fig. 10-21, line *D*). The RCA 16-mm projector is of this type.

PROJECTORS FOR USE WITH THE IMAGE-ORTHICON CAMERA

There are several advantages in using the image-orthicon camera instead of the iconoscope for film pickup. Edge-flare and shading problems are avoided, and a standard studio or field camera may be used for the purpose. This is an advantage in the field or in theaters where projection-room facilities are not available.

One of these projectors is the Du Mont Super Speed. The name refers to a very fast pulldown mechanism which utilizes an intermittent sprocket. Because of the fast pulldown (less than $\frac{1}{1,000}$ second) it is possible to use a much longer light flash than most projectors employ. Instead of casting light through the film for only about 5 per cent of the time, like the television projectors previously mentioned, this projector keeps an illumination on the face of the camera tube for 75 per cent of the time. This type of light cycle would not work with the iconoscope tube (for reasons which are too complicated to explain here), but when the image orthicon is used, it is not even necessary to keep the projector running in constant sync with the television system. There is no need for phasing this projector to the sync generator like all the other projectors mentioned above.

Since phasing is not necessary, this projector can be started up from a single frame similar to the pulse-light projectors on the market. It will stop within 2 or 3 inches of film travel, which is a valuable asset when accurate spotting of film cues is necessary; there are no phasing bars in the picture either on starting or stopping.

Some stations have installed permanently mounted image-orthicon cameras in their projection rooms and use the Super Speed to project a picture directly onto the face of the image-orthicon tube. Other stations double up on the use of their cameras (such as WHBF-TV, Rock Island, Ill., Fig. 10-22) and simply project the film on a screen or ground glass

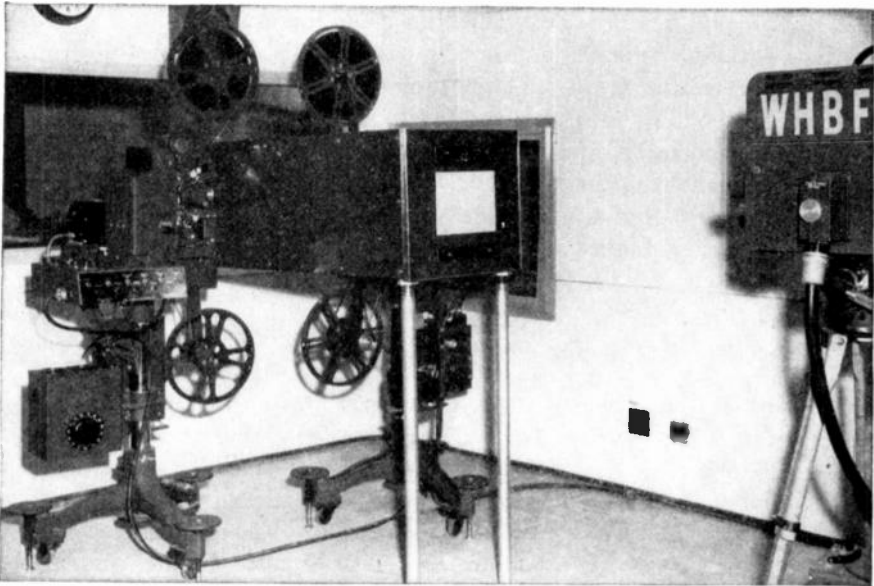


Fig. 10-22. Studio camera used for film pickup with Du Mont Super Speed projector.

where the image is picked up by a regular studio camera. These fast pulldown machines also find use as rear-screen projectors for process backgrounds.

PRECISION IN TV PROJECTOR EQUIPMENT

One of the basic limitations of many television projectors is that the film-feed mechanism is adapted from standard 16-mm projectors which are on the market for school and home use. Naturally such equipment must be relatively cheaply made so that a popular selling price is possible, and precision construction and long-lasting qualities are not of primary importance. Furthermore, it is considerably more difficult to make

16-mm equipment which will duplicate the performance of the larger 35-mm theatrical machines. The requirements of machine tolerance and accuracy are about $2\frac{1}{2}$ times higher in the construction of 16-mm equipment. Television projectors, moreover, must take constant use, several hours a day, every day of the week. This is something that was never asked of amateur equipment. The quality of the lens supplied with standard 16-mm projectors is also not very high, and this further reduces the quality of the transmitted film.

THE CONTINUOUS-MOTION PROJECTOR

A superior type of projector which may find increasing use in television stations is the continuous-motion projector. This design does not move the film intermittently (with inevitable strain on sprocket holes, etc.) but passes the film continuously through the projector gate. In the Du Mont Cinecon the image of each frame is kept centered on the projection axis by means of a rotating prism. The Cinecon, although it looks like a projector, is not actually a projector at all since it does not project an image onto a camera tube. Instead, the Cinecon itself is the camera, scanning the film by the flying-spot method.

THE FLYING-SPOT SCANNER

The probable successor to the iconoscope for the pickup of film and slides is the flying-spot scanner. The principle is briefly this: The image of a cathode-ray (receiver) tube is focused on the slide (or frame of film) and behind the slide is a photoelectric cell. The illuminated raster of a cathode-ray tube is really just a tiny spot sweeping back and forth and, because of persistence of vision and the decay time of the phosphor coating, looking like a series of horizontal lines. At any given moment, then, the light which is "projecting" the slide or film onto the photocell consists only of a tiny spot. As this sweeps across the slide, it passes through to the photocell according to the density of the emulsion on the slide. The photocell then, just as in a sound-film projector, passes an electrical signal which varies as the light that falls upon it. Thus the slide is scanned by the light itself, a much simpler method than the usual means of pickup where an image of the slide is scanned inside a camera tube. Not only is the flying-spot "camera" less expensive (no camera tube required) but the results are superior in matters of gray-scale rendition, etc. There is no edge flare and no shading problem as in the case of the iconoscope, no halo, streaking, or clouding as the image orthicon will frequently exhibit.

The RCA Flying Spot Scanner for slides is built in the size and shape of

an audio turntable, and can be placed in the control room to be operated by the director or TD.

MULTIPLE USE OF SINGLE FILM CHAIN

Film-pickup camera chains are expensive, and every station has devised some means or other to associate the maximum possible number of projectors with each camera. If the station can afford only one film-pickup camera, there is then no way for the control room to preview an up-coming picture from one projector if another is in operation. A second camera makes this possible and also ensures against loss of program due to equipment failure. In such a case if there is a 16-mm projector on each camera channel, for example, the station can always carry on. Where many projectors must be fed into a single camera, some very ingenious methods have been worked out. As many as seven or eight different projectors have worked into one camera.

The Rotating-table Method. Several projectors are mounted on a table which rotates in front of the camera, placing each projector in turn on the optical axis of the camera. All transitions between projectors must be made by fading to black. The indexing system is highly critical—the table must stop absolutely accurately (Fig. 10-23).

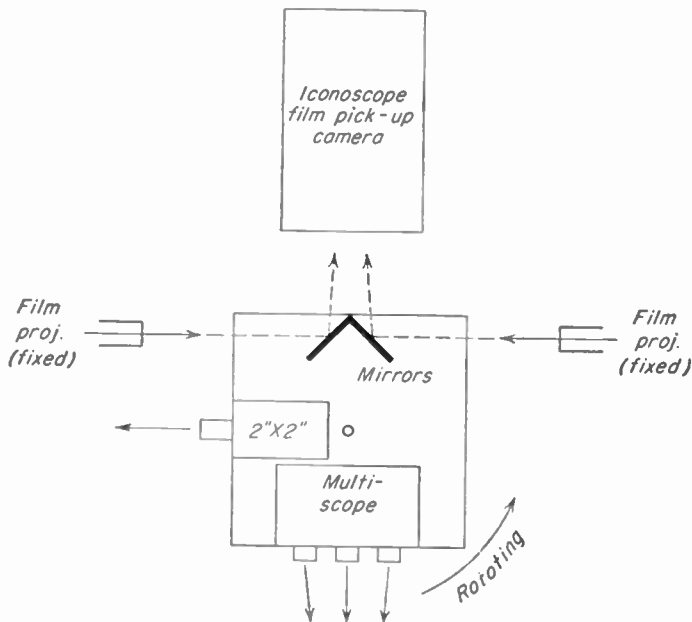


Fig. 10-23. Rotating table carrying two projectors plus mirrors to reflect two more. WBKB, Chicago.

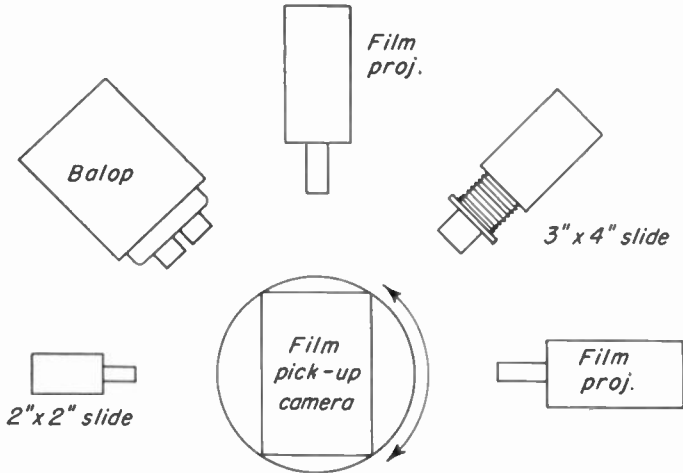


Fig. 10-24. Film-pickup camera on central turntable.

The Rotating-camera Method. The camera in the center can turn to face several projectors. Again, accurate register is important, and transitions can only be made by fade to black (Figs. 10-24, 10-25).

The Lateral-track Method. The camera is slid along a track to face several projectors. Same limitations as foregoing.

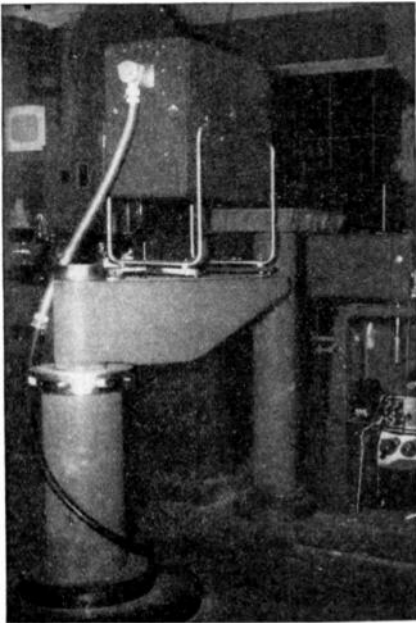


Fig. 10-25. Gray turret mount.

The Adjustable Mirror. A mirror set to rotate about a vertical axis squarely in front of the camera can be placed to reflect any one of several projectors grouped around it in a semicircle. Same limitations as foregoing. Difficult to keep accurate. (Fig. 10-26.)

The Sliding Mirror. A mirror held rigidly in one plane is slid across in front of the camera. This can be either vertically or horizontally. The effect, when this is done on the air, is a soft-edged wipe since the mirrors are considerably out of focus (Fig. 10-27).

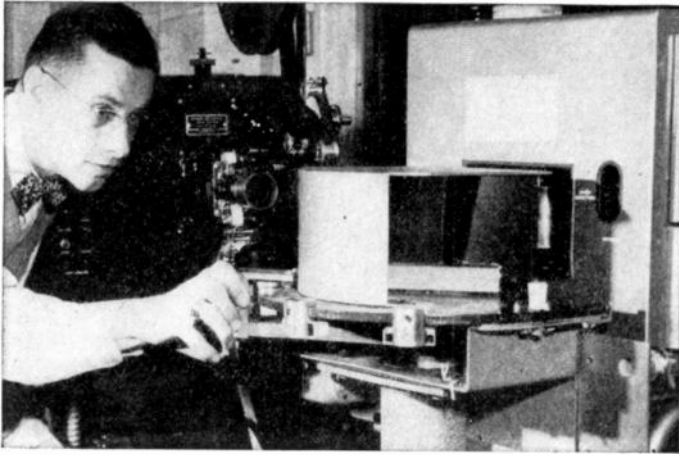


Fig. 10-26. General Electric mirror change-over.

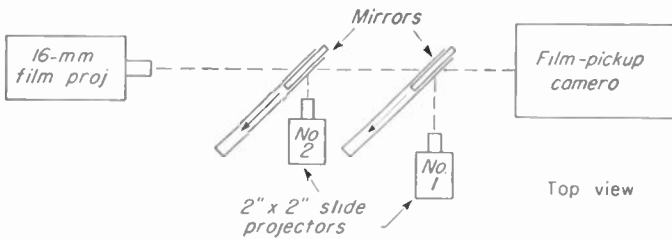


Fig. 10-27. WNBQ sliding-mirror change-over.

The Multiplexer. A multiplexer is a series of fixed mirrors. Since camera and projectors are also fixed, there is no accuracy-of-registration problem. Transition by cut, dissolve, or fade. Best solution. (Fig. 10-28.)

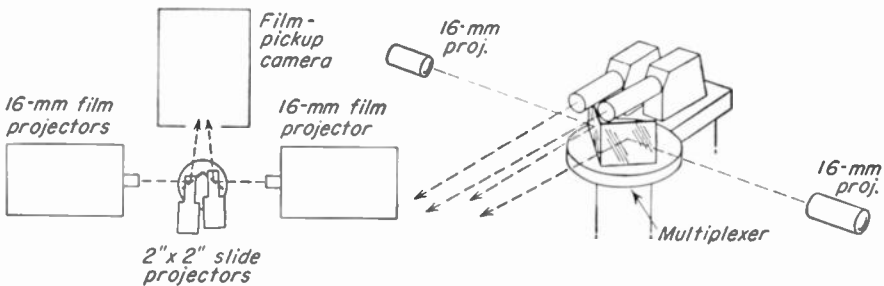


Fig. 10-28. Multiplexer.

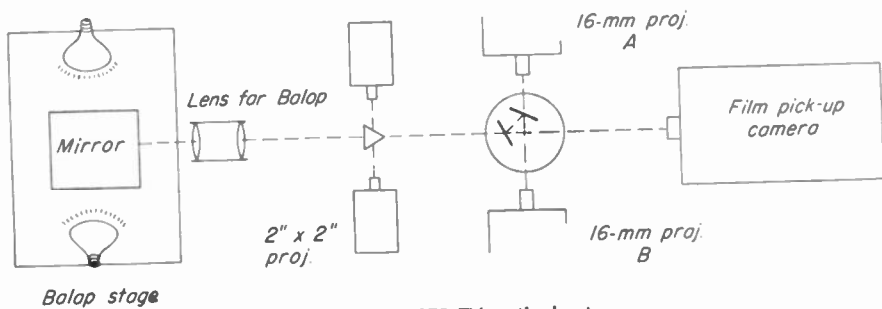
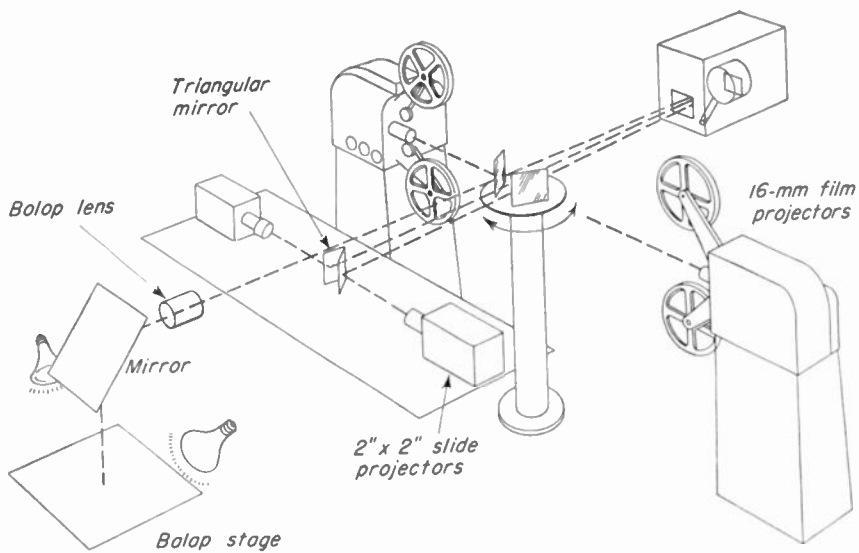


Fig. 10-29. KSTP-TV optical setup.

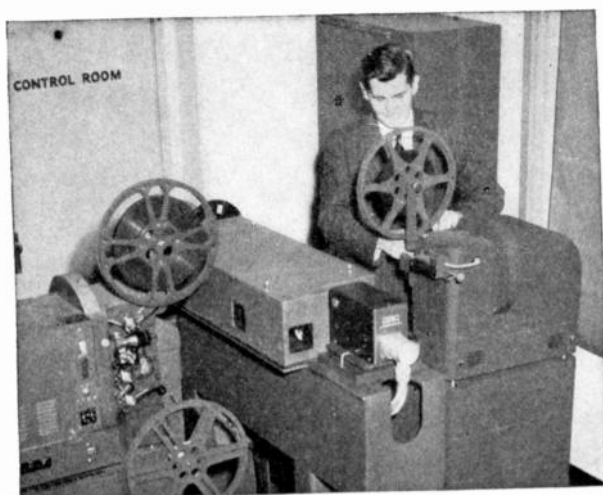


Fig. 10-30. Vidicon film pickup camera in foreground, with special multiplexer.

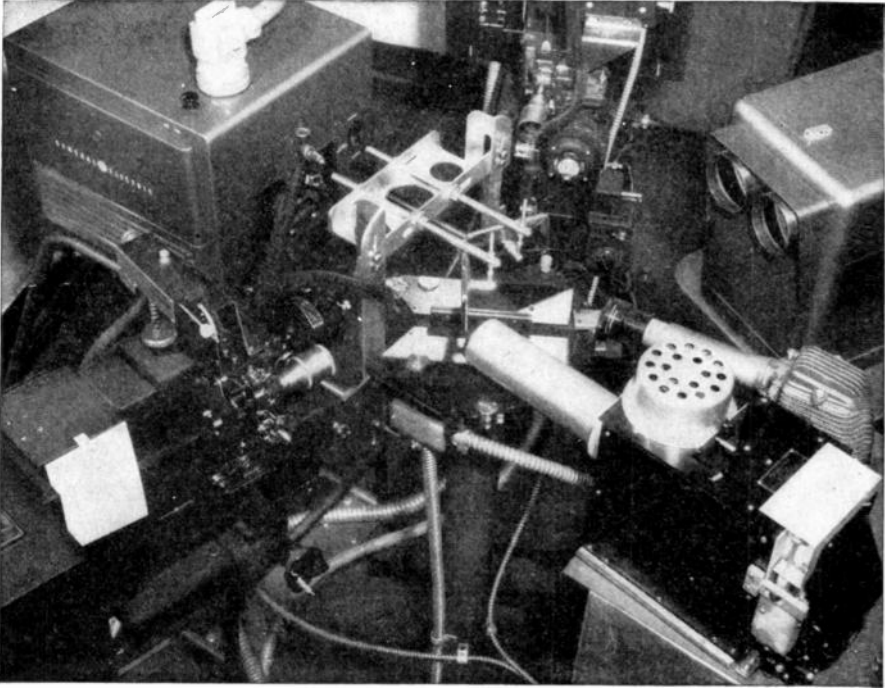


Fig. 10-31. A specially designed multiplexer setup built by WSYR-TV, Syracuse. The optical paths of the various projectors pass through the multiplexer on three levels. Top level, two mirrors in V shape to reflect two 16-mm projectors. Lower level, one long mirror to reflect both stages of GE balop. Middle level, open to allow 2- by 2-inch projector and Projectall to shoot through.

MULTIPLE USE OF TWO FILM CHAINS

When two film-pickup cameras are used, each may be provided with a multiplexer and surrounded by a group of projectors. There are several other possibilities.

The Lateral Track. This has limitations. With two cameras on the same track one camera cannot get past another to reach a projector which is beyond it.

Leap-frogging. Both cameras are mounted on dollies and can be rolled from one projector to another. This arrangement was used frequently in cities where fire regulations required keeping projectors lined up on one side of a wall and cameras on the other. Hard work for projectionist dollying cameras in addition to threading film, etc. (Fig. 10-32.)

Circular Track. Two cameras on the inside face a ring of projectors around the outside. Each camera can move in either direction and face any projector. Reaching cameras to move them is a problem for the projectionist.



Fig. 10-32. General Electric film camera on dolly to be rolled from port to port.

Quadriplexer. A moving multiplexer in which the mirrors can slide left or right (Fig. 10-33), thus reflecting the projected beam from the fixed projector either to the left (into one camera) or to the right (into another).

Camera 1 in the diagram (Fig. 10-34) is set up on a multiplexer to receive the pictures from two 35-mm projectors. It may be rotated 90

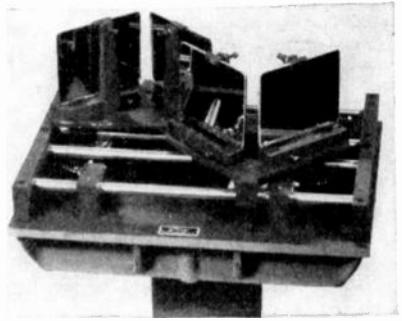


Fig. 10-33. Gray quadriplexer used in KECA-TV setup.

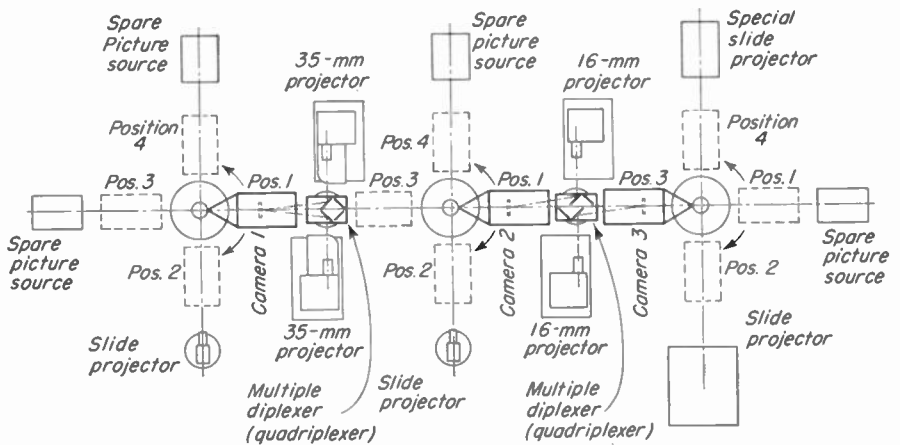


Fig. 10-34. Projection-room setup at KECA-TV using Gray film camera turret mounts.

degrees to a slide projector. However, should camera 1 fail, camera 2 can be swung around into its position 3. The quadriplexer mirrors are then moved to the opposite end of their travel, and camera 2 will be receiving the images from both 35-mm projectors.

A similar quadriplexer between the two 16-mm projectors is set up to send one image into camera 2 and the other into camera 3, but this could be quickly changed by sliding the top pair of mirrors to the left so that camera 3 would carry both projectors and camera 2 could be released.

PROJECTION OPERATIONS

Many film projectors require a few seconds after they are started to come up to speed. Common practice is to standardize on a five-second "roll cue," that is, the projector is started five seconds before the film is to be shown. When Academy leader is used, the number 8 is set in the film gate, if plain black leader, a punch mark or similar cue is made a little over 3 feet ahead of the start of the film and this is placed in the projector gate.

At the end of a reel the projectionist and/or the director must have a warning cue at least five seconds before a reel ends, and again one second before the end, so he has time to react and the film doesn't run out and leave blank screen. To minimize the effects of such a possible error, a short length of black leader is generally fixed to the end of the film. Some film editors use an extra scene at this point for added safety. The cue marks are generally provided by punching small holes in a corner of several successive frames. Since each station has some slightly different system governing this, TV films accumulate a fantastic variety of punch marks, in every corner of the frame and of every size. Some stations tape over the old punch marks blacking out many frames of film. An industry standard is badly needed here.

REMOTE CONTROL OF PROJECTORS

Although "start" and "stop" buttons are available for the projectionist on the film projectors themselves, these are almost always duplicated in the control room and a remote switch is provided on the projector with which the projectionist can give the TD control. The usual setup provides a ready light on the switching panel, which lights up when the projectionist has punched the remote button and indicates that the film is threaded up and ready to roll. On the cue "Roll film" the TD punches the "start" button, and the projector begins to turn. Then a third step is necessary before the picture is actually on the air. If there is only one film chain and it is already on the line, a change-over must be effected by operating the doublers. These are small shutters

which slide across the light beam. If two film channels are involved, it is simply a matter of previewing the upcoming picture and putting it on the line.

WHEN uses two Selectoslide projectors (2 by 2 inches), each of which can be loaded up with 16 slides. The TD must know which slide position is ready to project on each machine, and WHEN's arrangement for this aspect of remote control (Fig. 10-35) is similar to that which was worked out for a similar setup at KECA-TV in Los Angeles.

At KECA-TV a General Electric balop and two Selectoslide projectors

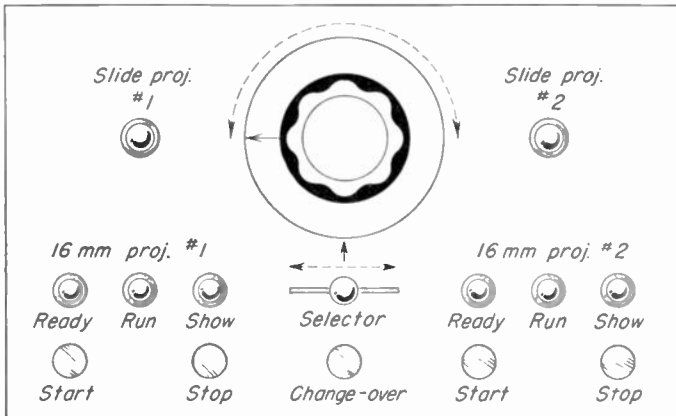


Fig. 10-35. WHEN, Syracuse, remote-control change-over panel. Variac knob at top is for dissolving between slides. After selector switch at center is set, change-over button operates all necessary dousers and lights and switches film audio so wrong projector cannot be heard.

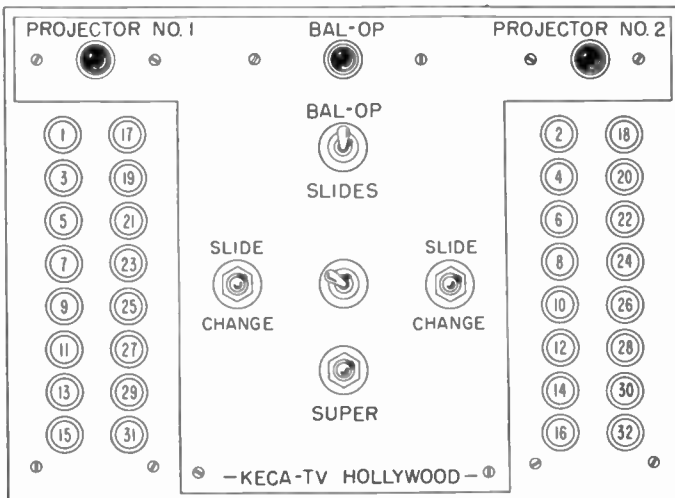


Fig. 10-36. Remote-control panel built at KECA-TV, Hollywood.

are set up in front of a single iconoscope camera. The TD's control panel for this assembly is shown in Fig. 10-36. Three tally lights at the top keep track of which of the three projectors is operating. The two rows of numbered lights at either side indicate which slide position is in place for projection. The same numbers are repeated on the machine itself so that the projectionist can put the proper slides in their assigned positions. For simplicity in operation all even-numbered positions are on one projector, and all odd-numbered positions are on the other. The slide-change buttons advance a projector one position and work only on the projector which is off the air. A toggle switch (center) makes the change-over from one slide to another. Since only one projector can be on at a time, a special super button has been added which will add the second projector for as long as it is held down. All transitions are instantaneous; however, there is no provision in this control setup to allow a fade, a dissolve, or a slow superimposure.

COMBINATION DEVICES

Several manufacturers have attempted to solve this entire projection problem in one machine. The Super Projectall 300 is a good example.* This machine includes two 35-mm slide projectors and two 3 by 4 opaque stages, plus a multiplexer system to provide for the use of two 16-mm film projectors as well. Sliding mirrors are used. This machine fits in a tall cabinet somewhat less than 2 feet square and stands directly in front of the iconoscope between the two film projectors.

The Du Mont answer is embodied in a large flying-spot scanner, the Multiscanner, which incorporates two 16-mm "projectors" (Cinecons) and two opaque stages. The scanning light is generated by a single cathode-ray tube and a flip mirror directs it either into the two 16-mm channels or the two balop channels. Two output channels lead to two monitors in the control room; thus slides or films may be previewed before they go on the air, a feature which is not possible with single iconoscope systems.

VIDICON PICKUP

The Vidicon camera, built around a tube 1 inch in diameter and 6 inches long, has proved quite superior to the iconoscope for the pickup of film and slides, needs no shading operator, and exhibits no burn-in or spurious effects like the image orthicon. Several manufacturers now offer a Vidicon system complete with special multiplexer and optical system to make possible the projection of images less than an inch wide (Fig. 10-30).

* Manufactured by Tressel TV Productions, 11 So. LaSalle St., Chicago 3, Ill.

11 MIRRORS AND PRISMS

Perhaps the most useful single device in the field of special effects and illusion is the mirror. Almost any kind of television production requires some understanding of the properties of mirrors and how they can be used. The effects that can be achieved with mirrors will be discussed first, after which the properties of mirrors will be briefly outlined.

HIGH-ANGLE SHOTS

Figure 11-1 illustrates a common use of the mirror in television studios. The mirror reflects a top shot of the subject which could otherwise be

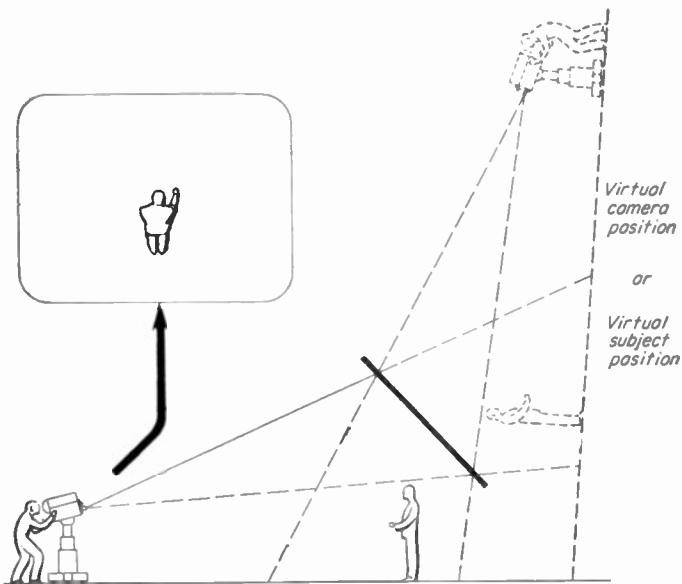


Fig. 11-1. The use of a mirror will seem to put either the camera or the subject in a different position, whichever seems most logical. In this case it is the former.

obtained only by positioning the camera above the set. A “virtual” camera position is obtained. The direction of the camera view has been changed by the mirror. If the viewer does not know a mirror has been used, he will think the camera is actually placed above the set.

This is one aspect of the mirror’s effect: the mirror seems to transport the camera to a different position. In other cases the change seems to have happened to the subject instead, and a virtual position of the subject is obtained. You can think of it either way. In this particular example the subject is seen in mirror image walking on the wall, which is impossible. So the eye believes instead that the camera has assumed a high position.

To determine which end of the subject will be up, in Fig. 11-3, simply trace out the top or the bottom edge of the camera’s field of view. The bottom is shown as a dotted line in the accompanying diagrams. The subject’s feet are closest to this bottom line, and his head is closest to the top line; hence he is not inverted. Left and right appear to be reversed, however, and the subject seems to hold the cane in his left hand instead of his right. It is only the *actor’s* right and left that are reversed, however; camera left and camera right remain the same. In a direct shot the cane would be on the camera-left side of the man; in the reflected shot the same is true: the cane is camera left of the man. Camera left is still camera left.

Taking advantage of the mirror’s property of creating a virtual camera position, the camera can apparently be placed in impossible positions. Two examples from field pickups will explain this. The camera setup for hockey at Boston Garden had to be so close to the press box that a shot of the commentator was not possible. To solve this problem, the staff installed a mirror in a spot where the commentator was visible and gave the camera a more advantageous apparent position. The mirror shown in Fig. 11-2 is on a swivel so that it can be set at any angle.



Fig. 11-2. When the camera can't see the subject directly, a mirror can make it possible. (WNAC-TV, Boston.)

Figure 11-3 illustrates some other methods of using the mirror for the effect of a top shot. A single mirror between camera and subject will give the camera a high-angle shot, but the image will be upside down. This can then be righted by the use of an image-inverter prism (b) or by the use of another mirror (c).

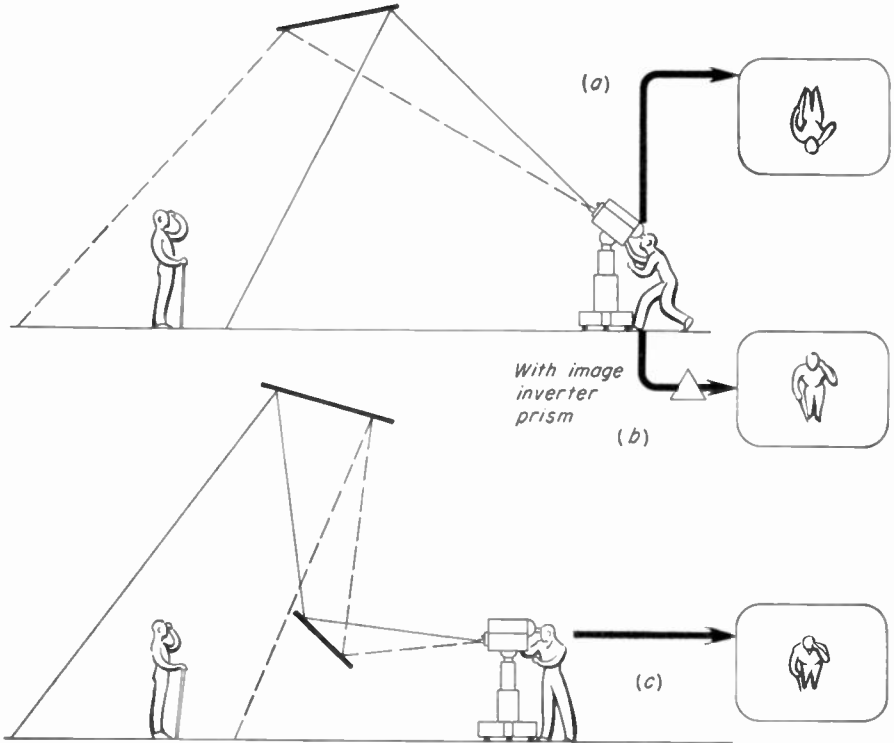


Fig. 11-3. Some other methods of using an overhead mirror for a top shot. (a) Single mirror, (b) single mirror with image inverter, (c) two mirrors.

THE PERISCOPE

The two-mirror method illustrated in (c) has been incorporated into large periscope devices where both mirrors are adjustable and the entire unit can roll quickly into place and be removed after it has been used (Fig. 11-4). In the top photograph in Fig. 11-5 the still photographer has pointed his camera into the lower mirror of such a pair, showing the reflection of the larger mirror above and also, over the top of the small mirror, the actors as they appear from standard camera height. The lower photograph shows a different way of mounting the mirrors; the lower mirror is flat on the floor, while the upper one is suspended from the ceiling. It will be noticed that a microphone-boom problem develops

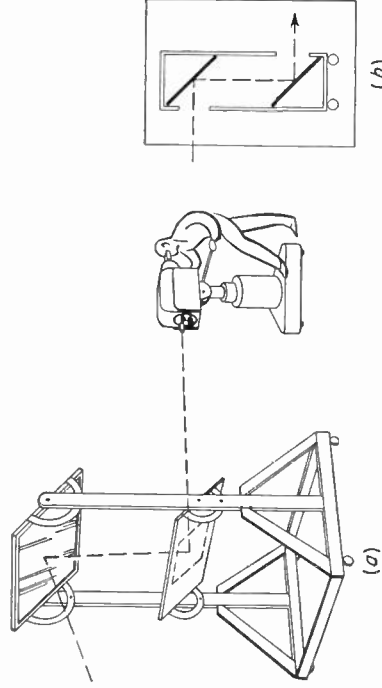


Fig. 11-4. Studio periscopes, (a) for high-angle shot, (b) for low shot.



Fig. 11-5. Above, top-shot periscope in use on CBS show. Below, mirror on floor in NBC's "Cameo Theatre" reflects top shot from mirror on ceiling.

when a top shot is used. The camera cannot pan very far, either, without panning off the mirror, unless a very large mirror is used.

WPTZ in Philadelphia was probably the first station to use this device in a production of "The Medium." The effect of a high top shot down through a skylight was obtained, and the window mullion bars were made by sticking black tapes across the face of the upper mirror. Some studios have installed permanent mirrors on the ceiling above the permanent sets for kitchen shows, demonstrations, etc., so that a camera may use a top shot whenever desirable without special preparation. This particular use of the single mirror is quite often seen in television: a group of people stand in front of a fireplace, for example, looking up at the family portrait. Out of camera range above the portrait is a mirror; and a second camera, side by side with the first, shoots into this mirror, for a shot of the group from the portrait's point of view. The only trouble with this shot is that stage left and stage right are reversed. Whereas the girl was on the stage-right end, for example, in the mirror shot she appears to be stage left. When there is a group such as this in which left and right make a difference, the single mirror shot may look wrong. If only one person is involved or a subject in which the left and right elements are similar, this reversal will not be noticed.

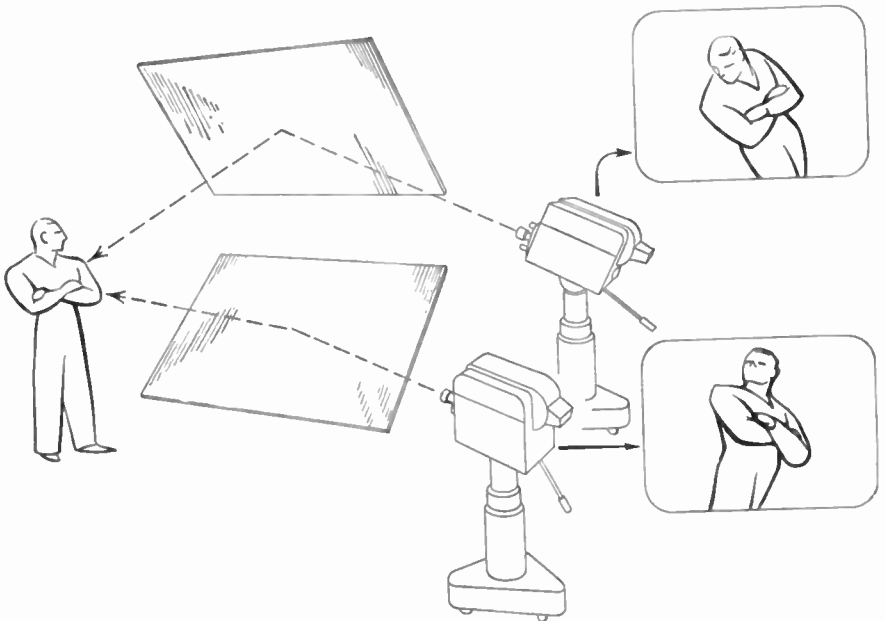


Fig. 11-6. When the mirror is placed to the side of the subject with its surface out of the vertical plane, a canted image will result. See Chap. 4 for other ways of obtaining a canted shot.

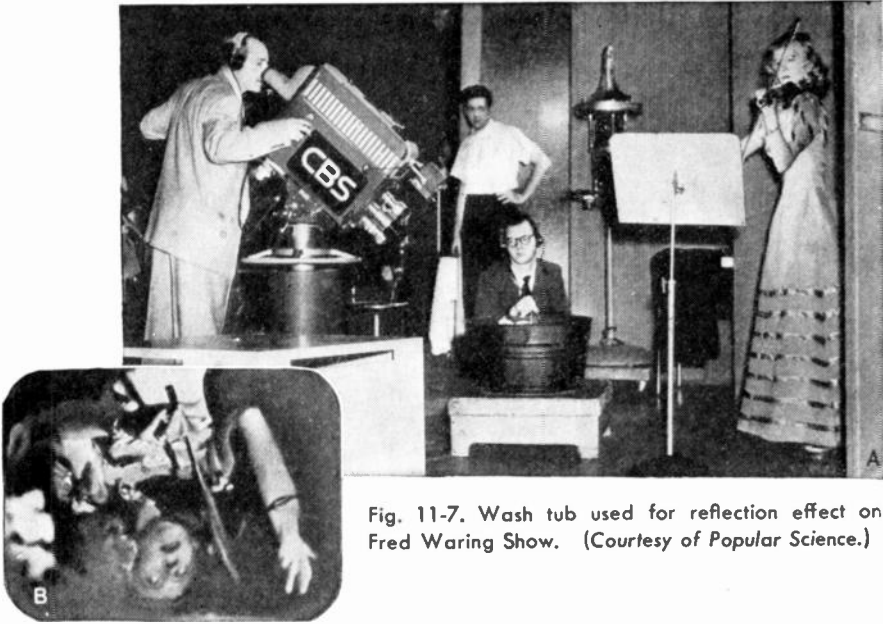


Fig. 11-7. Wash tub used for reflection effect on Fred Waring Show. (Courtesy of Popular Science.)

REFLECTION EFFECTS

Sometimes a show will call for the effect of a reflection in a woodland pool. This is best achieved by a large mirror which is covered by a half inch or so of water. An electric fan can be used to ripple the surface of the water or, if this is too noisy, a stagehand, well off-camera, can disturb the water with the end of a stick. Sometimes water alone will create this effect without need for a mirror beneath it. Figure 11-7 shows an ordinary wash tub of water being used for a reflection effect. The inside of the tub must be painted black in this case, however, or its image, somewhat out of focus, will be superimposed on that of the girl.

An old photo trick to create the illusion of reflection in water is to put a small mirror just beneath the camera lens. The drawing in Fig. 11-8

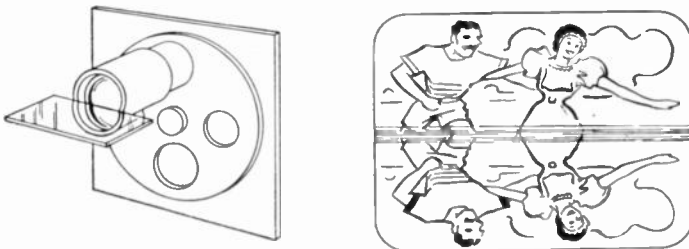


Fig. 11-8. Use of a small mirror beneath the camera lens for reflection effect.

indicates the kind of shot which this trick will produce. The mirror must be held parallel to the optical axis of the lens and placed just as close to the center of the lens as possible without interfering with the picture or cutting out any light. If the lens is stopped down to a small opening, the mirror may be placed as shown in Fig. 11-8 without blocking out light.

SPLIT SCREEN AND WIPE

A large mirror has been used for the split-screen effect, set at a 45-degree angle to the camera and extending only halfway across the frame. Thus the camera sees half of the image by direct viewing, the other half

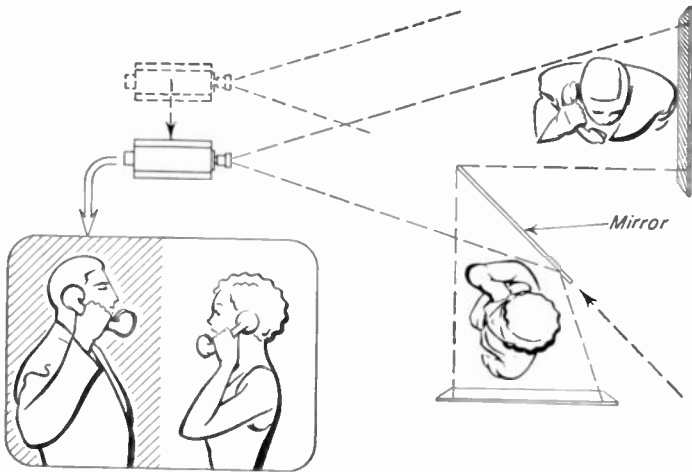


Fig. 11-9. Split-screen effect done by a mirror. Dash arrows indicate two methods of wiping in the reflected image: moving the camera and sliding the mirror.

reflected. Two ends of a phone conversation can be shown at once in this manner (Fig. 11-9).

The mirror will have a sharp or a soft edge, depending on how close it is to the camera. If the mirror is very close to the lens, it will be well out of focus and one scene will seem to dissolve into the other along a border area up the center of the screen. If the mirror is as close to the subject as possible, it will be more nearly in the plane of focus and the edge will be sharp.

The method of getting into and out of an effect smoothly is important to consider at the time the effect is being planned. In the case of the phone conversation the split screen might appear in a direct cut after a single shot of the person making the call. However, if the mirror or the camera moves, a wipe effect can be obtained. This can be very smooth: an actor picks up the phone and dials a number; then a wipe

begins at the opposite side of the screen and moves in far enough to reveal the party at the other end of the line as he answers the phone.

The mirror may be put on tracks and effect the wipe by sliding into the scene. This requires accurate tracks, however, both at the top and at the bottom. The mirror must be held solidly and kept moving in exactly the same plane. If it should tilt ever so slightly, the reflected image would ride up or down on the screen. Sliding a mirror can be done more easily when it is small and light, although the smaller the size of the mirror (and the nearer to the camera), the greater the accuracy of movement which is required (smaller irregularities are enlarged on the screen).

SUPERIMPOSURES AND GHOSTS

A superimposure effect is the appearance of two images on the screen at once. To do this optically with only one camera, the camera must see two things at once and in the same place. A plain sheet of glass will permit this, since it will both transmit the image of the scene behind it and reflect a scene which is to the side. Reflections from glass in windows or picture frames are often a problem on the TV set; but in this instance the mirror property of clear glass is put to good use. This is the method of the old "Pepper's ghosts" illusion, known almost as far back as the manufacture of plate glass. The real actors were seen on Pepper's stage through the glass; the ghosts were reflected from the wings (Fig. 11-10).

This method of producing ghosts is used frequently in motion-picture production because the final effect can be watched and the coordination between live actor and ghost can be accurately set during rehearsal. It has one big advantage for television, which is that the camera can move freely without changing the relationship of live actor to ghost. As long

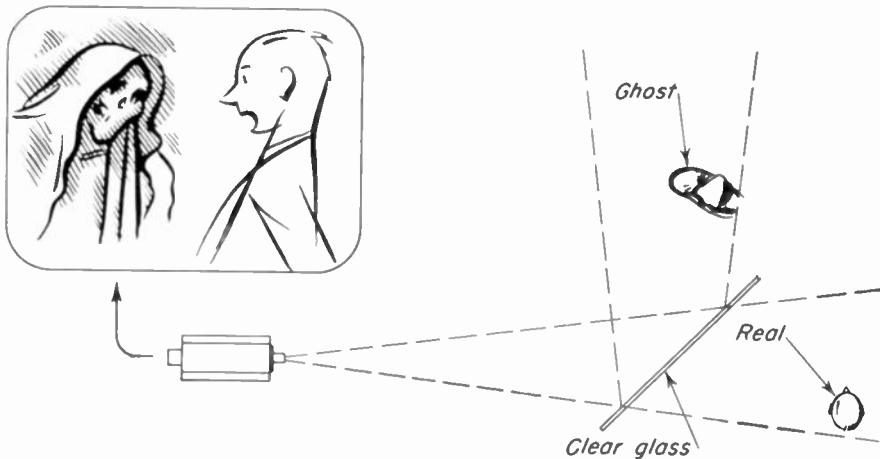


Fig. 11-10. "Pepper's ghosts" illusion—reflection from sheet of glass.

as the positions of the actors and the mirror stay the same, it does not matter from what angle the effect is viewed. The usual method of producing ghosts on television requires the superimposing of two cameras. Whereas this is much simpler than installing a large sheet of plate glass, both cameras must be motionless during the superimposure. If either camera should move, an unnatural floating effect of the ghost is seen which can easily spoil the illusion.

If the large sheet of plate glass is impractical, a small sheet of glass closer to the camera can accomplish the same purpose. This can be mounted either in an effects box on the front of the camera or on a floor stand separate from the camera itself. Lining up the camera on the shot is greatly simplified if the glass is separate from the camera; if the two are connected, the actual position of the camera itself will determine the relationship of live actor to ghost and this position may take considerable time to find. Also if the glass is attached to the camera, the camera must be absolutely rigid throughout the effect.

The effect of sliding the mirror to produce a wipe can be applied here. If the glass which is reflecting the ghost is slid away (and kept accurately in the same plane), the ghost will be wiped out of the shot. If the glass is moved from its original plane, hinged up or swung out like a door, the ghost will be seen to move bodily or float within the scene. This can be useful if the movement is smoothly controlled.

A sheet of glass at a 45-degree angle to the camera will reflect only about 15 per cent of the light from the "ghost." Of the light from the transmitted scene about 85 per cent will reach the camera through the glass, a similar 15 per cent having been reflected off the back side. The reflected "ghost," therefore, must be very brightly lighted in comparison with the transmitted scene in which he is to appear, or he will be only faintly visible.

TRANSPARENT MIRRORS

A more even balance between transmitted and reflected light can be obtained with a transparent mirror. This is a standard item, available from glass manufacturers, but expensive in comparison with ordinary mirrors. It is sometimes called a half-silvered mirror.

Transparent mirrors have sometimes been called "one-way glass." This is a confusing term and leads people to believe that there is something about the glass which prevents light from going through in one direction while allowing it to pass in the opposite direction. This is entirely untrue. When such glass is installed in the police line-up, in hospital observation wards, or for photography with a concealed camera, the person under observation sees only a mirror because all the light is on his side of the glass. The observer on the other side remains hidden

as long as he remains in the dark. If the lights should change and the lighted room become dark and the dark room lighted, then the erstwhile observer would find himself revealed to the person he was spying on, while he himself could see only an ordinary mirror.

The transparent mirror has found valuable use in television in the construction of multi-stage balops or shadow-box devices for handling of graphic materials on the studio floor. Control of lights on two or more stages (in the manner of the telop (Fig. 10-19) will make optical dissolves, wipes, and superimpositions possible through the use of only one camera. The various types of shadow boxes utilizing these mirrors will be described in a later part of this chapter.

PROPERTIES OF MIRRORS

There are two laws of reflection which govern the action of mirrors. The second law is the more familiar and can be explained more easily before the first. It states that the angle of incidence is equal to the angle of reflection.

This means simply that a ray of light bounces off from the mirror surface at the same angle that it came in from. The angle is measured between the ray of light and the normal (perpendicular) to the mirror surface (Fig. 11-11). Instead of speaking of a ray of light, we can apply

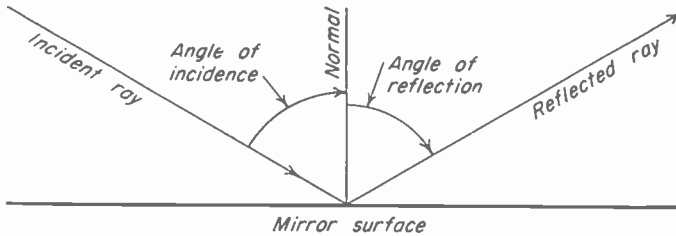


Fig. 11-11. The second law of reflection. Angle of incidence equals angle of reflection.

this rule to the line of sight from the camera to the object. By changing the angle of a mirror in front of the camera, the camera will be able to see in different directions (Fig. 11-12). Swinging the mirror during the shot will give the effect of panning the camera. Notice how more mirror is necessary when the camera shoots into it at a flat angle.

The first law of reflection states that the incident ray, the reflected ray, and the normal to the surface lie in the same plane. There is a symmetrical triangle formed by the imaginary lines between camera, mirror, and subject; and the normal to the mirror surface bisects this triangle. Figure 11-13 applies this to the tilted mirror, which is used for the canted-camera effect. It explains why the image is low when the mirror is tilted back and high when it is tilted forward.

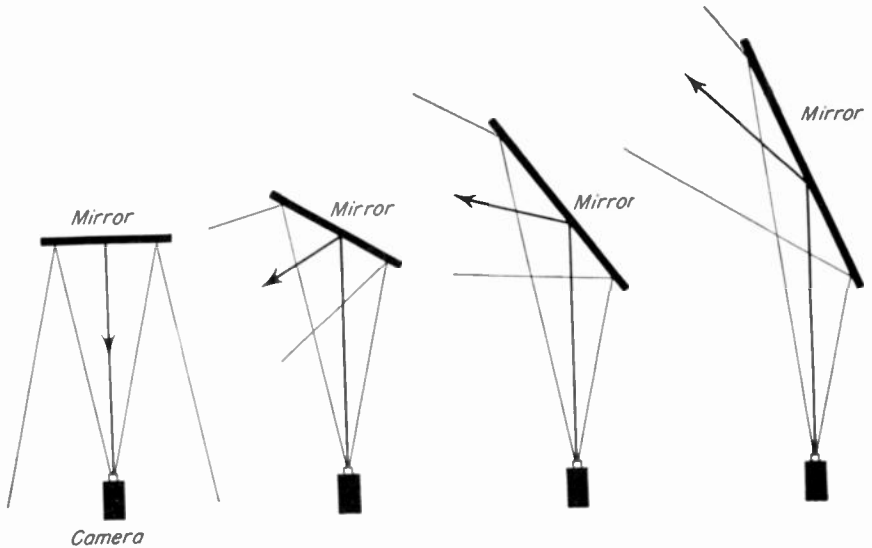


Fig. 11-12.

In shooting a picture through a mirror, the cameraman *does not focus on the mirror*. A plane mirror gives an illusion of position; it makes the subject seem to be in a different place from where it is. It does not bring it closer. The mirror is intermediate between camera and subject. If you focus on the mirror, the subject will very likely become fuzzy. All that will be seen clearly will be the dust and fingerprints on the mirror surface. Focus the camera always on the subject, just as though there were no mirror involved. The distance from subject to camera is the total distance the light must travel to get there.

IMAGE INVERSION

There are three methods of turning a picture upside down: the mirror, the prism, and the electronic method of reversing the scanning in the camera. Naturally they can each be used to erect an image also. If a mirror, placed where it will give a desired camera angle, also gives the undesired effect of image inversion, this can be corrected by any one of the above methods. The use of a second mirror has been described. An image-inverter prism is in many cases simpler to use.

The image-inverter prism is a right-angle prism of a rather large size, a "porro prism" or a "dove prism" (Fig. 11-14). It can be mounted in a tube which is fastened to a regular lens shade. The lens shade carrying the prism is screwed onto the front of the lens when the effect is wanted and does not interfere with the functioning of the other lenses on the camera.

If this prism is placed on its side and the camera directed toward a

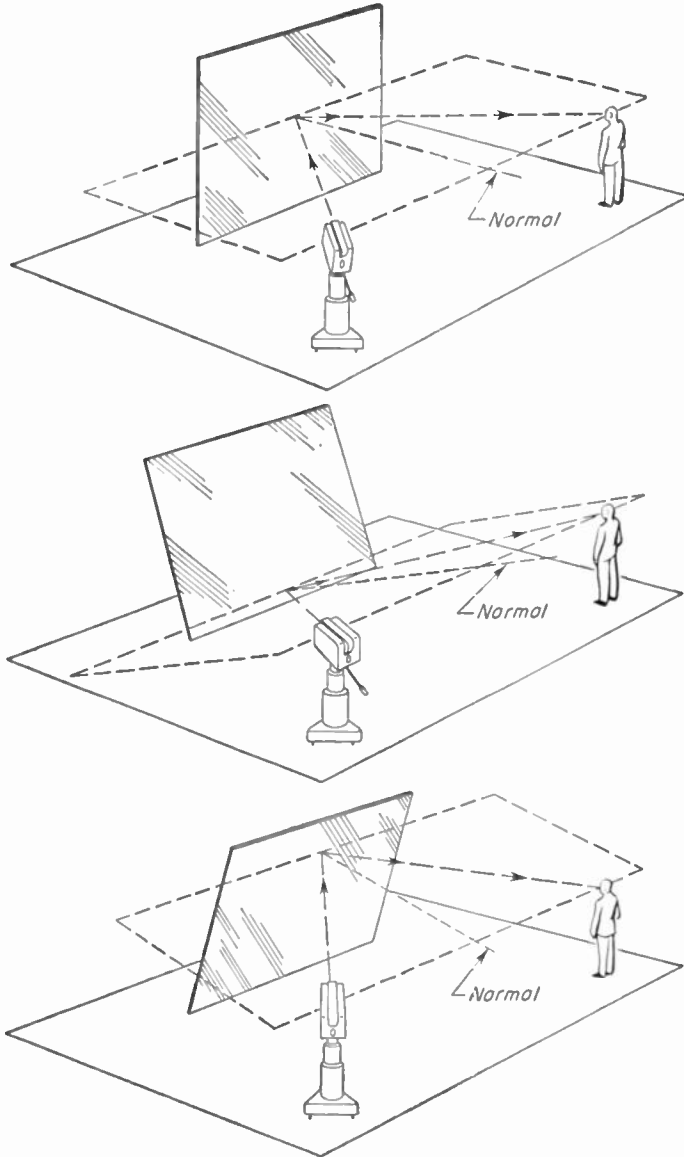


Fig. 11-13. The first law of reflection. The incident ray, the reflected ray, and the normal to the surface lie in the same plane.

scene, an erect image will result, but reversed from left to right just like the image in a single mirror. As the prism is rotated, the scene rotates in the camera's view, until with 90 degrees of prism rotation the scene has completely turned around (180 degrees) and is upside down. It is still

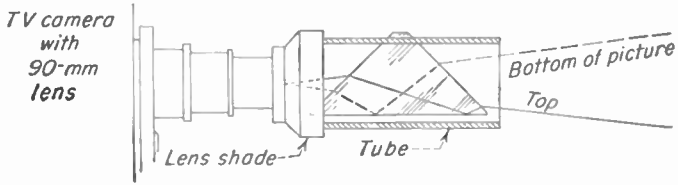


Fig. 11-14. Image-inverter prism.

seen in mirror image, however, just as it would look in a single mirror held above or below the camera.

The rotation of this prism can be accomplished by hand, either by the cameraman himself (if he locks his camera controls so that he can move around to the front of the camera) or by an assistant. The engineering department at NBC has devised a better means of controlling the rotation of effects on the front of the lens by the method used in controlling the Zoomar lens, a rod through the center of the camera turret shaft (Fig. 11-15). A simple gear system on the prism mount makes it possible for

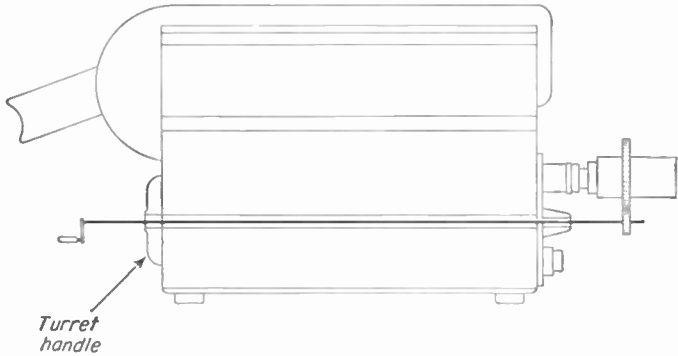


Fig. 11-15. Control for rotating prism from rear of camera.

the cameraman to rotate a small crank at the back of the camera and turn the prism around with quite an even motion. Other prism effects, which are described later, can also be used with this rotating device.

The show "Tom Corbett, Space Cadet" has put the image inverter to very good use. When the space ship had suffered the failure of its artificial gravity apparatus, the crew had fun for a few installments by walking on the walls and ceiling. A special set was built for this effect, lying on its side, so that the actors could really walk on the wall. Then the set was erected by means of the prism. An actor in the foreground (Fig. 11-16) who was supposed to be standing vertically and talking to the man on the wall was placed horizontally on a table in front of the camera. The use of the image inverter reversed left and right, and since

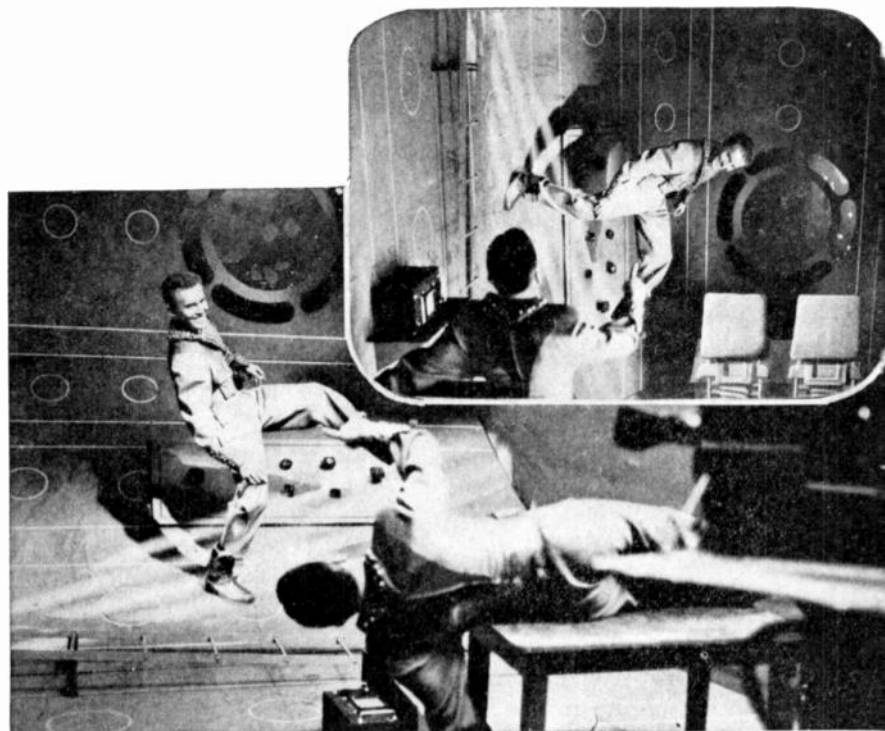


Fig. 11-16. Example from "Tom Corbett, Space Cadet," showing use of image-inverter prism to give illusion of actor walking on wall.

this was undesirable, electronic scanning reversal was employed to correct for it. This meant, oddly enough, that the prism was first set up to give an inverted picture; then this was righted by scanning reversal so that a straight shot resulted, everything right side up and right way to. Then 45 degrees of rotation of the prism produced the sideways shot.

If a prism of the type described is not available, the same thing can be done by a series of small mirrors. Simple image inversion can be accomplished by three mirrors as shown in Fig. 11-17. If these are mounted so that they may be rotated, the image can be placed at any angle or rotated just as it may with a prism.

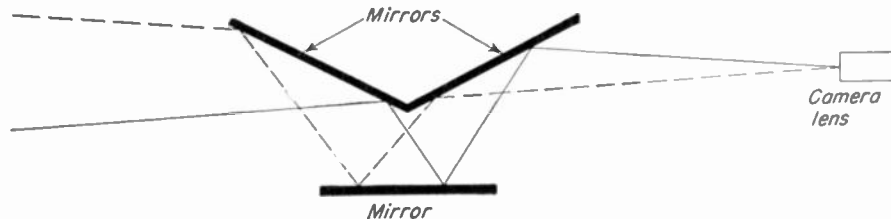


Fig. 11-17. Simple image inverter made with three mirrors.

If four mirrors are used, the image is fully corrected just as it is when seen through two mirrors. The four-mirror system is thus superior in this respect since both the prism and the three-mirror method reverse the image and require the cameraman to pan or tilt in the opposite direction from that he is used to. The four-mirror image inverter was first used on television in 1947 by Karl Weger at WPTZ on the Ted Steele "Piano Patter" show. The same man is responsible for the three-mirror method and is credited with the later introduction of the image-inverter prism into general use. The mirrors, each only $2\frac{1}{2}$ by 3 inches in size, are arranged in the manner shown in Fig. 11-18. When rotated about the

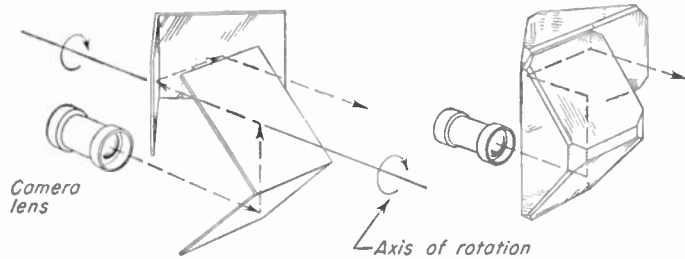


Fig. 11-18. Image inverter made with four mirrors. Right, with porro prisms.

proper axis, which is also shown, the image will turn through twice the angle of rotation of the mirror assembly (similar to the prism). The mirror system is inferior to the prism because of the greater light loss from all the reflecting surfaces, but it has one advantage. Four mirrors, like two mirrors, correct the image, and a reversed picture does not result.

Two right-angle prisms instead of two pairs of mirrors can be used. This is the principle used in the erecting systems of prism binoculars. Two pairs of right-angle prisms used in this way are called porro prisms. The only difference is that if prisms are used, a rotation of the system will not rotate the image—the picture remains inverted. The image can be righted only if one of the prisms is rotated against the other.



Fig. 11-19. Typical canted shots for dynamic composition obtained with image-inverter prism. Left, a shot from the "Lucky Strike Hit Parade"; right, a shot taken by the author with the facilities of the School of Radio Technique.

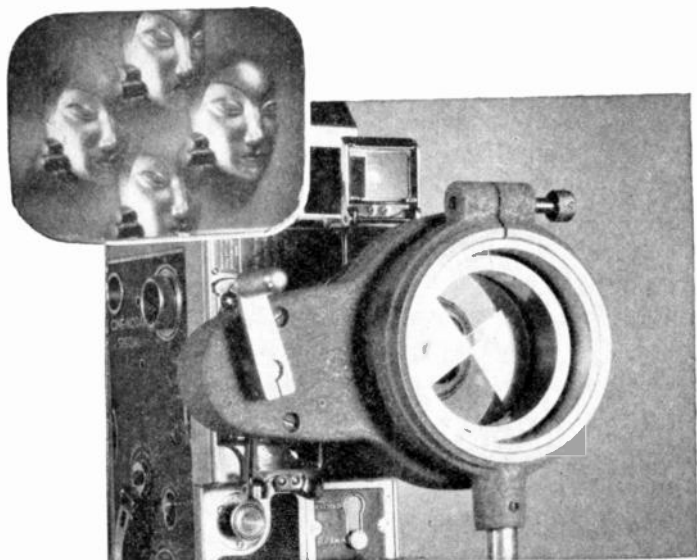
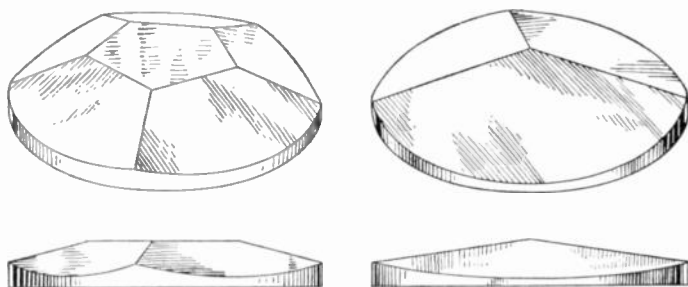


Fig. 11-20. Camart Optical Effects Unit attachment for multiple-image prisms.

MULTIPLE-IMAGE PRISMS

A type of prism which produces a multiple image has been used in motion-picture work for many years and has recently made its way into television. Effects such as that in Fig. 11-20 can be obtained with almost any number of images if the proper prisms are set before the lens.

If these prisms are rotated, the images will revolve around each other, like a side view of the seats on a ferris wheel, remaining upright all the time. The NBC rotating-effects gadget (Fig. 11-15) will take multiple-image prisms and rotate them smoothly from the rear of the camera. The prisms involved in these devices are relatively simple pieces of glass on the front surface of which several facets have been ground (Fig. 11-21). The number of facets determines the number of images.



6 - facet - 6 - image prism

3 - facet - 3 - image prism

Fig. 11-21. Two types of multiple-image prisms.

THE KALEIDOSCOPE

One of the special uses of mirrors or prisms is in the design of a kaleidoscope. The kaleidoscope, as anyone will remember who has ever taken a child's toy kaleidoscope apart, is essentially a pair of mirrors between which the eye looks at a subject. Since the subject is reflected and re-reflected in these mirrors, a beautiful, symmetrical pattern of many radiating segments is seen.

The first projection kaleidoscope was designed by Bill Eddy at NBC in 1939 and was used to project moving patterns on the film-pickup camera. Patterns were drawn or photographed onto a strip of 35-mm film which was then driven horizontally through the picture at a steady rate. A long, V-shaped prism was used (rather than two mirrors).

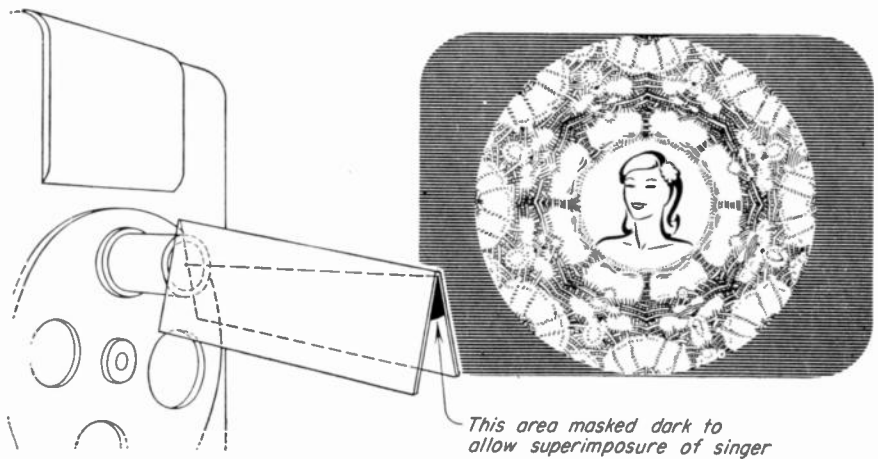


Fig. 11-22. Kaleidoscope used by NBC on "Garroway at Large."

The pattern was centered, not in the middle of the screen like a rosette, but at the bottom of the screen, so that only a half-rose pattern like a rising sun was seen. Highly imaginative production techniques were used, and the patterns were synchronized to music and were even used as semiabstract transitions between scenes in dramatic productions.

Bill Eddy has since marketed a simplified version of this kaleidoscope through his Television Associates Inc. This device uses a circular disk to carry the pattern, turning so slowly that it takes three minutes for a complete rotation. There can be no actual synchronizing with music, however, but the eye is quick to note chance relationships between picture and sound, and with almost any music the viewer gets an illusion of synchrony although none is planned.

A kaleidoscope was used successfully on one occasion as a decorative *lei* to surround a singer on the "Garroway at Large" program. Built by

the cameraman John Casagrande, this kaleidoscope was fastened to the lens of the television camera, which then was focused on the far end of the kaleidoscope (a few inches from the lens), and pointed toward some suitable source of illumination for transmitted light. Since a full rosette was wanted in this case, the apex of the two mirrors had to be centered in the frame. This meant that the kaleidoscope had to be mounted on the camera at an angle (Fig. 11-22). The center of the rosette was made black, and a small close-up of Connie Russell was superimposed over this area from another camera. The changing patterns originated from the traditional bits of glass, which tumbled about as the kaleidoscope was rotated.

WPTZ in Philadelphia fascinated viewers watching musical shows and interludes by a device they simply called the "whirligig." Accurately synchronized to whatever music was played, a wiggling, jumping pattern in a rosette shape made endless fascinating gyrations on the screen.

A conspiracy of silence kept viewers (and the staff of other Philadelphia stations) in a quandary for months. Spies sent into the WPTZ studio on trumped-up business returned with no information on the new invention, having seen nothing but the usual studio equipment: cameras, mike boom, and test oscilloscope standing in the corner. Had they examined the oscilloscope a little closer, however, they would have noticed that Karl Weger had been at work and had built a kaleidoscope onto the front of it (Fig. 11-23).

An oscilloscope, as the reader may already know, is a testing instrument which when fed by an audio signal transforms the sound vibrations into a visible wave pattern which is seen as a green wiggling and jumping line. The camera, looking between the mirrors of Weger's kaleidoscope, saw only a portion of this line multiplied into a rosette. Since the television

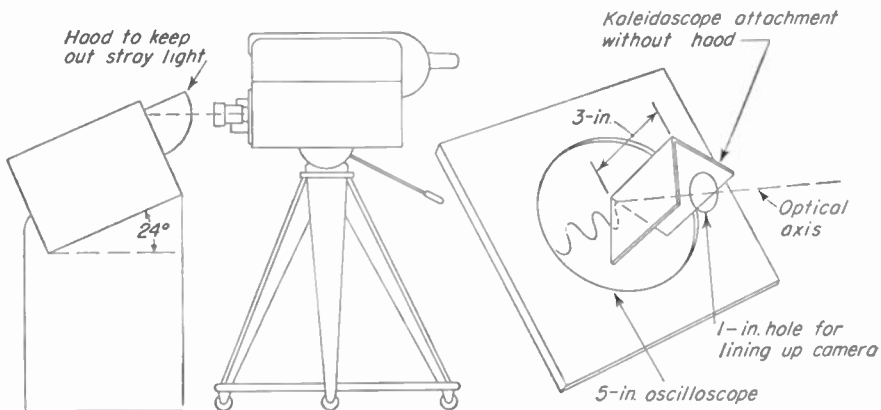


Fig. 11-23. WPTZ Whirligig.

audio line was fed to the oscilloscope, the moving line synchronized perfectly with the music because it *was* the music, in a visual form.

Each mirror in this kaleidoscope is 3 by 2½ inches, and the two are mounted at an angle of 36 degrees to one another. Dividing the full 360-degree circle by 36 degrees results in 10 segments to the rosette.

12 COMPOSITE SHOTS AND THE ILLUSION OF SPACE

Television studios are usually much too small for the kind of production they are expected to provide. Quarters are badly cramped where cameras should have free play and flexibility, and sets often look small and confined when they should have a more spacious look. There are some productions, however, of such gigantic scope that even the largest television studios do not provide enough space. In these productions the designer often creates the feeling of endless space. Backgrounds go back to infinity; the great outdoors is reconstructed in the studio.

James MacNaughton and Bob Bright consistently achieved these effects in designing the "Paul Whiteman Revue." Realistic or stylized, the backgrounds were always vast, giving a feeling of space almost unlimited. The designers of this production achieved their great feeling of space with properly designed sets and painted backdrops and did not resort to the "trick" effects of process photography (Fig. 12-1). Smaller studios, however, will have greater need for these illusions, all of which have been put to use at one time or another in motion-picture production but which are only beginning to find application in the television field.

ARTIFICIAL PERSPECTIVE

The tricks that the artist uses to create the illusion of depth in a two-dimensional drawing are centuries old. They constitute the art of drawing in perspective. When perspective painting was added to the stage, it had to be combined with three-dimensional actors, props, and scenery. No matter how well the artist had created his illusion of depth on the two-dimensional backdrop, if it did not fuse with the three-dimensional elements of the stage it was not a successful illusion.

Depth on a painted backdrop was never wholly successful in the theatre because the audience had to view it from so many different



Fig. 12-1a. Set by James MacNaughton for a production of the "Paul Whiteman Revue." This high-angle photo reveals painted perspective in several areas of the set. (Courtesy of Life Magazine and copyright by Time, Inc.)

angles. Designers compromised, of course, and gave the better-paying patrons in the orchestra seats the benefit of a good background illusion, banking on the "willing suspension of disbelief" to keep the balcony customers happy.

Theoretically, the perfect fusion of foreground and background design is possible for only one spectator position. An exception is the diorama and habitat groups at the natural-history museums, which create wonderful depth illusions for a great range of viewing positions in front of the glass. One advantage that the diorama can have over the stage is that it can have a curved backdrop, while the stage drop must be flat. Furthermore the natural-history exhibit will rarely attempt architectural subjects where straight lines in the foreground must match with lines on the background painting.

For a foreground construction and a background painting to combine and give the illusion of a single scene, *the perspective of the two must match*. A simple example is a road running from the apron back to the drop and continuing on the drop far into the distance (Fig. 12-2). The



Figs. 12-1b, c. Camera-level photos of same set show painted perspective from the proper point to give the intended illusion.

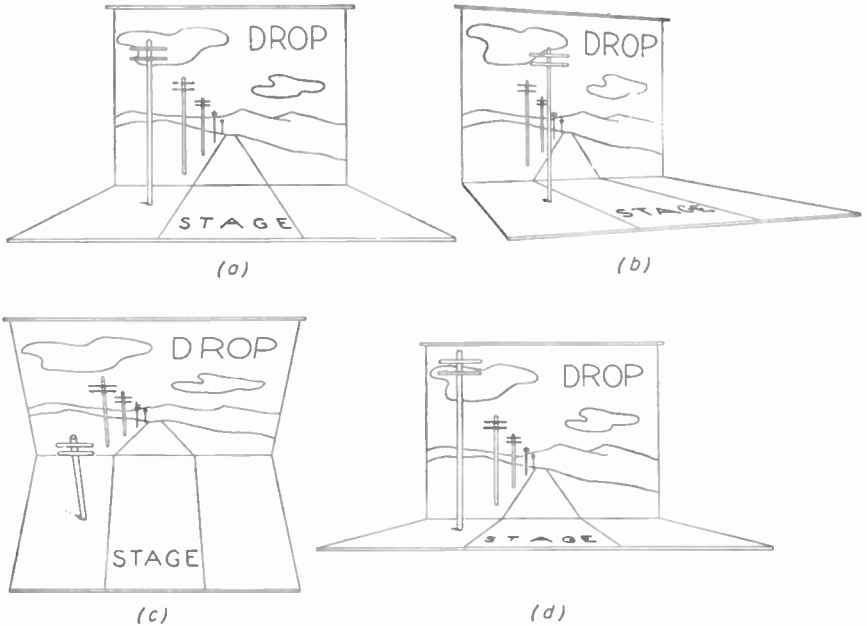


Fig. 12-2. Painted perspective in the drop will match the actual three-dimensional construction on the stage only if seen from the correct point of view (a). In (b) the illusion is lost because the viewpoint is too far to the side; in (c) too high up; in (d) too low.

viewpoint must be right, or the perspective will not match. First of all the height from which the real road is seen and the height from which the painted road is depicted must be the same. The eye level of the painting must be at the eye level of the observer. Since the horizon is always at eye level, we can put this another way and say: The horizon of the picture must coincide with the real horizon. Since for the people in the top balcony eye and horizon level is well above the proscenium arch and for those in the pit it is about stage level, it is never possible to give everyone a perfect match in perspective.

When only one camera is involved instead of an auditorium full of spectators, the problem is greatly reduced. The horizon line on the painting is drawn at camera height. The camera may not move very far, however, without spoiling something. Other cameras from different viewpoints cannot be used unless for such close shots that the matching between foreground and background does not show.

These considerations are most critical only when architectural forms with straight lines are used. If there are no straight lines or architectural planes which must carry through, the perspective can fail to match exactly without calling attention to the fact.

PAINTING THE FLOOR WITH ARTIFICIAL PERSPECTIVE

Since the floor of a television studio is seen a great deal, especially in long shots, it constitutes background for the shots just as much as the vertical flats and drops. Only in the larger studios, usually, is there enough budget to afford floor painting, or enough time when the studio is not in use. Some studios have laid ground cloths to protect their original floor surface; others have laid sheets of masonite for a painting surface. In either case the covering cannot be removed or replaced between rehearsals, and the floor painting must remain after the show until the floor is washed or a new design is put on.

The significant thing about floor painting, however, is the opportunity for forced perspective. James MacNaughton, dean of television-set designers, has been the foremost proponent of this technique. His floor designs usually contain straight lines running from the camera into the "distance," or they may contain design figures which by virtue of their change in size will seem to dwindle in the distance.

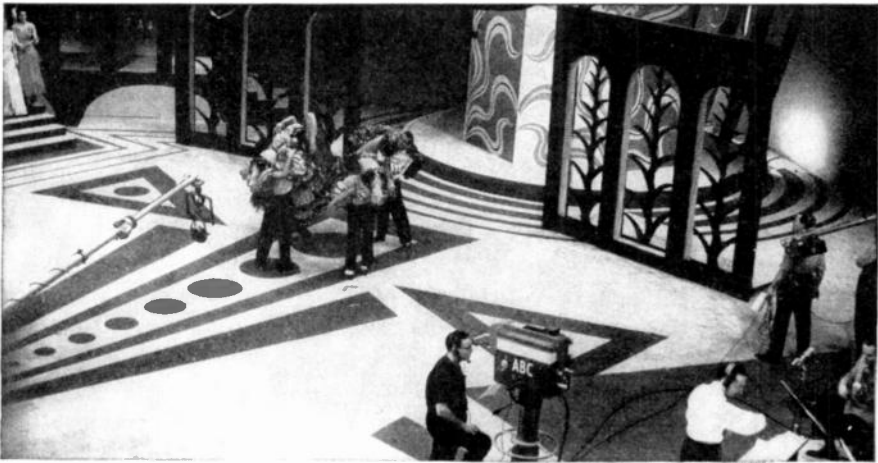


Fig. 12-3. MacNaughton-decorated floor.

It is usually quite difficult to make a perfect match between floor and drop; so most designers provide a ground row to disguise the break, or the change in perspective, between the two. This allows a greater freedom of camera position and movement, but there are still certain limitations. The perspective can be painted for only one camera position. Of course, cameras may be used freely all over such a set in any desired direction as long as they do not show the floor. But shooting backward or across the design will make the floor look very peculiar. It may even

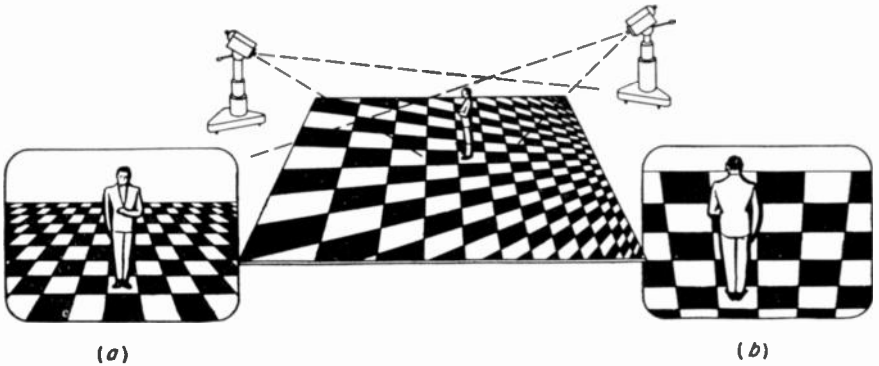


Fig. 12-4. Forced perspective seen from correct angle of view (a) and from the opposite angle (b).

refuse to look like a floor and take on the appearance of a wall instead (Fig. 12-4).

THE GLASS SHOT AND THE CUTOUT

The glass-shot method of creating the illusion of space is very old in the motion-picture art. It consists in painting the backgrounds of the shot on a sheet of glass in front of the camera instead of on flats or drops behind the actors. The camera takes in the glass painting, shooting directly through certain clear areas of the glass to photograph live action in the distance which appears to be in the foreground of the finished shot. This method was widely used in photographing large exterior sets and often saved considerably in construction, especially when the large parts of buildings could be painted on the glass. A similar method made use of a cutout board instead of a sheet of glass. The portions through which live action was to be seen were open instead of being clear glass. It must be noted, of course, that (Fig. 12-6) foreground action cannot appear *in front of* "background" painting. If backgrounds are to be seen behind the actors, such as the doorway and steps in Fig. 12-6 a portion of a real background must be built and made to blend into the glass painting.

An accurate match between "foreground" live action and "back-

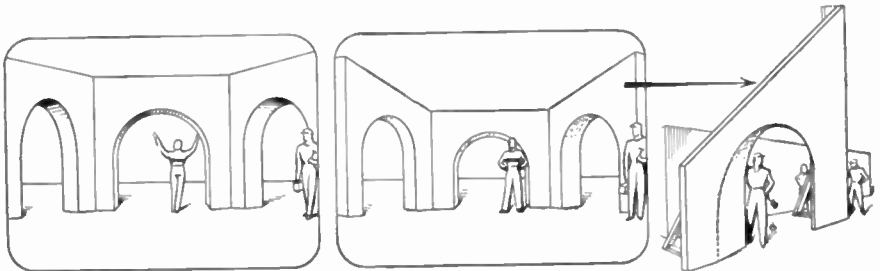


Fig. 12-5. The illusion of space obtained by building sets in forced perspective.

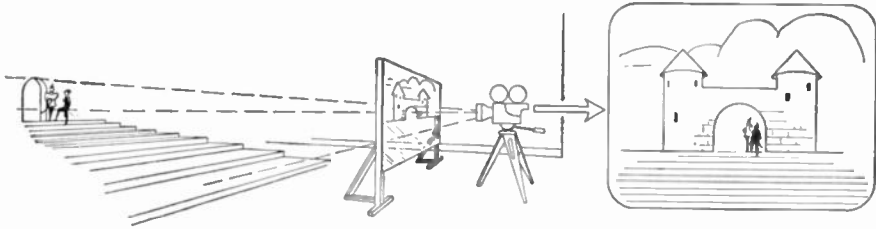


Fig. 12-6. Motion-picture glass shot.

ground" glass painting can be achieved only by very careful camera placement. A great deal of time was always consumed by the motion-picture camera crew in getting their camera and painting adjusted correctly. This careful adjustment is necessary only when actual backgrounds must blend with painted backgrounds on the glass. If the glass should contain *foreground* elements only (trees, archways, a theatre proscenium, etc.), there would be no such critical problem of camera placement.

It is largely in the creation of foreground rather than background that the glass shot has been used in television, and it is usually the cutout method rather than the glass sheet that is used. The use of the technique for foregrounds eliminates the necessity for exact camera placement and makes it possible to focus a television camera quickly on the effect. The use of the cutout instead of the glass eliminates the hazard of reflections, which is always present when the position of camera or lights may vary slightly between rehearsal and air time. NBC has standardized on 20- by 30-inch and 30- by 40-inch cutout boards (called "goboes") which are mounted in front of the camera on simple H stands. (Fig. 12-7). An effect is sometimes wanted where the camera dollies in toward the gobo until the cutout area fills the screen and the gobo has disappeared. This might be used for the effect of dollying through an archway or through a door. As the camera moves forward, the area of live action seen through the cutout widens very rapidly. If the live portion is supposed to look like a two-dimensional picture on the cover of a magazine or song sheet, the camera may not dolly forward without immediately revealing that the two elements of the picture are in separate planes. A zoom lens, however, will allow the camera

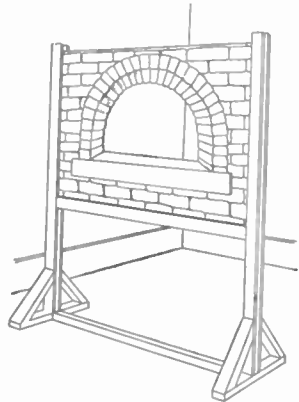


Fig. 12-7. NBC gobo, a two-dimensional cutout containing foreground elements of the composite scene.

to move into a close-up of the "picture" without widening the field of view through the cutout.

After the camera has moved up to a close-up of the cutout area (either by dollying or by zooming), it is often desirable to clear the gobo so that the camera will have freedom of movement. This can be done easily if the gobo is made in two parts and supported by two H stands, one on either side. It is then necessary only for the stagehands to pull the two stands away, and the camera is free.

Karl Weger has invented a derivation of the glass-shot which he calls Studio Z. It eliminates any depth of focus problems and at the same time permits the camera to dolly forward and back freely without the difference in size between the live action and the gobo painting becoming obvious. In this method the live action is imaged onto the same plane as the gobo by means of a positive lens (a pair of large condensing lenses) behind the opening (Fig. 12-8). The lens behind the cutout has its own depth of focus, and there is a certain limitation involved here,

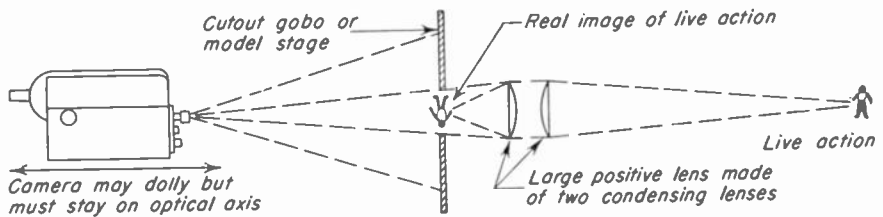


Fig. 12-8. Karl Weger's Studio Z, the ultimate in matte (gobo) effects.

but as far as the television camera is concerned, it need only focus on the gobo and the live action will also be sharp. Of course, the additional lens must be large enough to cover completely whatever door, arch, or window opening is provided in the cutout.

The image formed by a positive lens is inverted, as shown in Fig. 12-8. When this device was used on WPTZ in Philadelphia, the gobo was also turned upside down, and then both were erected by means of an image-inverter prism on the camera lens.

A better method is suggested by the inventor in his patent disclosure, which utilizes a system of three mirrors (see Fig. 11-17) placed behind the special large lens, between it and the live subject. This will allow the gobo to remain upright and simply erects the image of the live action.

THE MATTE SHOT

Matting is a method of making areas of the picture black. It involves placing a shutter of the correct shape in front of or behind the lens to block off the desired areas.

This is often used in television to combine two portions of a scene so

that they can be shown simultaneously on the same screen. A pitcher winding up, but watching out of the corner of his eye, is shown in fairly close shot in the upper corner of the screen, while a similarly close shot of the runner leading off first base is placed in the opposite corner.

Lens Turret Matting. The simplest way to matte out a portion of a shot is to turn the camera lens turret so that the lens is no longer directly in front of the tube. Part of the scene will then be cut off by the body of the lens turret and will appear black on the screen.

If the turret of one camera is off-set to the left and the turret of the other is off-set to the right, the black area of each picture will coincide approximately with the picture area of the other and when the two are superimposed there will be no ghosting. The effect is not exactly a split screen, of course, because the edge of the black area is out of focus and soft and has a curved shape—oppositely curved in the two cameras so that it does not match (Fig. 12-9). A fuzzy strip of black or of over-



Fig. 12-9. Matting by off-setting the lens turret. The two cameras are superimposed for the composite effect.

lapped pictures will be seen across the center of the screen. This is not necessarily a disadvantage, however; sometimes the area of demarcation is quite desirable.

RCA cameras will produce a different effect from Du Mont cameras when this technique is used. In the RCA camera the tube is centered, and the top lens is the taking lens. As the turret is turned, the direction of motion is an arc across the width of the picture. Thus an off-set position will produce a roughly vertical edge. The Du Mont camera, on the other hand, mounts the tube in the lower right-hand side, and the turret turns in an arc which goes diagonally across the end of the tube. An off-set turret will accordingly produce an edge which is roughly diagonal (Fig. 12-10).

The cameraman will find that as he turns the turret to an off-set position, the picture will move bodily off the screen. If he wants to keep the subject in the same position in the screen, he will have to pan the camera as he turns the turret. This is difficult to do smoothly but produces a

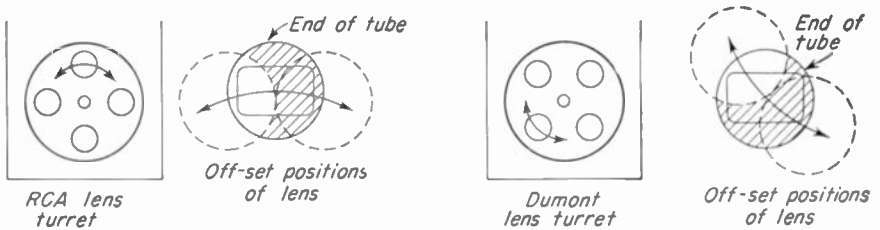


Fig. 12-10. Effect of off-setting the turret on RCA and Du Mont cameras.

nice effect. As the actor picks up a phone, for instance, a dark area appears on the far side of the picture; and as it grows, the other camera, previously made ready with the opposite off-set, is dissolved in. The person answering the call on the other end of the line appears as he is picking up the phone. At the end of the call the reverse procedure can be followed. Both actors put their receivers down, the cameraman on the first camera turns his turret back and pans the camera to keep the subject stationary, and the second camera is simultaneously faded out.

A common method of making matte shots in motion pictures is to fix to the front of the camera a matte box in which cutout masks can be inserted. The matte box also serves as a sunshade over the lens and is used for a great variety of filters and diffusing materials which are a part of motion-picture photography (Fig. 12-11).

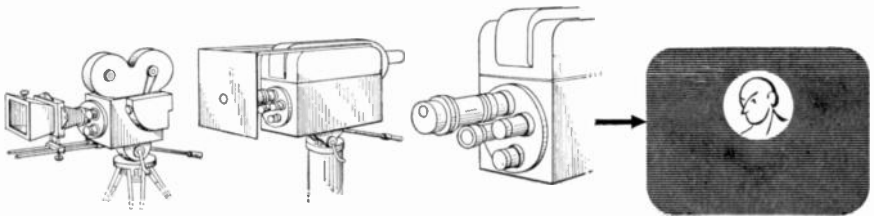


Fig. 12-11. Mattes attached to the camera.

Simple matte boxes have been used on television cameras, but the large rotating turret with its long lenses makes it difficult to design a permanent matte box.

There are many kinds of mattes besides the simple half mask. A matte may take the form of a vignette, allowing the camera to show only a small circle of picture. This might be used for the old motion-picture vignette effect to show what the actor was thinking about, in the upper corner of the screen. The device has been so frequently revived in television that it has almost lost its corny flavor.

A very complex device known as the Scenescopé has been developed for the purpose of creating composite effects, combining many of the methods already mentioned earlier in this chapter. Through the use of

this device it is said that an actor working in a black set can appear to be moving *in front of* a still or motion-picture background and *behind* whatever foreground objects may be desired. A film projector and 2 by 2 slide projector are combined into a very complex optical system involving 4 by 5 transparencies and cutout mattes (Fig. 12-12). The television camera rests on a shelf built out from the Scenescop machine. A similar but less complex device known as Vistascope is also available. The latter uses opaque slides about 8 by 10 inches in size on a single stage and has no motion-picture projector involved. A special optical system brings

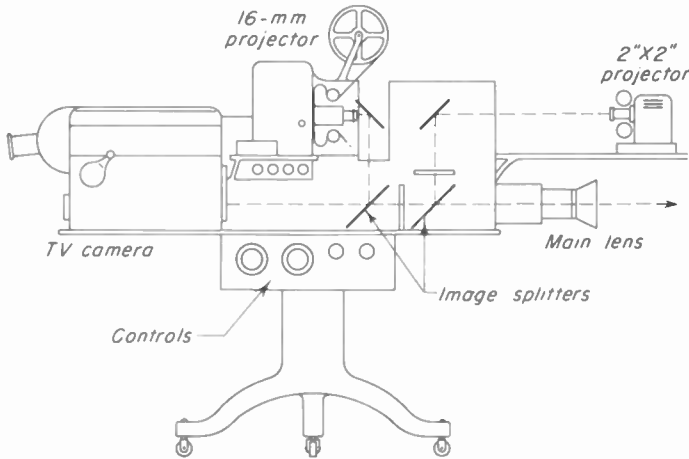


Fig. 12-12. Rough diagram of Dr. Frank Caldwell's Scenescop.

the distant live scene into the same plane of focus as the slide. It is inverted, and scanning reversal is employed to erect it.

REAR PROJECTION

Much experimentation has been going on recently in the use of rear projection in television. The process has great possibilities which, after the solution of a few basic problems, are certain to be realized. Several new developments in screens and projection equipment have come out of the experimentation to date, innovations which may well find application in the motion-picture field as well. Whereas the prime purpose of rear projection is to create the illusion of space by producing a composite shot, the process has many other advantages and there are frequently other purposes behind its use.

STILL BACKGROUNDS

Through the projection of slides, static background scenes of many different kinds are possible. Unless the background contains objects which naturally would be in motion, a slide will look as realistic as a

motion picture. When motion pictures are projected on a large-size screen, the slightest weave or jump becomes noticeable. In the case of static scenes, slide projection is frequently preferable.

Rear projection of stills has been used to create the illusion of great depth or space (outdoor backgrounds which go far off into the distance) or interiors, such as those of cathedrals, which could not be constructed in the studio.

The technique has also been used to create backgrounds which could as well have been built or painted, but would have cost a great deal more. Certain natural subjects, such as rocks and foliage, are very difficult to paint, and photographic backings must be used instead. Photomurals are quite expensive, especially when solidly mounted for use on a television set. The only cost for new backgrounds when rear projection is used, however, is the small transparent slide.

Sometimes a projected background can be only a few feet square, such as an exterior seen through a window. If such a projection is to play an important part in the story, however, it must look realistic and this requires that it be kept some distance behind the window frame. Different areas of the exterior scene will be revealed as the camera looks through the window from different angles, and movement of the camera will cause a realistic movement of the background scene behind the window frame. This will all be minimized if the backing is too close. Furthermore, if the camera takes close-ups at the window, the background will appear in close-up as well, unless it is considerably farther back. This applies to shooting against any "distant" background; if actors are to be seen in close-up, they must be far enough ahead of the backing so that distant objects will not look surprisingly close.

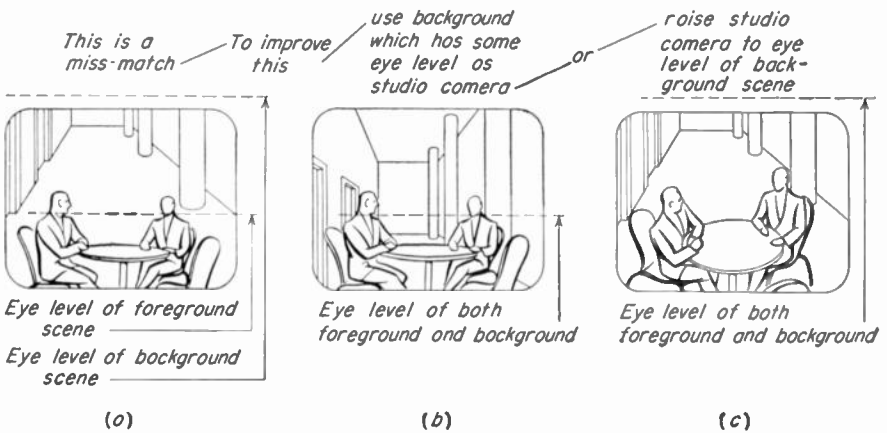


Fig. 12-13. Perspective in rear-projected background scenes must match the foreground. in (a) the two do not match; (b) and (c) indicate two solutions to the problem.

The perspective of background and foreground must match in a rear projection shot, or the effect will be unreal. This is the same problem that was described in connection with painted backdrops. The eye level of the background must be camera level (Fig. 12-13).

Movement in Rear Projection of Stills. A moving background can be produced with a long slide which is slid through the projector aperture. In the CBS show "Mr. I-magination," a background slide of trees and telephone poles was slid through the projector, and Paul Tripp's train appeared to be in motion. There are many cases where only a simple panoram motion is called for, and such a slide usually will serve the purpose better than a motion picture. Because the slide is larger than the motion-picture frame, it allows more light to reach the screen. A motor drive is necessary for these long slides, since irregularities in manual operation show up greatly exaggerated on the screen. The Trans-Lux projector incorporates this feature.

THEATRICAL EFFECTS PROJECTION

Effects projectors have been familiar equipment for many years in the theatre (Fig. 12-14). A large circular slide is rotated through the projection opening, and a 2,000- or 3,000-watt spotlight provides the light source. Stage-lighting companies like Kliegl and Century in New York keep libraries of these effect slides for rental or purchase. It is possible to get anything from fleecy clouds to fire, smoke, and demons ascending out of hell (an effect which the Roxy Theatre is fond of using every year for their Halloween show). The slides are circular (about 2 feet in diameter), but the projector aperture is the standard $3\frac{1}{4}$ - by 4-inch lantern-slide size. The slides are disks of mica, to withstand the heat, and designs are hand-painted on them in the type of paint that is used for frosting light globes. The turning mechanism, whether motor or clockwork, can be set for a wide range of speeds. Effect projectors are used very often in the New York stations. Most cloud effects are produced with these machines, either by rear or by front projection. They are superior to film in several respects: (1) projection is continuous

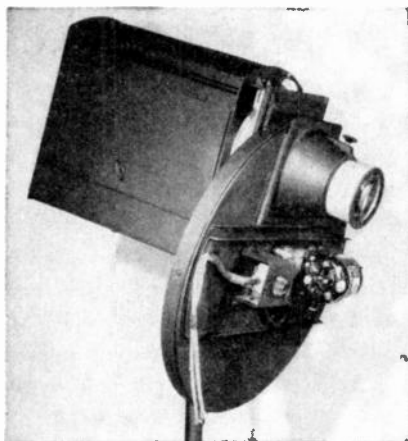


Fig. 12-14. Century effects machine. Circular effects slide rotates by motor drive. Projector will take 1,500- to 2,000-watt bulb.

without the problems of using a film loop, and (2) a better projection is usually possible because more light can be thrown on the screen. The slight arcing effect due to the circular motion of the slide may sometimes be undesirable on a large projection.

MOTION-PICTURE PROJECTION

With rear-projected motion pictures, the possibilities of effects are greatly expanded. Backgrounds containing action, often very distant action, can be produced. Street scenes and landscapes with figures or vehicles in motion are possible. One production of "One Man's Family" used the rear screen for a very realistic scene of two people on a bicycle as they crossed the entire length of the Golden Gate Bridge. The people were in the studio, pedaling a stationary bike, while the background film was a shot which had previously been taken from a slow-moving car crossing the bridge.

Sometimes an endless loop of film is used instead of a reel in the ordinary manner. A loop may be of any length. A special continuous reel is used which will wind up film on the outside of a roll and unwind it again from the inside. The advantage, of course, is that special timing is not necessary. The director is never afraid that his background film may run out before his shot is completed.

The splice with which the loop is joined, however, must be very carefully made, so that a jump in action is not discernible. One rear projection scene used showed people crossing a street, and each time the join came around, a car suddenly disappeared from the foreground and three people miraculously appeared in its place.

Length of Throw, "Hot Spot," and "Fall-off." The light which carries the images of a background projection must pass through a translucent screen. If this were a perfectly clear screen, no image would be seen, but only a bright point of light from the projector lens. This is because the camera would be seeing the direct rays of light from the projector. If the camera should move, this same bright spot would be seen in another part of the screen. The screen is designed to diffuse the light, however. The direct rays from the projector, instead of all passing through in the same direction, are reflected in many directions. The "hot spot" is reduced in intensity. A perfect diffuser would deflect just as much light in one direction as another, and no hot spot would be seen.

However, no existing screens can attain this ideal. The most intense transmitted light is still the direct ray. This means the camera will see a bright area in line with the projector. In television this hot spot very rarely shows up. However, a concomitant effect, fall-off of intensity around the edges of the screen, is a constant problem.

In Fig. 12-15 three rays of light are illustrated, and the relative intensity of the diffused light in various directions is shown by the length of the arrows. It can be seen that a camera placed perpendicular to the screen sees a maximum of illumination in the center of the screen and a minimum along the edges. If the camera were to move to a side position, the near side of the screen would then appear brightest and the intensity would drop off progressively across the screen.

In motion-picture studio practice both the hot spot and the fall-off problems are countered by an extremely long projection throw. The projector is placed at least five times the width of the screen behind it,

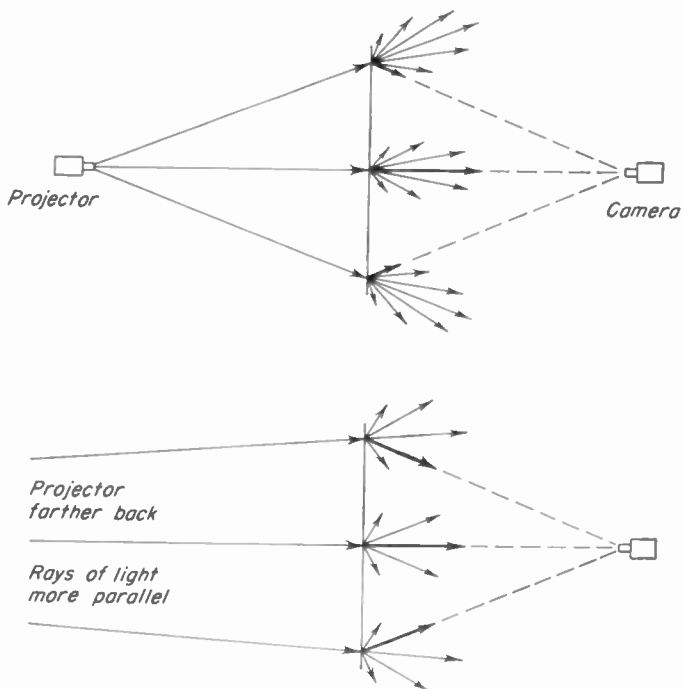


Fig 12-15. Diffusion pattern from three rays of light, one central and one at either side of the screen. When the projector is close to the screen, the sides of the picture are dark; when the projector is farther back, the screen is more evenly illuminated.

and usually much more than this. The advantage is that the direct rays from the projector come to the screen in a more nearly parallel condition, and the angle to which they must be bent to reach the camera lens is less. Hence better illumination around the edges of the shot and less fall-off.

In television, such space is unheard of. The studio is lucky that can allow a space equal to twice the width of the screen for the projector behind it. An ideal relation which everyone is working toward is the ratio of only 1 to 1, a space equal to only the width of the screen allowed behind it for projection. The Trans-Lux Teleprocess projector comes

closest to this goal, working from a distance equal to the *diagonal* of the screen. Figure 12-16 shows how this wide angle of projection differs from even the widest angle that is ever used in motion-picture rear projection.

The Front-light Problem. The lighting of foregrounds in front of rear projection screens has always presented a problem, since the light must not be allowed to fall on the screen. The darkest tone it is possible to achieve in the rear projection will be the tone caused by reflected light on the front of the screen. Whatever tone the screen assumes when the rear projection is turned off will be the darkest black of the projected picture.

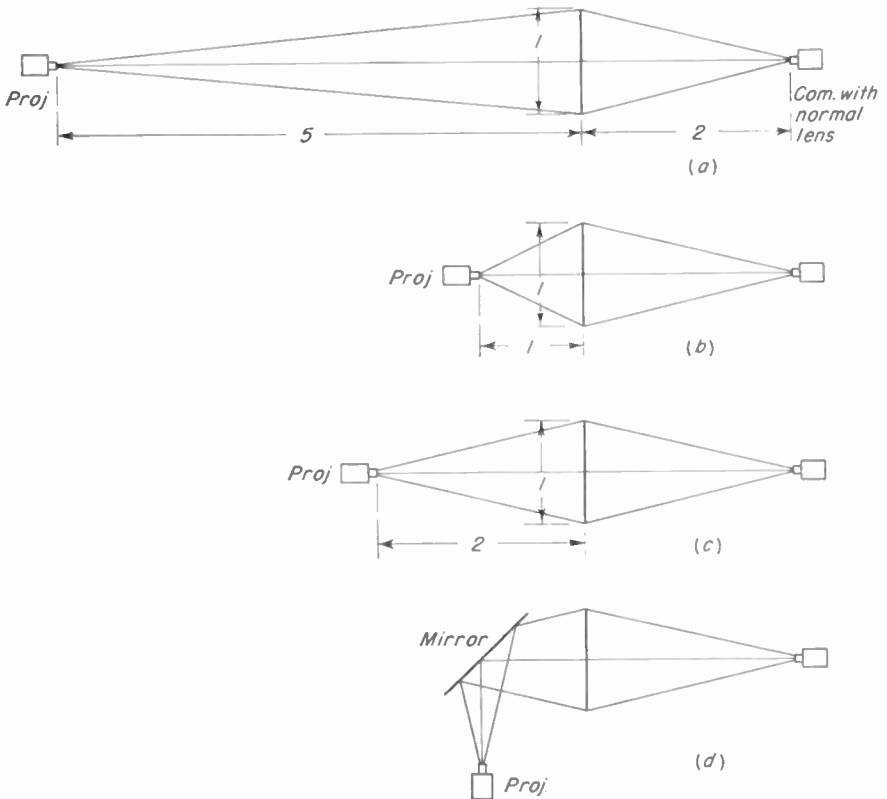


Fig. 12-16. Relations of camera and projector to process screen. (a) The most extreme conditions to be found in motion-picture rear-projection practice. Most motion-picture rear projection is done with a much longer projection throw and with a longer-than-normal camera lens. (b) A 1-to-1 ratio of projection throw to screen width is the most desirable condition in the television studio owing to the limited space available. (c) A 2-to-1 ratio is more commonly used and gives better results. (d) Sometimes this length of throw can be obtained even, though the studio is small, by using one or more mirrors.

This is often quite light, and rear projection is frequently unconvincing because of its grayish tone.

In order to keep lights off the screen, only side, top, or back light can be used on the actors, unless they are considerably in front of the screen. This leads to a contrasty style of lighting, which is even more difficult for a grayish screen to match. Front fill light, so important in television, must be very sparingly used. Even when direct light is kept from falling on the screen, there is enough reflected light loose in the room (ambient light) to illuminate the screen to a certain minimum shade. Light reflects off the foreground objects onto the screen, and it is very difficult, with standard white screens, to make the blacks come out black. A black screen was devised to solve the spill-light problem. Transmitting almost as much light as a white screen, it absorbed front light and reflected very little.

Sometimes such a short throw and wide screen are used in television that the illumination falls off to practically nothing along the edges of the screen. On a white screen the edges then come out the minimum milky gray, which is the darkest the screen can get. The black screen, however, falls off to pure black, which is much more noticeable. A compromise was effected, and Trans-Lux now provides a blue screen which both absorbs some front light and does not fall off so badly.

PROJECTION SCREENS

It is not always necessary to use the commercial rear projection screens for every television need. Quite often the size of the screen is small, fall-off is no problem, and a number of cheaper materials can be used.

The simplest of these is tracing paper or cloth. Oiled canvas has been used for this purpose also. Care must be taken in the selection of screen material, especially in the case of very small screens, to make sure the grain of the material does not show. If the grain of cloth, for example, should exceed the resolution of the projected image, this would cut down on the quality of the picture.

A fairly good screen can be made from white koroseal (the material from which raincoats are made and which is found in most department stores). The material comes in a 48-inch width only and must be butt-spliced to make wider screens.

Al Jenkins has experimented with sheets of white latex, 0.0064 inch thick, and says this material gives a very brilliant transmission and is very inexpensive. However, it is not permanent and is likely to soften and rot after a few months' time.

The standard commercial screens are made primarily by Eastman, Trans-Lux, and Bodde. Only Trans-Lux and Bodde make them in large sizes for studio use.

REAR SCREEN PROJECTORS

The larger the screen, the more projected light is necessary to illuminate it properly. This problem was faced in motion pictures and solved by projecting with three carbon-arc projectors at once. The "triple-head" projector used three identical films. The two side projections were reflected from a kind of multiplexer, while the middle one projected directly. Perfect register was necessary. The combination was in some cases built into a permanent booth and in others mounted on a movable base so that it could be used in different parts of the studio. Such an arrangement is considered economically impractical in television, and the problem must be solved by a single projector.

It is difficult to get an accurate estimate of the exact amount of light which should be transmitted through a screen in order to equal studio illumination in front. With night scenes, of course, the background can be much darker than the foreground and can exhibit considerable fall-off without being objectionable. Other factors such as size of screen, density of the slide, the kind of studio lighting being used, the angle of the camera to the screen, etc., also enter in.

Some studios have estimated there should be 90 foot-candles transmitted through the screen. Others, using a lower basic studio light level, figure only 20 to 40. In terms of light *quantity* (measured in lumens), this amounts to 20 to 90 lumens per square foot. That is quite a range. The most valuable expert advice obtainable is simply to put the slide in the projector, illuminate the screen, and see how it looks. According to the lowest estimate, the Trans-Lux Teleprocess projector, which puts out 5,000 lumens, could cover a screen 14 by 18 feet in size. According to the highest figure, however, this same projector could cover only a 6- by 9-foot screen.

The problem of getting enough light through the slide is much greater when 16-mm film is used because of the much smaller area of the film. A carbon arc will provide plenty of lumens and when used in a still projector will cover almost any screen, but such a projector must be attached to a vent pipe to carry off the fumes, and this greatly limits its flexibility.

CBS has used a 35-mm Simplex with a 1,500-watt incandescent lamp, but this is not powerful enough for a very large screen. Du Mont offers a Holmes 16-mm projector, the Super Speed (see Fig. 10-22), which can be wheeled about from place to place and takes a 1,000-watt lamp. The same projector may be used with a 100-watt lamp for direct projection of motion pictures onto an image-orthicon camera tube. This is a highly versatile instrument but will not give a suitable projection on a very large screen (6 by 8 feet maximum, according to the manufacturer). A heavier model, which must be permanently mounted on a pedestal, can be

equipped with an arc light, which under some conditions will cover a screen as large as 9 by 12 feet. General Precision Laboratory makes a 16-mm arc projector which provides 2,000 lumens. The 35-mm Simplex arc projector supplied by this firm puts out 7,600 lumens.

FRONT PROJECTION

For the station with limited space and facilities a little experimentation with the method of front projection is highly recommended. Karl Weger at WPTZ, with a relatively small studio, uses front projection in preference to rear projection. According to Weger, "the only thing which rear projection can provide that is not also possible with front projection is the ability to place action close to the screen. This, however, is not a disadvantage in the case of front projection because the effect of separation between the actor and his background heightens the illusion."

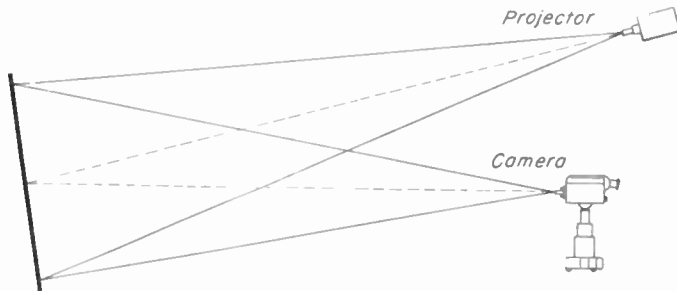


Fig. 12-17. Front projection from overhead with tilted screen.

Front projection does not require an expensive screen; almost any fairly light surface will do, although regular white rear-projection screens can be used for front projection. Front projection is not subject to hot spot or fall-off unless the camera is shooting from a relatively extreme angle. The projector is best placed above the cameras, shooting down at an angle over the actor's heads. The projector should be as far away as practical, at least as far as twice the diagonal of the screen. Projectors usually have a shallow depth of focus, and if it is not possible to keep both the top and bottom of the screen sharp in projecting down at an angle, it is possible to tilt the screen up a bit so that it is perpendicular to the projector (Fig. 12-17). The angle of projection and position of the screen in relation to the projector should be standardized, and if necessary the slides which are prepared can be predistorted. If the angle of projection, for example, causes the lower part of the background picture to appear larger than it should on the screen, the slide can be made (with special photographic methods) to be distorted in the opposite manner so that the

lower part of the picture on the slide is smaller than the upper part and an undistorted projection will result.

SHADOWGRAMS

Another method of still projection is based on the point-source lamp. Western Union has developed a zirconium arc lamp in which the light source is a tiny crater a few hundredths of an inch in diameter. Such a lamp will project an image of a transparency without a lens system at all. It is best described by first discussing a familiar theatrical projector, the Linnebach lantern.

The Linnebach lantern consists of a large box or hood containing a small-filament incandescent lamp. The front of the box will take a large celluloid slide at least $1\frac{1}{2}$ by 2 feet in size. A shadow of this transparency is cast on the screen. As with any shadow, it will vary in size directly as the distance of the screen from the projector and inversely as the distance of the light source from the transparent slide.

This machine is usable in the theatre only for soft or distorted images, since it cannot be sharply focused. A shadow, as anyone knows who has made shadows on the wall with the light of a candle, becomes softer the larger it is made. And the same simple experiment will show that a tiny candle flame throws a sharper shadow than a large light bulb, and

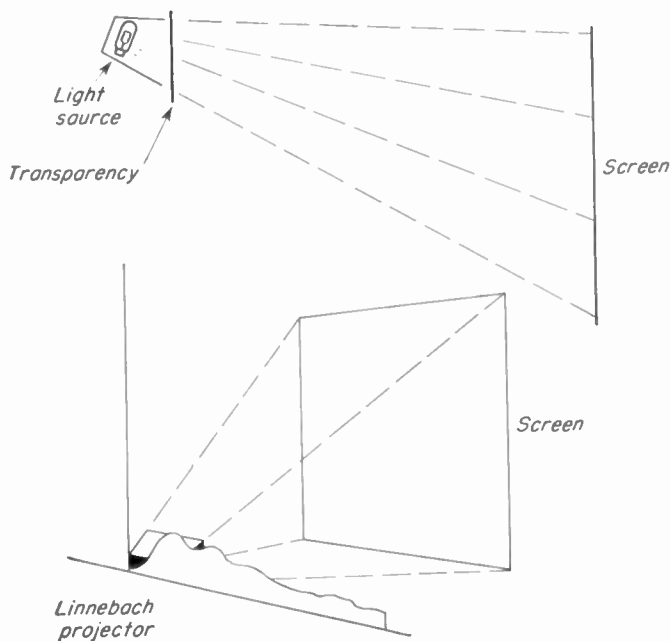


Fig. 12-18. Linnebach lantern used above or below screen.

the shadow cast by a lamp that is covered by a shade is so soft as to have very little form at all. That is why the lamp in a Linnebach projector must have the smallest possible filament and why the inside of the hood is painted black. The ideal light source for the Linnebach would be a point having no size at all. All rays of light would then emanate from one point, and the shadow would be as sharp as the image on the transparency.

With the new concentrated arc lamps, this is now possible. This light source is almost a point. A sharp projection is possible without a lens and in any size, depending on how close to the lamp the transparency is placed. It may be set at an angle to the axis of projection without the edges going soft as they would in an ordinary lens projector. This means that angle projection is possible. Old-style Linnebach lanterns are commonly used in this manner in the theatre, shooting up or down at the screen. As long as the transparency is kept parallel with the screen, there will be no distortion of the image (Fig. 12-18). Angle projection is no advantage in television rear projection, since the angle with which the projected rays would strike the screen would be too great. The entire screen would exhibit the fall-off usually noticeable only around the edges. For front projection, however, angle projection is a great advantage in television. It is possible to place the projector above or to the side of the screen and hide it from the camera. Western Union is making a 10,000-watt concentrated arc lamp which should produce ample illumination for this purpose.



Fig. 12-19. An episode in a CBS drama told with shadows cast on a rear-projection screen. Actors work between projector and screen. Note that both "hot spot" and "fall-off" actually enhance this style of production.

PROJECTION OF SHADOWS

The distinction should first be drawn between a shadow, or shadowgram, and a silhouette. The latter is not the product of projection, but an unilluminated object seen against a lighted background. The silhouette is usually made by keeping a performer in the half light in front of the lighted set or in front of a rear-lighted translucent screen. The silhouette can be sharper than the shadow since the camera can focus directly upon the performer.

Shadows may be large or small, sharp or soft-edged, strong or weak, natural or distorted. They may be produced by a moving or changing light source and thus become moving or changing shadows. The shadow may be produced by placing a performer between the light source and a wall surface, so that the shadow is cast upon the wall. Or the performer may work behind a translucent screen so that the shadow is projected onto the screen and seen from the reverse side (Fig. 12-19).

The size of a cast shadow made by either of these methods is inversely proportional to the distance of the subject from the light source.

$$\frac{\text{Size of shadow}}{\text{Size of subject}} = \frac{\text{distance of shadow}}{\text{distance of subject}}$$

The size of shadows can very easily be plotted on paper if the position of the light and the size of the performer are known (Fig. 12-20).

Sharpness of the shadow is dependent on the size of the light source and

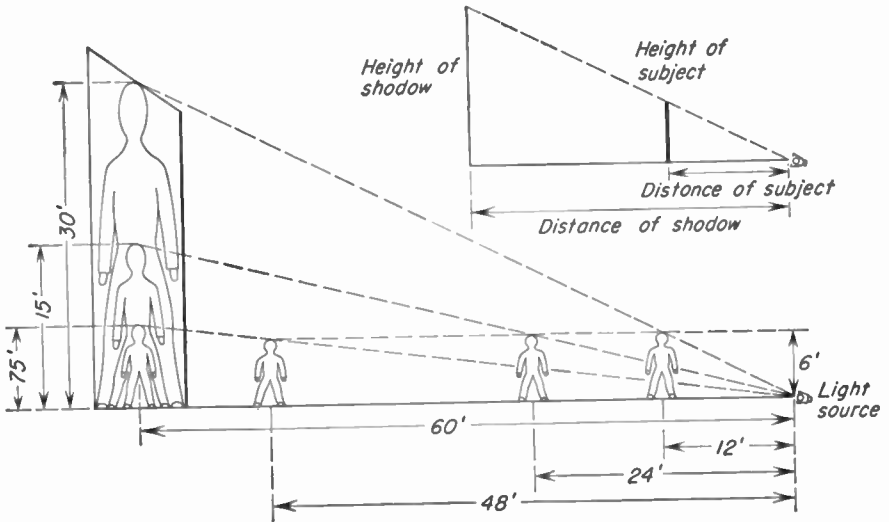


Fig. 12-20. Size of shadow varies inversely as distance of subject from light source.

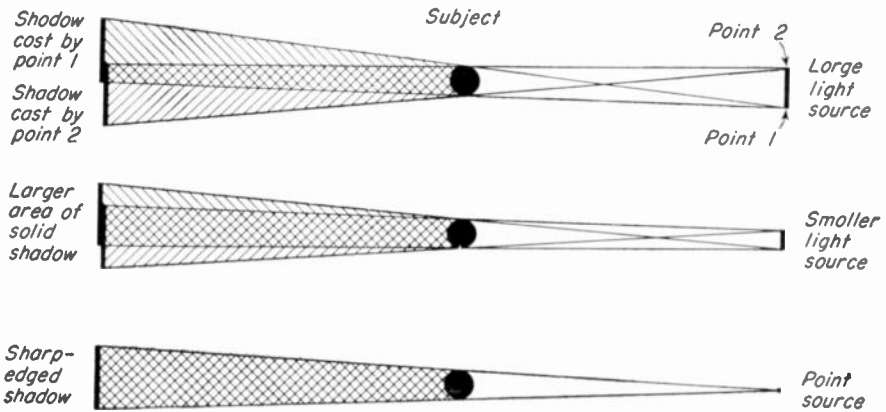


Fig. 12-21. Sharpness of shadow is determined by size of light source.

the distance from subject to screen (Fig. 12-21). A large source of light (say a floodlight with a diffusion screen in front of the bulb) will cast a soft-edged shadow. This is because light emanates from many sources. A shadow cast by light from one side of the lamp, for example, is partially wiped out by light coming from the other side of the lamp which can "see" around the corner of the subject a little farther. In astronomy these shadow and half-shadow regions are known as the umbra and penumbra.

A distorted shadow will result if the surface on which the shadow is cast is not perpendicular to the source of light. The larger shadows illustrated in Fig. 12-22 are distorted to a certain extent, since the top of the wall is considerably farther from the light than the bottom. If the surface is of an uneven shape, the cast shadow will be distorted in an irregular manner.

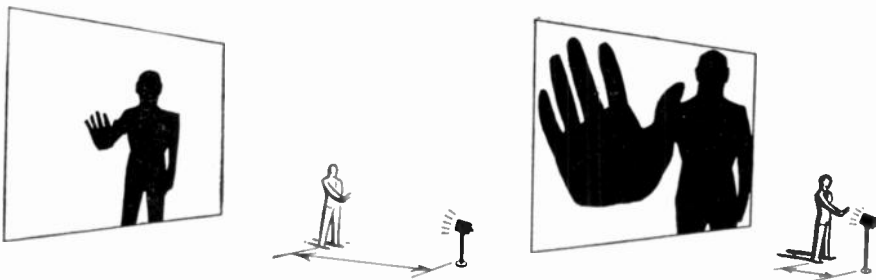


Fig. 12-22. Wide-angle shadows, like pictures through a wide-angle lens, exhibit exaggeration of "depth."

13 SPECIAL EFFECTS WITH GRAPHIC MATERIALS

Where special effects are concerned with graphic materials, they may be either optical or mechanical. Usually the purpose involved is to invest the graphic subject with some kind of movement so that it develops or animates on the screen. Some of the optical devices are simply complicated methods of handling graphic materials, changing titles, etc., a subject which was covered in detail in a previous chapter (Chap. 9, Graphic Materials) but which can now be explored further.*

THE TWO-STAGE SHADOW BOX

A shadow box is a title device containing two stages for titles or pictures. A transparent mirror is placed at a 45-degree angle between the two stages so that the camera may see either one stage or the other or both at once in a superimposition according to the illumination of the stages. Figure 13-1 illustrates a simple device of this type. Each stage is a card box. The mirror is sufficiently silvered to reflect and transmit equal percentages of light from the two stages. When the lights are dimmed down on stage *A* but are full up on stage *B*, the reflected image of *B* is seen (left and right are reversed because it is a mirror image). When *B* is dimmed down and *A* is up full, the transmitted image of *A* is seen. When both stages are illuminated, a superimposition results. This device permits one to run a series of stills or title cards with dissolves between them, entirely by optical means, only one camera being necessary. A method of shielding the lights must be devised so that when a stage is dark and cards are being changed in it, light from the other stage does not leak over and dimly reveal the motion. The most serious fault

*The reader is warned that many of the devices described herein are covered in the patent art and commercialization may be subject to royalty.

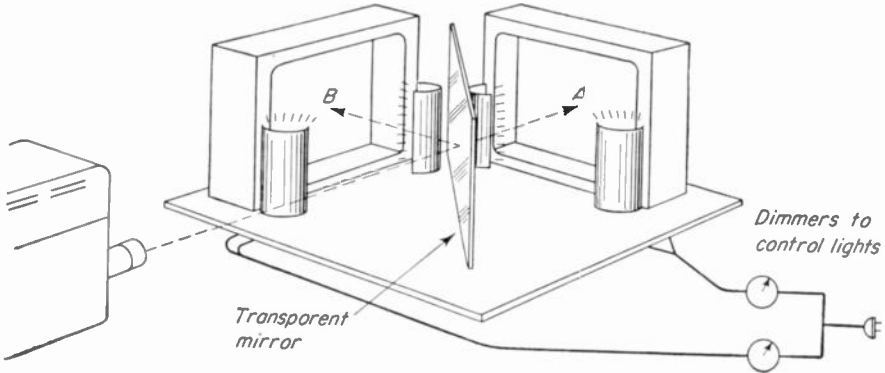


Fig. 13-1. Two-stage shadow box.

of this device, aside from the space it takes on the studio floor, is the fact that every other card or picture must be prepared in reverse so that it may be seen properly in mirror image; the cards are thus not interchangeable between the stages.

THE TWO-MIRROR SHADOW BOX

If two mirrors are employed instead of one, the reflected image can be corrected by the second mirror and cards can be used in either stage interchangeably. A shadow box of this type was built by the author at CBS in 1940; it had two mirrors and a total of three stages (Fig. 13-2a). Cards used on stage 3 were reversed (since the image of that stage was reflected only once), but stages 1 and 2 were interchangeable. The third stage was used primarily for rear-lighted cutout animation (to be described). All manner of materials were used on the two main stages: drums for continuous movement, slide-through effects, three-dimensional objects, and working models. The stage could be taken away and the operator's hand

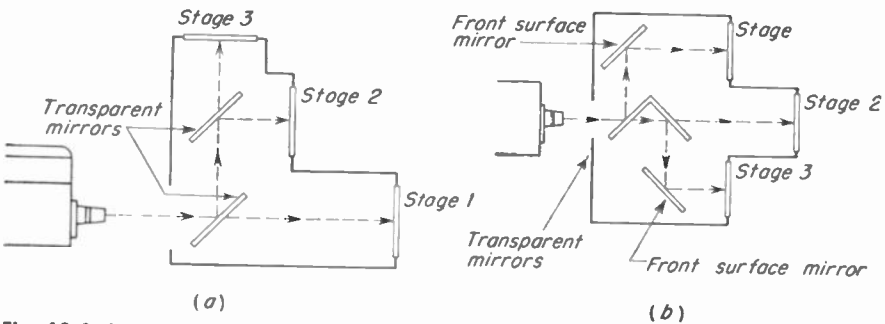


Fig. 13-2. Three-stage shadow box. (a) Type built by author at CBS, (b) alternative design in which no stages are reversed.

or face inserted instead. A particularly startling effect was obtained by having the operator look through a mask which revealed only the eyes and then slowly superimposing this very accurately over a portrait. The moving eyes made the picture seem to come to life. Another advantage to a machine with three stages is that two of the stages may be superimposed and then dissolved out together as a third stage is dissolved in. In a two-stage machine one part of the superimposure must first be lost and that stage changed before a dissolve can be made to another subject.

A wipe can be installed in a shadow box by one of two means. If the semimirror is replaced by a plain mirror, dissolves are no longer possible, but sliding the mirror in and out will produce a wipe. The Projectall opaque projector is equipped with two stages and a sliding mirror in this manner, and wipe transitions are made between stages. The focal-plane shutter method of wiping is a little more complicated to construct but does not sacrifice the dissolving feature. In this method, two shutters are ganged together so that as they are moved the second stage will be revealed as the first is obscured. Since the shutters are in the plane of focus (just in front of each stage), the wipe will have a sharper edge than will the sliding-mirror wipe where the edge of the mirror must be some distance removed from the focal plane.

This type of optical wipe may be done vertically or horizontally, or from corner to corner if desired. A horizontally moving shutter with a diagonal edge will produce the effect of diagonal movement. A vertical

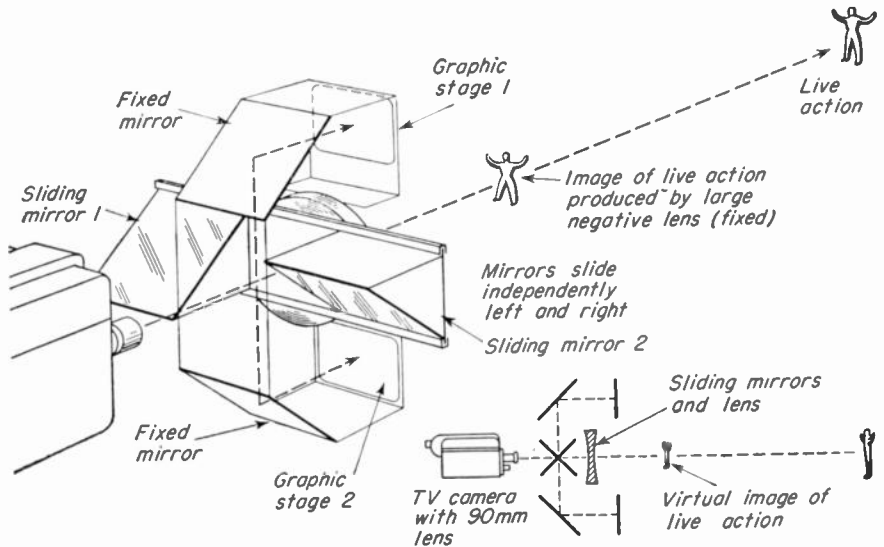


Fig. 13-3. Combination of shadow box with live action with mirror wipe. Designed by Karl Weger of WPTZ.

shutter of this diagonal-edge type could not be used on the shadow-box illustrated, since the long shutter for stage 2 would get in the way of stage 1. If the machine were laid out on a horizontal plan, however, long vertical shutters would be possible.

VUE-GRAPH AND VISUALCAST PROJECTORS

These two machines are built on the same principle; they are transparent projectors with a large, horizontal, open stage. Supplied as visual aids for school and industrial use, they also find application in television in the special uses of graphic materials (Figs. 13-4, 13-5).

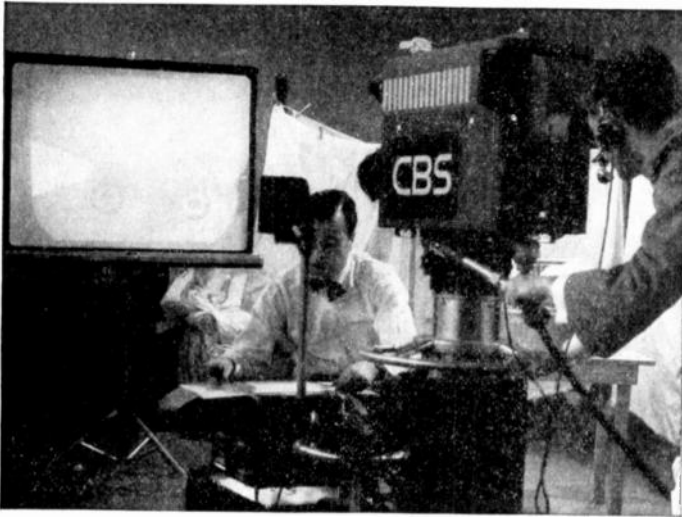


Fig. 13-4. Visualcast projector in operation. (Courtesy of Popular Science.)

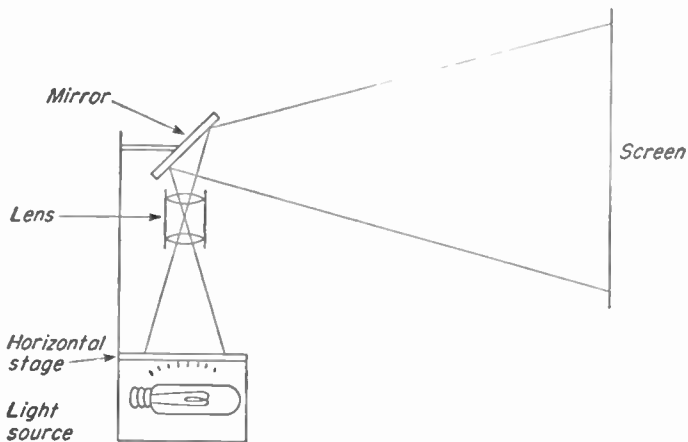


Fig. 13-5. Diagram of Vue-Graph and Visualcast projectors.

The horizontal stage makes it possible for the operator to write or draw on the focal plane. The light originates below this stage, and a shadow of the writing is projected on the screen. Of course, the shadows of pencil and hand are also visible. Additional elements in a drawing may be made to appear suddenly by hinging "layovers" of celluloid and flopping them down quickly onto the stage. Each layover may have further layovers hinged to it. Ingenuity has found numerous ways to utilize this machine for interesting presentation of graphic materials. It is projected onto either the front or the rear of a screen, where the studio camera picks up the image. A program called "Toon-a-vision" was built around this machine and the effects that it can perform. A small transparent screen was built into the rear wall of the set on which cartoon stills were projected. These were given a feeling of animation by quick overlays of dialogue balloons or additional elements of the cartoon. Parts of the drawings done on separate celluloid sheets could be moved across the backgrounds (background showed through foreground objects, of course, since both were transparent). Silhouettes could be moved anywhere, but figures done in line drawings could not cross background lines or these would show through the figures.

A 12- or 15-point celluloid is the best material for this machine; the lighter 10-point animation celluloid does not flop down quickly enough. Cel-flex or other celluloid paint must be used. (This paint is flexible and will not crack off.) Half tones are made by wiping on the wet paint. Line drawings are made on one side of the cell, and the half tone is wiped in on the other. Excess half tone which extends beyond the lines can be picked off with a damp brush. White tones or lettering can be made in the half-tone area by the same process.*

MYSTERIOUS WRITING

One of the most interesting special effects is the mysterious appearance of writing or lettering without pencil or hand being visible. The author will describe three methods of doing this, one of which utilizes back light and two illumination only from the front.

A Carbon-paper Scratch-off Process. This involves back light and can be done on the Vue-Graph projector. As a pencil writes on the rear side of a special carbon paper, the opaque carbon is removed and a white line appears on the screen. Shadows of pencil and hand may be cast on these lines, however, if care is not taken to keep away from areas which are already drawn upon.

* The firm of Howell and Reagin, artists, do most of the work with this machine in New York, and it is to Tom Howell of this organization that the author is indebted for the data above.

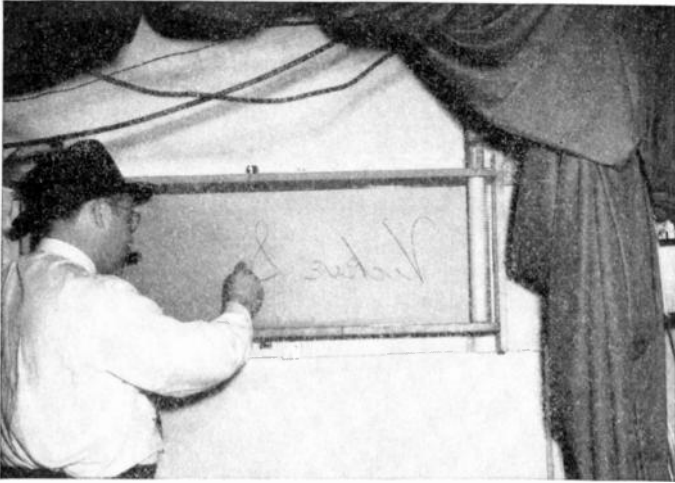


Fig. 13-6. Chuck Holden writing from behind the set on the ABC show "Stop the Music."

Ink from the Back Side. If a relatively thin paper is used and a thin and penetrating ink, black ink can be made to soak through from the back side. The artist ordinarily uses a "fountain brush" for this purpose.* Chuck Holden, ABC production manager, was the first to develop this method on television at WCBS-TV before the war. He built a vertical stage using newsprint paper which was supported on the front side by a sheet of glass.

In Fig. 13-6 he is applying the same technique to the more recent production of "Stop the Music." The name of the contestant answering the phone is mysteriously written out on a small panel behind the MC. Whoever writes out the name, however, must be an expert at writing in reverse.

A further development of this technique was made at WSPD-TV in Toledo. In this model, the Telescriber (Fig. 13-7), a horizontal stage was used, and the camera picked up the image by means of a 45-degree mirror below. This allowed the operator to work right way to. White wrapping paper was used in rolls and was pulled through the stage sandwiched between wide areas of felt, which held it securely

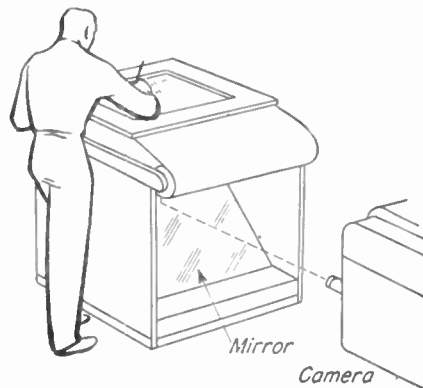


Fig. 13-7. WSPD-TV mysterious-writing machine, the Telescriber.

* Fountain pen with a piece of felt for a point.

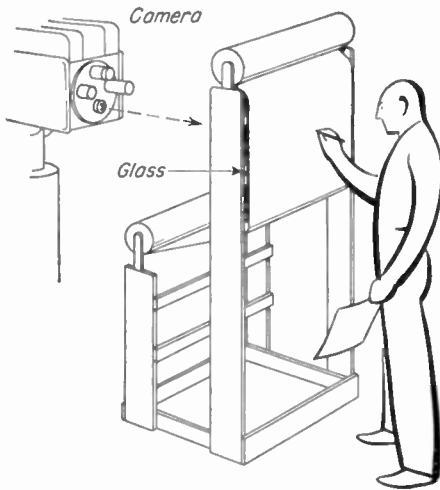


Fig. 13-8. WWJ-TV mysterious-writing device.

enough so that the pressure of writing would not bulge down the unsupported center portion of the paper.

Front-lighted Ground Glass. Ground glass, matte celluloid, tracing cloth, or layout paper will serve as the material on which this type of writing can be done. A white chalk or other soft crayon is used from the reverse side. All light is applied from the front. The hand must be gloved (as described later in this chapter in the discussion of the Bretzicon), and all but the

point of the crayon must also be black, or it will show. The white chalk, as it is applied to the back of the translucent material, reflects the front light, and the letters come out white against a dark background.

A black crayon may also be used in this method to achieve a black-on-gray as well as a white-on-gray effect. The black pigment absorbs some of the front light, which would otherwise be reflected back by the diffusing material.

TELEVISION ANIMATION

The term "television animation" is meant to exclude animation which is produced on film. Many of the techniques described below can be utilized in film production, especially when the producer is cutting corners in the attempt to produce on a low budget. However, the technique which is basic to almost all film animation, stop motion, cannot be used in live television. This section will describe devices which have been developed to produce at least the simpler types of animation without recourse to the stop-motion technique.

Stop motion, the reader will recall, is the process of shooting a motion picture in separate frames, one or two at a time, and changing the drawings or the position of "moving" objects between exposures. A tremendous amount of art work is necessary when so-called "full animation" is done—12 to 24 drawings per second of finished film—even though all parts of the picture are not repeated in every drawing. Only the moving parts of the picture are redrawn every frame, and since the drawings are done on celluloid, they can be laid over other drawings which carry the static elements. Sometimes as many as 10 or 20 layers of cells are neces-

sary for very complicated animation, and multiplane animation stands allow foreground, background, and middle-background cells to be placed on separate planes, each of which may have its own motion or animation.

HAND ANIMATION

In the most straightforward method the live performer simply adds picture elements by placing them on the picture or moves models or other objects by hand. This simple technique lends itself very well to the actuality and immediacy of television.

The old flannelgraph technique, known for years to sidewalk audiences of Salvation Army sermons, has been reborn in the television studio. The background of the picture is made of cloth, preferably velvet or flannel, and the picture elements are drawn or cemented onto "velour paper" or ordinary sandpaper. (Velour paper is coated with flock, feels like cloth, and can be purchased at most art stores in a variety of colors.) The speaker need only place the cutout against the cloth and it will catch and hold there even in a vertical plane. A picture can be put together piece by piece; it may be a simple two-dimensional design; or it can be drawn in perspective.

A variation on this technique was used by the author at CBS in 1941. Arrows and other symbols were placed on smooth-surfaced maps and held by scotch tape. A piece of heavy double-faced tape can be attached to the back of the symbol for this purpose, or if only single-faced tape is available, a circle of tape fastened to itself and flattened out will do almost as well. In utilizing this method of visualizing the news, the newscaster stood before the map with the various symbols in the order of their use spread out on the table before him.

POP-INS AND ONE-STEP ANIMATION

The instantaneous addition of new elements to a picture is one of the simple effects of animation. This can be done very easily in film by stopping the camera and adding the new element to the picture. In television, of course, other means must be found.

One way to achieve this effect is to cut from one picture to another, identical with the first except that it includes a new element. If the two pictures are in perfect register, there will be no change at the time of the cut except that the new object will "pop in." Since perfect register cannot easily be accomplished between two studio cameras, this effect is used only where a station has a multiple-stage projector, either slide or opaque, and the two stages involved can be in perfect alignment.

The illusion of a simple type of motion can be achieved by cutting back and forth between two pictures in this manner. The action of pumping up a tire, for example, can be shown in two stages, with the pump up and

with the pump down. Rapid cutting between the two stages will keep this one-step animation going for as long as desired.

The above is an optical effect when done in a shadow box or projector, since it depends on controlling two images by light and mirrors. Pop-ins may also be done entirely mechanically in front of a television camera. A drawing is done on celluloid, and the additional element which is suddenly to appear is drawn separately on a card, which is then placed behind the first. A shutter of the same material as the background of the second drawing is placed between the two, covering the new element. As the shutter is pulled out (Fig. 13-9), the new element is revealed. This is known as the "pull-out" technique. If the shutter is a heavy material (black paper, for example), the edge may catch the light and show as it is being pulled out. To avoid this, use a piece of matte celluloid for the original (front) drawing. As long as the picture beneath is held tight

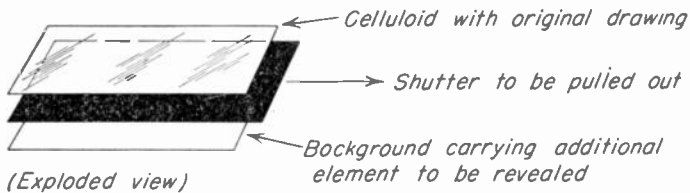


Fig. 13-9. Method of making new element of the picture pop in by quickly pulling the shutter that covers it.

against the ground surface, it will be seen clearly. There should be just enough diffusion to disguise the edge of the shutter. Heavy tracing paper, layout paper, or architect's tracing cloth can be used for this purpose.

The pull-out may be used for one-step animation if the first stage of an action is drawn on the shutter. When the shutter is suddenly jerked out, there is a split second of blurred motion and the eye is left with the subject in another position. Since the picture on the shutter moves bodily away, it gives a momentary sensation of directional movement. If the direction of shutter movement is the same as the direction of movement in the animation, this will add realism to the effect. The eye will interpret the sudden shutter movement as a transitional movement of the object from one position to the other.

Another means of achieving one-step animation is to draw both stages of the action on the same card, but in different colors. In operation, the camera is successively blinded to first one color, then the other, with the result that it sees two pictures alternately on the same card. The Dr. Jekyll-Mr. Hyde make-up change has been achieved by this technique.

Two methods can be used for blinding the camera to first one color and

then the other. Either the light on the subject can be changed in color, or filters may be rotated in front of the camera lens. Spectrolite, a commercial process that has been used in some television stations and in the production of filmed commercials, utilizes the changing light. The colors chosen for this technique are usually red and blue since they are widely separated in the light spectrum. It is possible to find a red-light source (or filter or pigment) which contains no component of blue, and vice versa. Thus when the red light is on, all blue portions of the art work appear black. (Blue pigment absorbs all but blue light, and since there is no blue light on the subject, there is nothing to reflect.) Red portions of the drawing, however, reflect a maximum of light, take on the same shade as the background, and disappear from sight. The background shade (usually a neutral gray) is carefully chosen to reflect the same amount of red light as the red pigment and the same amount of blue light as the blue pigment. Where this technique is not entirely successful, the trouble is likely to be found in this pigment-to-background match.

If red and blue filters are used in front of the lens, the subject is then illuminated with white light (which has the same amounts of red and blue in it). A red filter will turn the blue pigment black and make the red invisible. A filter wheel will make a continuous effect possible. The filter need not necessarily be placed in front of the lens, however; it may be a sheet of gelatin, for example, used in place of the usual opaque shutter in a pull-out. Whichever technique is used, its success depends on a very careful matching of pigment to background and of light or filter to both.

SIMPLE MOVEMENT

The most obvious method of injecting movement into a graphic is to rig up cutouts and added portions with levers and other manual controls so that they can be moved from outside the borders of the picture. A man's jaw may work up and down, a figure may bow and straighten up again, a golfer may work his club. Chuck Holden devised many such cardboard animations at CBS-TV before the war. One of the best of these portrayed the action of pumping up a tank of air. As the operator worked the pump up and down with one hand, he lifted a shutter to expose more and more of the tank with the other.*

The growth of a line on a graph may be shown by first preparing the graph by cutting out the line from the front card on which the lines of the graph are drawn. This is then backed with the same material, so that unless the front card is particularly thick the line will not be seen until a

*Joe Ferrier, at WNBW in Washington, has made his "Ferriergraph" animations familiar on many NBC network programs.

black (or a white) shutter is pushed in. As an alternative, the shutter may be the same material as the front card and pulled out to reveal a background of some contrasting shade.

By far the most successful and the most complicated animations of the mechanical type are the work of Joe Fox at WTMJ-TV in Milwaukee. These were not used before a studio camera but were worked instead on an open-stage opaque projector in the projection room. This WTMJ-TV balop is described in Chap. 10 on Projection Equipment. The stage is horizontal, and at convenient table height, but upside down to the operator. With space above and to all sides of the stage, it was possible to pull things across, hinge frames of celluloid or cardboard cutouts to lay over, and manipulate with considerable freedom. In a short paper distributed by WTMJ-TV to interested parties in the industry, Joe Fox describes some of his effects as follows:

“The simplest animations are those in which a message is obscured, or

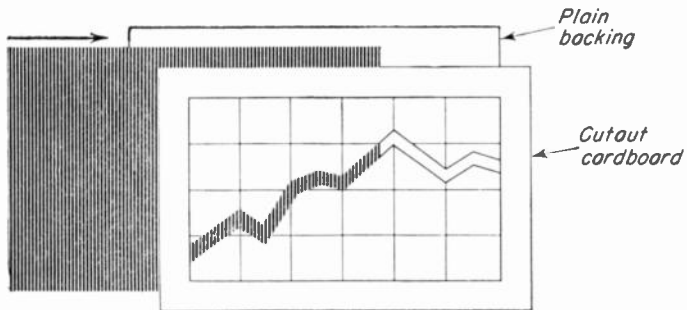


Fig. 13-10. One method of making a graph line slowly grow.

revealed, through a sort of wipe, done with a sliding panel. This can be elaborated into a whole section of the card moving into or out of the picture, carrying the message. The effect of this is to show the letters alone moving into the picture. Further, a glass strip or cellulose acetate sheet may be used, so that the letters move in or out over other parts of the card. The next development is to move a message or picture in or out by means of what we call a drop-over. This is an opaque card, or a cardboard frame holding a plastic sheet, hinged to one side of the picture-area rectangle, and allowed to fall into the picture Further development in animation is introduced with the use of panorama fields moving behind carefully cut-out windows. We use endless belts of some material like strong, flexible paper, or black cloth, fixing them so that they pass over pivoted rollers on either end of the card One of our cards uses a belt of this type to show coal sliding down a chute into a basement window of a house.”

Figure 13-11a shows a card designed to promote a program which this station was carrying. It is appropriate, I am sure, for a large number of television programs. The card showed two hands struggling over a knife. As the operator worked the proper lever, the hand with the knife was pushed back until it reached the far left side of the screen. At that point a rubber-band mechanism was tripped, and the hands flew back again to the starting point. Since the knife blade disappeared off-screen, the effect was that it had ended up in someone. Immediately following this a series of cardboard frames (Fig. 13-11b) were dropped over the picture, falling quickly enough to seem like instantaneous cuts.

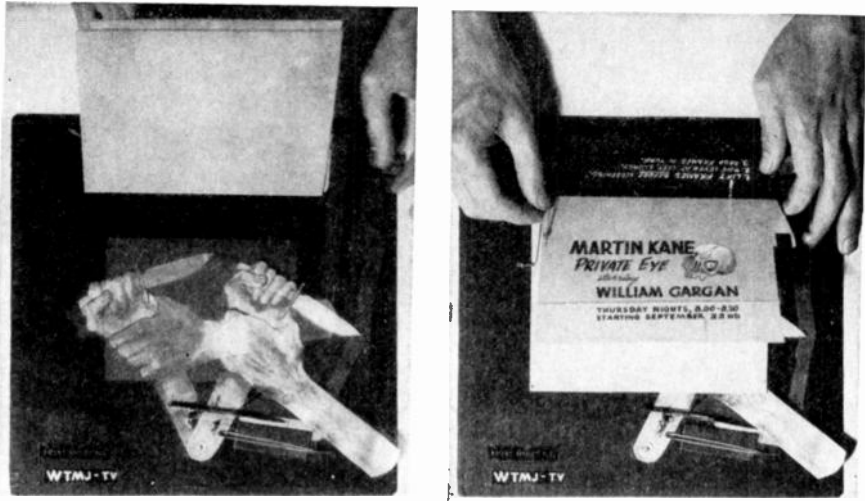


Fig. 13-11. Joe Fox animation for program announcement, WWTJ-TV, Milwaukee. (a) Hands struggle; hand with knife wins. (b) Frames carrying lettering are dropped in.

A somewhat more complicated animation is illustrated in Fig. 13-12. This was used as a spot commercial. The audience saw first of all a hopeless pile of junk. The script read "If your car looks like this, bring it to us [the man's arm was raised at this point to display the sign SOERENS] and we'll make it look like THIS!" At this point the operator pushed forward on tab *B*, and the parts of the car spun around and reassembled into a new convertible, complete except for rear wheel, which was added a moment later as a delayed "joker" by means of lever *C*. The man's arm was raised and lowered by means of lever *A*. Complete instructions for operation were attached to each animation; these are upside down in the illustration since the operator worked the card from the top edge.

Another Joe Fox animation showed a magic carpet leaving an Arabian roof and floating out of sight, to reappear again in the distance, going the other way. Another showed a football player making a place kick from

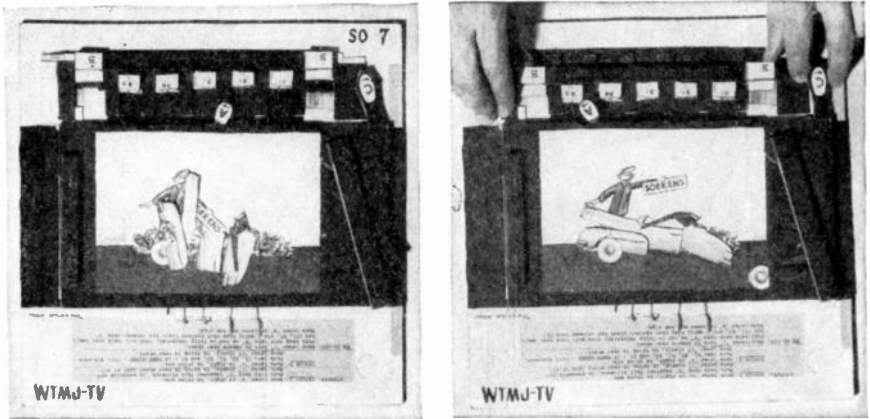


Fig. 13-12. Joe Fox animation for local commercial spot. (a) "If your car looks like this," (b) "bring it to us and we'll make it look like this"—parts rotate to make new car.

the finger of the holder. The picture showed the kick (with arms and legs flying high) and the ball sailing into the distance between the goal posts. When the author held this one in his hand and asked Joe how it was accomplished, he himself couldn't figure it out but had to take the animation apart to determine just what levers released which watch springs, rode on what cams, etc.

Joe has found that simple animations take about half a day to produce, complicated ones perhaps two days in all. Considering the fact that this is only one man's time and that there is no further cost involved, this compares most favorably with other methods of producing spot commercials. Only one essential requirement must be met: the station must have a man like Joe Fox on staff.

WIPE-IN, OR GROWTH, OF LINES, AREAS, OR SYMBOLS

The pull-out device, described earlier in this chapter, lends itself very readily to the wipe-in effect. The simple graph (Fig. 13-13) is a good example. The only animation required here is a slow growth, or wiping in, of the line on the graph. This may be done in one of several ways.

The subject (line on the graph) may be dark and the background light. The original crosslines of the graph are painted on clear or matte celluloid which becomes the front leaf of a pack. Just behind is a shutter of the same paper as the background, and very thin so that the trailing edge is

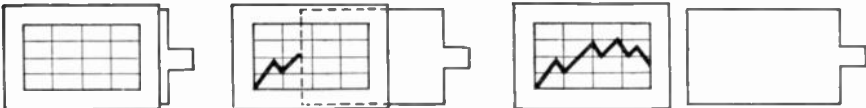


Fig. 13-13. Pull-out technique applied to growth of line on graph.

as unnoticeable as possible. And behind this is the background with the subject to be added painted on it. As the shutter is pulled away, the line of the graph slowly grows. If this line is on a piece of clear celluloid instead of on the background card, another shutter may be placed behind it, which when pulled in turn can add further elements to the picture. The same technique can be used with the reverse tones; the subject may be light and the background dark.

Paint against Paint. Still another method involves preparing the line of the graph in advance by painting a background tone on the back surface of the front cell everywhere but where the graph line will be. The line is left clear celluloid just as it will be when the animation is complete. When the cell is laid in contact with a shutter which has been painted with the same paint, there will not be even the thickness of a piece of celluloid to reveal the edge of the prepared area. Paint is in direct contact with paint. If the shutter is painted with two shades of paint, the appearance of the contrasting shade as the shutter is pulled will wipe in the line of the graph. This same technique can be used to wipe in letters or irregular areas or, with a rapid pull of the shutter, to make an element suddenly pop in.

Rear-lighted Cutouts. It is often necessary to devise a means to animate an arrow which grows by wiping in from tail to head (Fig. 13-14). The

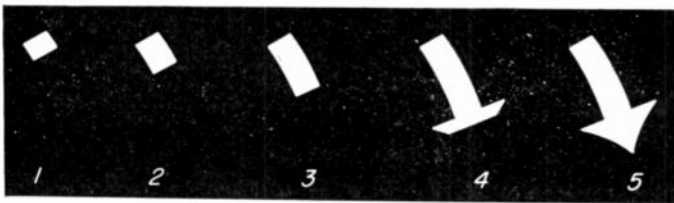


Fig. 13-14. Successive stages in wiping in a rear-lighted arrow.

base map on which the arrow is to appear is done on thin paper such as newsprint, and the arrow is cut out of a sheet of cardboard which is then placed just behind the map. An even illumination of considerable intensity is provided behind this, but the arrow is prevented from showing by a small, opaque shutter laid across it. As the shutter is pulled away, a white arrow is wiped in (Fig. 13-15).

When Chuck Holden first devised a machine for this at CBS in 1941, he used a vertical stage about 24 by 32 inches in size, with a spot on a floor stand for back light. With the vertical stage, shutters had to be fixed tightly to the board by scotch tape until they were operated. Further development of this method has shown that a horizontal stage of

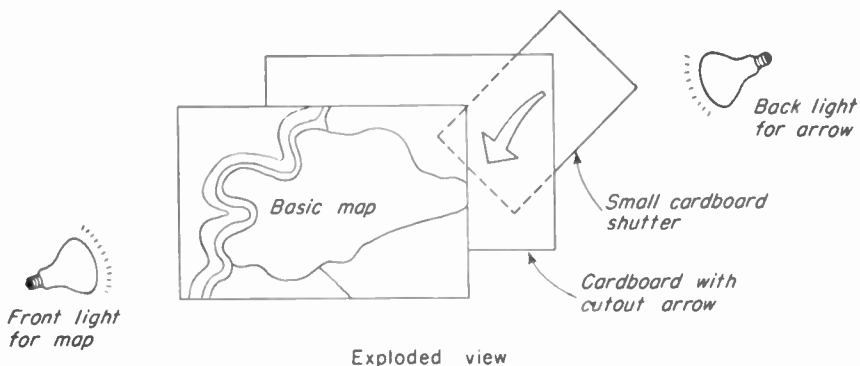


Fig. 13-15. Method of wiping in rear-lighted arrow.

considerably smaller size is more practical. The horizontal stage is viewed from beneath by means of a 45-degree mirror (Fig. 13-16).

The front map and the cardboard backing with cutout symbols are of course fastened securely together, either by stapling or cementing one to the other or, as in the case of the original Holden animator, by stapling both into a wood frame of 1- by 2-inch material. The wood frame made it possible to handle the animations and place them in position easily. A sheet of glass was placed on the front of the stage, against which the map was held. In the horizontal device the same sheet of glass is used, which in this case provides support for the hands or arms of the operator if he should rest them on the stage during operation.

It was found that a good many symbols could be revealed, either by wipe-in or by pop-in on the back of such an animation, provided that it was not necessary for the operator to reach across an already uncovered

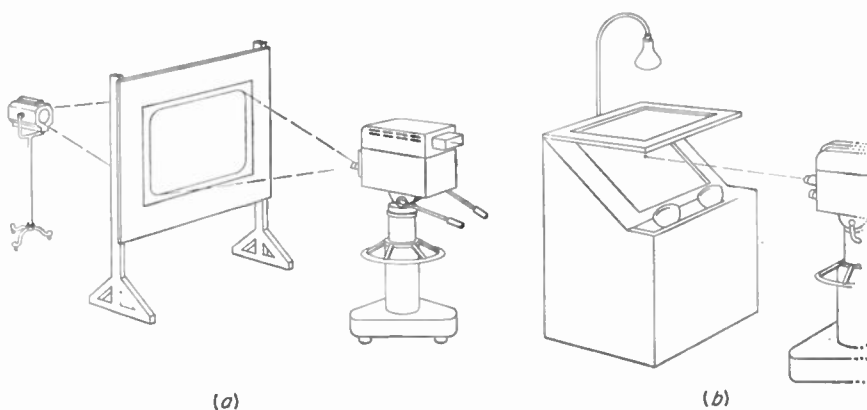


Fig. 13-16. Holden animator. (a) As originally built with vertical stage. (b) Same with horizontal stage similar to Bretzicon.

area. In such a case he might shadow symbols on the map and cause them to disappear again. A long, thin line that twists and doubles back on itself cannot be made to grow by pulling off a shutter, and the mere fact that it is cut out of the cardboard may weaken the latter and cause it to start to fall apart (Fig. 13-17). Occasional bridges of transparent scotch tape across the cutout channel will hold it together without being visible. The line can be covered by a long piece of opaque scotch tape, which when pulled off will wipe in the most convoluted line.

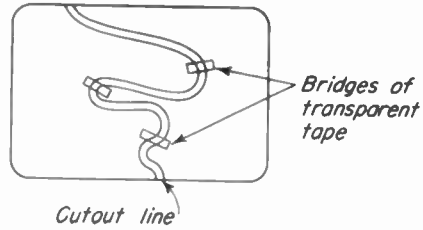


Fig. 13-17.

BODILY MOVEMENT

One step nearer to full animation is the technique of moving objects bodily across a background. It has been found in the development of new techniques of film animation that such simple bodily movement can have considerable charm and thus can replace the much more costly full-animation techniques that have been used before. When this method is used in film animation, at least the cost of art work is saved, although the photography is usually done by stop motion as always. Since, in this technique, an object does not change shape as it moves, realistic figures may look wooden when moved in this manner but *stylized* figures fit in with it very well. The simplest and commonest object that will require bodily movement is an arrow. It is clear that if this movement is to be flexible and free, it must be done by the hand of the operator. The problem is to devise a way to move these objects by hand without the hand itself being visible.

The rear-lighted animator described above is limited in the kind of movement it can perform. If an arrow is to move bodily from one side of a map to another, it must be cut out of a piece of cardboard sufficiently large to provide a shutter both before and after the arrow has been moved (Fig. 13-18). Of course no other symbols could be revealed in proximity to the arrow, or they would have to be cut out from the same piece of

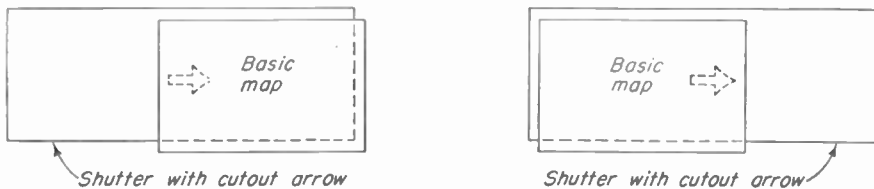


Fig. 13-18. Bodily movement of rear-lighted arrow.

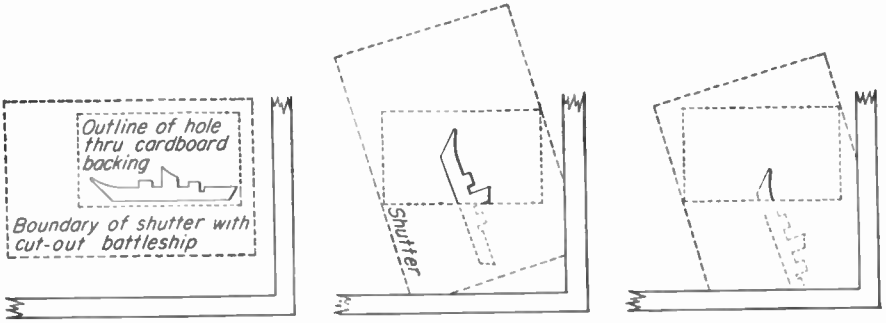


Fig. 13-19. Sinking of rear-lighted battleship.

cardboard and, if revealed before the arrow, would have to move along with it across the map.

The most complicated animation of this type that the author ever devised represented the sinking of a Japanese battleship (Fig. 13-19). The ship itself was cut out of a small piece of cardboard which was then laid over a hole cut into the main cardboard backing. The ship could be moved around a little as long as it did not disappear behind the edges of the background hole. When it was to be sunk, it was simply rotated so that it passed stern foremost slowly down behind the bottom edge of the hole.

An obvious method of moving symbols or figures is to build them out of iron or steel and control them with magnets from behind the card on which they are placed. A children's show called "Magnitoons" used

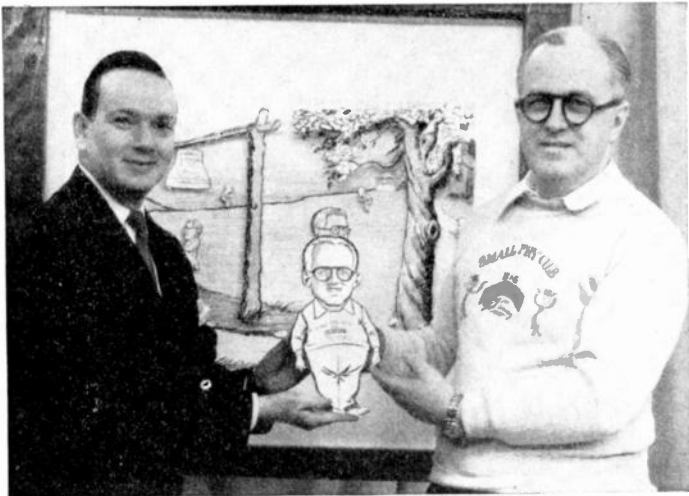


Fig. 13-20. "Magnitoons" magnet board as used on Bob Emery's "Small Fry."

this method for telling stories on a long series of programs on WABD in New York. Cartoon characters moved around on graphic backgrounds, were jiggled to indicate when they were speaking, and were occasionally provided with a little articulation so that arms, feet, or a lower jaw could move separately. The "Magnitoons" operators worked behind vertical screens to control the figures used in these programs (Fig. 13-20).* There have also been horizontal-stage magnet boards, the most ambitious undertaking of this type being the huge terrain model the Army constructed for training purposes, where dozens of operators moved around underneath a large relief map, each controlling a separate truck or tank. The greatest problem in magnet control is to make it possible for the operator to watch what he is doing, since he must work from the back side of an opaque board.

BRETZICON ANIMATOR

The Bretzicon was the first animation machine, to the author's knowledge, which was built with a horizontal stage. (A 45-degree mirror beneath the stage reflected a vertical image for the studio camera to focus on.) This machine made possible the bodily movement of white objects across a picture or map, limited articulation of figures, plus a combination of many of the other animation techniques which have been listed above. The pull-out technique was originally developed as part of the functioning of this machine. A front diffusing sheet (layout paper, tracing cloth, or matte celluloid) is the basic requirement. All light is from the front. Since the stage is horizontal, a number of symbols can be placed on it at one time and will stay in place of their own weight without having to be held.

When front light is cast on a translucent surface such as frosted acetate or the others just described, anything black behind it will not be seen. A black-gloved



Fig. 13-21. Bretzicon in operation at CBS in 1945. Operators are Dorothea Claras and Henry Cassirer, subsequently chief of "CBS Television News."

* "Magnitoons" was produced by Joe Seiferth, and the technique was developed by M. Murray-Gans.



Fig. 13-22. The author demonstrating with a small Bretzicon model.

hand, for example, is invisible. A white object, on the other hand, such as a white arrow cut out of cardboard, will reflect the front light brilliantly when brought into contact with the back surface of the diffusion sheet. If it is lifted away from the surface, it becomes fuzzy and, if taken far enough back, will dissolve away. It is thus possible to put a suitable handle on a symbol (such as an arrow, a ship, or an airplane) and move it anywhere and in any manner over the surface of the map. This complete freedom was very important in animating war strategy, when last-minute news stories left little time to prepare the animation of military

developments. Further, this flexibility in operation left a wide field for creative effort. Manual skill was very important, and there was found to be a great difference between a good and a mediocre animator operator.

Figure 13-21 shows the Bretzicon as it looked in operation except that a camera was not in position in front of the machine at the time the picture was taken. Two operators are working one animation, a method

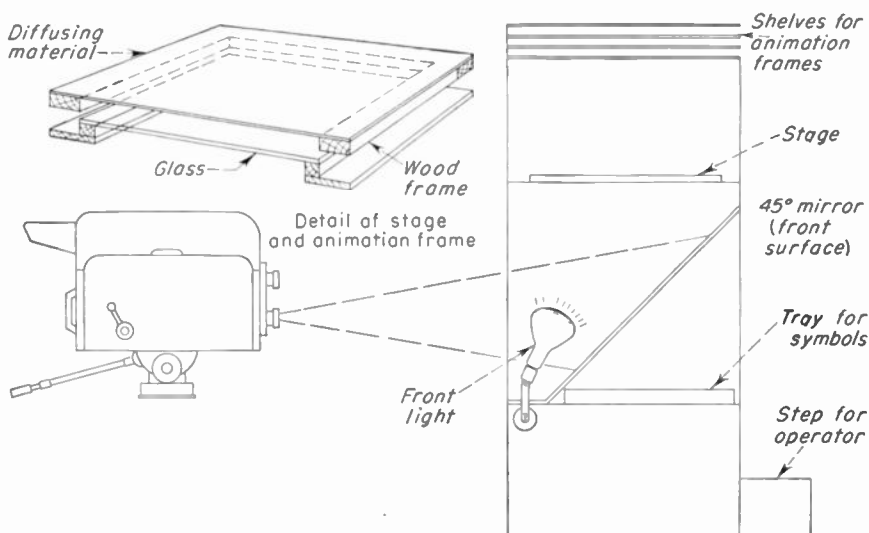


Fig. 13-23. Diagram of Bretzicon.

which was necessary when as many as four symbols had to be moved independently at the same time. If a group of symbols were to be moved together (such as a string of airplanes or ships), they could all be painted on one black card and slid along by hand against a guide.

One of the most complex animations performed by this method illustrated an interview with Bill Offenhouser about his new method of mosquito control. He described how a female mosquito was captured and a recording made of her mating call. Then how this was amplified and played over a loudspeaker in a mosquito swamp, attracting all the male mosquitoes for miles around. As they approached the source of sound, they were sucked into a crematorium and disappeared. To animate this story, an articulated mosquito was built which could flap its wings (by two-finger control) and hover around in front of the loudspeaker. To illustrate the sound radiating from the speaker, the rotating spiral device was used to indicate flow (Fig. 13-24). The spiral was painted in white on a black card, and a shutter with the proper opening was placed between it and the back of the picture. Thus only one segment of the spiral could be seen, and as it was rotated, the lines in this segment seemed to move outward from the center. This spiral and shutter assembly had to

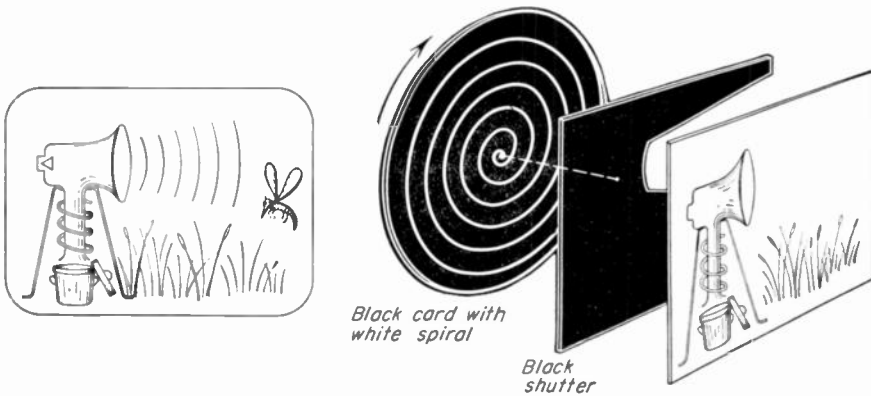


Fig. 13-24. Mosquito animation done on Bretzicon.

be removed from the back of the animation before a mosquito could fly across the same area, and this was done by simply folding it back on a scotch-tape hinge. The mosquito was flown in, buzzed around a little with a stylized flapping of wings (to the accompaniment of appropriate sound effects), and then entered into the loudspeaker. His wings folded, and he descended into the region of electric coils. Here the mosquito was deftly replaced with a tiny pile of ashes which continued on down to disappear into a garbage can at the bottom. The disappearance was effected by a kind of wipe-out. The symbol was moved behind a piece of black

paper (the edge of which could not be seen) which covered the lower portion of the animation up to the top of the garbage can.

It was found that symbols had to be weighted or they would be subject to a lot of unintended movements as the operator took hold of them or let go. Light cardboard symbols were much more manageable if a short piece of $\frac{3}{4}$ -inch iron rod were fastened to the back. This served as a weight and handle as well. When an animation required a battle line to bulge and change position on the map, a flexible and weighted cord was devised. A thick piece of white cotton cord would have looked as well but would not have formed itself into any desired shape and stayed there. We finally obtained strings of BB shot sewn into cloth for weighting the hems of dresses. Two or three of these strings wound with a heavy white yarn gave the required effect.

14 STUDIO EFFECTS

The field of special effects referred to here as "studio effects" includes everything from representing rain, snow, fog, and so forth, to the preparation of imitation food which will not disintegrate under the hot lights. There are a great many techniques listed in this chapter with which the author has not had personal experience although they have all been used in television or motion pictures. The reader is advised to experiment thoroughly with these effects before counting on them for program use. His experiments may reveal other and better ways of achieving the desired result.

SNOW

Snow has usually been simulated with bleached cornflakes or white confetti, either of which can be obtained from supply houses in New York or Hollywood for this specific purpose. For a light powder snow, rough unfinished Pabulum has been extensively used. It is usually superior to any other powder since it is nontoxic if inhaled, although there are some performers who will be found to be allergic to it. In one snow number on the Fred Waring program 500 pounds of Pabulum was used, calling for the services of six stagehands to scatter it down. Snow has also been simulated by chopped chicken feathers, unroasted potato chips, borax flakes, and soap flakes.

John Demott at CBS has simulated a swirling blizzard of snow with chopped feathers and two electric fans blowing from opposite sides of the set. Feathers are used for a swirling snow rather than paper or breakfast food because they are light and blow around much more easily. The two fans must not blow into each other, but past each other, so that eddies will develop between them. The trouble with feathers, however, is that they don't know when to stop swirling; after a heavy snowfall in one set, occasional snowflakes may be seen drifting through interior scenes in other parts of the studio.

More recently a new snow material has come into use—a light plastic fluff which looks and falls exactly like snow, even in the closest shot, and has no toxic or allergic effects on anyone. It is expanded polystyrene, obtained as a by-product in standard plastics manufacture.

The best method of scattering any of these types of snow is to construct a "snow bag" (Fig. 14-1). This is usually made from a piece of light canvas fastened at each end to a batten and suspended by the battens above the set. The canvas is cut up with innumerable slits 2 inches long and about $\frac{1}{4}$ inch wide. One end of the bag is held stationary, and the other is gently raised or lowered. As soon as the bag is touched, snow

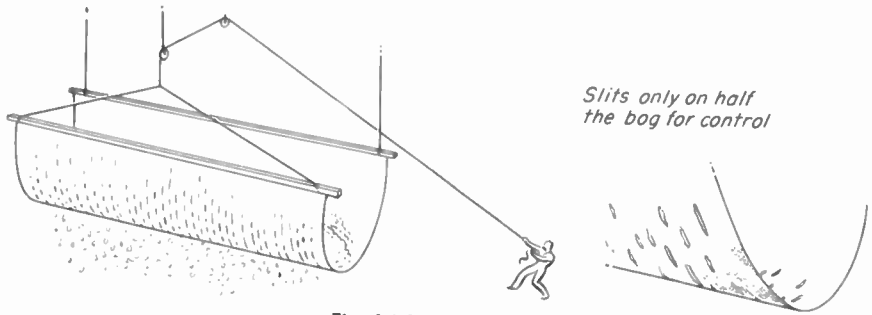


Fig. 14-1. Snow bag.

will begin to sift through the slits in the canvas and the amount of snowfall can be controlled by the degree of agitation. The higher the snow bag is placed, the more even and realistic will be the result. It is also safer; if a lump of snow should fall from the end of the bag, it will be somewhat broken up by the time it gets into the picture. Some snow bags have been made by splitting the bag into ribbons and relying on the spaces between ribbons to sift the snow down. This is not too safe, however, since large amounts of material can sometimes pass through such long slits, whereas the 2-inch slits mentioned above will never let too much go through.

Snowdrifts in a set may be built up out of wood frames covered with chicken wire and plastered with newspapers dunked in gelatin glue. The papier-mâché should then be covered with old canvas, which can be painted with scene paint plus asbestos powder.

RAIN

Rain can best be produced by using real water. Water is cheap and plentiful and gives a very good illusion of rain. It makes a mess on the studio floor, of course; and if anyone lives downstairs, it is recommended that some means be used for containing it, once it falls. John Demott usually spreads a large tarpaulin with a raised edge. When the show is

over and he has an inch or two of water to get out of the tarp, he throws a few wheelbarrow loads of dry sand onto it, lets the sand soak up the water, and shovels it out.

Sometimes a good illusion of rain is obtained without any actual drops falling. If the lighting is right, the sky is dark, possibly with clouds scudding across it, and a little glycerin is put on people's clothes, hats, or umbrellas to give them a wet shine, the effect will definitely be that of a rainy day. Actually, one has to look very sharply in the usual slow

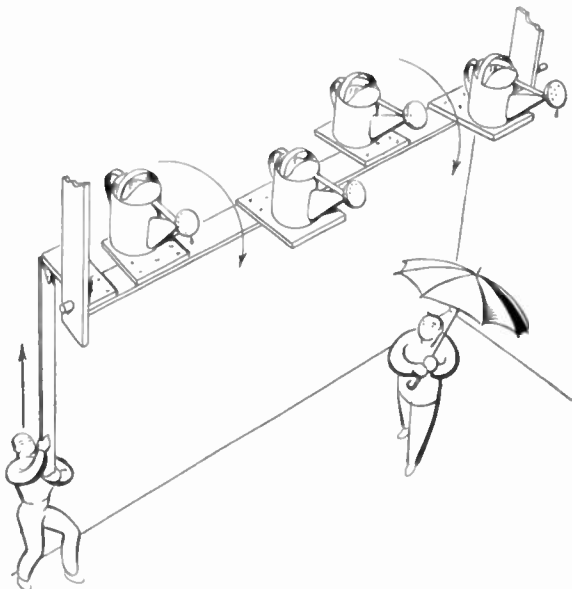


Fig. 14-2. Sprinkling cans ready to provide rain.

drizzle to see raindrops falling anyway. The feeling of rain is conveyed by the surfaces of things. It is only in a sudden summer shower that raindrops are really visible. Most of the methods that are used for producing a shower of rain make the drops too large to be real.

The set should be specially painted to give a wet effect on things. Demott suggests spraying over the regular scene paint with thin varnish or a solution of 1 pint of Lepage's glue to 1 quart of water. Only the areas which require a damp appearance need to be so treated. This will both darken the area and give it a wet and shiny surface. Props can be sprayed with common drugstore glycerin, which is then allowed to dry.

Motion-picture rain is usually produced by criss-crossing the top of the set with water pipes which have very tiny perforations on the top side. When the pressure is turned on, the water sprays up from these holes, strikes a deflecting plate, and falls in an even spray. Large amounts of rain, such as this, are seldom necessary in a television set. The perfo-

rated pipe is sometimes used above a window or along the edge of a roof, provided that there is some way of catching the water when it falls. A canvas "soaker hose" is often used instead of a pipe.

A group of sprinkling cans fastened to a rack so that they can all be tipped at once will usually give rain for long enough to satisfy most requirements. If other equipment is not available, a single sprinkling can may be used close in front of the camera lens. The actors don't get wet this way; they have to be made up with glycerin instead. But the raindrops, large to begin with, come out gigantic. Still it looks like rain.

The most satisfactory water device is a complete circulatory system, sprinkler, collecting pan, and pump, so that the rain may be kept going for as long as necessary. The collecting pan must be a "fur-lined bathtub" (hair felt will do) so that noise is eliminated. A pump capable of several gallons per minute at about a 10-foot head should be used. The pump and its electric motor must be built into a soundproof box. Austin Huhn has constructed these rain units in many sizes, including one in which the rain curtain is only about 3 feet square for use as a gobo between camera and scene.

For the studio which does not wish to use real water, Austin Huhn recommends superimposing a Rain Glamé, a long mat woven of $\frac{1}{8}$ -inch cellophane strips and run downward in front of the camera on a standard title drum. According to this expert, superimposing rain of any kind is generally superior to trying to do the effect in front of the camera which is shooting the scene.

Bill Healion at NBC in Chicago has simulated rain very successfully with thin ($\frac{1}{4}$ -inch) cellophane strips hanging from a batten. This method is for use behind a window when the camera is inside looking out. If the light is just right, gentle movements of the batten will cause highlights to run down the cellophane very much like drops of water running down the windowpane.

The lighting of falling rain is very important if it is to be seen at all. It must be lighted from the side, and always with a hard light. A fresnel spot with the lens removed will provide a good light source for this purpose. John Demott uses a little blue ink in the water to make it pick up the light better. Some have used condensed milk for the same purpose.

FIRE

Fire regulations prevent television studios from using open fire with quite the same freedom which is possible on the motion-picture set. Small amounts of fire are used in torches or braziers, provided that extinguishers are kept ready. If a large fire is needed, sometimes a small flame close to the lens will seem to be enveloping the entire scene. If open flame cannot be used, flames on film can be superimposed. Theatrical-

effects projectors can project flame effects on a background screen if the fire is to be in the background, or foreground projection can be used in the manner of the motion-picture glass shot. A fire in a fireplace can be simulated by pieces of silk or paper in an updraft. But this cannot be shown in close-up, or the illusion will be lost.

Small Open Flame. Canned heat or alcohol flames are best for a small flame near the camera. The flames won't show up very well, however, unless a little salt is put into the fuel. The yellow sodium flame shows up much better. When a small fire is used close to the lens or a film of flames is superimposed, the individual flames may look very large and it is hard to make the fire seem to be coming from the set in the background. Since the source of the flames is below the bottom of the screen, they will appear to pass across all the objects in the picture instead of beginning somewhere among them. If a lot of smoke is released in the set, however, this method can still give a fairly good illusion provided that it is not on the screen too long.

Projected Fire. Projected flames can be classified into two types, foreground and background. In the case of the background fire seen through a window or in the distance, either front or rear projection can be used, depending on the space allowed, with the appropriate type of screen. Theatrical-effects projectors achieve a fire effect by rotating two sheets of irregular glass at different rates in front of the light beam. If the fire is projected too large, however, it may fail to give the effect of distance because individual flames will be too big.

Foreground flames can be projected by the same machine on a sheet of glass in the manner of the motion-picture glass shot. The glass must be

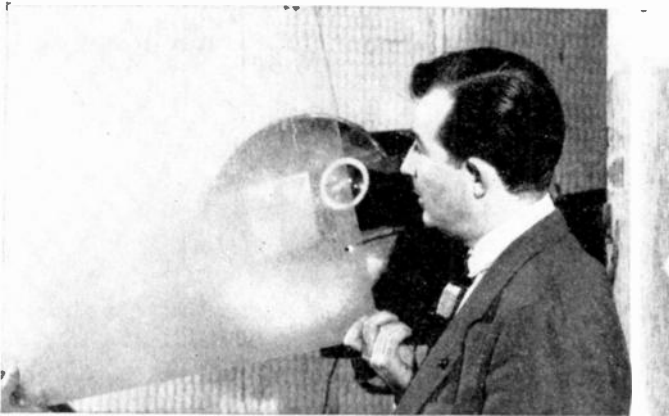


Fig. 14-3. John Demott with glass frosted with beer and epsom salts.

clear if the background scene is to show through it; yet it must be frosted in some way if anything is to be projected upon it. John Demott solved the problem on a CBS show by spraying the bottom portion of the glass with a solution of stale beer and epsom salts. This created a dense frosting which graduated into clear glass in the upper part. Since the frosted glass was close to the effects projector, the individual flames were relatively small in size and gave a better illusion of originating within the set than if an alcohol flame had been used (Fig. 14-3).

Fireplace Fire. The fireplace fire is created by implication better than by direct creation. If you can get around showing the fire itself and produce the illusion by creating a flickering *firelight*, the audience may feel they have seen a fire, even though you have not shown them actual flames. Methods of creating firelight are outlined in Chap. 18 on Television Lighting, under Special-effect Lighting.

If real fire cannot be used, paper or cloth flames blown up by an electric fan or the convection from a few hot lamps is convincing enough in a long shot, but this must be very well done to stand even a medium close-up. If a little smoke is added, the effect will be improved. A shot which enlarges the fireplace to even a quarter of the screen width is likely to give away the effect, however. Beware of close-ups on all standard theatrical effects; they are made for audiences which watch the show entirely in long shot.

SMOKE

Smoke and fog are similar in some respects, and sometimes both can be created with the same material if it is used in different ways. Realistic smoke is usually thick and billowing and moves rather rapidly across the screen, especially if it is in the foreground of the shot. There have been many unfortunate attempts at fog which more closely resembled the above description of smoke than the low-lying, evenly distributed haze which characterizes fog.

The easiest method of making smoke is to use liquid titanium tetrachloride. When this liquid is poured out and comes into contact with the air, it gives off thick white fumes. The more air is blown across it, the more smoke is produced. If a small amount of localized smoke is needed, a rubber bulb can be attached to a length of $\frac{1}{4}$ -inch rubber hose and the chemical is simply poured into the bulb or hose. In the CBS show "Mr. I-magination" a small locomotive was equipped to emit puffs of smoke when the engineer squeezed a rubber bulb in the engine cab. Titanium tetrachloride fumes, although not toxic, are extremely irritating and will cause actors to cough; so it is best used only in small amounts.

John Demott has another method of smoke production to suggest. A

solution of saltpeter in water is prepared, 3 parts water to 1 of saltpeter. Thin rags are dipped in this solution and then allowed to dry. If the dried rags are spread out on a board or piece of tin and ignited, they will smolder and give off a thick smoke, the amount of which can be increased by adding more thicknesses of rag.

Special "smoke candles" are available in Hollywood which when lighted with a match will glow like incense. Austin Huhn obtains more smoke from one of these candles by putting it into a can to which a bellows is attached and blowing the smoke out as from a beekeeper's smoke pot.

The hot plate is a useful piece of equipment for smoke production, and there are several materials which when heated on a hot plate will give off smoke. Eddy mentions asthma powder, a vegetable preparation, which emits a thick cloud of whitish-yellow smoke and creates a minimum of ill effects among the studio personnel. Powdered charcoal, he goes on to say, can be added to this after it is ignited to produce a black smoke. Common bath salts will produce smoke. Probably the best, however, is a smoke powder made from incense and ammonium chloride.

Chuck Holden at ABC has had success with a chemical method of making smoke. Three 2-gallon bottles with two-hole stoppers are used as shown in Fig. 14-4. Air is pumped into the first bottle, containing hydrochloric acid. The acid fumes are thus forced into the next bottle, which contains ammonium hydroxide (or ammonia). The fumes pass on through the neutralizing solution, and a thick white smoke (ammonium chloride) results. The acrid smell of this is greatly reduced by passing it through a third bottle of rose water before it is used on the set.

Another and totally different method of creating the effect of smoke has been mentioned before in connection with snow, rain, and fire—photographing the effect on film and superimposing it over the scene. If milk is poured into a tank of clear water and the camera shoots the action in slow motion and upside down, the billowing of the milk downward will look like smoke in the air billowing upward. For black smoke, ink or black water-color paint can be used.

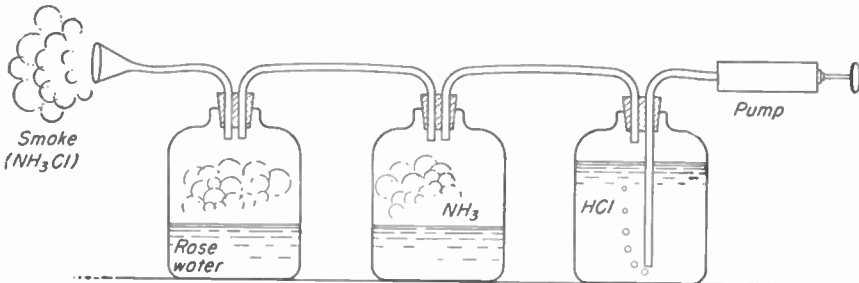


Fig. 14-4. Generator for ammonium chloride smoke.

The most controllable smoke effect that the author knows was developed by Bob Banner for his use on the Fred Waring show. This device was known as a "smokehouse" because the smoke was entirely contained (Fig. 14-5). One camera poked its lens through the drapes that formed the sides of the house, and the smoke picture that it picked up was superimposed on the other camera's shots. This is an extremely desirable method for a musical show, where throat irritation may ruin a singer's performance. Titanium tetrachloride, dry ice, or any other smoke pro-

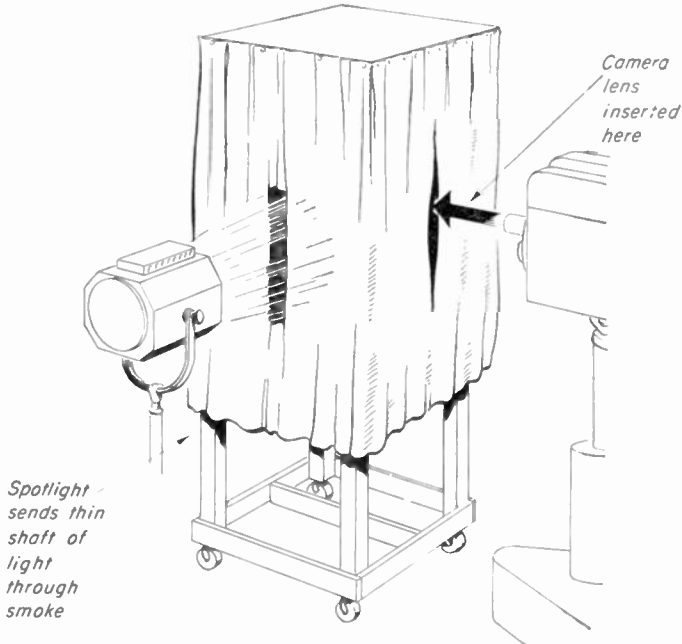


Fig. 14-5. Bob Banner's "smokehouse."

ducer was placed on a tray at the bottom of the unit, and the resulting smoke was illuminated by a thin wedge of light coming through a single slit in the side. This meant that the camera could focus on this fixed distance and all illuminated smoke would be in this plane of focus. Any degree of agitation could be achieved simply by moving the curtains which comprised the sides of the box. Other openings in the curtain were also provided through which air or more smoke could be blown into the chamber to provide a great variety of smoke effects. If the smoke should become too thick, the top of the unit could be removed and the smokehouse quickly cleared.

NBC built a smokehouse of a somewhat different design; a glass-walled box about 3 feet high and 4 feet wide and about 1 foot in thickness. This is used in front of the camera in the manner of a gobo.

FOG

Dry ice is a common material for creating fog and smoke. Real fog is produced in large quantities by this method, and breathed without discomfort. Dry ice is frozen carbon dioxide; when the substance thaws, it skips the liquid state and goes directly from a solid into a gas. This lowers the temperature of the surrounding air, and any water vapor that may happen to be present condenses into a cloud. The more humid the air, the more condensation; so the best smoke is produced when the dry ice is placed in water or when humid air or steam is blown across it. Boiling water must be used, however, or each piece of dry ice will simply

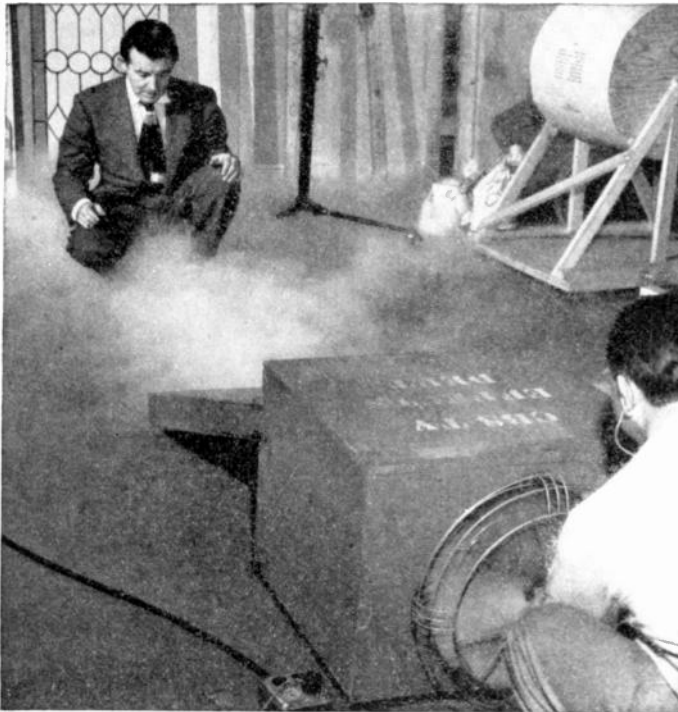
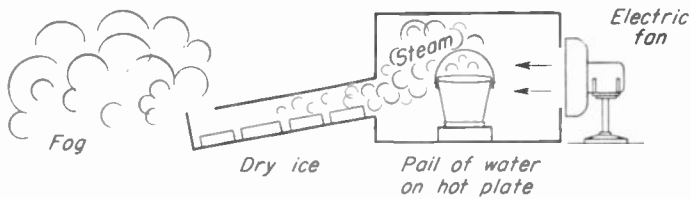


Fig. 14-6. Simple fog machine. Boiling water creates steam which is blown across dry ice to condense into fog.

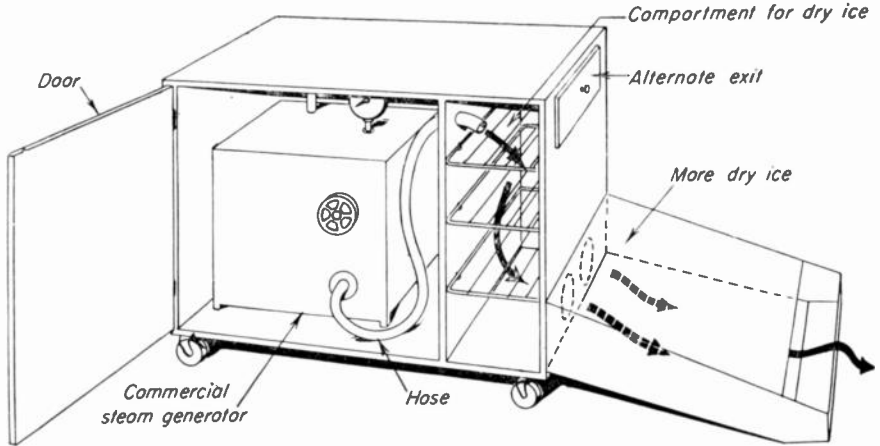


Fig. 14-7. Improved fog machine with commercial steam generator to produce greater quantities of steam, and hence fog.

freeze the water around it and seal itself into a chunk of ice. Some studios have created ground fog simply by keeping a series of pails heating on hot plates and when they were boiling dropping dry ice into them and setting them around at strategic places in the set. Such a pail will boil out great quantities of low-lying fog for a minute or so until the water cools down, at which time it must be replaced by another pail if the fog is to continue.

Fog on the motion-picture set is usually produced by atomized oil. This is known as crystal oil in Hollywood—castor oil without the smell. Light mineral oil has been used in oil-spray machines in New York television studios. Atomized oil will hang longer in the air than the fog created by dry ice. The latter will eventually evaporate, while the oil merely settles. Actors may find their hair and clothes a little greasy from this settling, but aside from that there are no adverse effects. A large paint-spray machine is used for laying the fog. Oil painted onto a hot plate with a paintbrush gives off vapors which are then blown over the set by an electric fan. Wherever smoke and fog are to be lying in layers, the studio must be cold and the floors must be wetted down.

Certain risks are undertaken when fog is produced in the television studio. Each of the following misfortunes has occurred at one time or another when fog was attempted: (1) The fog may be altogether too dense so that the scene is practically invisible to the television camera. (2) It may so fill the entire studio that interior sets will also be permeated with it, and there will be as much fog inside a house as there is outside. (3) The fog material may be irritating to the actors and make them cough (as when titanium tetrachloride or other fumes are used in large quanti-

ties). (4) Although a small amount of movement is desirable, the fog may swirl and billow too much and look like smoke instead. (All four of these faults were combined on one unfortunate program when the special-effects man spread titanium tetrachloride around with great enthusiasm.) (5) The fog may be too thin, may lie too low, or may evaporate too fast so that an insufficient effect is obtained.

All these troubles may be avoided if a fog filter is used over the lens of the camera. The "American Cinematographer's Handbook" lists 14 different kinds of fog filters used in motion-picture work, manufactured by George Scheibe or Harrison and Harrison. Lacking any of these, a very thin net or scrim can be placed in front of the lens. Some people have sprayed wax on a sheet of glass or clear plastic to make a fog filter. If several such diffusers are used, one can be moved against the other to create a moving or drifting effect. The filter method sacrifices one characteristic of fog, however, which is the swirling movement often seen, especially when someone walks through the fog. This can be simulated, however, by a small amount of smoke picked up by another camera and superimposed, provided that the movement is not too fast. Another possibility is to generate a small amount of $TiCl_4$ smoke just in front of the camera lens.

BREAKAWAY GLASS

Panes of glass which can be broken without danger of cutting the actors can be obtained in Hollywood and New York. Heretofore made of sugar, breakaway glass is now made from resin. Of course if the glass does not have to be broken by an actor's fist but is hit by a hammer or other heavy object and there is no particular danger, regular glass can be used and will create its own sound effect. Breakaway bottles are also made from sugar or from plaster, which is then painted to represent glass.

BREAKAWAY FURNITURE

To make a chair which will hold together until it is sat in or until it collides with someone's head, cut the chair in pieces and then peg it together with matchwood or small dowels of balsa. First mark the chair for cutting, and then drill holes across the cuts. After the cuts are made, the parts can be held together again by tiny dowels, which are all that really break when the chair goes to pieces. The strength of the chair can be con-

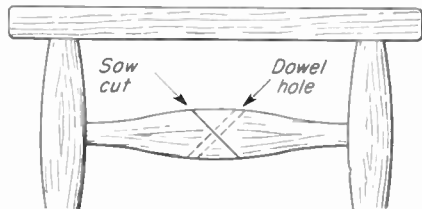


Fig. 14-8. Method of preparing break-away furniture.

trolled by the size and strength of the dowel sticks; balsa is the weaker of the two materials. The chair may be broken in rehearsal and pegged together again in a few minutes' time (Fig. 14-8).

COBWEBS

A simple way to make cobwebs is contributed by Chuck Holden of ABC. Two flat sticks are held together with a thick layer of rubber cement between. As they are pulled apart, long streaks of the partly set cement are stretched between them, which can then be laid across windows or bric-a-brac. Liquid plastic can be used instead of rubber cement if desired (Fig. 14-9). These cobwebs, like those made by any other method, are made much more visible and realistic if they are liberally dusted with talcum powder.

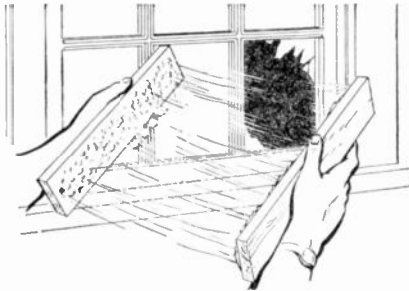


Fig. 14-9. Rubber-cement cobwebs.

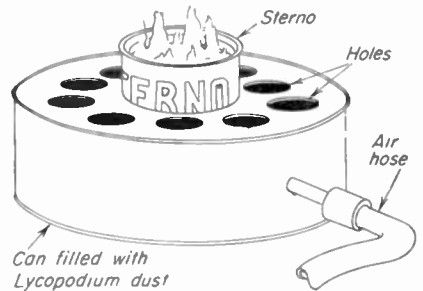


Fig. 14-10. Lycopodium-dust flash pot. (After Eddy.)

EXPLOSIONS, FLASHES, AND PUFFS OF SMOKE

Magnesium pills and lycopodium dust are the usual materials for these effects. A lycopodium burner for flash-fire effects is illustrated in Fig. 14-10. A lighted wick or can of sterno is placed in the center, and a sudden puff into the air hose will blow the lycopodium powder up through the holes, where it will immediately burn in a flash of flame.

Figure 14-11 illustrates two methods of preparing magnesium flash

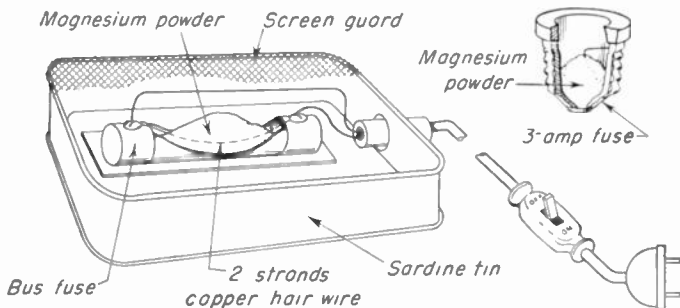


Fig. 14-11. Two ways to prepare magnesium-powder flash pots.

powder for studio use. A 3-ampere fuse is opened up and without destroying the fuse wire is filled with photographer's flash powder. The fuse can then be screwed into any ordinary electric socket, so long as it is horizontal. When the circuit is closed, the fuse will immediately blow and the magnesium will go up in a puff of white smoke. The second method shown is capable of a bigger effect and is somewhat safer to use.

It is a good plan to check local fire regulations before attempting any fire or explosion effects in the studio, and extreme caution should be exercised in their use at all times.

GUNS

Gunshots in television are usually handled by the sound-effects man, who coordinates, more or less, with the actor as he points the gun and pulls the trigger. Sometimes a special effect is required, however, where a gun actually spouts smoke or flame. A toy gun on the market, the Roy Rogers Smoker, which simulates a .45-caliber revolver, can be used for this purpose and altered to look like other types of guns by cutting off some of the barrel. The Smokers are equipped with milk of magnesia powder, which can be made to give off more smoke by the addition of common cornstarch. A smoking gun barrel may be simulated by cotton soaked in saltpeter, a method described earlier under Smoke. A Buck Rogers flame gun was once constructed with flashlight batteries and a thin-wire coil which would heat red-hot when the current flowed, and was then loaded with magician's flash paper.

MISCELLANY

Water droplets (that don't evaporate): Glycerin—use for raindrops, tears, etc.

Dew drops on flowers: Spray flowers with water containing a little ink—the droplets will be more visible.

Icicles: Strips of cellophane dipped in melted paraffin and gasoline.

Soap suds: For large amounts of suds, fill a milk bottle one-quarter full with powdered soap or detergent, and add same amount of hot water. Then drop in a few pieces of dry ice. Take cover.

Blood and gore: Ketchup; chocolate sirup; or whipped cream with vegetable dye and copper filings or tobacco.

A shot in the head: Special-effects man uses a peashooter from off stage loaded with a gelatin capsule containing vegetable dye. Or actor holds chocolate capsule in his hand and claps his hand to his head; when he takes it away, blood is visible.

Aging clothes: Put rocks in the pockets; dampen and hang overnight; rub with beeswax for shine.

Flying bullets: Drill holes in set, and put corks in them from behind. Pull corks for effect. Machine-gun holes can be made to appear by pulling scotch tape off series of prepared holes from the back of the set and letting back light shine through.

Breaking vase or window pane: A mousetrap is mounted beneath the vase or window and released by a hidden wire.

Falling petals: Petals are held on plant by threading them with a thin wire. As wire is pulled out, petals will fall.

Pots steaming or boiling: If the studio stove does not function, put dry ice into pots containing hot water. Don't close any such pot tightly, or a tremendous pressure will be built up.

For methods of making food look more appetizing (though less edible), the author is indebted to John Demott and Jim Furness for the following suggestions:

Beer: A pinch of sodium bicarbonate whitens the froth.

Coffee: At normal strength coffee often looks too black. A very weak coffee will look better. A little dry ice in the bottom will keep it steaming.

Butter: Butter will look better if mixed with a little margerine coloring.

Milk and cream: There is not enough difference between the tones of milk and cream to show any difference. Pour off the cream and add a pinch of turmeric (a yellow spice), then gently replace.

Meats: Paint the lean parts with undiluted grape juice.

Grapes: Powder with talcum, hold in front of an electric fan to blow off the excess and then dip in water.

For substitute foods for use under hot lights, the following may be employed:

Bread: A permanent loaf of bread can be carved from a block of wood.

Fried eggs: Sandwich bread and apricots (substitute colored bread for as many foods as possible).

Ice cream: Mashed potatoes colored with vegetable dye.

Cracked ice in glass: Crinkled cellophane.

Caviar: Buckshot and axle grease.

Wines: Coca-Cola, vegetable dyes in water.

Liquor: Tea.

15 ELECTRONIC EFFECTS

The most common electronic effect is the superimposure. Many supers are attempted for no greater purpose than the decorative effect which they achieve. An example is a shot of a violinist on which is superimposed a close-up of the strings of the violin. Sometimes a super will serve to associate two things which are not close enough to be shown in the same shot. A speaker and his opponent listening and reacting to his words can be shown on the same screen by superimposure, provided that the important part of each picture falls on a reasonably dark area in the other. If this is not possible, some form of matting (Chap. 12) must be resorted to.

The most successful superimposures are those which carry extra meaning which is not present in either shot alone. The whole is thus greater than the sum of its parts. A Philco commercial once superimposed a shot of a musician over a close-up of the speaker of a phonograph. The meaning was clear: This phonograph sounds as though the musician were actually present. Another use of the super is in the realm of fantasy. Ghosts and other supernatural effects are easy to achieve by this means.

Whether the two shots of a superimposure tend to blend together into a sort of composite shot so that they seem to be made with only one camera or whether they remain separate entities so that the effect is only that of two pictures on the screen at once will depend largely on the perspective within the two pictures.

Figure 15-1 illustrates creation of a superimposure effect for a General Electric commercial on the Fred Waring program. A washing machine was shown on the screen, and then the working mechanism of the machine was superimposed to give an X-ray view. The reader will notice, however, in the resultant picture, that the effect is not quite perfect. The sizes of the two pictures seem to match, but the perspective in one does not match the perspective in the other. Note how the camera on the washer is shooting down from a high angle so that the top of the machine

is visible. The other camera, however, is shooting level, so that no horizontal planes in the mechanism are visible. Either the mechanism should have been placed on a low stand the same as the washer, or the camera which took this second shot should have been considerably higher than the other camera.

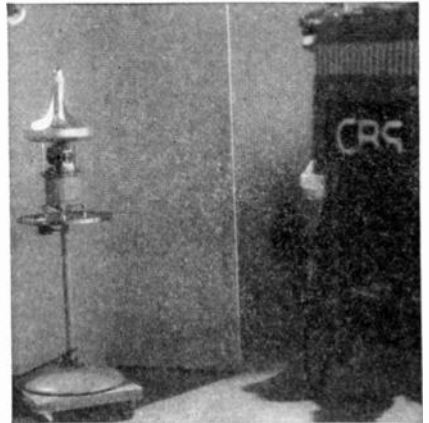
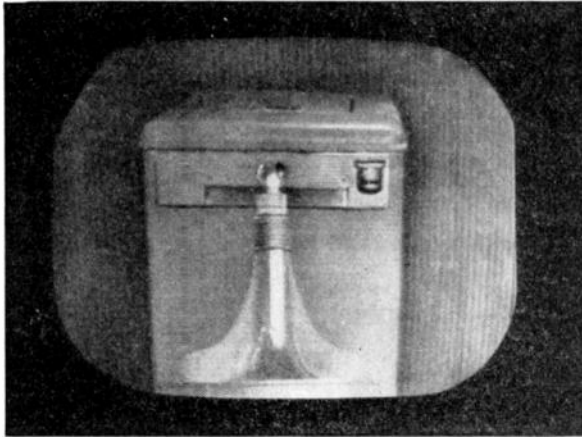


Fig. 15-1. The interior of a washing machine is shown in "X-ray" view by superimposure. (From "Fred Waring Show." Photos courtesy of Popular Science Magazine.)

THE GHOST EFFECT

The appearance of a ghost on the television screen is a relatively easy effect to accomplish, although what the ghost is called upon to do may complicate the problem greatly. Actually it is much easier to do ghosts on television than it is on film, because you can *see* the effect as you do it. This is very important, because inexact register of the two shots might place the ghost in the wrong spot—show him standing through a chair or

a few inches off the floor. When this is done in motion pictures, the easiest way is to use a large sheet of glass at a 45-degree angle between camera and scene and image the ghost on the scene by reflecting him on this glass. (This method is described in Chap. 11.) The advantage, of course, is that the cameraman can see the final result at the time of shooting. If he had taken two pictures, one of the scene and one of the ghost, and superimposed by double printing, he would not be sure that registration was correct until the film came back from the lab.

When two cameras are involved in a ghost effect—or almost any other type of superimposure, for that matter—the order is given to the cameramen to freeze before the cameras are superimposed; not even the slightest movement of any sort can be tolerated when the cameras are superimposed. The reason, of course, is that the two superimposed shots are supposed to look like one shot. If either camera moves, the ghost will be seen to shift within the set and the effect will be robbed of its illusion. This rule can be broken only if both cameras move in exact synchrony.

The usual practice on ghost shows is to equip one set with a black velour background and a black floor so that only the actor who is to portray the ghost reflects any light. Thus only the ghost is superimposed on the background scene; there are no background areas appearing at the same time.

If the ghost must move around through the set, careful marks must be made on the floor of his black set to represent the furniture of the main set so that he will seem to walk *around* a table instead of *through* it. If he is to go *behind* something, special arrangements must be made. It would not do to see the ghost through a solid table. The ghost will have to be matted out in the part which is supposed to disappear as he walks

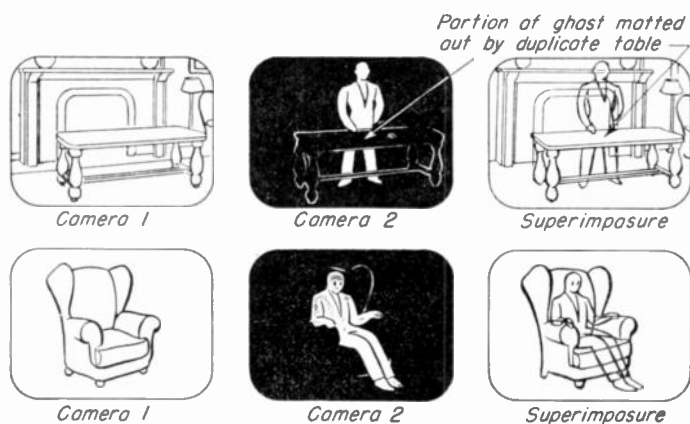


Fig. 15-2. Ghost effect complicated by necessity for ghost to move behind objects in the real scene. Solution is to have duplicate objects (black) in the ghost set.

behind the table. The best way to do this is simply to place a duplicate table, but black, in the ghost set. If this is carefully placed and the position of the camera is marked, it will register with the real table and matte out the ghost in just the proper way.

It was by this method that a ghost was made to sit down in a chair on one of the ABC shows. It was an overstuffed chair, and as the ghost sat in it, a part of him was hidden by the chair arm. The fact that this part of the ghost disappeared made the illusion of his being in the chair complete. The only way this could be done was to sit the ghost in a duplicate chair, which was accurately placed and covered with black velour. The arm of the black chair matted out the correct portion of the ghost (Fig. 15-2).

Whenever a ghost effect is used, the director is never really sure his ghost is going to be in the right place and disappear behind the right objects. Accurate register is possible only if the superimposure can be previewed just before it is used and last-minute adjustments made. Not all switching equipment can allow this to be done.

The positions of actors and furniture are, of course, marked on the floor, as is the position of the camera. The framing of the camera is very important, and this must also be marked. Wax pencil marks on the cameraman's view finder are generally used—just enough to help him register important points in the picture, but not so much that he can't use the view finder during the rest of the show. In the case of Fig. 15-2 it is the top of the table which is particularly critical.

This method of marking view finders is predicated on one assumption, however—the height and width adjustments on the camera must not be changed. If they are, the view-finder marks will be thrown out. In many studios it is the practice to wait until just before air time before lining up the cameras. If the view finders are to be marked, however, the cameras must receive their final line-up before the marks are made. Before an afternoon's rehearsal is usually too early for this to be done. Conditions within the camera may change so that further adjustments are necessary before the evening show. The best plan is to delay marking the view finders until just before air time, after the cameras have been lined up.

Another problem of the ghost effect has to do with the audio pickup. In most cases the ghost will be conversing with someone. But he will be in one set, picked up on one mike, while the other person is in another set under another mike. The problem is to make the quality of sound picked up by the two microphones match. The quality of the sound a microphone picks up is determined to a large extent by the conditions around the mike. Whether the walls of the set are hard and reflectant or soft and sound-absorbent like the black velour walls of the ghost set or

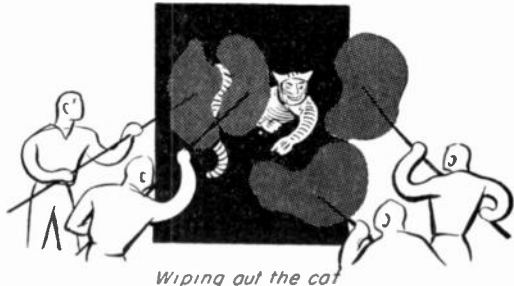
whether the mike is close or far from the source of sound are some of the factors that affect sound quality. The only way to be sure, of course, is to try it and see. If there is too great a difference in sound quality, the ghost illusion will be weakened. This same problem is met in doing two-camera montage or composite shots.

THE FANTASY SUPERIMPOSURE

In the ballet production of "Alice in Wonderland" on "Thru the Crystal Ball," Paul Belanger wanted the Cheshire cat to appear and disappear in a tree above Alice. Arthur Treacher, who played the cat, was placed behind a black flat, cut out so that only his head and arms could reach through. He was made up up like a cat, and the rest of the cat body and the



Superimasure of cat in tree



Wiping out the cat

Fig. 15-3. Fantasy superimposure: Cheshire cat disappears from tree.

limb it sat on were painted on the flat. When this scene was superimposed over the tree above Bambi Lynn, the tree limb with the cat on it matched a limb on Bambi's tree and the cat appeared fairly solid against a dark foliage background. The cat would disappear at will, then suddenly appear again to say something, and disappear again. Finally he was to fade away slowly from tail to head, leaving nothing but his smile. This was a wipe-out problem. Larry Goldwasser, the designer, solved it by providing several stagehands with black velour shutters of irregular shapes, with which they slowly obscured Mr. Treacher—all but the lower half of his face (Fig. 15-3).

THE SPLIT SCREEN

Optical methods of matting have already been discussed in Chap. 12. *Electronic* matting is also possible, provided that special equipment is installed. If the facilities are available, it is far simpler to make split screens, wipes, and composite shots by electronic means than by any of the optical processes.

Matting can be done electronically by blanking out the scanning beam over whatever areas are to appear black. If, for instance, the first half of



Fig. 15-4. Electronic split screen used on NBC's "Lights Out."

every scanning line is blanked out, the resultant picture that the camera makes will be only half a picture—the right-hand half. The left side of the screen will be black. If the reverse is done with a second camera and then the two are superimposed, a split-screen shot will result, in which the line of demarcation is extremely sharp (Fig. 15-4).

The electronic problem is to generate what is called a square-wave blanking pulse, a signal which causes the tube to start or stop blanking *immediately*, so that a sharp edge is possible. Actually, in normal operation the scanning beam is blanked out for a short time after each line to prevent scanning during the retrace time. If the reader will imagine these regular blanking signals extended in length so that part of each scanning line is also blanked out, he will see how the vertical split-screen effect might be accomplished.

THE ELECTRONIC WIPE

A horizontal wipe is accomplished by the same equipment that is used for the split-screen effect. A wipe-control handle similar to the fading handles on standard switching systems is installed, and the same two fading busses are used for wipe busses when desired. The two rows of buttons allow the switcher to select the picture which will appear on either side of the wipe.

A vertical wipe can also be accomplished with standard wipe equipment available on the market. A second wipe handle controls this effect. If both wipes are made at once, a "wedge wipe" will result. The new picture will start to appear along two sides of the frame (top or bottom and one side), and the old picture will dwindle in size toward the opposite corner. This wedge-wipe effect can be stopped at any point for an inset picture (Fig. 15-5) which can be any desired oblong shape depending on how the horizontal and vertical wipe controls are set.

The value of the wipe as a transitional effect has never been fully established. It easily calls attention to itself when it is used without proper motivation, and it can only rarely be used in place of the dissolve or other transitions where dramatic continuity is important. It sometimes has the effect of calling attention to the surface of the television screen and away from the scene which is beyond.



Fig. 15-5. Photo with insert to demonstrate effect of wedge wipe.

THE MONTAGE AMPLIFIER

The electronic composite shot is a very recent development in television. Patents on various methods of combining foreground figures in the studio with film or still-picture backgrounds were registered for 12 or 13 years before anyone had the time to build any of this equipment and make it work. A pioneer experimenter was Wayne R. Johnson, chief engineer at KFI-TV in Los Angeles, who early in 1950 demonstrated this effect to the Society of Motion Picture and Television Engineers. A background scene coming from a slide in the projection room was combined with an actor in the studio performing against a white backdrop. The actor appeared to be part of the background scene. It was found, as with most types of composite shots, that any camera motion spoiled the illusion. Panning would make the actor shift position in the scene in an unnatural way. Dollying the camera produced an acceptable effect if there was no lateral movement involved and if the background was composed of distant objects. The actor increased in size, while the background did not. Actor movement was confined to the boundaries of one static shot. It has been suggested that a second camera could be switched into the composite in place of the first studio camera or that the background could be

changed behind the performer. The result of cutting within a composite would be far from a realistic effect but might prove very valuable in musicals, comedy sketches, and other stylized productions.

The mechanism with which the electronic composite is produced is briefly as follows: An area must be blanked out of the background scene, which is the exact shape of the foreground actor, and changes from frame

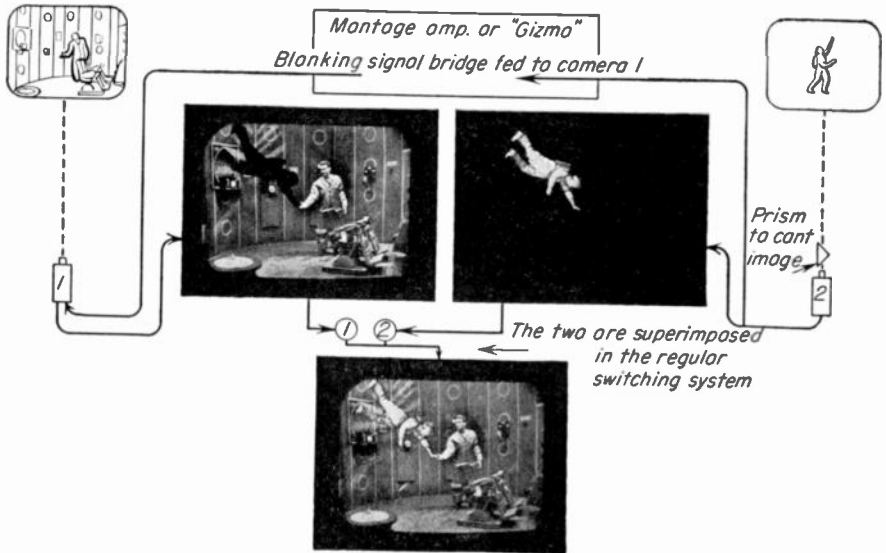


Fig. 15-6. Diagram of the "Gizmo," first montage amplifier in regular broadcast use. Designed by Rolf Drucker, David R. Fee, and George Gould for use on "Tom Corbett, Space Cadet." Photos taken off control-room monitors.

to frame as the actor moves. It is clear that only the outline of the actor himself can provide the right signal for blanking out this complex area. Figure 15-6 indicates how this blanking signal is obtained. A bridge is taken off the camera signal. (A bridge is a small amount of signal too small to affect the main current on the program line but capable of being amplified to amount to a very close duplication of the same signal.) This control signal is now reversed in polarity and saturated black so that a silhouette of the actor, pure black and white, results. This then is used as a blanking signal.

When this signal is added to the regular blanking pulses which the background camera receives, a blank (dark) area appears in that camera's picture which changes shape as the foreground actor moves about. From then on the effect is easily produced by simple superimposure of both cameras through the regular switching system.

A second method of doing the same thing involves the use of an electronic switch (a vacuum tube, not a mechanical switch in the ordinary

sense). The same silhouette picture “keys” or controls it. As the scanning beam (Fig. 15-7) moves across the white background of the control picture, the switch is set to feed signal from the background camera. When the scanning beam in the control camera encounters the black figure, however, the resulting change in current triggers the switch and it

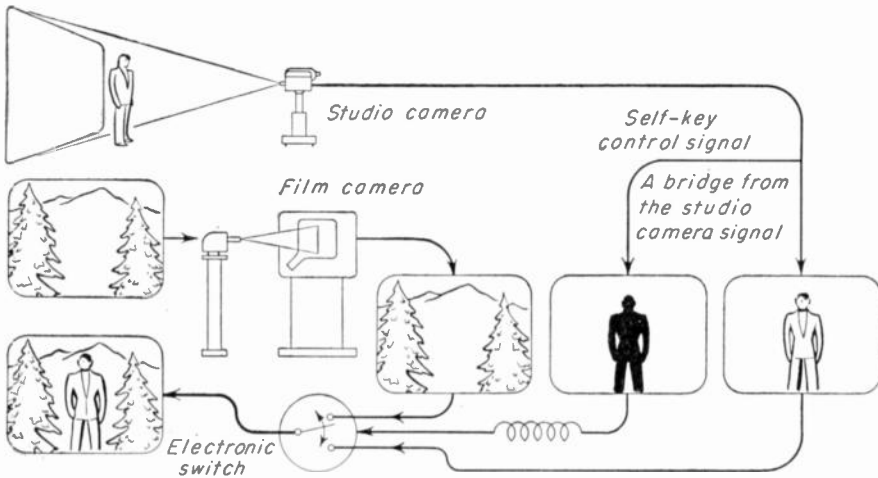


Fig. 15-7. Simplified diagram of a second type of montage amplifier.

immediately shifts to feed signal from the foreground camera. The electronic switch must work at least twice on every scanning line, more than 1,000 times in $\frac{1}{30}$ second.

The control, or “key,” signal which operates the electronic switch need not necessarily come from either camera involved. A third camera may originate the control signal, which then proceeds to switch signals from foreground to background picture according to the shape of some subject which is in neither picture. The key picture, for example, may be a silhouette in the slide projector (Fig. 15-8). The shape of this silhouette



Fig. 15-8. Keyhole area used as control signal to make composite of two other pictures.

will determine the shape of the area which is inset in the montage picture. Moving the slide back and forth in the projector will, of course, move the keyhole across the screen, but the picture which is seen through it will stay in the same position. (The keyhole will pan across the picture seen through it.)

This means that a black-and-white card, moved in front of a control camera or in a control projector, would produce a wipe. The shape

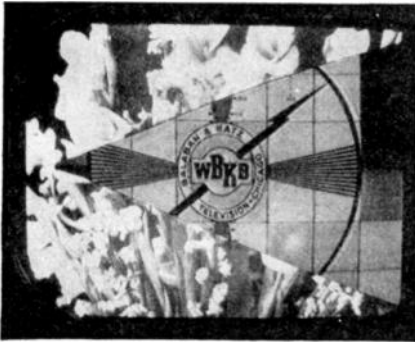


Fig. 15-9. Wedge wipe controlled by a piece of black cardboard of the proper shape moved across the control picture.

of these wipes would be limited, then, only to whatever methods could be contrived to slowly cover a white card with black paper (Fig. 15-9). A photographic iris, placed so that the circle that it makes would appear sharp on the control camera, could key an expanding or contracting circle wipe. A black-gloved hand, thrust in front of the control camera, would key a "hand wipe." brought to its completion when the hand approaches and blocks out the lens.

Many possibilities of abstract and stylized production present themselves to the imagination. Let us say that a picture of a dancer is used as the control signal. The foreground camera is focused on water, while the background camera is on clouds. The result is a dancer's form made of water, moving against the clouds. Or it might be newspaper dancing on city pavements and walls.

General Electric was the first manufacturer to offer a television montage amplifier. This was originally a separate item from the GE television wipe amplifier, but later the two were combined in one electronic-effects machine. It can do the following special effects: vertical, horizontal, and wedge wipes (combination of both vertical and horizontal), self-keyed insertions (such as a studio actor against a background coming from another source), or three-signal insertions such as the keyhole effect illustrated in Fig. 15-8.

A valuable operational aid in the use of either the wedge wipe or the three-signal insert is a thin, white locating line which can be made to appear on the view finders of both the cameras that are involved. In Fig. 15-10 the black-and-white slide on the film channel forms the key signal which determines the final montage, while locating lines of the same shape guide each cameraman for correct centering and composition.

The control panel (Fig. 15-11) associated with the GE television mon-

tage amplifier is similar to the two-bus fading systems described in Chap. 7. A row of eight push buttons at the top determines what special effect is to be produced. At the right of this row, there are three wipe buttons, one for horizontal, one for vertical, and one for wedge (which is both of these at once). The next button is marked "super," and when this is used, the control panel functions like any two-bus switching system,

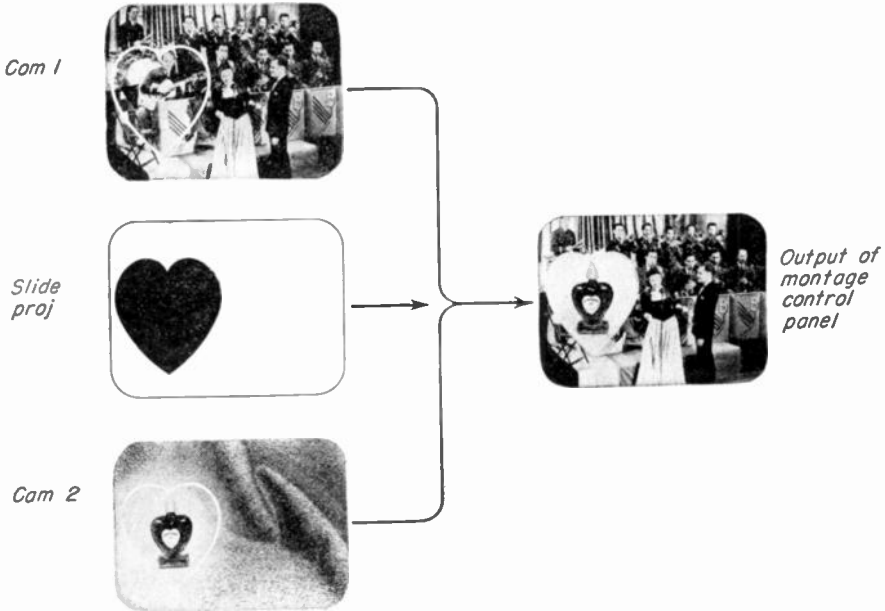


Fig. 15-10. General Electric montage amplifier provides a locating signal on each camera's view finder.

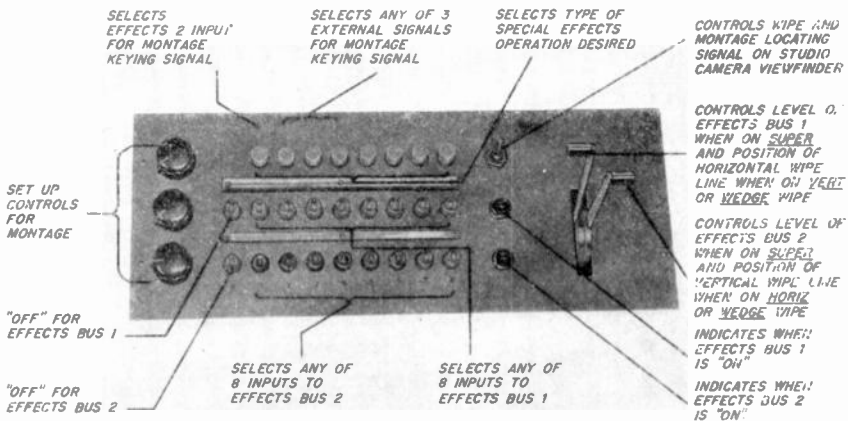


Fig. 15-11. General Electric montage-amplifier control panel.

making it possible to do dissolves and superimpositions. The four buttons on the left control four sources of key signals for three-signal insertions, self-key and three others. Although numbered 1, 2, and 3 these are not necessarily cameras 1, 2, and 3. Presumably the necessary channels would be patched into these numbered positions by means of a video patchboard separate from this panel. The small toggle switch at the top of the panel turns on the locating signal when desired. The two handles at the right, except when they are being used for superimpositions (when the super button is depressed), control the vertical and horizontal wipes, respectively. To wipe up, raise the left handle to the top: to wipe across from left to right, bring the right hand handle down to the bottom. If a series of wipes are to be made in the same direction, say right, the procedure would be as follows: Camera 1 is on the air; camera 2 is to wipe across left to right. Number 1 is punched up on the top row of buttons, and the left handle is up. Number 2 is then punched on the lower row. When the handle is brought down, No. 2 wipes in from the left. To wipe back again to cam-

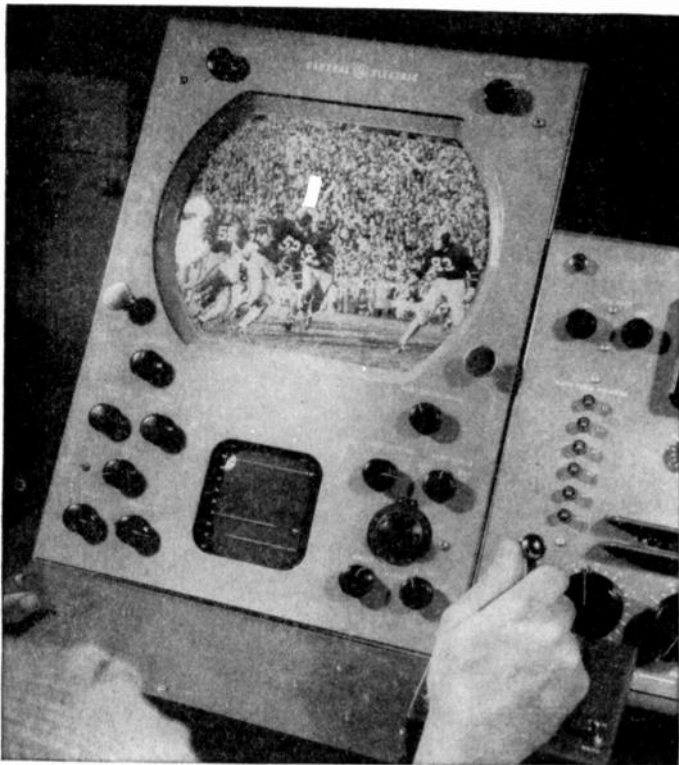


Fig. 15-12. General Electric electronic pointer.

era 3 from right to left would be simple: punch up No. 3 on the top row, and move the handle back up. However, let us say instead that we want to make *another* wipe in the same direction: left to right. Now we must punch up the same camera, camera 2, on both busses, so that we can move the wipe back again to the left-hand side without making any effect on the screen. Then we are left with No. 2 punched up in the top row and are free to punch up No. 3 or any other signal desired in the bottom row to wipe in from the left when we again pull the handle down.

THE ELECTRONIC POINTER

A device was offered by General Electric in 1951 which could place a small white or black marker within any desired picture. Since this marker (Fig. 15-12) could be moved about as desired by a simple control similar to the joy stick of an airplane, the commentator sitting before a monitor could point out any person or item as he was describing it. This could conceivably be of value in the use of small slides or movie film when locations must be pointed out on a map and a hand-operated pointer of any kind cannot be used.

REVERSAL OF POLARITY

Polarity can be reversed very simply in the television camera. The result is a negative picture: all blacks become white, and whites become black. Television film-pickup cameras come equipped with a handy switch for this purpose; a studio camera must have such a switch specially installed. Much newsreel film and last-minute news pictures on filmstrip are projected in negative (so that they can be used immediately without waiting for a print).

SCANNING REVERSAL

Ordinarily the electron gun within the camera scans the picture from left to right, making 525 horizontal passes across it in $\frac{1}{30}$ second. It starts in the upper left of the screen and ends in the lower right. All monitor and receiver tubes do the same. The receiver picture is built up on a fluorescent screen (the inside coating on the end of the tube) by a stream of electrons which moves in perfect synchrony with the scanning beam in the camera—from the upper left of the picture down to the lower right.

If the scanning beam (in the camera) is caused to start at the upper right and end at the lower left instead, the monitors and receivers will have no way of knowing this; they will go right on scanning in the regular way, putting the right-hand end of each line at the left side of the screen, and a backward picture will result. If the scanning beam is made to

start at the lower left of the camera tube and work up to the upper right, the receivers will show an upside-down picture.

It is often necessary to reverse left and right scanning permanently in a film-pickup camera when projectors are mirrored onto the iconoscope mosaic. The mirror reverses the image, and scanning reversal is necessary to correct it again.

Horizontal scanning reversal (left to right) will produce a mirror image on the scene. The subject will look the same as it would in a mirror held at the side of the set or when seen directly through a dove prism. Lettering will read backward.

Vertical scanning reversal (top to bottom) will result in an inverted picture such as a mirror mounted above the set might show or which could be obtained with the image-inverter prism (Fig. 15-13).

Double scanning reversal (left to right *plus* top to bottom) results in an inverted picture which is *not* a mirror image. It is as though the camera had actually been rotated into an inverted position. Stand on your head and look at a shot made by this means, and lettering will read correctly. This will not be true of any other type of inverted picture. If a card is held upside down in front of the camera, ordinary scanning reversal or prism image inversion would turn it right side up again, but it would read backward. Only double scanning reversal (or single scanning reversal of either type plus a prism or a mirror) would achieve a corrected image. When scanning is reversed in studio cameras, a special switch must be installed on the camera.

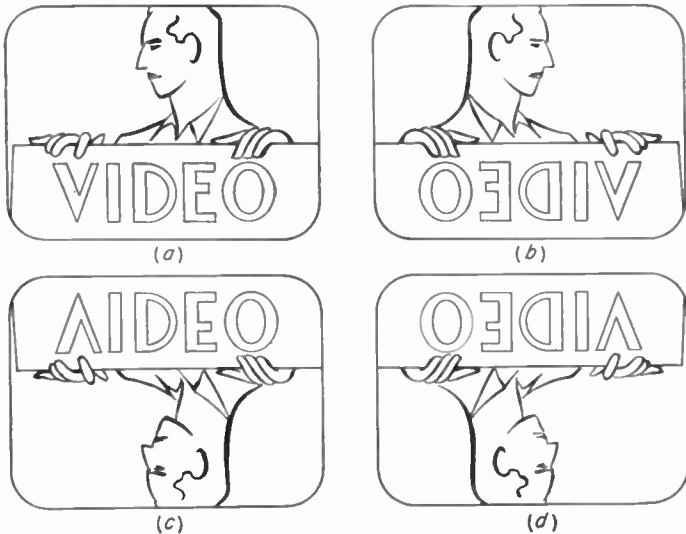


Fig. 15-13. Three types of scanning reversal. (a) Straight shot; (b) horizontal reversal; (c) vertical reversal; (d) double reversal.

STRETCHING

The controls which regulate height and width of a picture are located on the camera. They are usually regulated only when the camera is lined up and are handled by the cameraman under directions from the video engineer in the control room. They could be handled on the air only if the cameraman locked his camera and did nothing else.

However, purposeful distortion of the picture either vertically or horizontally can often play a dramatic role as a subjective or a fantastic effect. Paul Belanger used stretching as an abstract movement in some of his visual-music shows on CBS-TV in 1945. The image was stretched and compressed first in one direction and then in the other in time to the music.

Stretching both vertically and horizontally at the same times does not distort the picture but brings the central portion up to full screen size. It is a kind of electronic dolly shot, resembling the effect of the Zoomar lens. An image-orthicon tube cannot be left in this stretched condition for any length of time, however. What is actually happening is that the scanning beam is covering less of the target plate so that a smaller area of the picture is reproduced on the monitor full size. This is under-scanning. This smaller scanned area may burn in on the tube, to reappear within the scene whenever the tube is used in the regular way again.

Stretching is sometimes used to correct other distortions in the television picture. When a camera with a long lens is shooting down on a playing field, for example, the compression of depth caused by the long lens has a foreshortening effect and the players look squat and dwarflike. A certain amount of vertical stretching is often used to counteract this effect. CBS has adopted a policy of stretching every picture an extra 10 per cent of normal in the vertical direction. This, they feel, improves the look of the video performer and is more likely to result in a correctly proportioned picture on the average home receiver, which is so often stretched beyond normal in the horizontal direction.

IMAGE ACCELERATOR

The image accelerator is one of the electronic controls on the back of the camera generally handled by the cameraman only in removing S distortion when the camera is being lined up. Turning it back and forth has the effect of twisting, or rotating, the picture on the screen, so that vertical and horizontal lines become somewhat diagonal instead. The rotation does not go far enough to make it very useful as an electronic "canted-camera" shot. However, the effect of working the control back and forth will seem to make the room reel and is very good for a subjective

shot when a character is losing his senses in some way. On one dramatic show a girl was going out of her head, and two cameras were superimposed, a medium shot of the girl in bed and a close-up of her anguished face. The medium shot was slightly out of focus, and the cameraman twisted it back and forth with the image accelerator for a very successful effect.

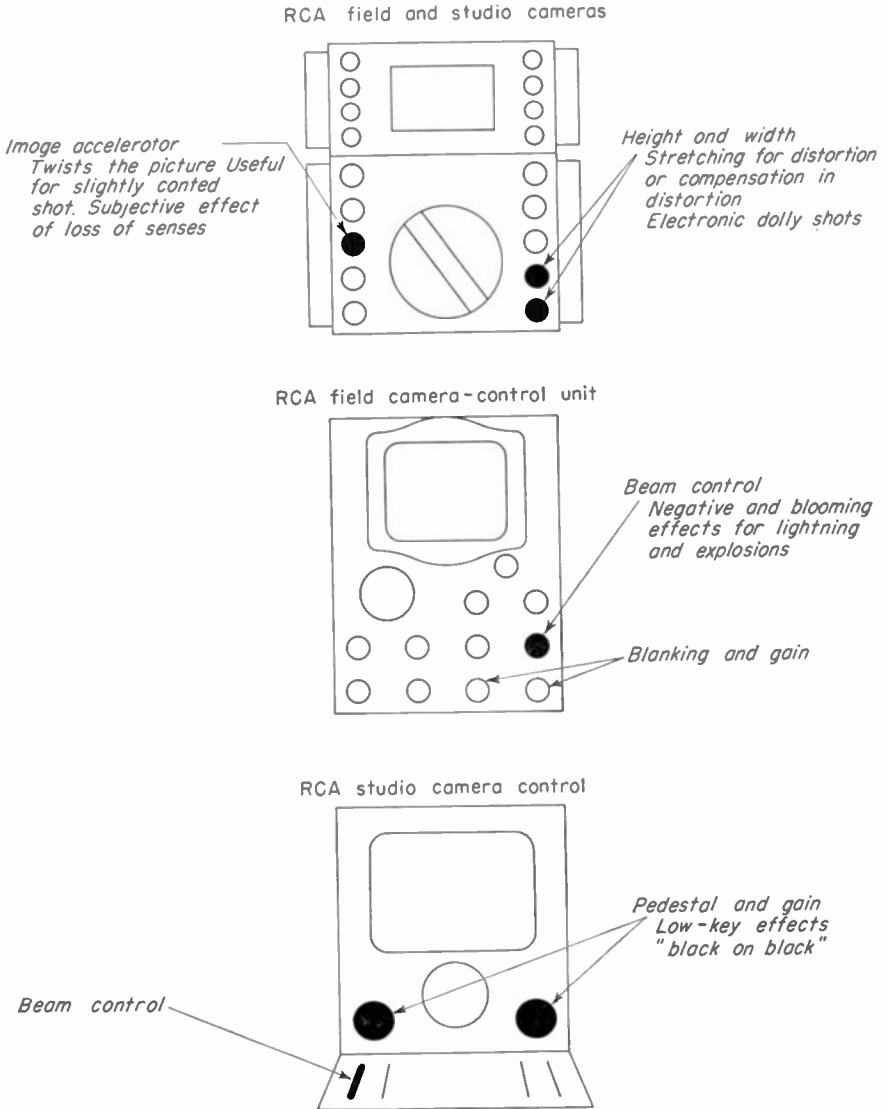


Fig. 15-14. Electronic controls on RCA field and studio cameras and camera-control units which are useful for special effects.

BEAM CONTROL

If the beam control on the camera-control unit is turned just a little higher than the proper setting, the picture blooms and turns negative. This effect has been used to simulate lightning or the flash of an explosion.

BLANKING AND PEDESTAL CONTROL

By operating the gain and blanking controls on the camera-control unit, the lights and darks in the scene are properly distributed over the tonal range of the television system so that as few tones as possible go pure black and as few as possible pure white. The video engineer watches the little green line of the oscilloscope as he does this, because

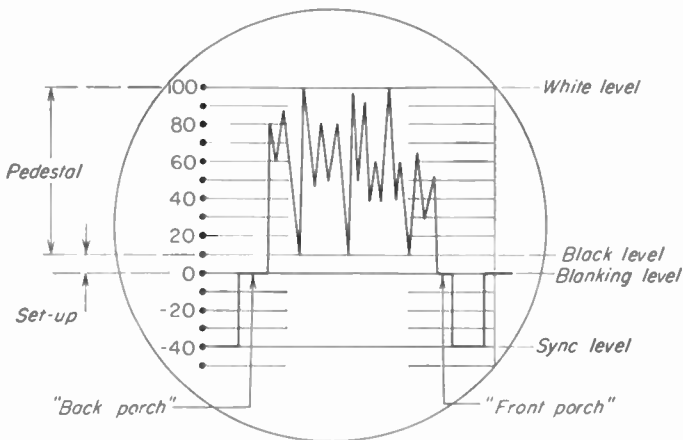


Fig. 15-15. Oscilloscope (also called wave-form monitor, oscillograph, and CRO).

although a monitor picture might be out of adjustment, the oscilloscope always gives a constant measure. When this screen is set for a certain type of measurement, it shows a graph of the ups and downs of every line in the picture, line 1 at the left, line 525 at the right. The level of pure white is generally marked in grease pencil at the top of the scope and the level of pure black at the bottom (Fig. 15-15).

The video engineer will endeavor to keep the ups and downs of the picture within these boundaries. Some of the high peaks should reach white, some of the low points should touch pure black, and the majority of the trace should fall between. This area of green "grass" has been known loosely as the "pedestal," since it seems to sit up like a pedestal above the front and back porches and the blacker-than-black sync pulses on either side. "Raising the pedestal" is done with the pedestal control (or blanking control on the RCA field gear) and causes the entire trace to move bodily upward. This, of course, brings more than just the highlights into the white region, and the picture blooms.

Lowering the pedestal brings a lot of intermediate tones down into the black. If the pedestal is lowered way down and the gain control raised so that the highest peaks shoot up to white level, while all else is black, a contrasty picture of pure whites and pure blacks is created. This is sometimes known as "jamming the pedestal" or "saturating black." Some very interesting effects can be created by this method, as for example a television version of the effect known theatrically as "black on black," where a dancer robed in black against a black set is invisible to the audience, who see only his partner defying gravity in seemingly impossible feats. Carlton Winckler did a half-hour ballet entirely in this technique at KTSL in Los Angeles, and the effect was striking.

In recent years the networks have devised a circuit which they call the "artificial black level." The addition of this simple circuit to the cameras makes it possible to obtain solid black areas without the necessity of jamming the pedestal to the point where other tones in the picture are affected.

THE USE OF AN AUDIO OSCILLATOR

It has been found that if an audio (regular sound) signal is fed into the horizontal scanning circuits of the camera a great variety of weaves and wobbles can be induced in the picture. By varying the frequency of the audio signal the picture can be made to ripple in larger or smaller waves. The wave effect can move up the screen or weave back and forth like a water reflection. By slowly varying the volume of the audio signal, the effect can be made to appear or disappear slowly, leaving a clear picture. This has been used for transitions in place of the defocus technique and has many applications in scenes of fantasy, dream sequences, and musical programs. NBC has named this device the "Flexitron."

THE MONITOR IN THE PICTURE

An interesting effect is achieved by placing a monitor in the set so that both the live performers and the images on the monitor are visible. By feeding a different picture to the monitor from the one which is on the air we can permit Captain Television to talk with his distant patrol cadets on the screen. Probably a more significant use is found in such shows as Ed Murrow's "See It Now," where films and remote pickups appear first on the monitor beside him before being seen full screen. He will often carry on an interview with someone in a distant city whose image appears beside him on the screen.

The monitor should be kept either fully above or fully below the center of the picture. If the camera tilts so that the monitor screen moves from top to bottom of the picture, a shadow edge moves rapidly down the

monitor screen. This appears where the scanning lines of the monitor fall into synchrony with the lines of the main picture itself. A separate distribution amplifier and a simple one-bus switching system are necessary to feed a floor monitor a picture other than what is on the program line.

A note of caution should be interjected here, and a plea on the behalf of the belabored engineers whose carefully adjusted equipment is called upon to do the various unusual things listed above. Remember that all camera controls must be accurately readjusted after they have been played with. Sometimes this is possible by accurately marking the dial before the effect is attempted, so that the original setting can be quickly found. These and probably many more electronic effects can be created with the cooperation of an imaginative engineer. Without this cooperation, however, all these effects are better left unattempted.

16 TELEVISION SCENERY

The primary purpose of scenery in theatre or film is the creation of illusion. Since illusion in the theatrical sense (*i.e.*, simulation of a place other than the studio or stage) is necessary to only a part of television programming, it is quite logical that we should find many new ways of using scenery in the television studio and many variations in its use between the complete illusion of the movie set and the complete reality of the "location."

A great many television shows of the panel-discussion, interview, variety, or comedy format take place obviously on the stage or in the television studio, and scenery is used not to create an illusion but merely to dress up what is plainly a functional area. Again, in a show like "Garroway at Large," scenery may be used to give a complete illusion during a musical number, after which the camera may show stagehands changing the scenery, or Garroway may pass by the back of the flats so that the backstage view, so totally shunned in theatre and film, contributes greatly to the actuality of the television transmission.

Where real backgrounds are available, they are, in the author's estimation, greatly to be preferred to studio sets. Many production problems are of course intensified outside the studio, but the compensating gain in actuality and immediacy well repays what trouble may be involved. Those who have experimented along this line find their budgets considerably eased when "sets" can be borrowed rather than built. The weekly production of "Your Lucky Strike Hit Parade" is an excellent example in point. This production uses the Centre Theatre, largest stage in the world, with center turntable, two elevating stages, and all the finest machinery of the theatre. Neither the rotating stage nor the elevating platforms are used once in three months. Instead the producers of this show have found countless fascinating locations in and about the theatre from which to stage at least one number each week. The tremendous back stage of the theatre has been well used, the alleyway outside, the

sidewalk and street, the auditorium, balcony, foyer, and long staircases leading to the mezzanine. Productions have been done from the roof garden atop the theatre and, in the winter, from the ice rink in Radio City a block away. One imaginative dance number originated from the boiler room in the building's subbasement.

Some months ago the Du Mont network sold a dramatic show and then found to its embarrassment that there was no studio available in which to present it. A fast-thinking executive remembered the mobile-unit equipment housed in a garage in Queens and the lumberyard next door. The show's writers went to work on lumberyard stories, and for the first 13 weeks each episode took place from location. Both client and audience were well satisfied with the result.

On the other end of the scale is the studio dramatic program which purposely uses no scenery at all. Albert McCleery at NBC began with an adaptation of "theatre-in-the-round" techniques to the television studio and through a series of productions called "Comeo Theatre" developed a style of television production in which all scenery is left to the imagination and the camera concentrates on well-composed groupings of people in which the waist shot, close-up, and extreme close-up predominate. The studio is prepared for a "Comeo Theatre" production only by hanging a dark purple cyclorama around the studio walls. The backgrounds for all shots appear to be dead black on camera. Some key props are used, such as a bed for a death scene or an occasional table and chair. Special effects such as snow or rain may also be used to set the scene (Fig. 16-1).

Considerable space has been devoted in previous chapters to the special-effects devices which can be used to superimpose or insert backgrounds in a studio scene. Proponents of these various "process" techniques commonly predict the elimination of scenery altogether. Whereas many new effects can be achieved by these devices, actually all that can really be eliminated by rear projection or Scenoscope or almost any of the other methods is the painted background drop. Shooting a scene against a rear projection screen or in the limited area prescribed by the locked and immobile montage camera carries with it the same limitations on action,



Fig. 16-1. "Comeo Theatre" production "The Lottery" in rehearsal. The only scenery used is a prop tree. (Photo courtesy of NBC.)

camera angle, and mobility that playing the scene in front of a drop would involve. The camera viewpoint must be pretty well fixed. Only one completely satisfactory shot is possible, and that from a frontal angle and at only one level. Very little freedom of movement is allowed the actors lest they go beyond the camera's range, and no great amount of dollying of the camera is possible without materially changing the looks of the background scene. In addition to this a peculiar kind of lighting must be employed.

THE REQUIREMENTS OF TELEVISION SCENERY

The first requirement of television scenery is that it must be light. Scenery must be set and struck again in the shortest possible time in the television studio, and light scenery, similar to that used in the theatre, is necessary. Moreover, the units (such as flats, doors, windows, etc.) must be so designed that they can be put together and taken apart quickly, and here again the theatre methods of rope lashing or loose pin hinges are the most practical for television.

Unlike movie scenery, the television set does not have to pass close inspection in high-definition pictures. For most television purposes stage techniques seem to work fairly well.

SCENERY PERSONNEL

The personnel involved in scenery design, construction, painting, and handling will of course vary greatly from station to station. In a small operation, one man may do the scene designing, construction, and painting, as well as all the station's art work and titles. Of course there are many small stations which do not have anyone on staff in this capacity, and the staff directors design and construct new scenery if any is required.

More often there is an art director who is also the production manager. He designs scenery and art work, as well as directing all the station's production operations. He will then have under him one or more scene painters and graphic artists who actually execute the work he lays out.

In the large-scale network operation there may be many specialists on staff each of whom concentrates on a small aspect of a show's production. Union jurisdictions define the areas in which these people may work, and a member of one local may not do the work which is covered by another union's contract. A network will employ a staff of scene designers, a number of union carpenters in a construction shop, a similar number of union scene painters, and finally a group of union stagehands, including at least one prop man, one stage carpenter, and one electrician in every studio. Present television contracts allow both prop man and electrician to move scenery when necessary, although in the theatre only the stage carpenters are allowed to touch the sets.

Beyond these union classifications the network will employ men with interior-designing background as set decorators; there will be an extensive prop department with personnel in charge of storing and preparing props, renting and buying props, and, of course, handling props during rehearsal and show time. A large number of people in this department will be called "prop shoppers" and will spend most of their time in leg work, visiting pawnshops and antique dealers, department stores and poultry markets in search of the great variety of material required for television production.

SEVERAL METHODS OF USING SCENERY IN TELEVISION

Some of the smaller television stations have avoided the problems of setting and striking scenery by erecting a permanent set and using it for all purposes. There are many kinds of television programs for which the set is only a background, and a little change in draperies, wall decorations, etc., will often allow one set to be used as a background for a news commentator, a children's show, a gardening demonstration, a charade quiz, and on and on through the studio's program schedule. Usually such a studio will have two or more of these permanent sets so that while one is in use on the air, another can be redressed for the following show. The permanent set is an advantage to the small station for several reasons: (1) It saves time in striking and setting, and the studio may be used for air shows during more hours of the day. (2) It saves having the additional storage space near the studio which is necessary when demountable sets are used. (3) It looks better in some respects since cracks may be covered and it may be built out of heavier material than canvas. (4) It lasts longer than a set which is taken apart and moved in and out of the studio frequently. The usual set can get dog-eared, smudged, and injured rather rapidly if it is frequently moved.

However, the disadvantages of the permanent set are obvious. No matter how the set dressing is changed, every show will have the same look. Permanent sets are not practical for dramatic shows, except the very simplest type, unless the show is written specifically for the set. This method has been used with considerable success where the sets are not necessarily permanent but where there is a limited number of stock units on hand and no budget with which to build more.

While only a few of the smallest stations build multipurpose permanent sets, most small studios simplify their setting and lighting problems by establishing permanent *set areas* within the studio. If a studio is, say, 24 by 40 feet, it will be found that each end forms a natural set area, and an occasional shallow set may be placed along the side, but the center area must be kept free for camera movement. When permanent set areas are used, any great changing of lights is unnecessary.

When several shows are to take place from one set area during a programming session, the production staff may often resort to a method used in theatres known as "in-setting." The last set to be used is set up around the back of the area and folded back where possible to take up as little space as necessary. Then a preceding set is placed directly in front of it. Sometimes a third set can be placed in front of this. Of course furniture and large set pieces cannot be preset in this manner, but the background flats, which take the most time to erect, can be set long ahead of time (Fig. 16-2). Often the first set at the very back of the studio is a permanent set, used regularly every day, and is never struck. The studio kitchen, part of nearly every television operation, is such a permanent set.

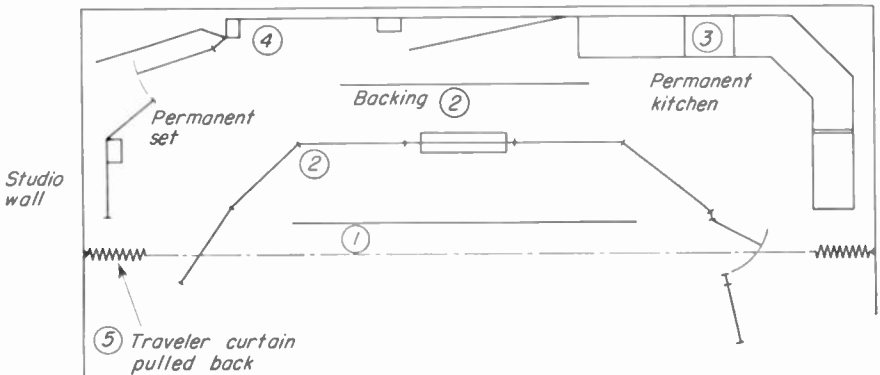


Fig. 16-2. Playing area at end of typical small television studio showing four sets in place to demonstrate the process of in-setting. (1) Roll drop let down for background of show 1. (2) Set for show 2. (3) Permanent set for show 3. (4) Permanent set for show 4. (5) Traveler curtain may be pulled across for still another background.

Plumbing, gas, and current are frequently connected so that the kitchen is fully workable, and other sets are placed in front of the kitchen cabinets when the cooking program is over. Another set which is commonly left permanently erected is the news set, usually only a background to the commentator's desk, with globes, maps, clocks, or sponsor's identification intended as visual interest, while the audience watches the commentator reading from his script. Unless a show is on five times a week, it is not generally considered good use of a small studio's space to leave sets permanently erected. A once-a-week show is almost always set and struck each time unless the studio is unusually large.

In the larger network studios where dramatic shows are produced it is important that the set designer be able to place his sets anywhere in the studio that he desires. This requires resetting of lights for each show, but personnel is allowed for this in the network operation. Usually a full day of a studio's time will be devoted to a half-hour dramatic show, and

shows of an hour's duration will more commonly rehearse two and sometimes three days in the studio. The designer's placement of sets usually results in a group of small two- or three-wall sets with the side walls opened out at an angle to allow cameras to shoot in from the sides. These are then placed around the studio walls so that the cameras may have an open working area in the center.

Very often the action of a drama will call for one set to open onto another, such as two rooms, room and hall, or living room and outdoor terrace. Often this requires the sets to be placed in the center of the studio so that the cameras may be operated from several sides. This type of placement allows greater freedom in camera angle, making reverse angles possible which could not be achieved in the usual box set. However, every camera shot is more difficult when the sets are so placed; one camera is likely to show in the background of another's shot, and thorough planning and rehearsal are necessary. Several methods of providing camera access through the back of apparently solid and unbroken sets for reverse angles will be discussed later in this chapter.

STANDARD UNITS OF THEATRE SCENERY

The simplest standing unit is the "flat." In the theatre these units are constructed of almost any height, but the usual television studio will not accommodate scenery higher than 9 or 10 feet. Whereas the most common width is 4 feet, flats are built of 3-, 2-, and 1-foot widths and occasionally 5 feet 9 inches. Any but the last can be handled by one man. Figure 16-3 illustrates the frame work of a common flat and the standard hardware which is attached. The method of lashing it to another flat is also shown. Two flats may be lashed together side by side or with an inside angle (a V shape with the front sides of the flats facing in). If the flats are bent away from each other in an outside angle, a wide crack will result. A 90-degree outside angle is possible, however, by butting the edge of one flat up against the side of the other. All hardware and joinery are generally kept about $\frac{7}{8}$ inch back from the edge of the flat to allow another flat to be butted up against it. The two flats are generally nailed together when placed in this way.

There are two common ways of supporting the flat (besides the support it may receive from being lashed to other flats on either side), the "jack" and the "stage brace." The jack is a triangular frame hinged to the back of the flat, then swung out and weighted at the bottom. The stage brace is an extensible stick made of two lengths of 1- by 1-inch wood with a hook at one end to fit into the brace cleat on the flat. The bottom end is usually fastened to a footplate about 18 inches square on which sandbags or other weights may be piled to secure it. Stage counterweights are use-

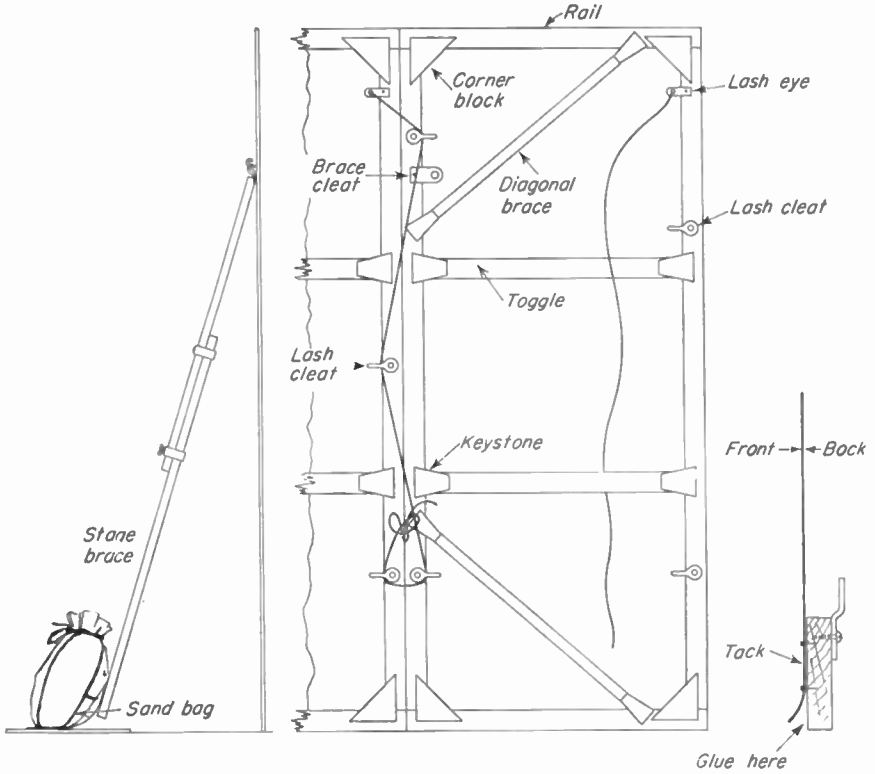


Fig. 16-3. The back of a plain flat, showing frame construction and standard hardware. Part of a second flat is shown at the left to indicate the method of lashing the two together.

ful for weighting jacks. They have U-shaped notches at either end, and if two angle irons are attached to the back of the jack, the counterweight may be laid between them and will be held there by the notches (Fig. 16-5).

“Loose-pin hinges” are commonly used for attaching jacks to flats, holding collapsible platforms together, and many similar purposes. Half of the hinge is attached to each unit, it separates as soon as the pin is withdrawn, and the two pieces can be easily reassembled simply by fitting the two halves of the hinge together again and inserting the pin.

When a door or window is used in theatrical scenery, it is made of two parts, the door or window itself, and a flat into which it is placed. The door or window is known as a “plug” since it fits into a hole in the flat. The door frame and trim are fastened solidly together, and the door is placed in the flat from the front side so that the trim, which extends around the door like a flange, is in contact with the face of the flat. Then the door is locked into place on the back side by means of a strap hinge.

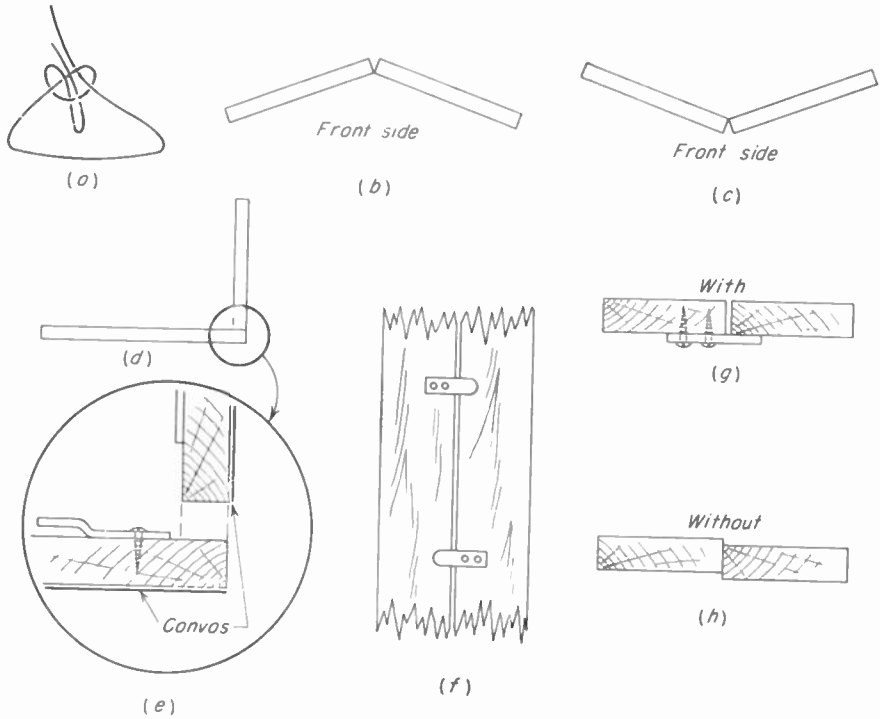


Fig. 16-4. Details of standard set construction. (a) Method of tying lash line into a slip knot so that it can be quickly pulled out; (b) flats lashed together on inside angle—no crack shows; (c) flats lashed together on outside angle—large crack results; (d) flats butted together at a 90-degree angle; (e) close-up of same, showing how hardware is kept $\frac{7}{8}$ inch back from the edge to allow for this type of joint; (f) stop cleats to keep flats in line; (g) cross section of same; (h) if cleats are not used, one flat may stick out farther than the other, increasing the size of the crack.

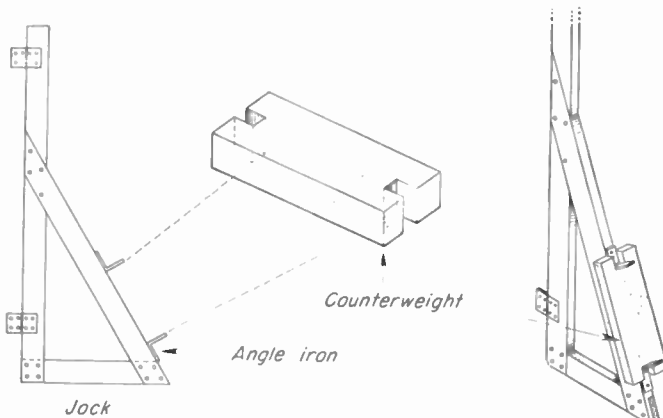


Fig. 16-5. Jack. This unit is hinged to the back of the flat and weighted at the bottom to keep flat from falling forward. This may be accomplished by means of a sandbag or a standard counterweight set into angle irons as indicated.

This simple method of quickly locking things together is one of the most ingenious things in scene construction. A strap hinge (Fig. 16-6) is fastened to the side of the door jamb with the upper half of the hinge free. This is folded up flat when the door is inserted and then bent down

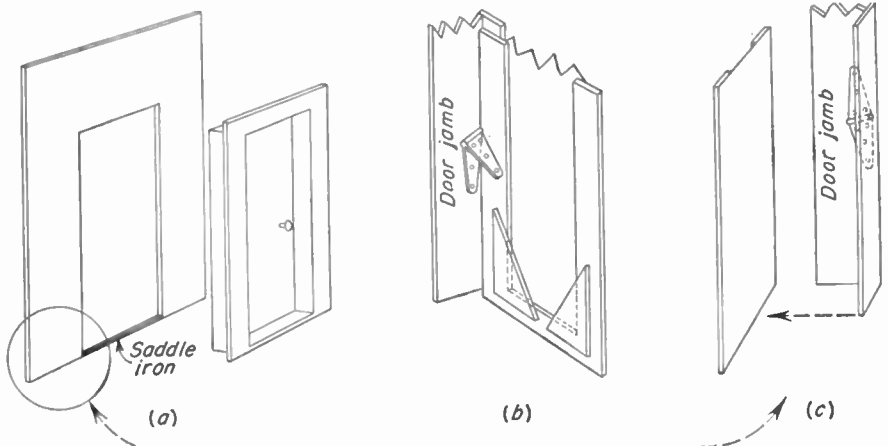


Fig. 16-6. Door flat and door plug, indicating method of securing the plug by means of a large strap hinge.

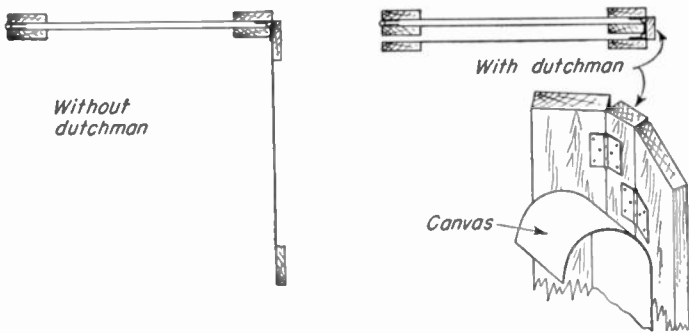


Fig. 16-7. Method of constructing a threefold flat so that it can be folded flat. A wooden dutchman is inserted between two of the flats.

behind the flat to hold the door in place. One hinge on each side of the door is sufficient. A window is held in place by the same method. It is known as a "practical" window if it can be opened, "impractical" if it is permanently fixed. Usually only the lower half of the window (just a frame without glass) is made movable. Fireplaces and bookcases are other examples of plugs which are inserted in special flats.

Besides single flats, there are several types of multiple flats. A "two-fold" is composed of two flats hinged together so that they fold inward. They are usually covered by a single piece of canvas, although two ordi-

nary flats may be hinged together and the crack covered. A "threefold" consists of three flats hinged together in the same way. When three flats are hinged together and then folded up for storage, they cannot be folded flat unless an additional member, the thickness of one flat, is inserted between two of them. Figure 16-7 will make this clear. This piece is called a "dutchman," a term which is used for several different kinds of things in scene construction and joinery.

When an outside corner is necessary, a "corner post," or a "return," can be used. This is usually constructed of two narrow flats permanently fixed together at a right angle and covered with one piece of canvas. The return may also be made to hinge like a twofold, but in the reverse direction.

The cracks between flats constitute a problem. Dean Wagner solves it by gluing a gauze dutchman across the crack before painting. A dutchman here is a long strip of cloth. Since the set is usually painted outside the studio, the dutchman must be carefully peeled off before the sets are erected, then glued on again when they are in place.

HANGING UNITS

The most common type of hanging unit is the canvas drop. This is usually built out of a large piece of heavy duck fastened both top and bottom to a long stick of 1- by 3-inch lumber called a "batten." Drops in the theatre are usually fastened to lines which will pull them straight up above the stage, an operation known as "flying" the scenery, and the area above the stage into which the scenery can be pulled is known as the "flies." In television, however, there is rarely enough space above the studio for this purpose, lighting grids and other installations are in the way, and a roll drop must be used instead. This is also theatrical prac-

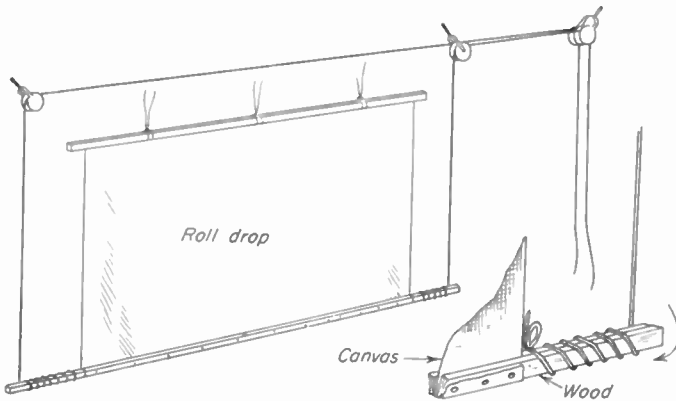


Fig. 16-8. Simple roll drop.

tice in small stages or summer theatres where there is no fly space. The upper batten of the drop is tied to the overhead grid, and the lower batten is allowed to extend 1 foot or 18 inches beyond the drop on either side. When the drop is lowered, a rope is wound several times around each end of the lower batten and led up through a small pulley and over to the side of the stage. As the rope is pulled up, it unwinds from the batten, thus turning the batten and rolling up the drop which is fastened to it (Fig. 16-8).

Another common hanging unit in television is the "cyclorama." The eye is a semicircular or U-shaped hanging which is as high as the studio light grid will permit, covering at least one end of the studio and often three studio walls. If the eye is made to curve around the corners, the corners of the studio will not be visible in any shot and the apparent studio size is considerably extended.

Cycloramas in television are most useful if they are of the "sky eye" type, that is, stretched tight instead of falling in drapery folds. The top of the eye is laced to a curved pipe batten which is fastened solidly to the overhead structure. The bottom of the eye is also laced to a free curved pipe which is weighted so that it almost touches the floor but keeps a constant tension on the eye. The eye is made of stout duck or linen canvas; if this has to be sewn together to make the necessary width, the seams should run horizontally. Both top and bottom are reinforced and grommeted along the edge. Lacing the eye is better than tying it since any localized pull which might otherwise result in a wrinkle is taken up and equalized by the entire lacing as it slips slightly through the grommets.

DRAPERIES

Drapes or curtains are a traditional background for performances on the stage, and drapes hanging in vertical folds are used in television studios for much the same purposes. Perhaps the simplest handling of drapes is to fasten them to flats so that they are arranged in neat and permanent folds and can be moved around the same as any other units of scenery. The description of screens in a later section of this chapter describes the use of drapes in this manner, attached to folding screens.

Naturally those television stations using theatres have inherited all the mechanics of the stage and use almost any type of curtain known to stagecraft. In the television studio, on the other hand, many of the stage curtains are unusable owing to the elaborate installation required and the lack of fly space. The theatre traveler curtain, however, can be easily installed and can be moved from one part of the studio to another without a major rebuilding job, and so it has met with wide acceptance. The traveler curtain is a draw curtain made of two halves which can part in

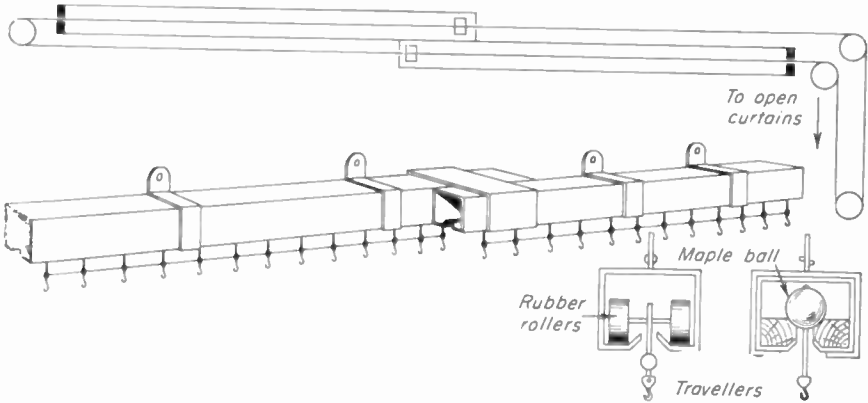


Fig. 16-9. Travelers for traveler curtains. Either rollers or balls may run in the track. One cord moves both curtains.

the middle. Each half of the curtain travels on a separate track, or traveler, and a single rope or draw line installed as shown in Fig. 16-9 will move them both at the same time in opposite directions. A number of fiber balls or rubber rollers ride in each track, and the curtain is attached to these.

BUILT UNITS

A common type of built unit is the platform. Platforms are made in many sizes. Some are mere steps; others are 3 by 6 feet in top area and only 8 or 12 inches high. In these sizes platforms are usually hollow boxes made of 3/4-inch fir plywood well strengthened beneath. Since storage space is always at a premium, larger platforms should be made collapsible. This is achieved by building them of two parts, a platform top, or floor piece, and a "parallel" which supports the floor.

The platform top is built so that when it is in place it fits just inside the

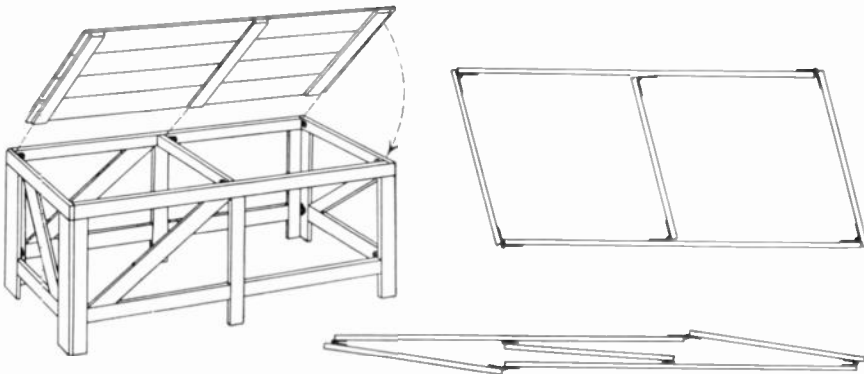


Fig. 16-10. Large platform, built of two parts for easy storage, platform top and parallel. Method of hinging parallel so that it will fold flat is indicated.

edge of the parallel and holds it rigidly. The parallel is a light frame, suitably braced, and hinged in a particular way so that it can be folded up with one motion (Fig. 16-10).

Platforms are noticeably hollow-sounding under foot, especially when made of heavy five-ply. This noise can be reduced if the inside of the platform, or at least the underside of the floor itself, is covered with a blanket of hair felt or other soundproofing material.

Other constructed units include steps and columns, as well as various natural forms such as trees, stumps, and rocks. None of these can be made collapsible, however, but must be built up on a wood frame with lath, or with chicken wire if the surface is to be irregular, over which canvas soaked in glue is laid. Detailed instructions for building such units, as well as for all the other types of scenery here described, will be found in books on stagecraft.

SET PIECES

Set pieces are generally flat and free-standing but constitute separate units and don't fit together with other pieces of scenery like most standing units. A familiar set piece is the ground row—a low, cutout piece made of beaverboard or other stiff material strengthened by a simple wood frame. Ground rows are built to represent walls, flower beds, hedges, etc., and sometimes, a row of distant hills. Some television shows, such as the Fred Waring program, use set pieces against a sky eye to the exclusion of flats and other scenery.

FLAMEPROOFING

The fire regulations in most cities require any materials that are to be used for scenery to be flameproofed. This can be done by spraying or painting the scenery either before or after it has been painted, with special flameproofing chemicals. These may be obtained from companies which deal in stage equipment, or they may be mixed at the studio. A flameproofing solution can be made from the following ingredients, which can be found in almost any drug store:

- 1 lb borax (sodium tetraborate).
- 1 lb sal ammoniac (ammonium chloride).
- 3 qt water.

NBC SOLID SCENERY

To avoid the drawbacks of frame and canvas scenery, NBC has standardized on a more substantial type built of fir plywood covered with unbleached muslin. The frame of a plywood flat can be built of lighter wood than the canvas flat must have, consisting only of 1- by 2-inch wood

turned edgeways. This means that each flat has a $2\frac{1}{4}$ -inch thickness which gives it considerably greater rigidity than standard flats, which are only $\frac{3}{4}$ inch in thickness. Instead of being lashed together, these flats are held by clamps or bolts, which makes them somewhat slower to put up. They are also heavier to move than canvas flats.

However, there are several advantages to this design. Plywood flats are flatter; they fit tightly together without noticeable cracks and do not vibrate visibly when doors are opened and closed. Because they are made of harder wood than pine, at least on the face panel, normal battering has less effect and accidents to the face of the flat are not so often fatal. By using casein paint NBC has averaged 100 coats of paint on these flats before they need new muslin.

WRGB CARDBOARD SCENERY

While quality is of primary concern to the network studio, speed and economy are the keynote in the small station. Even standard theatrical scenery has proved too expensive in some stations. WRGB in Schenectady, a station which pioneered in many production techniques, discovered early that large sheets of corrugated cardboard, such as cartons are made of, can find good use in the television studio. This cardboard can be obtained in 4- by 10-foot sheets and can be attached to any flat with a large staple gun. Thus it is possible to leave the flat set up in the studio, paint a new covering for it, and when the time comes to dress the set, take it into the studio and staple it on. When this use is over, the flat itself is undamaged, the cardboard can be pulled off and either stored or thrown away, and the flat is just as it was and can be used for its original purpose again without another repainting. Some stations have constructed their scenery originally from wood frames and cardboard, protecting the edges of the cardboard by binding them with wide (2- or 3-inch) strips of scotch masking tape. Naturally accuracy and realism are not a prime consideration when this material is used.

SCREENS

One of the best multipurpose units to have in the small studio is the folding screen. Screens need no jacks, they can be stood up anywhere and handled quickly, and they make excellent backgrounds for the display of products, simple interview or demonstration shows, and many other purposes.

A particularly useful type of screen was designed and built at WTMJ-TV in Milwaukee (Fig. 16-11). These screens are double-hinged so that they may fold in either direction and can fold up into compact, readily stored units which protect the covering fabric. Built 10 feet high, one of

the screens illustrated is 4 feet wide in the center panel with 2-foot flippers, while the other (right) has a 6-foot center panel and 3-foot flippers. Cellotex inserts on the back of the screens permit pinning pictures, sponsor's trade-marks, or other display materials directly to the face of the screen.

Another innovation in the use of screens was instituted at the same station by its imaginative production manager through the use of an expanding magnesium frame manufactured by the Magnesium Products



Fig. 16-11. Screens built and used in studio of WTMJ-TV, Milwaukee.

Company of Milwaukee. In the collapsed position these screens are only 6 feet high and can be moved through low doorways; when fully extended, they reach 16 feet. Figure 16-12 shows two frames in the foreground and two more draped with fabric behind. The jack portion of the frame is counterweighted to prevent the frames from falling over when loaded with draperies. Several studios of various sizes have acquired these frames and find them very useful.

FLOOR COVERINGS

In many television studios it has been found advisable to paint the floor. A large area of floor space is inevitable in many shots, and the pictures are

greatly improved when the decoration of the set can cover this area also. Few small studios have found this possible, since the same floor must serve many programs in a few hours' time, but in a network studio where a day or two is devoted to each production, the floor may well be painted anew each time.

Since most television studios are floored with linoleum, the simplest method of decorating the floor is to paint with water paints directly on

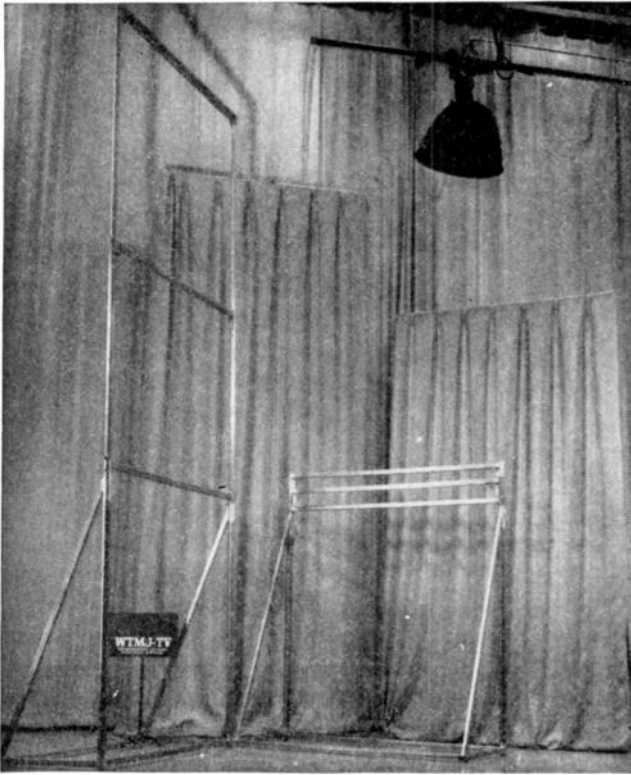


Fig. 16-12. Magnesium frame screens at WTMJ-TV, Milwaukee. Photo shows same type of screen draped and undraped and at different heights.

the linoleum surface. This can then be mopped off with water after the show. Where the studio has a wood floor, paint might be likely to soak into the wood and some kind of ground cloth must be laid down first, just as it is on the stage of a theatre. This is usually a heavy duck which is painted and repainted until the paint becomes so thick that it cracks off, at which point it is generally discarded. Some studios have found that the best procedure is to lay down 4-foot squares of hard-surface masonite. This can be painted and repainted even more often than the canvas before it has to be replaced.

BACKGROUNDS

Painted background scenes are an important part of complex television production, although, as indicated in the opening of this chapter, they are only one of many scenery elements and certainly cannot be considered sufficient in themselves. The term "backgrounds" is here used to include canvas drops, already discussed, photomurals, rear or front projection screens, painted traveler curtains, and the large, flat set pieces which may sometimes be used in a sizable television studio.

Photomural backgrounds are often used in television studios, and the effect that they create is better than either painted drops or projections. Painted drops are likely to look flat and unrealistic and are usable only where realism is not required. Rear or front projection is likely to be weak-looking and grayish, whereas photomurals under ordinary illumination pick up with good rich blacks and natural tones. Like any photographic material used in television, however, they should be soft in quality rather than contrasty. Hollywood companies which regularly service film studios can supply photomurals as wide as 25 feet and as high as 14 feet. These murals are enlargements made originally on photographic paper and then mounted on heavy duck. They can also be made by enlarging them directly onto canvas which has been sensitized with a photographic emulsion. The latter type stand up much better in use, there being no paper or paint to crack as a result of folding and rolling.

Small studios which use photographic murals have found that a few subjects such as the local sky line, a clouded sky, a wooded exterior with foliage, and perhaps some kind of public building are standard backgrounds that will find many uses.

If the photomural is mounted on flat beaverboard or canvas, it should remain erected permanently, since, as previously noted, rolling the canvas might tend to injure the photograph. When erected, the photomural is often laced to a rigid frame in the same manner as the rear-projection screen and this frame must be braced to a rather wide footing. Photomurals mounted in this way are not economical of studio space. One mural can be mounted on the back of another, it is true, but those which must be stored, if they are of any size, must be stored in the studio, and this takes up needed room.

When the mural has been made on sensitized canvas, however, it may be rolled without danger and handled in much the same manner as an ordinary painted drop, fastened to battens above and below. It has been found cheaper in most cases to have a photomural made than to have a good drop painted, and the results are always more realistic.

The rear-projection screen cannot be rolled but must be stretched permanently on a solid frame (Fig. 16-13). It is subject to considerable

danger as sets are moved around in front of it, and its life is definitely limited. The problems involved in the use of rear projection are discussed in detail in Chap. 12. They have by no means been satisfactorily solved for television.

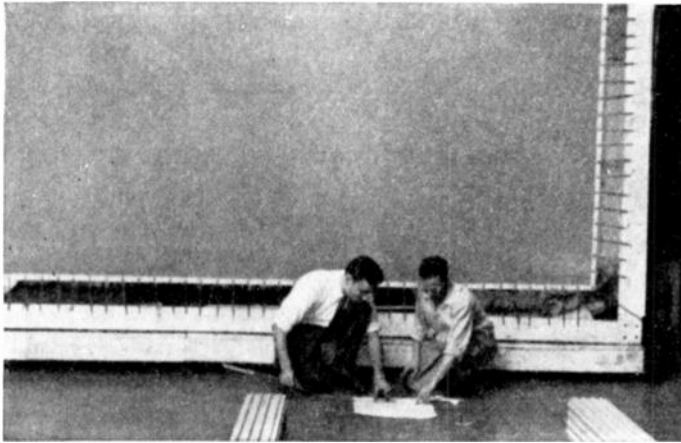


Fig. 16-13. Rear-projection screen laced with heavy rubber bands to rigid frame. (Photo courtesy of CBS.)

PROBLEMS WITH EXTERIOR SETS

Scenes laid out of doors pose quite a problem to the set designer, since the simulation of nature with canvas and paint is at best a poor approximation of reality. It is a rare scene painter who can make foliage, and especially rocks, look convincing. The photomural is of course one answer, but flat backgrounds do not entirely suffice, and three-dimensional rocks and trees will always be necessary.

Where large quantities of foliage are necessary, only real foliage can be used, since artificial leaves are expensive and cannot be obtained in large bushes or trees. In using real foliage it is not possible simply to go out and cut a few limbs off a handy tree, since the leaves of most trees quickly wilt as soon as they are cut. Laurel, rhododendron, smilax, water oak, and broadleaved evergreens must be used since they merely dry up without wilting. When no great amount of foliage is necessary, sometimes real branches can be used to which sprigs of artificial greenery have been wired.

Rocks present an unsolved problem in television. There is seldom enough time or budget available to build rocks out of heavy screening and plaster so that they have the proper texture. Such construction would probably have to be done on the set, and the television studio is never available long enough for such an operation. Small rocks are built up in

the construction shop, as explained earlier, of wire and canvas, and are light enough to be carried into the studio. However, large rocks must be thrown together in the short studio setup time allowed and seldom look anything near convincing. The folds of canvas are painfully evident, except when a great deal of foliage is used to cover them up. Success has been attained only with stylized rocks and trees which are not intended to look realistic. These are accepted by the viewer as stage sets, no attempt is made to induce him to think of the program as a remote pickup or as a film, and his "willing suspension of disbelief" provides him with a perfectly satisfactory illusion.

METHODS OF QUICK SCENE CHANGING

Beyond the usual method of quick lashing of flats and rolling or flying drops, several television stations have adapted further quick-change methods from the theatre which have proved useful in the television studio. Small revolving stages have been tried, where one set is placed on one side of the turntable and a second set on the other. Both these have been permanent sets, however, and the turntable has been placed permanently in a certain spot in the studio. A turntable which can be easily repositioned has never been devised in a size large enough to hold a set.

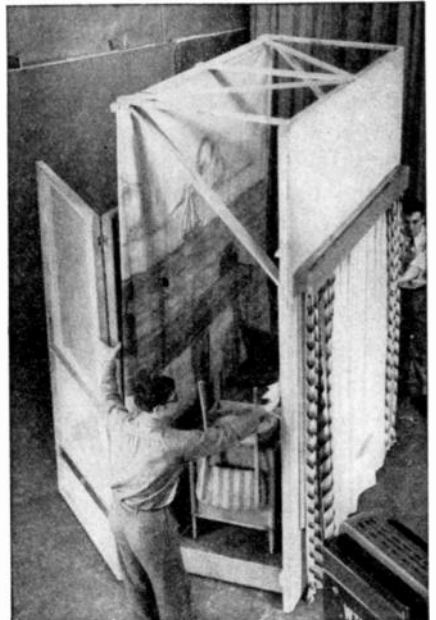
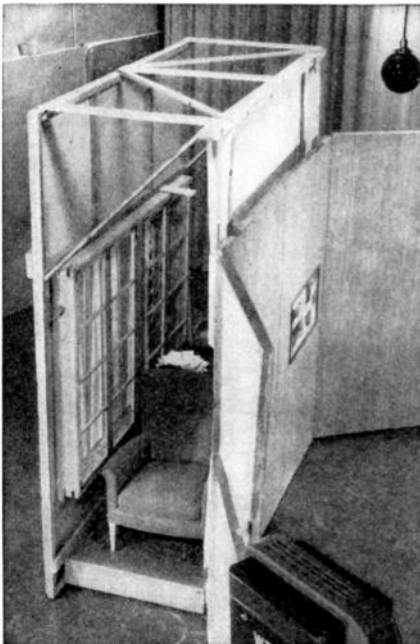


Fig. 16-14. Left, WTMJ-TV stage wagon carrying two sets. Right, stage wagon after being turned around, with another set open and ready to be used.

Small turntables have been built, however, out of ordinary platform materials and strong dolly wheels mounted in a circle to run on the floor.

Another method of quick scene change involves the use of castered platforms known as "stage wagons." This equipment was first adapted to television use by Charles Zoeckler at WTMJ-TV in Milwaukee when he built several of the stage wagons illustrated in Fig. 16-14. These were 8 feet long, 10 feet high, and 3 feet wide. They were mounted on four heavy-duty, rubber roller-bearing casters. On one side of the wagon illustrated is a set for an interview show composed of an 8-foot central panel and two 4-foot side flippers which can open out to a total width of 16 feet if necessary. The opposite side is part of a studio stock set with a removable window that can be replaced by a bookcase of the same size or some other inset piece. The interior of the wagon is used as a handy storage space for the props and furniture that go with the sets.

TRICK SCENERY

There are many times when the scenery of a television show can play an important part in the special effects which are created. One example is the trick of moving the scenery to create the illusion that the actor is moving. This has been done in the theatre by having the actors walk on a treadmill (as in "Green Pastures") while the scenery passed by behind them. Treadmills are not necessary in television, however, since the camera shot need not necessarily show the person's feet. One number in the "Garroway at Large" show involved a couple riding a bicycle, and they had to sing an entire song while pedaling along. The bicycle was of course raised slightly off its wheels and supported out of camera range so that the performers were free to pedal, and to give the illusion of movement, various set pieces—trees, bushes, etc.—were pulled through the background of the shot. To give an even greater illusion of reality, one set piece representing a distant hill was moved through slowly while nearby bushes, telephone poles, and so forth, moved by much more rapidly. Another time on the same program a couple were in a carriage which was being rocked and jiggled to indicate movement, while cutout tree trunks and branches were moved through between the camera and the performers.

A thin net or gauze material called "scrim" is used frequently in the theatre for special effect and has been utilized in television in much the same manner. Scrim is practically transparent when the lights are kept off from it, giving only a slight mistiness to the scene when the audience must look through it. A certain amount of light on the scrim, especially if it is projected from directly above so that it hits the scrim at the smallest possible angle, will make it give the effect of either a thick fog or an opaque curtain. Designs may be painted on the scrim to be illuminated

On one occasion a designer was asked to design a nightmare set which would look completely unreal and carry with it the feeling of the dream which it was supposed to be part of. The designer came up with a set which had no walls. Not unknown in the theatre, this was something new for television. Window frames and doors were suspended by wires from the lighting grid, and pictures and other wall decorations were similarly hung from above. A few feet behind the invisible wall was placed a plain eye to make a simple background. To everyone's surprise the set seemed to have walls as solid as if they had been made out of plywood



Fig. 16-16. Camera access through removable panel over fireplace. (Photo courtesy of CBS.)

flats. The background eye provided a neutral tone which naturally seemed to be the wall.

Moreover, this set was peculiarly fitted for the use of cameras from all angles. There was a 5-foot space between "wall" and eye in which a camera could move, and it could shoot from any place behind the set. The only limitation involved here, of course, was that a very carefully worked out camera traffic plan was necessary lest cameras appear in the living-room walls and the set take on a nightmare quality indeed.

SETS AND THE MICROPHONE

Very often a set is so large and the shot which the camera takes of it is so wide and so high that the usual boom microphone can hardly get within earshot of the performer without showing in the picture. In such case it is almost mandatory that the designer plan some spot in which to hide the

microphone. Sometimes mikes can be placed in the bottom of hanging chandeliers. Sometimes a garden scene can feature a prop bush or vine sufficiently close to the performer so that the audio pickup is satisfactorily made. Overhead microphones can be placed under the eaves of a porch or hidden behind the pickets of a rose-covered fence.

A perennial problem is the shadow of the microphone, which moves across the scene whenever the mike-boom operator inadvertently moves his microphone across a shaft of light. Sometimes this shadow seems to be inevitable. It is then that the set designer can go to work for the audio department and devise a foliage cutout or a chandelier shape to attach to the mike so that the necessary shadow will seem to be part of the set.

THE PROCEDURE OF TELEVISION SCENE DESIGN

The design of a television set begins with the show's director in most cases, who visualizes his action and comes to the set designer with a sketch of the kind of set he would like to have. Before the designer can go much further, however, he must know many other things. He must know the general mood of the show, and of course its locale and period. Most of this information he can obtain by reading the script. However, the director must have worked out a rough plan of the show's action, the movement of actors both on the air and off the air between sets. The designer will find out whether or not there are any fast moves where an actor must finish one scene and begin the next in another set. Between-scene traffic like this will determine which sets must be adjacent in the studio. Except for this the designer tries to run the sets around the studio in a logical order so that cameras do not have too far to go at any time in the transition between scenes. If there are key shots which the director must have, the designer should know about these also and find out just what kind of reverse-angle shooting the director has in mind so that the necessary camera access and backing can be allowed.

Then the designer must know the studio in which his set is to be erected. He must know the limitations of studio height and the studio areas which cannot be well lighted and which should be used for sets as little as possible. He should know what *else* besides his sets will have to be placed in the studio. Many shows use a live orchestra, and room for this must not be overlooked. A show involving make-up or costume changes during the performance will require two portable dressing rooms on stage, thus further reducing the area of the studio that is available for sets. Last and not least the set designer should remember the sponsor of the show and the agency men who are producing a commercial segment to extol the sponsor's product. The commercial should be found out about

as early as possible so that sufficient space can be allowed; otherwise the agency producers will take space arbitrarily and at the expense of the show.

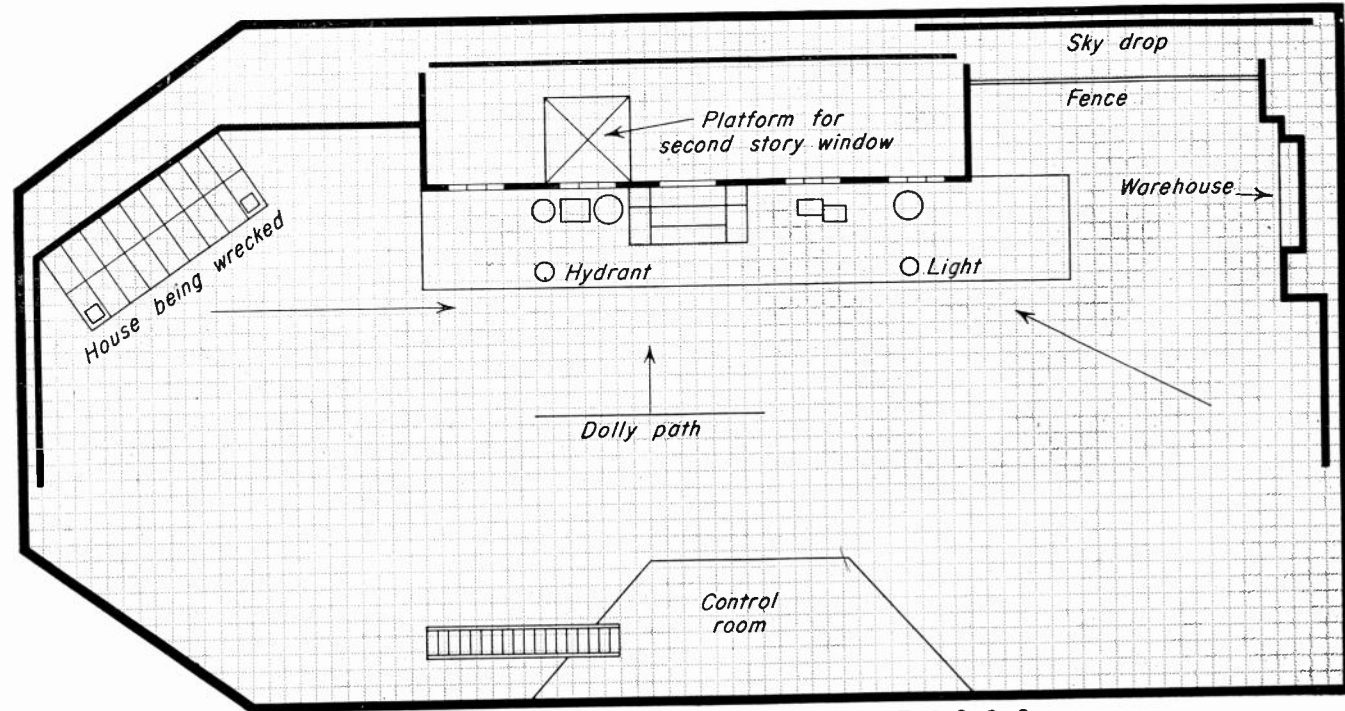
The designer must also consider the throw necessary for rear projection, if this is planned. This will be about twice the width of the screen; the NBC studios usually allow 20 feet of throw for the average large screen projection.

After all these requirements and limitations have been considered, the designer must remember the route into the studio and not design anything which is too large to fit into the elevator it must ride in or too long to go around the corners of the corridor leading into the studio. Like the man who builds a boat in his basement and has to tear the house apart to get it out, a scene designer has sometimes had to watch his masterpiece of scene design being cut into pieces to fit into an elevator or eliminated from the show because he couldn't get it into the studio at all.

The next step is the preparation of a floor plan and set elevations. The designer will know just what scenery units are in stock and can be repainted and used again, and he will indicate this on the set elevations. Only the construction department will need elevations, but many departments will be interested in the floor plan, including the director himself, and it will be duplicated with many copies.

Floor plans are usually made to a scale of $\frac{1}{4}$ inch to the foot, and the designer works on printed blank copies of the floor plan of the particular studio he is designing for. Every television studio has its own floor plan printed up in quantity for the use of every designer, producer, or director who uses the studio, and it is on this basic floor plan that the designer works. All designers use the same architectural symbols for doors, windows, etc., but they are always careful to write out in detail each dimension and description as well. To illustrate how a studio floor plan looks, a typical floor plan for a television dramatic show is reproduced (Fig. 16-17*a*), along with a photograph of the final set after it was erected. (Fig. 16-17*b*).

In certain instances when a set is rather unusual or camera and staging problems are anticipated, the entire set will be built first in miniature. This gives the director an opportunity to plan his shots with much greater accuracy and allows him to anticipate many problems of camera and mike-boom traffic before actually starting studio rehearsal. A studio model is especially helpful to new directors no matter what type of show is attempted, and many studios have kept studio models handy, equipped with cameras and mike boom and the standard stock scenery built to scale (Fig. 16-18). If the model studio is built to the scale of an inch to the foot, standard ten-cent-store doll furniture can be used since these are



PHILCO — "STREET SCENE"
FRED. COE — DIRECTOR

NBC STUDIO 8-G

Fig. 16-17a. Typical floor plan. (Courtesy of NBC and Otis Riggs.)

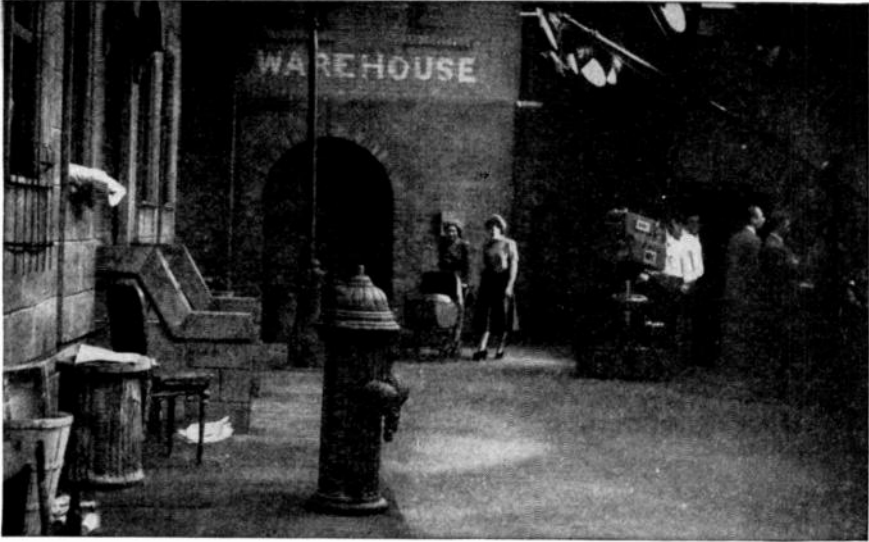


Fig. 16-17b. The finished set as it looked in the studio. Set for "Philco Television Theatre" production of "Street Scene," designed by Otis Riggs. (Photo courtesy of NBC and Otis Riggs.)



Fig. 16-18. Richard Rytkarick (right), CBS designer, conferring with the director over the set of the "Studio One" production of "Julius Caesar." (Photo courtesy of CBS.)

commonly made in that scale. The staff of the "Garroway at Large" show, after the first two years of production, facing ever more complex production problems, finally built a studio model to this scale and found it was a tremendous help in preplanning of the show's production.

SCENE CONSTRUCTION

Although some stations have found it necessary to construct sets in the studio itself, this is considered very poor practice and an uneconomical use of highly expensive space. A space at least as large as the studio should be allowed for a construction shop, and it should be close to the studio, if at all possible, to eliminate the time and labor involved in transportation.

A height of 15 feet is usually considered necessary for the construction shop. There should be enough space to make possible a trial setup of an entire set without disturbing other work in progress. Flats are constructed most easily on a bench called a template, just the size of the flat, with a rim around it to hold the lumber in place as the flat is going together. One or two templates of standard sizes will be necessary, and these should be casters so that they can be moved about. Room must also be provided for the operation of several power tools. A large bench saw is mandatory, and if 12-foot lengths are going to be ripped on it at



Fig. 16-19. Scene-construction shop, showing jig tables for flat construction. (Photo courtesy of CBS.)

any time, it must be so placed that there is 12 feet of free space both in front of it and behind. A band saw is also necessary, and many shops have a jig saw as well for scrollwork. Racks must be provided along the side of the shop for the storage of lumber and its ready accessibility. Plywood panels, especially of the $\frac{1}{4}$ -inch thickness, should be stored flat to prevent warping, not on edge.

A very useful tool for cutting out odd-shaped patterns from beaver-board or almost any other material is the "cutawl." This tool has a short, strong knife blade about $\frac{1}{8}$ inch in width which is vibrated up and down by the motor. The depth to which it cuts can be regulated, and the entire machine is moved around over the work as the knife is guided along the lines of the pattern. The cutawl is superior to a jig saw in several respects. (1) It is portable (weight, 16 pounds) and can be used anywhere. (2) It is moved while the work lies flat and so can be used on work of any size. (3) It can start cutting anywhere; it is not necessary to bore a hole from which to begin.

Another highly useful tool, which should be as much the property of the scene dresser as anyone else, is the staple gun. Of all tools around the television studio, with the possible exception of the claw hammer, the staple gun is used the most. There should be at least two in every studio. A heavy-duty size should be used when thick material, such as corrugated cardboard, is to be stapled. The staple gun is operated simply by holding it firmly against the material to be stapled and squeezing the handle. A self-contained spring shoots a staple directly into the material. When posters or pictures must be stapled to canvas flats, the canvas will not hold the staple and it must be clinched on the back side. This can be arranged if someone stands behind the flat with a flat piece of iron (clinch iron) for the staple gun to shoot into.

For the reader who would like a check list of tools and materials for simple set construction, the following is a short summary of useful items:

CHECK LIST OF SHOP REQUIREMENTS

Power tools:

- Multiplex radial saw (overhead arbor)
- Saber saw—a portable motorized tool
- Cutawl

Also useful:

- Portable electric drill
- Motor and grinding wheels for sharpening tools
- Portable electric saw
- Drill press

Hand tools:

- Crosscut saws (fine-tooth and standard)

Ripsaw
 Claw hammers, curved and straight claw
 Jack plane
 Block plane
 Keyhole and backsaws
 Brace and set of wood bits
 Yankee screw driver
 Set of chisels
 Set of files and wood rasps
 2-foot steel square
 Try square
 5-foot ruler
 Expanding rules

Also useful:

Spoke shave
 Compass
 Soldering iron

Stock materials:

For NBC-type sets

No. 1 clear pine 1 by 2 in., 1 by 3 in., 1 by 4 in., 1 by 6 in., 1 by 9 in.,
 and 1 by 12 in.

$\frac{1}{4}$ -in. fir plywood—sheets 4 by 8 ft and 4 by 10 ft

$\frac{1}{2}$ -inch plywood the same

$\frac{3}{4}$ -inch plywood the same (plywood can be good one side only for
 set construction)

Bolts of unbleached muslin 72 in. wide

For frame and canvas construction:

Pine strips and boards as above

$\frac{1}{2}$ - and $\frac{3}{4}$ -in. plywood as above

Light canvas duck

For corrugated-cardboard construction:

Pine as above

Plywood as above ($\frac{1}{2}$ and $\frac{3}{4}$ in.)

Sheets of corrugated cardboard 4 by 10 ft

Bolted whiting, flake and ground glue, wallpaper paste, shellac, and
 alcohol

SCENE PAINTING

The carpenter shop is a noisy and particularly dusty place when construction is under way, with sawdust flying around through the air and settling everywhere, and it is no place to paint scenery. Nonetheless some stations have attempted it, having the choice of doubling up on the use of this space or painting in the studio itself. Quite properly, how-

ever, a special paint shop should be provided, and here again almost nothing is quite so valuable as adequate space. When flats are painted, it is convenient if they can be laid down flat. When an entire set is painted at once and left for a while to dry, a large floor area is in use. Running water should be provided in the paint shop, as well as suitable cabinets and racks for the storage of paints and brushes. Good scene-painting brushes are fabulously expensive and should be kept under lock and key.

Painting a drop is a difficult task. Even though there is space to lay it out flat on the floor, it is often so large that the scene painter must walk around over it to reach all portions, painting with his brush on the end of a stick. If scenery is to be painted in great quantity, a special *paint frame* is necessary. The paint frame is a wooden framework large enough to hold a drop or several flats at a time, counterweighted and hung vertically against a wall so that it can be lowered gradually through a slot in the floor. By lowering or raising the frame the scene painter can easily reach any part of the scenery he is painting, and large areas of floor space are not tied up. In the large ABC studio in New York, James MacNaughton uses background drops 34 feet high and 100 feet wide. Since there is no suitable space outside the studio for painting drops of this size, they must be painted in place. Instead of lowering the drop on a paint frame, the painters are raised on a motor-driven scaffold. Thus able to reach any part of the work, they paint quietly away during studio rehearsals and turn out at least one such tremendous drop each week. An example of one of these large drops is shown in Fig. 16-20, a set from a production in

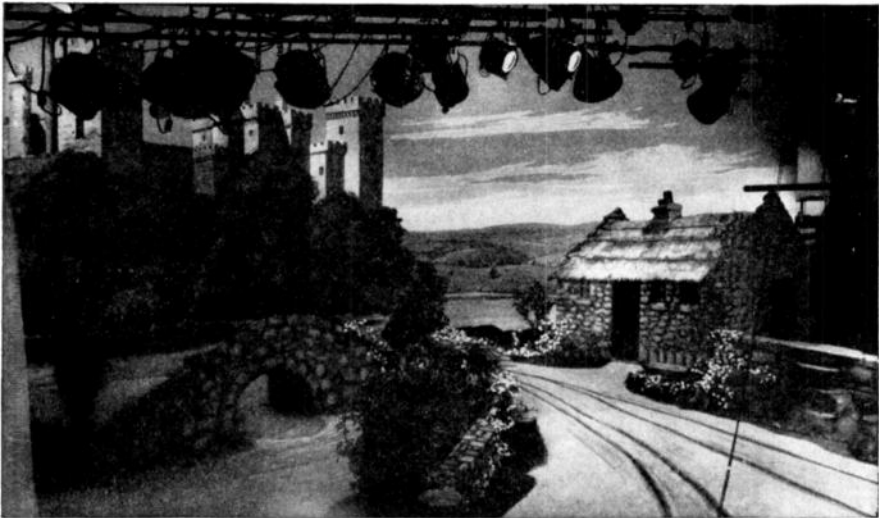


Fig. 16-20. Painted background drop 100 feet wide in ABC Studio 1 for production of "Paul Whiteman Revue." (Photo courtesy of ABC.)

the "Paul Whiteman Revue" series. This set is also an excellent example of realistic treatment of the floor area.

There is considerable difference of opinion on the question of using color in scene painting. A discussion of this problem will be found in Chap. 8 in connection with the color response of the television tube. Some designers work only in monochrome, either in shades of gray or in one color at a time. Most scene painters, however, are used to working in full color and should be allowed to continue so if they like, provided that the results on the screen can be controlled. At some stations all scene colors are mixed in standard shades and calibrated against a gray scale so that the designer can specify just which shade he wants and be sure of how it will look when it is on the air.

Some painting always must be done after a set is erected. Occasionally something must be redone which does not pick up satisfactorily. Sometimes there is touching up to do where the paint job has been damaged in transit. When the floor is to be painted, it is frequently easier to wait until the set is up so that the total effect of perspective can be perceived and the floor design most easily matched to the rest of the scenery. Time for this floor painting and time for it to dry must be planned on and allowed before the set is scheduled for rehearsal.

A check list of useful tools and materials necessary for the paint shop is included below:

- Lay-in brushes for priming coats.
- Liners and foliage brushes.
- Various pails, measures, pots, etc.
- Straightedges, lining sticks, and other drawing devices.
- Stepladders.

In regard to scenic paints, Bob Wade, NBC's scenic pioneer, has made a very interesting comparison between ordinary scenic paint (distempera) and casein paint the gist of which is given below.

Regular Scene Paint

Casein Paint

- | | |
|---|--|
| 1. 25 coats maximum. | 1. Will take 100 coats before recovering. |
| 2. Former coats of paint soften up under application of new coat. | 2. Not soluble in water when dry; hence does not rub up. |
| 3. Must be mixed with animal glue. | 3. Mix with water only. |
| 4. Leftovers rapidly spoil as the glue deteriorates. | 4. Left-overs are easily mixed with new paint. |
| 5. Drying is uncertain. | 5. Rapid drying. |

SCENE STORAGE

Facilities for scene storage require further space, and this also has been frequently neglected in the design of television stations. Many stations do all their storing in the studio, a practice which is a very poor use of the studio space except where the studio is larger than the programming needs require.

One station, WHEN in Syracuse, built an alcove off the side of the studio for a scene dock, in which flats could be stored on edge. This vertical file of flats, with identification marks along the edges of each piece of scenery, is a familiar theatrical method of storing scenery. The theory behind placing this scene dock in an alcove of the studio, however, was that if space were to be found somewhere for this purpose, it might as well be right at the studio itself and save moving the flats any more than necessary. After a year or two of operation, however, studio space became so crowded that the storage alcove was preempted in favor of another studio set, and storage space was created outside the studio after all. The scene dock along the studio wall was very convenient but had to be kept open since it could not be used if a set were placed in front of it. The elimination of the set dock made the entire studio usable for sets.

17 TELEVISION MAKE-UP

The subject of television make-up has been regarded by many as a mysterious art filled with secrets and special formulas. Naturally this attitude was not discouraged by the cosmetics manufacturers, who brought out special lines of television make-up enough different from their regular products to look impressive. Television make-up men, too, have been responsible for the use of special materials and colors. Actually almost any kind of make-up is usable on television, provided that the right shades are used and it is correctly applied.

The *creative art* of make-up, however, goes far beyond the basic rules for the choice of materials and the techniques of application outlined in this chapter. It is not on the basis of "trade secrets" that the make-up artist establishes himself in the television profession, but because of his creative talent, skill, and imagination. Dick Smith of NBC, for example, at the top of his profession, is a sculptor of no mean achievement in the fine-arts field. It will not be the purpose of this short chapter to attempt even an approach to the art of make-up, on which several books have already been written. Make-up for theatre and for the photographic media is basically the same, differing only in technique and practice. This chapter will attempt to indicate to the reader only when make-up may or may not be necessary and some of the simplest techniques involved in preparing actors for the television camera.

It is not uncommon for people to go before the television camera without benefit of any special make-up at all. If a man, for example, has a light beard, so that his "five o'clock shadow" is not visible to the eye, and he has no skin blemishes or rings under the eyes to conceal, he will probably televise satisfactorily without make-up. The same is true for a woman, who, of course, has usually covered up her blemishes and plays down her bad features by her own cosmetics.

In dramatic programs, actors often appear without make-up when a special effect is desired. In crime stories, for example, the director may

want the effect of harsh reality or the haggard look that a rough and slightly bearded face will convey. The final judgment, of course, must be made during camera rehearsal, when the make-up man and the director can get a fairly accurate idea of how the actor will look on the air.

PURPOSES OF MAKE-UP

When make-up is used, it is for one or more of several reasons. The first of these is to smooth the complexion, give the person an even, healthy skin tone, and outline and dramatize the features where necessary. No actual changes are made in the face; nature is simply improved on slightly, in the same way in which powder, rouge, lipstick, eye shadow, eyebrow pencil, and mascara are subtly used in street make-up to improve the feminine face.

The second purpose of make-up is also involved in every woman's efforts to make herself more beautiful. This is the *corrective* function of make-up. Broad jaws are made up to seem narrower, small eyes to look larger, long faces to seem not so long, etc., in the attempt to bring each face a little closer to the classic ideal of beauty.

The third purpose is to *correct for age*. Obviously this is involved in the make-up of many actresses except in character roles, since a certain optimum age is implicit in our current concept of beauty. This is a purpose of regular street make-up as well. In the case of actors playing roles in which they must appear many years younger than they really are, the make-up artist must often employ complex methods usually necessary for character make-up only.

A fourth purpose is to make certain corrections to suit the lighting which each particular studio or production may use.

Finally, there is the purpose of creating character. This usually involves changes in the personality, nationality, age, etc. The most involved techniques of make-up are devoted to this purpose and require a highly skilled make-up artist. Very little that is applicable to this function will be described below, and the reader is referred to other books on the subject for the techniques which are involved.

PECULIARITIES OF TELEVISION MAKE-UP

The techniques of television make-up closely resemble those used in black-and-white film photography. They lie somewhere between motion-picture and stage technique, but closer to film than to stage. This is primarily a matter of visible detail. Stage make-up is usually broad and exaggerated, too much so in many cases for the spectator in the first row. Stage make-up will do on television also, provided that the camera does not come too close and the actors are in flat, even lighting. Television theatres (legitimate houses adapted for TV) are usually lighted in this



(A)



(B)



(C)

manner, and the make-up requirements under flat lighting are much like those of the stage. In the television studio, however, where modeling light is used, the make-up must be much subtler.

Each studio is different because of different lighting installations and may even vary from day to day. The way in which the cameras are functioning will influence the way the make-up comes across. Another factor is the tone of the backgrounds, which will change from one production to another or between sets on a single show. Light backgrounds, for example, tend to make the face appear darker, while dark backgrounds make it seem lighter in tone. The make-up man should be on hand for rehearsal in any but the most routine productions so that he can adapt to whatever conditions may exist.

In earlier years television camera tubes exhibited strange reactions to colors; and one of the purposes of television make-up was to alter the normal colors, avoiding some and exaggerating others, so that the monochrome effect would look natural. Today's image-orthicon tubes are about as faithful in their translation of colors into tones of

Fig. 17-1. Special make-up devised by Dick Smith, NBC, to disguise undesirable shadows caused by top light. Drawings by Dick Smith. (A) Typical top lighting of television. Note bags under eyes, shadow between cheek and upper lip. (B) Special make-up applied to shadow areas. (C) In top-light the light make-up helps remove the unwanted shadows seen in A.

gray as panchromatic film, and the consideration of color response is no longer of any great importance.

Television lights are predominantly ceiling-mounted and illuminate the subject from above. Shadows under the eyebrow and beneath the eye are a constant problem which lighting cannot altogether solve. The make-up man can assist in disguising these effects if he applies a slightly lighter tone of base make-up in the shadowed areas (Fig. 17-1). Care must be taken not to overdo this operation, however, since too much lightening is worse than the shadow.

MATERIALS OF TELEVISION MAKE-UP

All kinds of make-up foundations look the same on television, provided that comparable shades are used and applied in the correct fashion. However, certain types of make-up are preferred for reasons which are entirely apart from the way they look on the air.

For one thing, make-up must be put onto an actor before dress rehearsal, so that it can be checked on camera and with the final lighting which the show will have; and then it must be worn until the show. This may sometimes be as long as five hours. Grease-base make-ups tend to become shiny in this length of time, and cake make-up is preferred.

Another factor is that often the foundation must be put on by the actor himself. Cake make-up is superior here also, since it is quicker to put on, blends easily, and requires no great skill in the application. Almost anyone can apply cake make-up and come out with a standard result.

The most frequently used cake make-up is Max Factor's Pancake, which is made in two series suitable for television. One is the panchromatic series, Nos. 21 to 31; the other is the X series, Nos. 1 to 11. They look identical on the air, but the X series is usually preferred because it is more natural in color.

Lipsticks are made in a number of medium or dark red shades, almost any one of which may be used on television. The only exception is the light red or orange lipstick, which is simply too light in tone to contrast with the skin when transferred to monochrome.

Beard stick is a common item. This is a grease-base make-up which is chosen in a tone which closely matches the person's skin and is applied over the beard, to remove "five o'clock shadow." Very often a performer will need no other make-up. It is important, however, not to take away all the beard shadow, or the performer will have a somewhat glassy look. Stein's lining color sticks are commonly used for covering the beard, in shades 22, 23, and 24.

The rest of the items in the make-up cabinet are standard stage and film equipment. It is not necessary to go to the great lengths in detail which films require, but many of the film devices, such as rubber noses,

for example, are necessary, where putty noses are adequate for the stage. Rubber, of course, cannot be used in connection with grease paint, since the grease will deteriorate the rubber. Max Factor's Rubber Mask Grease Paint must be used instead.

Sometimes a person will exhibit an allergy to standard make-up foundations. Such a person can obtain a protective base from his dermatologist, which is applied before the make-up and prevents it from entering the skin pores. A semi-nonallergic Pancake is put out by Factor which contains no perfume and no preservative and often solves the problem satisfactorily.

PROCEDURE IN THE USE OF TV MAKE-UP

The procedure in applying make-up will vary from one station to another, according to the number of people who are available to assist in the process. Even in the New York network studios there are not always enough make-up people to take care of each performer individually, even though Dick Smith, for example, at NBC has under him a staff of 14. Schedules are usually so rushed that everyone must be made up at once in very short order. This makes it necessary to rely on the actor in large part to apply his basic make-up himself.

Accordingly, everyone is given the right shades of Pancake, powder, and lipstick to apply himself, and the make-up artist then devotes as much time as he can to those who have the most complex make-up jobs to do and need the most help. Actors who appear on TV regularly sometimes acquire sufficient skill in the usual techniques (which are not too different from what they have been used to in the theatre) and can be trusted with a large part of the job.

Make-up on a man usually takes 2 to 5 minutes when the make-up artist does the job himself. If there is a change of age or other complicated work to be done, it may take as long as 15 minutes, though this is unusual. A make-up job on a woman will always take at least 10 or 15 minutes for a complete make-up and often takes up to three-quarters of an hour. This is because many women's make-up calls for some change of age (in the direction of youth). It is interesting to note here that it sometimes takes longer for the make-up to be applied by the artist than if it is put on by the performer himself. Coordination is lacking between hand and face. This is especially true of lipstick.

One of the hardest problems to solve in television make-up is the quick change which must be made during the show itself. This problem is unknown in film but occurs fairly often in the theatre. Television writers are frequently unaware of the make-up problem and often advance an actor's age 20 years during a 30-second commercial. It is almost impossible to accomplish any kind of extensive make-up change (according to Dick Smith) in less than a minute, no matter how many make-up people

can work on the actor. The problem is usually complicated by the fact that the actor must be making a costume change at the same time. The wise producer contacts the make-up man before he finally accepts a script, describes the nature of the make-up changes, and determines whether or not the writer has left enough time.

The most common requirement in the quick change is the graying of hair. Yet there is no really quick method of whitening a whole head of hair properly. Face powder, silver powder, white mascara, and Griffin Shoe White are standard materials for this purpose, but they must all be applied skillfully and with considerable care.

One solution to the problem is to apply wigs or gray hair pieces at the temples, fastening them on with spirit gum, rather than to try to gray the actor's natural hair.

When a face must age in a quick make-up change, the actor is sometimes given two faces. First the actor is made up as an old man. This make-up is applied in grease paint and then powdered so that it will set and become waterproof. Then right on top of the old face, a young face is applied, this time in a water-soluble type of make-up. When the quick change is made, all that is necessary is to sponge off the first layer and the older face is quickly revealed. This may be done a little at a time if the aging is to occur between several scenes. There are, of course, certain additions which must be made in the aging process, such as various hair pieces, noses, bags under the eyes, and drooping jowls; but the time-consuming job is already done.

At one point in a historical-novel production the actor was given about 30 seconds off the set in which to make a costume change and age 15 years. The make-up man was standing just to the side of the set, in between technicians and mike boom, with gray hair pieces in one hand and spirit gum in the other. The actor had been on camera almost constantly for the greater part of an hour and was wringing wet, so much so that the spirit gum wouldn't go onto his hair. The make-up man had a towel handy, mopped him off, and managed to get the spirit gum to stick. Then he found he had the wrong hair piece in his hand. He laid it down on the piano next to him, got the right one in place, and then prepared the other side with spirit gum. Meanwhile, of course, the actor was struggling into his costume, pouring with perspiration all the while. When the make-up man reached to the piano for the second hair piece, it was gone. Only a few seconds were left, and a frantic search of the floor underneath failed to reveal it. The next scene was beginning, and the floor manager waved wildly to get the actor into the set. Just as he started to go in, with one gray temple, the make-up man reached out and jerked it off, knowing well that nothing at all would look better than only half a job. That was one make-up change that was too quick for safety. The missing hair piece was soon found, of course, having been

brushed off by a careless elbow, and the actor's hair turned gray during the following break between scenes instead. This kind of quick make-up change is recommended rather for graying the hair of the make-up artist than that of the actor.

MINIMUM MAKE-UP FOR NON-DRAMATIC PERFORMERS

For the station which is not intending to go into dramatic production and will not require make-up which includes great change of age or character, a few minimum materials will suffice. Beard stick is probably the most useful item, and this can be used not only on dark beards which are likely to show through the skin but also on circles under the eyes. A few of the intermediate shades of Pancake make-up will be useful, especially when an actor has an extremely pale skin. The rest is standard cosmetic material: face powder, lipstick in standard shades, eyebrow pencil, etc.

The author is indebted to Dick Smith of NBC for the following list of make-up materials:

<i>Minimum Equipment</i>	<i>Additional Items</i>
Foundation, etc.	
Factor's Pancake:	Factor's Panstik: 4N, 5N, 6N, 7N, 8N, 11N
At least one each of the following: 21, 4N, 5N, 6N, 7N, 8N, 9N, 10N, 11N, Light Egyptian, Dark Egyptian	Factor's grease paint: 1N, 5N, 6N, 7N, 11N
	Factor's Rubber Mask Grease Paint: 1N, 6N, 10N
Powder:	White
Westmore's Tru-glo	Brown
Powder puffs	Large (for body make-up)
Sponges:	
Plex	
Eye make-up, etc.	
Pencils:	Uppity eyelash curler
Brown and black	Tweezer
Mascara:	
Allura cream	
Stein's water	
Grease eye shadow (any color)	
Mehron's Lashes (type B)	
Johnson & Johnson's Liquid Duo adhesive	
Small scissors	
Lip make-up, etc.	
Lipstick:	Light (any brand)
Medium (any brand)	Extra-dark (Revlon's Russian Sable)
Dark (any brand)	Lipstick containers
Medium reddish brown (Factor's Moist Rouge Panchro No. 7) for men	Lipstae

<i>Minimum Equipment</i>	<i>Additional Items</i>
Brushes	
Lip brushes	Toothbrushes (for graying hair)
Make-up shading brushes	Nailbrushes
Spirit-gum brushes	
Mascara brushes	
Powder brushes	
Hairbrushes	
Character make-up, etc.	
Stein's lining color sticks (for beard cover):	No. 7 dark brown
No. 22, No. 23, No. 24	Nonflexible collodion
No. 15 white	Stein's nose putty
No. 6 light brown	Stein's black tooth wax (for blocking out teeth)
Spirit gum	Tooth enamel (for covering discolored teeth)
Hair whitener	Artificial blood
Factor's Plasto Wax	Lampblack water color (in tube)
	K Y Jelly (mixed with above for quick-change dirt and smudge effects)
	Clown white
	Burnt cork (minstrel make-up)
	Nail polish
Hair materials, etc.	
Crepe hair, straight and kinked:	Medium brown
Light gray	
Light medium gray	
Medium gray	
Dark gray	
White	
Combs	
Tuck combs	
Hairpins:	
Brown	
Black	
Extra large	
Bobby pins:	
Brown	Hair nets
Black	Ace bandage (to bind hair under wigs)
Solid brilliantine	Bandoline
Atomizers	Wave set
	Scalp Masque (for darkening scalp where hair is thin)
	Rubber bands (for hair dressing)
Solvents, etc.	
Alcohol	Ether
Acetone	Sea Breeze or astringent
Witch hazel	Brilliantine
Energine (fireproof)	Glycerin
Hair lacquer or Liquidet	Mineral oil
Disinfectant	Murine

<i>Minimum Equipment</i>	<i>Additional Items</i>
Equipment	
Barber shears	3 large jars (for cleaning make-up equipment)
Palette knife or spatula (for distributing lipstick)	Hand mirror
Nail file	Crepe tray
Sponge tray	2 make-up trays
Bottles for cleaning lip brushes	Plastic make-up cape
Tape measure	Whisk broom
Razor	Eye dropper
Miscellaneous	
Tissue	Masslim fiber towels
Cotton	Paper baking cups for cold cream (keeps dirty fingers out of the main jar)
Cold cream	
Paper butter chips (for lipstick)	Drinking cups
Soap	Brushless shave cream
Razor blades:	Styptic pencil
Single edge (for sharpening eyebrow pencils)	Safety pins
Double edge	Needles and thread
Toupee tape (double-faced adhesive used for attaching mustaches, side burns, etc., in comedy shows where it doesn't matter if they happen to come off)	Adhesive tape
	Band-aids
	Gummed labels

HOW TO APPLY STRAIGHT MAKE-UP

Woman:

1. Apply Pancake make-up. Do not remove original make-up. Use moist sponge. Apply evenly everywhere.
2. Apply Pancake two shades darker for shadowing.
3. Apply eyebrow pencil if necessary. Do not overdo.
4. Apply mascara in standard fashion.
5. Apply lipstick.

Man:

1. If dark beard, apply beard stick.
2. Powder (this sets the beard stick).
3. Apply Pancake—a light wash. Generally two shades darker than woman. Avoid making him “look pretty.”

18 TELEVISION LIGHTING

Television lighting has been for some time a highly controversial subject. It is not that there are too many conflicting theories of lighting: there are really only two. But proponents of the two points of view use the same terms to mean different things in many cases, and arguments over television lighting usually boil down to haggling over definitions of terms. Witnesses to these vehement discussions will recognize the term "key light" as a prime offender.

The two schools of thought may be classified, for lack of better terms, as the technical school and the artistic school. The technician is concerned with optimum functioning of his electronic equipment. He accuses the photographer of thinking he is still in the movie studio. He deplores the stage director's insistence on "shafts" or "pools" of light and spotlight effects. He likes his lighting nice and even. He would be happiest if light were like the studio air, everywhere the same, and having no perceptible source of emanation. He plasters the studio ceiling with fluorescent tubes, turns them all on at once, and then adds floor-lighting units to remove the undesirable shadows which they cast. And he is entirely right, as far as he goes: the television camera must have a certain basic amount of even illumination in order to function.

The proponent of the artistic school looks at lighting only from the creative or photographic point of view. He is used to taking pictures with cameras which are much less limited in tonal range. He likes contrast, highlights, and shadows. He baffles the engineer with talk of "notan" and "chiaroscuro." He prefers the incandescent spotlight to any other lighting instrument. He thinks in terms of hardness and softness of light, of highly directional lighting coming from very few clearly perceptible sources. He hates top light. And he is right too, or would be, if he took the engineering requirements into consideration.

The network studios have advanced to the point of compromise and

cooperation. The solution lies in the middle ground, but closer to the concepts of the photographic school than the engineers would like to admit. There can be no argument with the view that television is essentially a photographic art. It is an art of moving pictures on a two-dimensional screen. There is a different type of "film" in the camera, but photographers have been varying their techniques over many years to fit a great variety of film emulsions. There is no need to discard all the techniques of painting with light which have been developed into the arts of still and motion-picture photography. These need only be adapted to the television tube as they were to the three-color emulsion or to the panchromatic plate before that.

The most advanced television lighting today, however, takes account first of all of the technical limitations peculiar to the television camera tube (described in Chap. 8) and satisfies the technical men with an adequate picture signal. The well-understood techniques of lighting for still or motion-picture photography are then applied wherever practical within the limits of studio and equipment.

In any other photographic field, the cameraman has charge of the lighting of the scene; indeed, it is usually his primary concern. In television, however, the cameraman is only an operator and never has anything to do with lighting. In most stations lighting is a responsibility of the engineering department. Where a special lighting man is not available, the practice in many studios has been to set up an even, flat illumination to cover the studio satisfactorily from all possible camera angles, and to leave it there. This provides a very inexpensive but totally dull kind of studio lighting. In some stations a special lighting man is designated; and although he may be basically an engineer, he usually endeavors to learn as much as possible about the creative methods of lighting employed in film and theatre and to familiarize himself with the best lighting methods in use in television. A few stations have delegated the responsibility for studio lighting to the program department or have at least installed a lighting man who is primarily responsible to the program manager instead of the chief engineer. In such cases the light man is more likely to have had production experience in theatre or film, or perhaps in still photography, and approaches his problems with the background of knowledge he has acquired in these fields. The best lighting man, however, must have in addition to this a pretty thorough understanding of the technical side of television and particularly of the pickup characteristics of the camera tube. He should be able to judge technical quality. Not only should he be able to create and experiment on an artistic level; he should also be expected to veto any lighting effects which result in poor technical quality of the transmitted signal. He should not make it necessary for this action to come from another source.

It is essential that he have the confidence and cooperation of the technical staff.

In brief, it can be said that the technical objectives of television lighting are (1) to illuminate the scene before the camera and make possible a satisfactory picture signal safely above the noise level and (2) to provide good "picture quality," which includes good resolution, a realistic balance of tones, and lack of spurious effects. The nontechnical objectives are: (1) To assist in achieving a pleasing composition by the distribution of light and shadow. (2) To support the illusion of reality which is attempted in the setting (*i.e.*, sunlight, moonlight, firelight, or other "effect" lighting). (3) To support dramatic values and help in creating or sustaining mood (as in low-key and high-key lighting). (4) To help bring out the depth dimension in the scene; the roundness of objects and their three-dimensional form are revealed by modeling light; edge lights and back lights separate foreground objects from background. (5) To add sparkle to the picture by the use of highlights, back lights, etc. (6) To add beauty and glamour to the face by smooth soft lighting; often a special "eye light" is used to bring out the highlight in the pupil of the eye. (7) To correct an actor's looks, bring out the good side of his face, and play down undesirable features.

SPECIAL PROBLEMS OF TELEVISION LIGHTING AS COMPARED WITH THOSE OF STAGE LIGHTING

The greatest difference between stage and television, as far as lighting goes, is that on the stage one is lighting a scene which is to be perceived by the human eye, whereas on television it must be picked up and transferred electronically by an intermediate system. The human eye is the most marvellous optical mechanism known. It has built-in automatic exposure control. It can function within a brightness range of 1 to 100,000,000. It can register a large range of gray tones at one time, seeing detail in the darkest shadow and also in the brightest light. It is not blind to colors.

A great number of lighting effects are possible in the theatre which cannot be accomplished, at least by the same direct methods, in television. Shafts and pools of light so dramatic on a darkened stage will not look the same to the television camera as they do to the eye. Even the simple spotlight effect, standard on the vaudeville stage, imposes quite a strain on television equipment. These effects can be achieved, and often with good effect on television, but only with cooperation from the video engineers.

Stage lighting involves a concept of two kinds of light: general and specific, much like the basic and modeling light of television. General, nondirectional light is provided by the overhead border lights of the

stage, plus the footlights and whatever other front illumination is provided from other parts of the auditorium. Specific illumination is provided by spotlights which cover certain areas of the set, with the purpose of highlighting, modeling, accenting, and in general bringing out the form of objects and the depth of space on the stage.

Acting-area light on the stage will range between 2 and 25 lumens per square foot (foot-candles).^{*} Although the image-orthicon camera tube will pick up an image under these lighting conditions, it is usually considered best for optimum performance to have at least 100 foot-candles in the television studio.

COMPARISON OF MOTION-PICTURE AND TELEVISION LIGHTING

Motion-picture lighting, just like television lighting, must be designed to fit the particular means of reproduction which is to be employed. Lighting for color film is entirely different from lighting for black and white, for example. In general, film has a wider range of sensitivity to grays, can record darker shades of gray without going pure black, and can record lighter tones without completely washing out.

In physical placement, the lighting in a motion-picture studio is quite different from that in television. Most of the lights are on movable stands or towers which rest on the floor. Some are attached to the scenery itself, which is built strongly enough to support a platform around the back (the parallels). From this position, electricians can handle the spotlights which are fastened to, and shoot over, the back of the sets. A few motion-picture studios have permanent catwalks above the working area, and certain very intense lights with a long throw are worked from there. There is usually lots of room in a motion-picture studio, and wide use of the floor for the placement of lights creates no problem. In television, on the other hand, floor space is always limited, and what little there is must be kept free for the movement of cameras. The television light man will try to use as few floor lights as possible, preferring to pull lights down from the ceiling on extension mounts when low light sources are desired.

One of the primary problems of television lighting is the microphone boom. This is a factor that must be considered in motion-picture lighting as well. The microphone boom must never pass through the beam of a spotlight, or it will produce a sharp and recognizable shadow on the background. On the motion-picture set there is enough time to work out precise movements of boom, lights, and camera, so that these shadows will not be picked up. In television, on the other hand, such accurate and detailed rehearsal is not possible. The entire studio must be pre-lighted so that wherever the boom mike must go, it will not cast a shadow.

^{*} Selden and Sellman, "Stage Scenery and Lighting," p. 221.

Floodlighting does not present as much of a problem as spotlighting. Under fluorescent banks, as a matter of fact, the boom may move around without casting a shadow at all. Where modeling light is concerned, however, the lighting man's only solution is to apply his spotlights from a position where the boom *isn't* and *won't* be.

THEORY OF CREATIVE LIGHTING

The most important qualities of any particular light are, first, the *direction* from which it comes; second, its *intensity*; and, third, its *quality*, in terms of softness or hardness. The type of lighting fixture that produces it is not too important, nor are its color or any of the other qualities which a light may possess, except as they influence direction, intensity, and quality. It is not possible, for example, to look at a television picture and determine whether the studio where it originates is using fluorescent or incandescent lights. (The soft fill light of the fluorescent bank can easily be achieved by a group of incandescent bulbs or floods with diffusers.) It *is* possible, however, to determine which *direction* a light is coming from, whether it is *soft* or *hard* in quality, whether it is relatively high or low in *intensity*. The control of lights in the television studio is built around the control of these three elements.

Light is best known by the way in which it is used. Direction, quality, and intensity will depend on this. The several types of light listed below could be produced by almost any kind of light source. They differ only in the way they are used and, of course, in the three essential qualities mentioned above.

BASE LIGHT

Base light is the only type of light which is peculiar to television. The other kinds of light listed below are well known in all types of photography and are occasionally referred to in the same terms on the theatre stage. Base light, however, is a concept which has developed out of the technical requirements of the television camera. A certain basic overall illumination is necessary for proper functioning of the TV camera. This light must be flat and even. It may be provided by any kind of light source and any type of instrument. It must be soft so that it does not cause noticeable hard-edged shadows. Most television studios require about 80 to 100 foot-candles of basic light, and on this is built further highlighting. Some studios leave it at this and content themselves with nothing but flat lighting, every side of an object receiving exactly as much illumination as every other. Base light has no quality; it has no direction; it has nothing but a certain minimum intensity. It is the beginning of every light setup.

The engineer may sometimes use another term for basic light: he may

call it "key light." This is a very unfortunate confusion in terms. Key light has another and almost diametrically opposed meaning (defined below) which is used throughout the still and motion-picture field. How the television engineer began applying the term to basic illumination is not known, but it has caused more misunderstanding and unnecessary arguments than any other factor in the lighting field. Be absolutely sure, when you use the term "key light," that you are not talking to an engineer who understands you to mean "base light" instead. And don't ever let anyone say "key light" to you without asking him to define his term.

MODELING, OR "ACCENT," LIGHT

Modeling light is highly directional light which builds up highlight areas, casts shadows, and brings out the form of objects. The light man usually attempts to set his modeling lights above the stage, forward of the actors, and to one side or another of the primary camera angle. This is the usual angle from which directional illumination comes. The morning or afternoon sun or the ceiling fixtures in the interior cast the main light from above. Sometimes for bizarre effects the main light is placed behind, to the side, or below the subject. Light coming from such unusual directions is better classified as effects light, however.

The main modeling light is usually called "key light" in the photographic fields. It is the main source of directional light that falls on the scene. It might better be called "main light" to avoid the confusion in terms described above under Base Light. Since there may be many light sources providing the main light for various portions of a scene and the direction or even the quality of this light may vary from one area to another, some television light men have broadened the term "key light" to mean *any* modeling light. And of course, TV engineers have used the term to mean base light, which has no modeling effect at all. In the face of all this confusion, the author has found it best to eliminate the term "key light" and to use the term "modeling light" instead, which is universally understood and describes the function of the light as well. "Key light" has accumulated so many meanings it has become virtually meaningless.

FILL LIGHT

Fill light is used for the purpose of illuminating shadow areas left by the modeling lights. The shadows are "filled in" so that they will not be too dark. Lights are often used for this specific purpose in photography, but in television, where a basic soft illumination has already been provided in the base light, special fill lights are not always necessary.

The base light provides the fill. Fill light is almost always soft and diffuse so that it will not cast its own set of shadows. Sometimes the terms "fill light" and "base light" are combined (since the same lights perform both functions) and one hears "basic fill light" discussed. It is enough to know that whatever is meant by this term probably is not casting any shadows, is weaker in intensity than other lights on the set, is soft and diffuse rather than hard, and originates, if not from all directions, at least from the general direction of the cameras.

In still photography fill light often originates from the direction of the camera. If the light unit is placed as close to the camera as possible, it will "see" the same portions of the scene that the camera does and illuminate every shadow no matter how inaccessible. In flash photography, a flash bulb is commonly placed on the camera, even when one or more other bulbs are held closer to the subject for modeling light. (When only one bulb is used, as in newspaper photography, it is set off at the camera and illuminates the scene with completely flat light.) Television cameras have been equipped with small light units fastened just above or to the side of the lens, but these are ordinarily used only for close shots in dark corners of the set where there would not otherwise be enough fill light.

BACK LIGHT

Back light is named entirely for the direction from which it is used. It is a light which is placed high behind the subject, opposite to the camera, and which is trained on the subject's head and shoulders. The effect is a bright halo about the hair and a rim of light around the top of the shoulders. Back light is a very attractive but almost wholly unrealistic light. Its use was overdone in motion pictures in the early years, and even today it is easily possible to identify a motion picture still from a photograph of reality by the heavy back lighting. Back light is a high-intensity light, usually provided by incandescent spots and concentrated on limited areas. It must be adjusted to suit the subject, however; it is readily evident that blonds, for instance, need less back light than brunettes.

BACKGROUND LIGHT

Occasionally special lighting effects will be desired which involve the background of the set. Shafts of light, areas of light and shadow, or patterns of various types are projected by means of special background lights. In motion-picture studios where the incandescent spot is used for every lighting need, backgrounds are often lighted by many small spots so that there is a considerable play of tone between light and dark

areas. Variations in the background tone such as this are often a great help to composition.

There are several other terms which are also applied to lights according to the way in which they are used. Since these terms will not be used in the text which follows, they need only be defined and related to the more common terms which have been covered above.

Various modeling lights:

Accent light: Usually a back light, although it may be from the side. Its purpose is to add a highlight where one is needed.

Kicker light: Same purpose, usually from the side. For these purposes spots are always used because an intense light must be concentrated on a small area from a relatively distant point.

Crosslight: This term is applied to modeling light when it comes from the front and side of the set, "across the subject."

Rim light: Back light.

Edge light: Back light.

Floor light, cross back light: These are further terms which describe a light by the direction from which it comes.

Clothes light: A motion-picture term for additional light necessary on dark clothing.

Eye light, or eye catch light: A special light placed so that an image of it is reflected from the performer's eye. It is necessary only in close-up but makes a big difference. A close-up without eye light looks very dead; the addition of the tiny glint in the eye brings it to life.

QUALITY OF LIGHT

By quality is meant the hardness or softness of a light. Hard lights cast sharp shadows. The nose, the eyebrow, the chin cast sharp-edged shadows across the face and neck. The shadow edge along a forehead or cheek is not gradual, but sharp also. A soft light, on the other hand, casts a very gradual, soft-edged shadow, or no shadow at all, depending on how soft it is.

The factor which determines quality is the size of the light source. A sharp-edged shadow can be cast only by a light which originates in a very small source; a fluorescent tube can never produce a hard light.

Soft light is much more flattering to the actress than hard, and modeling light is often diffused for the glamorous effect. Fill light is always diffuse, but back light and accent lights never. These lights must create brilliant highlights, and intensity is the prime requisite; quality is unnoticeable. Putting a diffuser on a light always cuts down on its intensity, both because it absorbs some of the light as it goes through, and because it spreads the light out over a larger area.

INTENSITY OF LIGHT

It is always a good plan to measure the lighting, once a good setup has been achieved, and record the position of lights and the areas they cover so that the same conditions can be reproduced again quickly if desired. The final proof of the lighting must be the picture as it appears on the monitor; and the light man must have a jeep monitor at his control point which is kept in perfect adjustment at all times. Although final adjustments will be made by eye, to "light it so it looks right," and a certain variation will be found in technical requirements owing to different camera tubes or other equipment, the following table will provide a close approximation of the usual light intensities used in television studios.

Light intensity is measured in foot-candles, or lumens per square foot. A lumen is a basic quantity of light (the total amount of light which one candle emits). Any light gives out a certain number of lumens, and the number of these which fall on a square foot of surface is a measure of the light intensity at that point. Naturally the farther this square foot of surface is removed from the light source, the fewer lumens will fall on it. This illumination may be called lumens per square foot, or foot-candles, which is a more familiar but a more complex term.

TABLE OF TYPICAL LIGHT LEVELS

These figures assume the use of the 5820 image-orthicon tube or its equivalent in sensitivity. The camera lens is usually set between $f/8$ and $f/16$. Many studios work with wider lens openings and achieve standard high-key lighting at lower levels. Depth of field is, of course, more limited, but if the producer (and cameraman) are willing to accept this added problem, more effective lighting is generally possible.

High-key:	
Base light	100 foot-candles
Back light	150 foot-candles
Modeling light plus base light	150 foot-candles
Low-key:	
Base light	25-40 foot-candles
Modeling light	150 foot-candles

The lighting man will often block out the lighting on a television set several hours before cameras will be operating in the studio, and he must wait to check his results. In order to ensure even lighting, he will generally use a light meter of the incident type, reading in foot-candles (lumens per square foot). In order to register the light which is *seen by*

the camera, the meter should be *pointed at the camera*. This means that the light-sensitive area of the meter is held in a vertical plane, since vertical planes (walls of sets, sides of furniture, fronts or backs of people) make up the major portion of the camera's view. It is obvious that a meter faced up or toward the back of the set will register a lot of light which does not affect the camera since it falls on surfaces which the camera does not see.

LIGHT SOURCES

There are only four basic types of light source around which the actual lamps are built. Light instruments of various types have been designed for each of them. The light source is the luminous material *within* the lamp which emanates light. The four light sources are:

1. The incandescent filament.
2. The incandescent gas.
3. The carbon arc.
4. The fluorescent tube.

Some new light sources which are combinations of the above are being experimented with. However, at the present time, all light units used in television are built around one or another of these basic light sources.

1. *The Incandescent Filament.* The incandescent filament is the original light source known to electricity, the type of light bulb that Edison first invented. A filament of tungsten wire is heated by the passage of an electrical current which is too great for the size of the wire. It heats up under the strain and radiates heat and light (much more heat than light, as any performer can tell you) and can be built into a light unit with a reflector so that these radiations can be concentrated into a beam.

2. *The Incandescent Gas.* The most familiar example of this type of lamp is the colored neon, argon, or xenon tube spelling out the name of your local bar. The combination of gases determines the color. Lamps containing mercury vapor were used experimentally in the early days of television but proved unsatisfactory because of their extreme blue color, upsetting the color balance of everything on the set, including flesh tones.

3. *The Carbon Arc.* The arc is a spark that jumps across a gap between sticks of carbon. It operates in the air, requiring no vacuum or gas envelope, and gives off a very intense light from a small source. Arcs were experimented with in early television stations but have been pretty well eliminated as impractical.

4. *The Fluorescent Tube.* The fluorescent tube is a development of the incandescent gas lamp and contains mercury vapor which is the original source of the light. A large part of the radiation from the mercury gas is ultraviolet light. There are many fluorescent chemicals which will glow under ultra-violet light and change these invisible radiations into visible light. The interior of the fluorescent tube is coated with a mixture of some of these phosphors. The ultraviolet light radiated from the interior of the tube is transformed by the phosphor coating into visible light, the color of which will depend on the mixture of phosphors used. This produces the most efficient type of lamp. More light is produced from the same amount of current than by any of the other means.

At one point in the development of television lighting, everyone was swearing by fluorescent lights. That was in the days of the 5765 image-orthicon tube, which was particularly sensitive in the blue region of the spectrum. Fluorescent lamps are high in blue light (owing to the mercury vapor within the tube), though they may look white to the eye; and when used with the blue-sensitive tube, they resulted in more picture signal per watt of light than any other type of lighting available. They were thus more economical to operate and resulted in a higher signal-to-noise ratio. However, certain disadvantages soon began to be apparent.

In the first place, they could not be dimmed. This was not too serious, since they were used for basic lighting, which, except in the case of low-key or effect lighting of some kind, stays the same throughout a program. Another trouble was the blue color. As with mercury-vapor lighting, this required special make-up. Reds came out dark under these lights. Most of the wrinkles, pimples, and blemishes in the complexion are red in color. The effect was to exaggerate facial blemishes. In the third place, light from a fluorescent bank has no directivity, and it was impossible to obtain any modeling with fluorescent light.

Some studios today use no fluorescent banks at all, preferring to obtain all their fill and base light by incandescent floods. Others, such as CBS, use fluorescent banks for base light (low and from the front) but do their modeling and accenting with incandescents. Everyone seems to agree that a mixture of both types of light provides a better color rendition and is more flattering to the complexion than fluorescent light alone. Only 4500° white fluorescents should be used.

LIGHTING INSTRUMENTS

Lighting instruments are characterized mostly by the distribution of the light they put out. An open lamp without any light unit built around it will radiate light equally in all directions. This is highly inefficient, since the subject to be lighted is usually within a very small

segment of the space into which all this light is radiated. Only a fraction of the total emitted light would go in the right direction. In order to concentrate more of this light onto the subject area, the reflector was designed. The reflector is usually a curved mirror or other highly reflective surface. It intercepts the light which is leaving the lamp in unwanted directions and turns it back toward the subject. This forms the light into a beam. The light unit can be pointed toward whatever portion of the subject is to be illuminated, and the light will be concentrated on that area.

Different types of reflectors produce different-shaped beams. A light which delivers a wide-angle beam is usually referred to as a *floodlight*, or

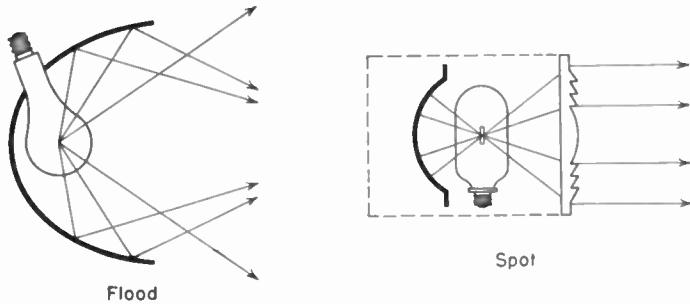


Fig. 18-1. Formation of light beam in wide-beam floodlight (left) and narrow-beam spotlight (right).

broad. A light in which the beam is narrow is called a *spot*. Spotlights can usually be focused so that the width of the beam is adjustable (Fig. 18-1).

Both the flood and the spot type of light can be produced by the internal-reflector lamp, which has the proper type of reflector built and sealed into the bulb. These lamps require no housing of any kind and are used widely in television studios when relatively small amounts of light are necessary. The width of beam is not adjustable in these lamps, however, since the distance between filament and reflector is fixed. (Fig. 18-4).

THE FLUORESCENT BANK

A fluorescent bank is a group of fluorescent tubes mounted close together, each tube usually having its own semicircular aluminum reflector behind it like a trough. Manufacturers of television lighting equipment have built fluorescent fixtures in banks of four or six 40-watt tubes. These tubes are 4 feet long; so the size of the bank of six, for example, is 48 by 44 inches. A somewhat larger bank is built from the newer Slimline fluorescent lamps which are instant-starting, and don't falter and flicker when you turn them on.

The best-constructed bank is supported at each end by a yoke which permits it, if the yoke is large enough, to be tilted into a vertical position. This is very important, because many stations use these units for base light, and they must cast an even illumination on all surfaces that the cameras see. Since most of the surfaces which present themselves to the camera are vertical surfaces, it follows that base light must be cast predominantly in a horizontal direction (Fig. 18-2).

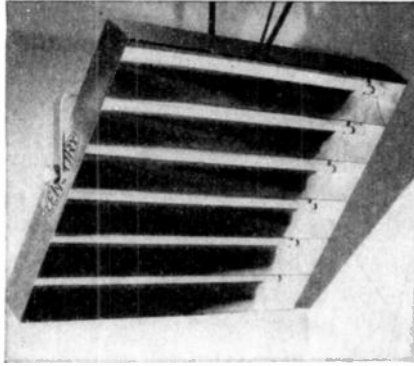


Fig. 18-2. Fluorescent bank or "pan."

A great number of the small stations made the serious error of mounting their fluorescent tubes permanently on the ceiling (Fig. 18-3). According to experts, if there is any direction from which light should *not* come, it is from directly above. Excess top light may not look too bad to the eye or show up badly in the usual photograph; but when seen on the television system, it proves to be far from an even basic lighting. An added amount of light must be provided from floor sources to fill in the unwanted shadows. Fluorescent banks are commonly mounted on floor stands for this purpose; sometimes incandescent floods are used. But both also serve to clutter up the studio floor.

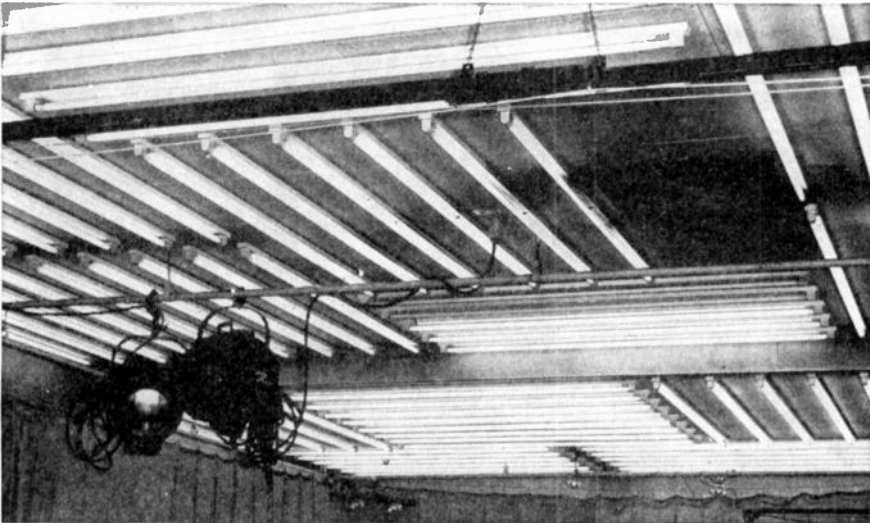


Fig. 18-3. Ceiling of small television studio with Slimline fluorescent tubes permanently mounted. Studios with this type of installation achieve very poor lighting.

THE INCANDESCENT SCOOP

The scoop is a floodlight with a very wide beam. A reflector with a parabolic shape is built around a lamp base which will take anything from a 750-watt to a 2,500-watt lamp. Lamps of 1,000 or 2,000 watts are generally used. NBC has standardized on these lights, mounting them overhead to shoot into the sets at an angle, and using them for base light. Scoops are often used on floor stands when fill light must come from a low angle. The scoop puts a lot of floodlight into a single unit not too large in size. For this reason, when lights are taken out of the studio for remote pickups, the scoop is very often preferred.

THE BANK OF INTERNAL-REFLECTOR BULBS

These bulbs come in two types, the R40 and the PAR 38 (Fig. 18-4). Each of these is made in a narrow-beam projector (spot) version and in a wide-beam projector (flood). A number of television stations have built the R40 floods into units of 6 to 12 and use them in much the same manner as a fluorescent bank, for base light. Lamps of 150 and 300 watts are available, and the R40's can be obtained in the very much brighter but shorter lived photoflood type. The standard R40's are rated at 1,000 hours. A bank of several of the projector-spot lamps will create a directional beam and can be used for modelling.

A small studio can make very excellent use of these lamps at a great saving, of course, since the lamp is its own lighting unit. One or two spots fastened with spring clamps to the back of the set and directed properly will provide nice back lighting for limited areas. In the case of a pianist, for example, where an accurate position is known and the lamp does not have to be too far distant, a single R40 projector spot will

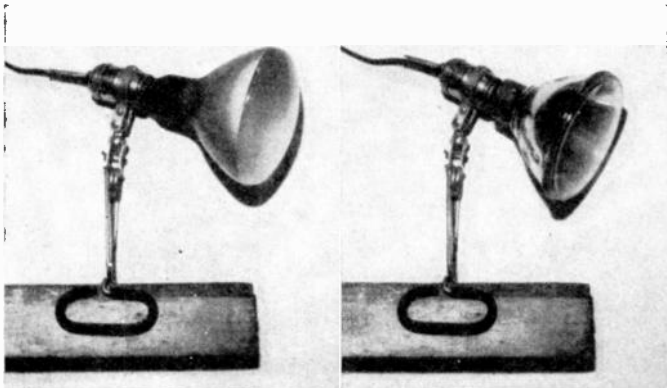


Fig. 18-4. Internal-reflector bulbs: left, R40; right, PAR 38. (Photo courtesy of Karl Weger.)

suffice. In the use of effects lighting, where lamps must be placed below the camera, hidden in the foreground scenery, or behind ground rows, these lamps are very useful because of their small size. Any other type of light unit with external reflector, housing, etc., would take up a great deal more space.

To increase the usefulness of the projector spot for back light, a clip-on metal baffle is available which prevents spill light from reaching the camera lens. It is a series of concentric bands on edge through which the light can project forward but which prevent it from leaving the lamp at an angle. The heat of these unprotected bulbs, especially the photoflood type, makes them dangerous to place where someone might touch them or where they might come in contact with scenery or props. To guard against this, a second type of clip-on is available which puts a protecting shield around the edge of the lamp. In a later section on special-effect lighting, it will be described how these lamps have been built into home-made projectors for background patterns and long-throw accent lighting.

The internal-reflector *photoflood* bulb, available at almost any photographic store, gives a great deal more light. These are really low-voltage lamps which are run at a higher-than-rated voltage when used on 110-volt current. They burn very brightly but are short-lived (6 to 8 hours) and constitute a certain hazard because they occasionally end their short life in a burst of glory, showering the set with bits of glass. Additional light can be obtained safely from PAR 38's by running them at a higher voltage than the normal 110 for which they are rated. Several studios transform the voltage going to these lamps and run them at 150 volts. Their life is materially shortened, but they give off a great deal more light.

STRIP LIGHTS

There is very often a need for a light unit which will provide general light along a strip. The strip light (Fig. 18-5) is well known in the theatre as the border and is used in television for many of the same purposes. It can be laid on the floor behind a ground row or mounted on a stand vertically to illuminate a cyclorama

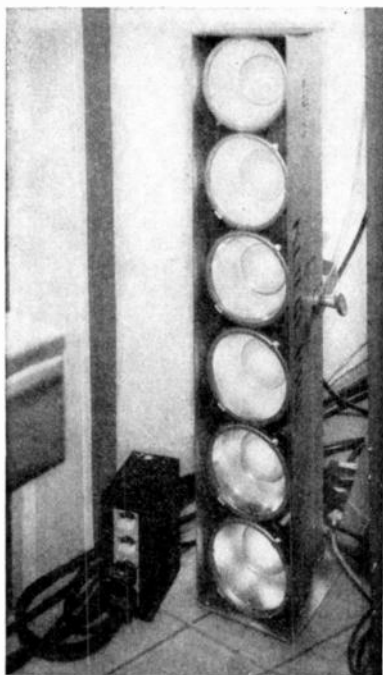


Fig. 18-5. Strip lights.

from just behind the edge of a set. It is frequently used for background light. One studio, which uses semipermanent sets, attached a strip light to the top of each flat, out of camera range, but in position to flood the face of the flat with light. The strip light is built with reflectors for standard lamps or without reflectors (at a very great saving) for the use of R40 lamps.

Strip lights built with two 42-inch Slimline fluorescent tubes are also available (Century) and can be used for the same purpose. They are good for creating a graded tone on a flat background surface. Century also makes a particularly intense (1,200-watt) mercury-vapor strip light which can be used when more light is needed.

The following floodlights are transitional forms which have some of the qualities of the spotlight and may perform many of the same functions.

THE FOCUSING SCOOP

The width of the beam that a scoop throws out is dependent on the position of the lamp within the reflector. In this particular light the bulb can be moved back and forth to produce the wide beam of the regular scoop or a narrow soft-edged spot very similar to what a fresnel-lens spotlight of equal wattage would produce. It was designed for floodlighting in studios where the ceiling height is 14 to 18 feet and the lights must be built for a long throw. It has a usefulness far exceeding the production of floodlight, however, and should find increasing use as a source of modeling light. The amount of spill light coming from the large reflector would make it unsuitable for back lighting unless some means were found to mask off the unwanted rays and keep them out of the camera lens. Kliegl calls this unit the "long-range scoop" and can equip it with a 750- to 1,000-watt lamp. These particular lamps are rated at 1,000 hours.

THE BEAM PROJECTOR

The beam projector operates on the principle of directing all possible light from the lamp backward into a highly polished parabolic reflector

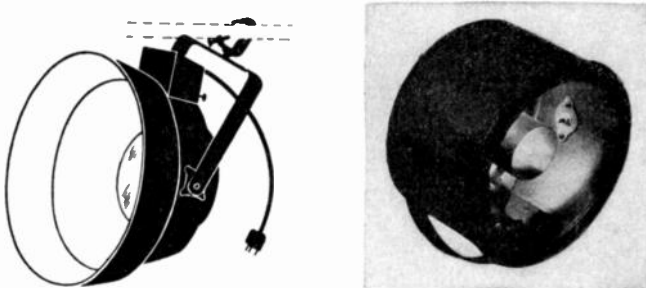


Fig. 18-6. Left, focusing scoop; right, beam projector.

which then focuses the light into a high-intensity narrow beam. This also produces a rather hard light. The interior of the lamp housing is painted black so that there is little light emanating outside of the direct beam. Century makes these units in a small size which will take a 250- to 750-watt lamp, and both Century and Kliegl make a larger unit which will take up to a 2,000-watt lamp. The smaller unit has been used for background lighting when hard distinct streaks of light across drapes were desired. A softer light would not have cast the sharp-edged streaks or brought out the texture and folds of the drapes.

FLOODLIGHTING BY REFLECTOR

The reflector is not a light, but a surface which reflects light coming from some other source. The size and texture of the reflecting surface will change the quality of the light, making it softer and more diffuse. Many kinds of reflecting surfaces can be used, depending on the need. At one end of the scale is the glass mirror or highly polished metal reflector which exhibits "specular" reflection. The light beam is only changed in direction; it is not altered. At the other end of the scale is the diffuse surface, such as white plaster or paint. A light beam reflected by such a surface is diffused in all directions by the myriad tiny facets throughout the surface, and it casts as much light (looks as bright) in one direction as in another. Neither of these is exactly what is necessary in creating floodlighting with a reflector. A surface which retains a semblance of the beam carries the light for a longer distance. Pebbled aluminum foil or silver paper works well for the purpose in television as it has in photography. In motion-picture work a pebbled gold surface is often used to reflect sunlight into the shadow areas of close-up shots. The warm color of the reflected light seems to be especially flattering to skin tones.

Reflectors have been suggested for various purposes in television lighting, but Karl Weger, at WPTZ, is the only one who has, to the author's knowledge, put them to use. Karl uses a pebbled silver reflecting surface the width of the set and about 3 or 4 feet wide and bounces incandescents off it for base lighting. It is placed above the cameras in front of the set and produces a soft and shadowless illumination, coming from a rather low angle, which is ideal for base lighting. The actual light sources used are internal-reflector spots mounted a foot or two from the reflector. Although the studio at WPTZ is one of the best-lighted studios in the country, it illustrates only what can be done by the local station. The studio is small, and the lights are placed in a semipermanent arrangement, covering certain rather limited playing areas which are not changed very greatly from one show to the next. The reflector panels and R40 lamps mentioned above, for example, are permanently installed and are not subject to any type of adjustment. In a larger

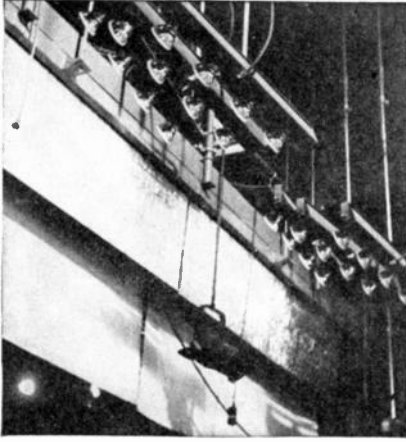


Fig. 18-7. Aluminum-foil reflectors used by Karl Weger at WPTZ. These were inspired by a stage-lighting technique used by Mariano Fortuny shortly after 1900 and have been nicknamed "Fortuny reflectors." The white board hanging below the reflectors is only a baffle to keep unwanted light off the studio beyond.

studio, where playing areas will change entirely for each production, movable and adjustable fixtures are necessary. Readjusting both a reflector and the light which shoots into the reflector would be a much more complicated procedure than simply directing a scoop or a fluorescent bank.

THE FRESNEL SPOT

The term "fresnel spot" covers all types of spotlights which are equipped with a fresnel lens. These lenses, easily recognizable by the concentric grooves, or steps, on their front surface, form the light into a soft-edged beam. Within the spotlight, the lamp and reflector are movable and can be adjusted by a screw-and-crank arrangement in the larger lights or by a simple slide mechanism in the smaller ones. As the lamp bulb is moved closer to the lens, the spotlight beam is widened out; and when the lamp is moved as far back in the housing as possible, the spot is at its narrowest. If the spot were to be made any narrower by further adjustment, the lamp would be coming into the focal point of the lens and an image of the lamp filament would be cast on the scene.

Fresnel spots are made in some six or eight different sizes, depending on the manufacturer, and range from the tiny 100- to 150-watt "dinky-inky," with a lens only 3 inches in diameter, to the 5,000 watt "senior," with a 14- or 16-inch lens. Neither of these extremes is often used in the

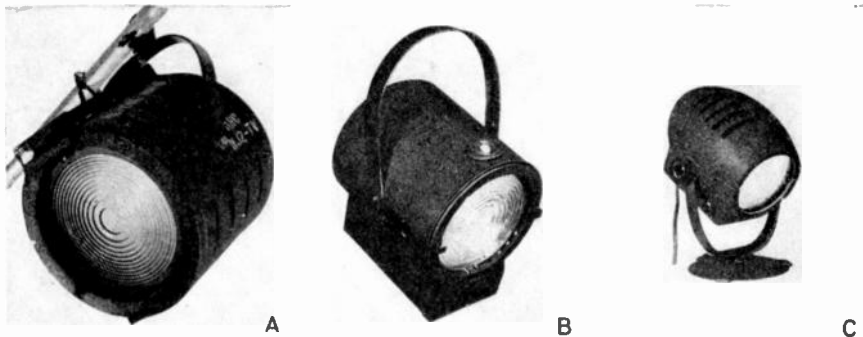


Fig. 18-8. Three typical fresnel spots: (A) Kliegl, 2,000-watt; (B) Century, 1,000- to 1,500-watt; (C) Century, 250- to 750-watt.

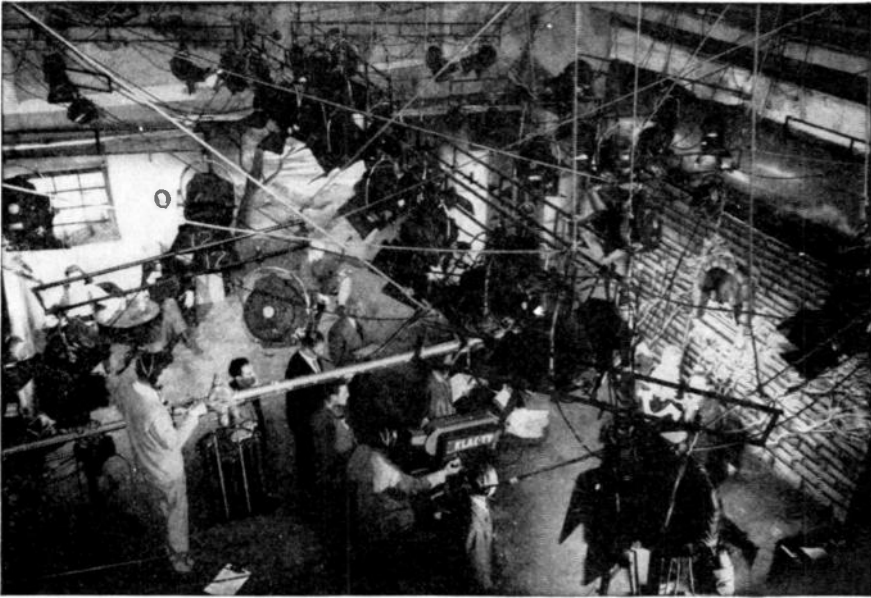


Fig. 18-9. Studio lighted entirely by fresnel spots. KLAC-TV, Hollywood. Lamps are Bardwell McAllister keg-lights.

television studio, but the 750-, 1,000-, and 2,000-watt sizes are everywhere to be seen. Some of these units may take several sizes of lamps (Fig. 18-8).

The incandescent spotlight is the backbone of photographic lighting. Motion-picture studios use it almost exclusively. The studio of KLAC-TV in Los Angeles, strongly influenced by Warner Bros. production methods, uses nothing but spotlights for its entire studio lighting (Fig. 18-9). By controlling some of these lights on dimmers, "flooding them out" to the widest beam, and adding diffusing screens in front of them, a soft fill light can be obtained.

THE PROJECTION SPOT

This type of spotlight projects a sharp-edged spot which can be focused and also shaped into any rectangular shape desired. A reflector is used which is ellipsoidal in shape, and this concentrates more of the light into the lens. Whereas the usual spotlight design places the lamp ahead of

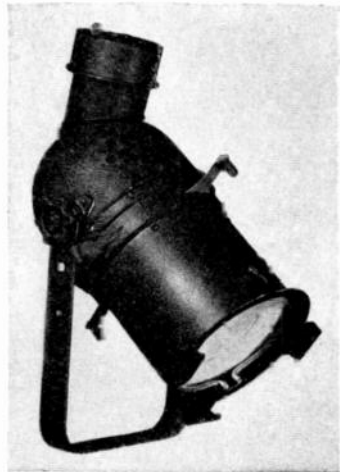


Fig. 18-10. Projection spot (Century LekoLite).

the focal point of the lens so that an image of the lamp filament is not projected on the scene, this type of unit avoids that effect by placing the lamp *behind* the focal point of the lens. Shutters can then be placed in the focal plane, and a sharp-edged image of these shutters is projected. There is no spill light. Tests have indicated that this design of light is about three times as efficient as the regular spotlight. Century claims 30 to 40 per cent efficiency for their Lekolite, which means that 30 to 40 per cent of the total lumens emitted by the lamp is to be found in the projected beam. This is exceptionally high.

Projection spots can be equipped with iris shutters if desired, or special patterns may be inserted in the focal plane if the unit is adapted for this purpose. They are excellent for long-throw highlighting of small areas. Kliegl makes this type of light in two sizes: the junior, which will take from a 250- to a 750-watt lamp; and the Master Klieglight, which will take 1,500- or 2,000-watt lamps.

THE LARGE PROJECTION SPOT

These are the largest light units used in the television studio. They are 43 inches long and built on the same principle as the units just described, except that a 3,000-watt lamp is used. An iris shutter in the focal plane can be adjusted to give a sharp-edged spot of any size, and curtain shutters top and bottom can form this circle of light into a wide oblong shape (Fig. 18-12). There is an extra lens inside the unit which can be quickly put in place, and this has the effect of spreading the ordinarily narrow beam to twice its width. The maximum spread is about 24 degrees with the spread lens, 12 degrees without. These lights are primarily intended for long-throw purposes. In theatres which have been adapted to television, one will usually see two or three along the balcony rail. While one of these may be used as a follow spot for theatri-



(a)



(b)

Fig. 18-11. Large projection spots: (a) Century Lekolite; (b) Kliegl Dyna-beam.

cal effects, the other two are used for front fill light (in the spread-beam adjustment).

Since the Dyna-beam unit is very large and heavy, it is never mounted above the studio but is always used on a floor stand. If it is necessary for its light to come from a high point, it may be placed temporarily on a platform for the purpose.

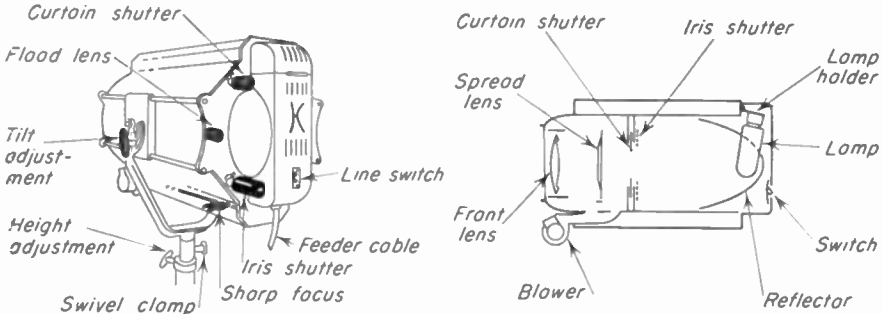


Fig. 18-12. Construction of Dyna-beam spotlight.

MOUNTING OF LIGHTS AND CONTROL OVER DIRECTION AND QUALITY

Although many of the smaller stations have equipped their studios with permanently mounted lights which cannot be adjusted in any way (except to be turned off or on selectively), any studio which attempts to do artistic lighting will have given considerable thought to control. A light must be placed where it will give the best effect. It must be directed toward the proper subject. Often it must be changed in quality by the addition or removal of diffusing screens. Barn doors and goboes must be adjusted to prevent spill light from reaching the camera lens or to keep the light off certain areas of the scene.

In lighting for still photography, where all the lights rest on floor stands, the photographer has only to reach out, and he can quickly make any adjustment he wants. In motion-picture work, although the photographer may not handle the lighting equipment, every light is under manual control. If a light is to be adjusted, an electrician can be quickly beside it, with his hands on it, making adjustments according to the cameraman's directions. In television, on the other hand, lights must be kept off the floor and consequently are relatively inaccessible. Several methods of reaching these lights have been devised, none of which is entirely satisfactory.

THE PIPE GRID

The use of a pipe grid is perhaps the most common method of handling lights in television studios. Heavy pipes are run across the ceiling, 4 to

8 feet apart, and anywhere from 14 to 20 feet above the studio floor. A similar set of pipes is run at a right angle to these. Lights are clamped to the pipes. This allows one to place a light in any part of the studio ceiling; and if the pipe squares are 4 feet wide, the greatest compromise between where a light should be and where it can be placed is 2 feet. This is only mounting, however; what about control?

In this kind of installation lights are usually adjusted by the ladder method. Setting up a ladder is slow; it ties up the rehearsal while a light change is made; it requires a couple of men (one to hold the ladder), in addition to the light man or director who is watching the effect of the light. The advantage, however, is that the electrician gets his hands on the light. Some good remote-control devices have been developed, but these usually go no further than directional control. There is only one device (Century) which provides a method of focusing a spot by remote control. Diffusing screens can't very well be put in place at the end of a stick, and adjustment of barn doors is awkward. At least for spotlights devoted to modeling or back light, direct manual control is necessary.

Where general base light is concerned, however, no such accurate control is necessary. Units which supply the basic fill can often be permanently mounted and simply redirected when sets are changed. The electrician rarely has to go up the ladder to change the position of a fluorescent bank to another part of the grid, unless the new set is in some entirely different area from the previous one. Adjustment in rotation

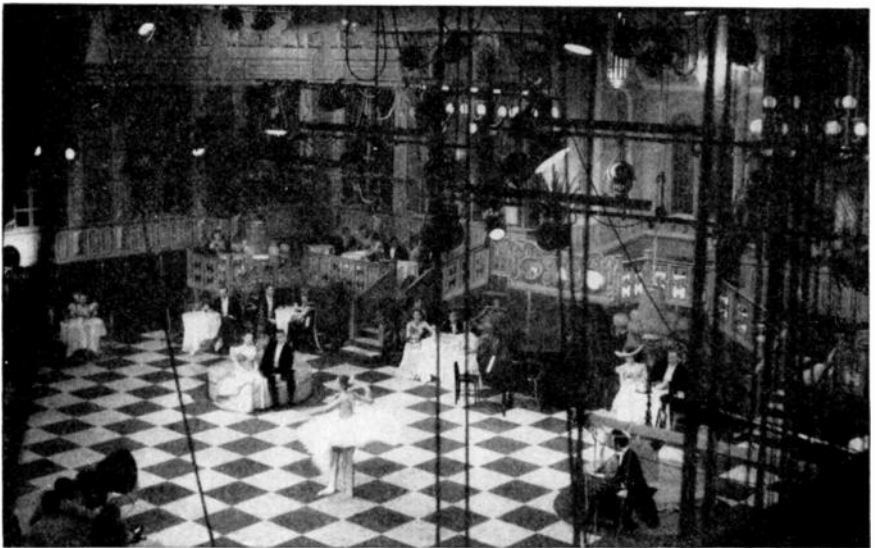


Fig. 18-13. Lights mounted on counterweighted battens (ABC-TV, New York, Studio 1).

and tilt can be accomplished from below in many cases, by using a stick with a hook on it (often only a stage brace will do) and simply pulling the bank of lights around into the desired position. The author has seen the basic fluorescent banks (of a studio which used only base lighting) completely swung around and redirected toward another set in the 30 seconds between the end of one program and the start of the next.

An alternative method to that of installing a crisscross pipe grid is to put in permanent battens (single pipes which run in only one direction). This does not give quite the freedom for placing a light exactly where it is needed; but for base lighting, exact position is not too critical. The battens, or the cross-grid work, is sometimes built with 8-foot spaces between the pipes, when it is only to be used for base lighting.

COUNTERWEIGHTED BATTENS

The counterweighted batten is an old stage device. In the theatre, pipe battens the width of the stage are suspended by ropes, and on these the spotlights used for specific lighting are mounted. It is only when the studio is completely clear that battens may be lowered to the floor, however, and television studios are rarely known to be clear for any length of time. Besides, adjustments of lights can be made only after the sets are up. The result is a recourse to the ladder method.

Mounting the lights on a batten is convenient only when they are first being installed, or in case it is decided to change the height at which all the lights are hung, or when wholesale changes must be made. The large ABC studio in New York (Fig. 18-13) is provided with batten mountings. In this particular studio, some productions are done which require tremendous space and great ceiling height, and the battens make it possible to raise the lights for these shows.

THE POWER RAIL

Several television stations have experimented with a light-mounting method in which the lights hang from a power rail and can be slid back and forth along it without interrupting the flow of current. This is called Feedrail by one manufacturer, Trol-E-Duct by another.* Figure 18-14 is an early picture of the WCAU-TV lighting setup, where the fluorescent-base-light units are clamped to a catwalk or to pipe battens, while the spotlights are made more adjustable by being mounted in the sliding ducts. Adjustment is quick by this method and can be made with a stick from the studio floor but is limited to only one line. Any adjustments in height of the spots or beam spread must be done on a ladder.

* Feedrail, Feedrail Corp., 125 Barelay Street, New York 7, N.Y. Trol-E-Duct, Bulldog Elec. Products, Detroit, Mich.

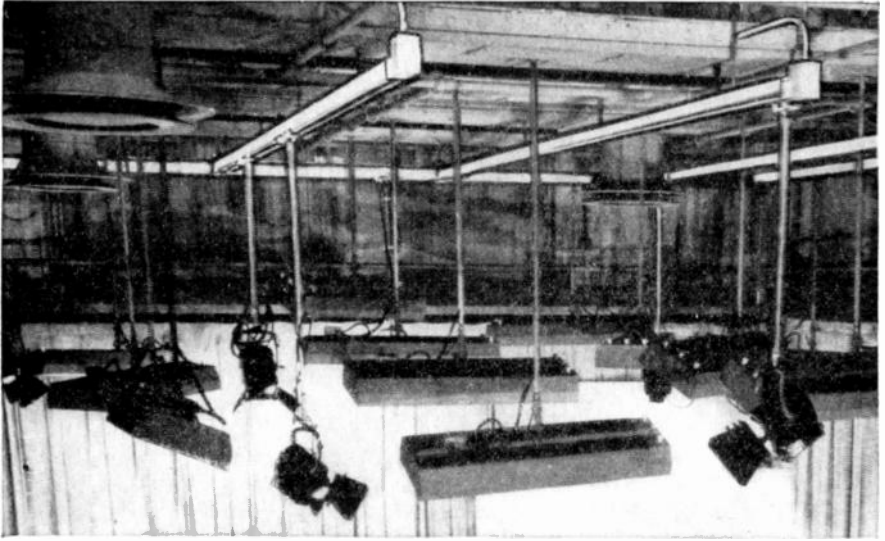


Fig. 18-14. Lights mounted on a power rail (WCAU-TV, Philadelphia).

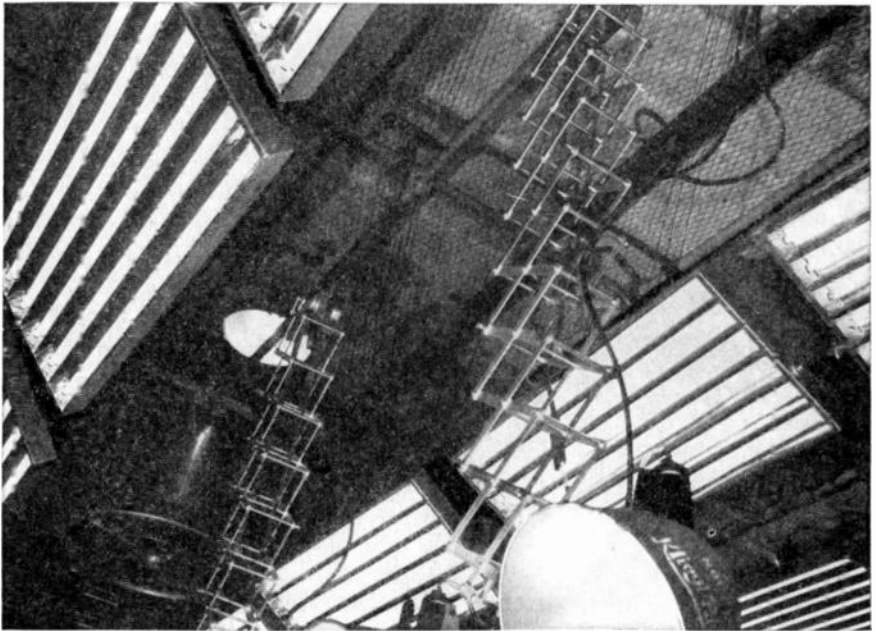


Fig. 18-15. Lights mounted on individual pantographs (NBC-TV, New York).

INDIVIDUAL LIGHT MOUNTINGS. CONTROL OF ELEVATION

Many of the studios are using a type of pantograph, or lazy-tong, mounting which enables a man with a hooked pole to pull the light down to camera level or push it up against the ceiling. Figure 18-15 shows an NBC studio equipped with these adjustable devices. Beam spread, barn doors, etc., can be adjusted by lowering the light within reach, and final directional adjustments can be made after the light is again raised to operating position. These mounting devices were developed by Display Lighting, which also makes a "sky hook"—a vertical telescoping pipe provided with a counterweight to balance the light unit, so that it will rest at any extension. Counterbalancing in the lazy-tong variety is achieved by means of a spring which can be adjusted to match the weight of the light that is used.

CATWALK

The idea of providing a means whereby electricians could move around above the studio lights and make adjustments from above rather than below has been put into practice in many studios (Fig. 18-16). Catwalks are usually placed at a height of 15 to 20 feet from the studio floor and extend around the sides of the studio. Some only run along one side or one end and an end, but others not only encircle the studio but cross it in one or more places, depending on the studio size. When a catwalk is

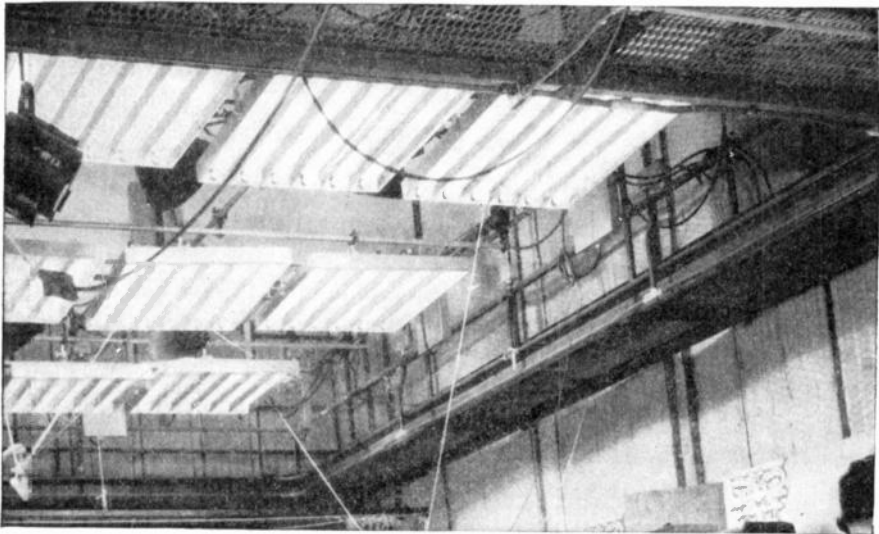


Fig. 18-16. Typical catwalk in small television studio (WPIX, New York). Note ceiling light, poor practice in studio lighting.

used, the light man will generally spend most of his time up there and his control center, dimmer board, etc., are located there as well. The catwalk is provided with a rail, to which spotlights may be fastened. Since these are around the sides of the studio, they are in good position to be used for back lighting. Unless the catwalk crosses the studio, however, many other modeling lights must be mounted in the middle of the studio and will have to be floor-controlled.

A disadvantage of the usual catwalk is that it is difficult to light anything properly which happens to be set just beneath it. Strip lights have been mounted below catwalks, but they give only top light, which is not too desirable. Back light and crosslight are the problem. In a small studio it is always desirable to set scenery right up to the studio wall, and the space beneath the catwalk cannot be sacrificed. If in studio construction the catwalk space were taken from some other portions of the building, so that the catwalk were built over a hall running alongside the studio, for example, this problem would be eliminated.

Another factor which has operated against the use of catwalks in television studios is that the stagehands' union has required a second electrician when lights are handled from the catwalk. There must be a man on the studio floor at all times. This has been impossible for many small studios to comply with; so catwalks, useful as they might be, have not been built.

A variation on the catwalk has been in use at some of the CBS studios in New York, where narrow walks of planking have been laid down over the entire studio above the pipe grid. This enables the electricians to reach at least the clamp which mounts a light, even though the unit itself may be hung on a rod which puts it several feet lower down. Cables, connectors, outlets, and so forth, are also readily available to the electrician above the set. This is the most practical method of light control which has yet come to the author's attention.

REMOTE-CONTROL METHODS OF HANDLING LIGHTS

The first remote-control method was worked out by Capt. Bill Eddy in the first television studio in the country, NBC's Studio 3H at Radio City in New York. It is still in use today, and many like it have been installed in studios throughout the country. Captain Eddy's system involves the use of ropes (nylon cord in the current version) which run from each unit to a control panel from which they can be operated. Three cords run to each unit (Fig. 18-17). The center cord is for tilting the unit: pull it, and the light tilts up; release it, and the lamp drops down to horizontal. The other two cords control rotation and are really one cord, continuous from the lamp, to the control board and back to the lamp again. Pull one cord and the lamp turns in one direction; pull the other, and it turns back again.

Most of the studios which have installed this system use it primarily for controlling the direction of their base lights. Units of all different types can be placed on these controllable mounts. The manufacturer, Television Associates, suggests a basic pipe grid, with pipes 7 feet apart, on which these light units are permanently installed. Any remote-control method is necessarily permanent. One look at the maze of ropes on the

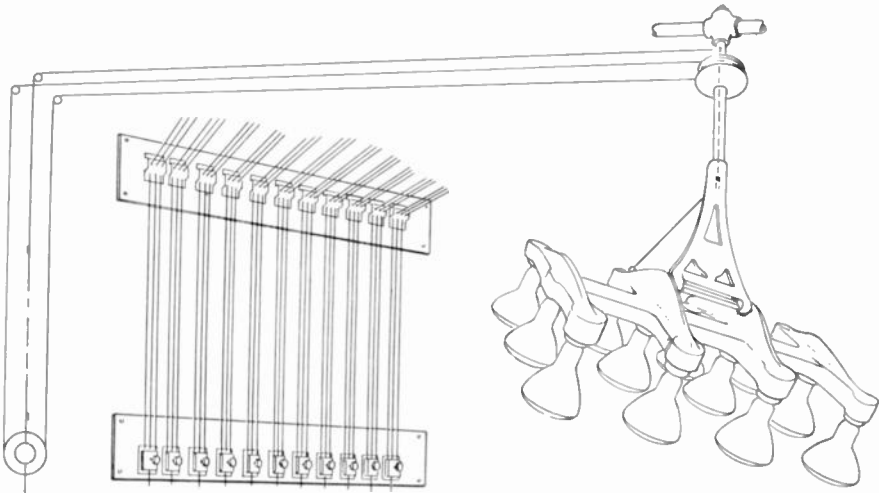


Fig. 18-17. Television Associates remote-control system.

ceiling of one of these studios will convince one of the fearful tangle of string that would result if any of the lights were repositioned. As long as they are being used for base light, however, they do not need to be repositioned. This or any other remote-control method does not seem to have much practical application to lights which are used for modeling and back light. These must be accurately placed and require many more adjustments than rotation and tilt. Spotlights are used on the Tele-line system, but it is the author's guess that their full value is not realized. Some studios have made no attempt to change lights between different shows but instead have set up certain lighted areas where modeling and back light are correctly adjusted for the regular camera positions and then design their sets and stage each show in accordance with the lighting. When this is done, remote control or any other type of lighting control except dimming is almost unnecessary.

OTHER METHODS OF MOUNTING LIGHTS

In a large studio such as the ABC studio in New York, there is room for a light tower (Fig. 18-18). Light towers are commonly used in motion-

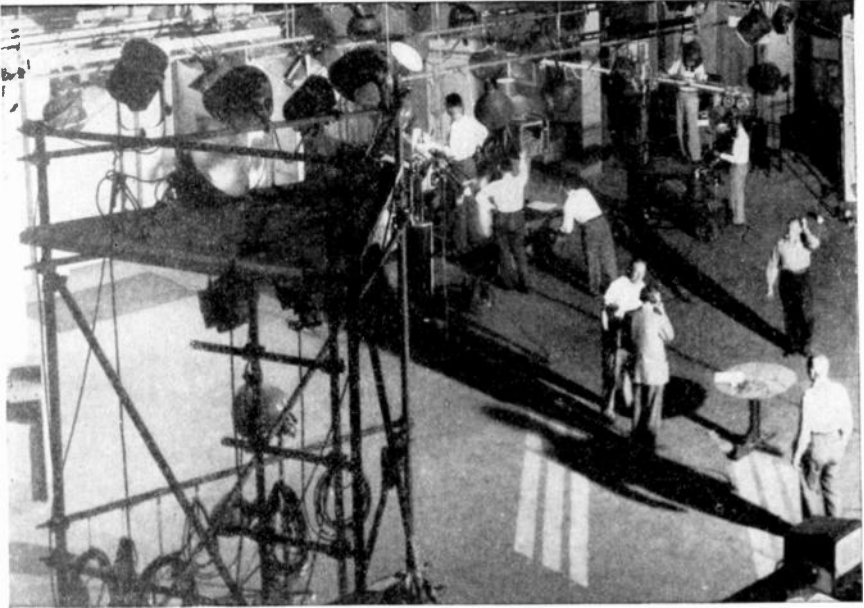


Fig. 18-18. Light tower (ABC-TV, New York).

picture studios, where there is room to move them about on the studio floor, but they have no place in the usual small television studio.

Lights on floor stands are generally to be avoided for the same reason; there is little enough room in most studios for camera movement, and every square foot of floor space is precious. Studios with top lighting, as previously explained, find they must provide considerable floor fill to eliminate unwanted undereye and -chin shadows. This is frequently achieved with banks of R40 floods. Banks of Slimline fluorescents, used vertically on the floor, provide the most light for the least floor space. Floor stands should be avoided for another reason also: studio noise. Floor units have to be moved as cameras reposition; they have to be lifted over camera cables. And every time they are touched, something is sure to rattle or clank (Fig. 18-19).

Some television studios experimented with spotlights on the end of a long "giraffe" boom mounted on a floor stand. Display lighting makes a very well constructed unit of this type. The spot can be raised and controlled remotely in rotation and tilt from the lower end of the boom, or it may be lowered to the floor for low effect lighting. Theoretically this type of unit could be used behind the set to reach up over for back light, but this rarely works out in practice, because it needs considerable floor space, and there is rarely room enough behind a set to get the unit in. A larger studio will have a few units of this kind for special uses, but the

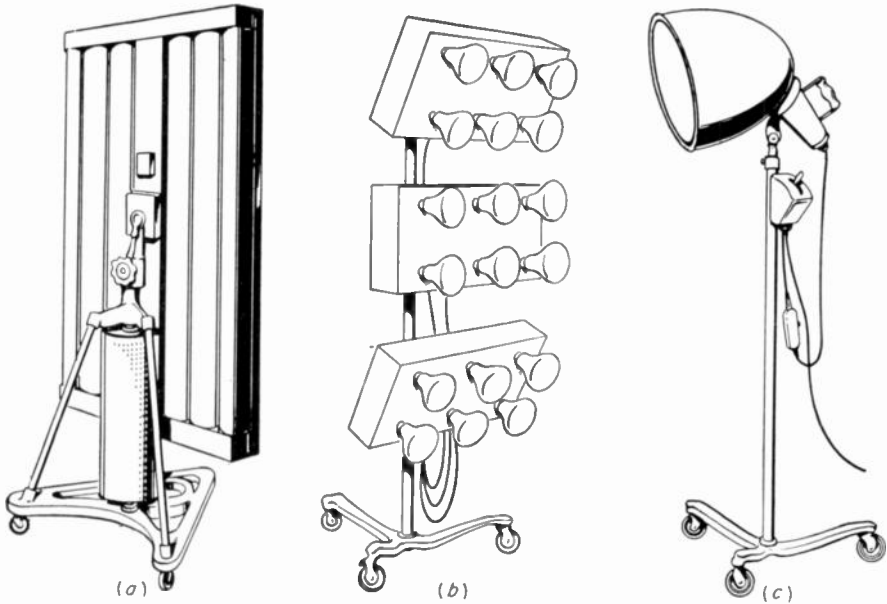


Fig. 18-19. Three types of floor units: (a) fluorescent bank; (b) banks of R40's; (c) scoop.

giraffe boom belongs properly in the photographic studio, where lights can be floor-mounted.

Fastening lights to the top of the sets is standard motion-picture practice, but television scenery is usually built of pine battens and muslin and will support little more than its own weight. Some studios, however, prefer to build sets of sturdier material, and some leave these permanently in place. In these rare cases, back lights are clamped to the top of the set. Some motion-picture studios use a hook for this purpose, which fits over the front of the set and carries a spot. KFI-TV lights each flat individually with a strip light for background illumination. Even muslin flats will support the weight of an R40 or a PAR 38 lamp in a small spring clamp and socket, and these are used occasionally for back light or modeling light on limited areas.

LIGHTS ON CAMERAS

It is standard motion-picture practice to mount a small eye light on the front of the camera. Sometimes several lamps are used surrounding the camera lens. Attempts have been made, in TV studios which needed floor fill, to provide this with lights on the front of the cameras. When more than one camera is used, however, the off-the-air camera, in repositioning, sweeps its light across the set, producing a noticeable effect.

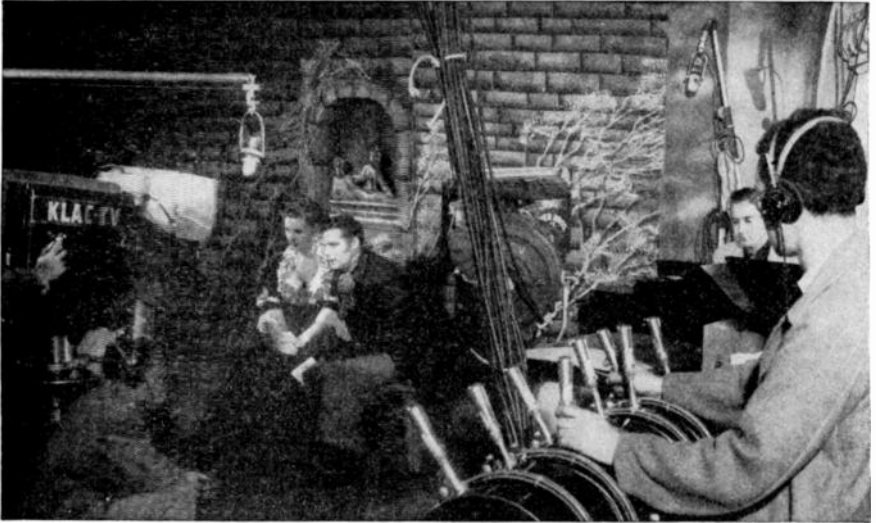


Fig. 18-20. Fill light on front of camera (KLAC-TV, Hollywood). Portable resistance dimmer in foreground.

KLAC-TV in Los Angeles solved that problem by automatically switching the camera-fill lights off and on as the cameras were switched. This was accomplished through the use of a relay actuated by the camera tally light, one of the two on the front of the camera (Fig. 18-20) being sacrificed for the purpose.



Fig. 18-21. 150-watt fresnel spot used as fill light on front of camera.

There is another problem connected with camera lights also. When a camera dollies in to a subject, the light attached to the camera also approaches the subject and gains rapidly in intensity. This can be avoided only by individual dimmer controls on the camera fill lights and close vigilance on the part of the light man whenever the cameras are in close to the action. Some studios mount a dinky-inky on the camera and use it only when the camera is shooting from an unusual angle, such as from behind the set (through a door, a window, or a sliding picture frame) where there is no other fill light available (Fig. 18-21).

CONTROL OF LIGHT INTENSITY

Control of light intensity is achieved by means of dimmers of one type or another. Switching lights off and on is a method of controlling intensity, but crude because the changes must be made in perceptible steps, whereas in dimmer control the change is smooth and gradual. The manufacturers of fluorescent banks, for example, usually equip a six-tube unit with three switches, each controlling two tubes, and the intensity of the bank can be controlled in three stages. This type of control cannot be exercised during a show, however, but is valuable only for setting light levels beforehand. Although even the simplest studio installation will provide for a central control point at which all the light switches are located, some studios are in a more primitive state than that and change their studio lighting only by plugging or unplugging lamps.

The larger studios that attempt full-scale productions are all equipped with dimming equipment. Temporary dimmer boards of the type used in motion-picture studios (often leased from the firms which supply film-production units) are seen quite often (Fig. 18-20). As new studios are being built, however, permanent lighting-control boards are going in. A light-control position must be so placed that the operator can watch his effects in the studio as well as on his own monitor. He should be able to reach the lights and make adjustments easily without going too far from his control board. Various positions on the studio floor have been tried, and the stations which have catwalks above the studio have usually placed the light-control board on the catwalk.

There are four main types of dimmers, operating on separate electrical principles, which are found in theatres and are adaptable for television studios. These are (1) the resistance dimmer, (2) the reactance dimmer, (3) the autotransformer dimmer, and (4) the electronic tube dimmer.

THE RESISTANCE DIMMER

This is the standard type of dimmer used in most theatres. The dimmer consists of a long wire (compactly arranged into a circular coil) through which the current must pass before it reaches the light. An adjustable arm runs a contact around the coil and either shortens or lengthens the amount of resistance wire the current must pass through. The more resistor in the circuit, the less voltage is left over to light the lamp and the weaker the light will be. The rest of the voltage, however, is dissipated in heating up the dimmer. It takes just as much current to run a lamp which is dimmed way down as it does to run a lamp without a dimmer. This is inefficient in comparison with the other methods listed below. Because of the bulkiness of these dimmers and the heat they gen-

erate, plus their inefficiency in operation, many television stations are following the lead of the newer theatres in installing dimmers of the other, superior types.

THE AUTOTRANSFORMER DIMMER

Several types of autotransformer dimmers are on the market today and are being built into television dimmer-control systems. The Powerstat, the Autostat, and the Variac are the chief brands. The operating principle is similar to that of the regular transformer. The main-line current flows through a coil (the primary) which is wound on the same iron core as another coil (the secondary), which is in turn connected with the light.

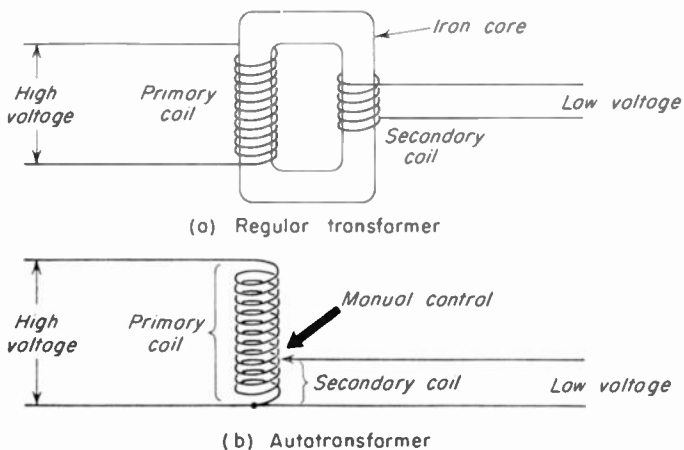


Fig. 18-22. Principle of autotransformer dimmer.

There is no direct connection between the two circuits; but when current flows through the primary coil, another current is induced in the secondary. This can be either a larger current with a lower voltage or a smaller current with a higher voltage, depending on the relative size of the coils. In the case of dimming a lamp, the voltage is gradually reduced. The autotransformer dimmer works on the regular transformer principle, except that the same coil is used for both primary and secondary. A sliding contact is run along the surface of this coil to change the voltage going to the light. Autotransformer dimmers can be built very compactly (they do not have to be cooled in operation), and both Kliegl and Century can furnish relatively small dimmer boards built around these units, which can be added to as the needs of a studio grow. Century will provide a remote-control board composed of small switches and levers which controls motor-driven autotransformer dimmers mounted outside the studio.

THE REACTANCE DIMMER

The reactance dimmer has been in operation in theatres such as the Radio City Music Hall for a good many years. It lends itself to remote control, so that the entire dimmer apparatus does not have to be mounted in the lighting-control board.

The principle is a little hard to grasp if one does not understand electricity. The alternating current flowing to the lamp passes through a coil which is wound around a second, or "control," coil. Through this control coil is passed a small amount of direct current. The passage of this current sets up a voltage in the main coil, which opposes the main-line current, cuts it down in voltage, and dims the lamp. With this method only the power which is used to light the lamps is being consumed; there is no heating up of the equipment. Besides, all that the light board needs to control is the small current which flows through the control coil, and the dimmers themselves can be installed elsewhere in the building. Reactance dimmers can also be built without a control coil, a movable iron core having much the same effect. This, however, requires mechanical operation instead of electrical, and remote control is more difficult. Reactance dimmers have not been installed in television studios, owing mainly to their high price.

THE ELECTRONIC-TUBE DIMMER

The most advanced and in many ways the most flexible type of dimmer utilizes electronic tubes to control the flow of current. The main lamp current flows through a thyatron tube which acts as a valve to allow greater or smaller amounts of current to flow. The action of this large tube is controlled by a smaller control current which can be remotely operated.

Being a remote-control system, the electronic-dimmer system allows one person to operate a great many lights in any possible combination, working from a seated position. The control location can be placed anywhere. The first lighting board of this design, built by George Izenour at Yale University, is equipped to handle 44 lights, but there is no serious limitation on the total number that can be controlled.

LIGHTING-CONTROL BOARDS

Most built-in dimmer installations in television studios are specially constructed to meet the specific needs of the particular studio. Whereas many television studios contain lighting switchboards which do not include dimmers, any studio which attempts musical or dramatic shows will be provided with facilities for dimming at least a certain proportion

of the total light units. Base light, for example, might never be touched during a dramatic show; the only lights in need of intensity adjustment would be the spots which create modeling and back light. On the other hand, when low-key lighting effects are desired, common practice is to keep the major highlights as they are and lower the intensity of the base light to something like a quarter of its normal level. Lights going off in a room, dusk falling in an exterior set, or theatrical effects associated with dance numbers, for example, would call for dimming the base lights. In any case, several lights are dimmed at once in nearly every light change, and the best television dimmer boards allow several lights to be fed through each dimmer so that they can all be taken down with the same motion.

Naturally the same lights will not work together under all circumstances, certainly not from one show to another. Often from one scene to another within a show the grouping of lights will change. This means that it should be possible to group any light units together and change that grouping at will. It is not possible to "pair" or "marry" lights, as is sometimes done in the theatre, so that they both are fed by the same cable and are controlled by the same switch. This might work for one scene or one show, but for the next only one of a pair might be needed, and they should be individually controlled, at least by switches.

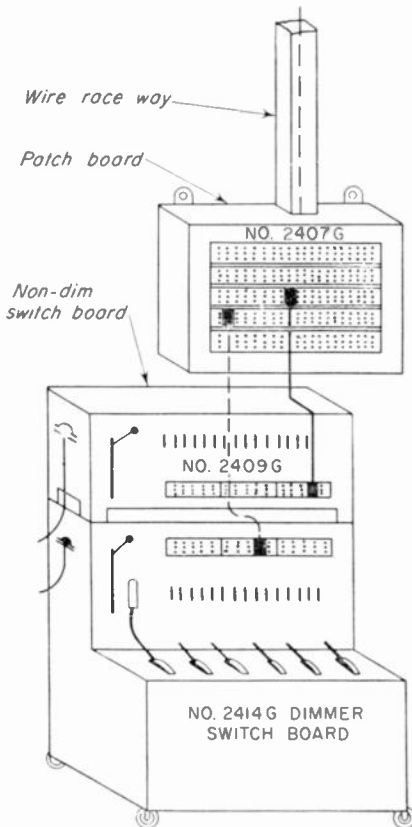


Fig. 18-23. Kliegl patchboard used with non-dim switchboard and dimmer switchboard containing five dimmers.

PATCHBOARDS

It is important that the light man have complete freedom in connecting whatever lights he wants to the desired dimmer controls. In a temporary setup, such as a great many television studios have, this is accomplished by leading the cable from every studio light down to a central point, where they all terminate in a great confusion of wire and terminal plugs on the

floor behind the control board. The light man has these marked in his own code and changes lights on the dimmer simply by hunting down the right terminal plug and plugging it in. A lighting patchboard is offered by Kliegl to simplify this process, which works much like an audio patchboard or a telephone switchboard, except that the terminals are much heavier to take the necessary lamp current. Each light is terminated in a connector on the board, of which there are 100. It is a simple matter then, and very well organized, to use short patch cords and connect the desired terminals on the patchboard with 15 or so dimmer connections on the dimmer board. Lights which are not to be dimmed are patched instead to a nondim board which is fed by the main-line current. It is possible to connect any set of lights to the dimmers, and these may be changed during the show if necessary.

One of the big advantages of this method of connecting lights to dimmers is that it is impossible to overload the incoming electrical circuits. The electrical code requires that the capacity of the incoming lines should equal the total wattage of lamps which it is possible to connect to them. Allowing for the fact that a studio may install a great many more lamps than it will use at any one time, the code allows a 15 per cent diversity from this total, and the incoming lines must be capable of carrying at least 85 per cent of the total wattage of all the light units installed. The result of this rule is that the capacity of incoming lines must either be very great or the number of light units installed in the studio is artificially limited.

The patchboard method removes this limitation, since although there may be any number of lights installed and any number of cables terminating in the patchboard, there are only so many female plugs on the patchboard (beneath the patchboard in Fig. 18-23) and this determines how the incoming lines will be loaded. Thus it is impossible to overload the incoming lines no matter how many lights are installed in the studio, since only a certain number of them can be plugged in at one time.

Figure 18-24 illustrates another type of patchboard manufactured by Century, in which 134 individual outgoing lines (lamps) terminate in patch cords much in the manner of a telephone switchboard.

These may be plugged into any one of 18 dimmers or 12 plain switches. The capacity of the dimmers (4 and 8 kilowatts) cannot be exceeded without burning out the dimmers; so the incoming lines cannot possibly be loaded with anything greater than the total rating of all the dimmers.

One of the disadvantages of the first type of patchboard lies in the human factor in its operation. It is not foolproof in a certain important respect. Despite the fact that the board may be clearly marked with the warning "Do not interplug while circuits are hot" and each outgoing line is clearly marked in respect to the exact lamp which is fed by it, electri-

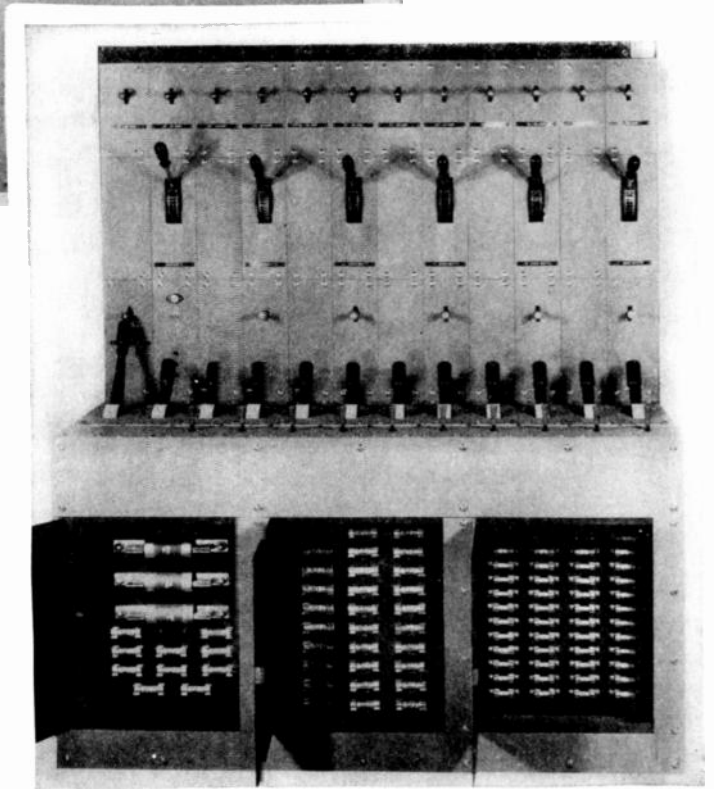
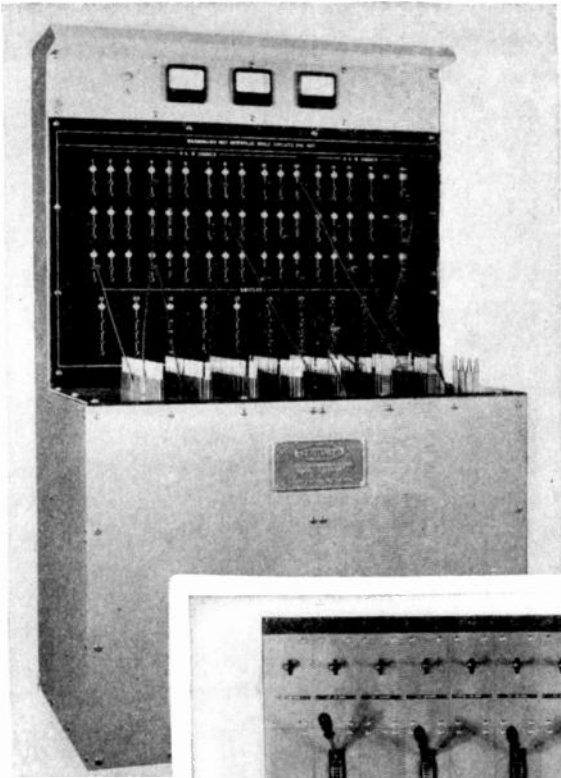


Fig. 18-24. Century patchboard in use at WABD, New York, with 134 lines, 16 dimmers. Above, patchboard; below, dimmer board.

cians find it easier to run the hot connector along the rows of male plugs, briefly lighting one lamp after another in the studio until they find the right one. Naturally this causes a certain amount of arcing, rapidly burning out the connectors. The Century board is not so likely to be misused in this fashion since the hot connectors are solid to the board and only the plugs feeding the outgoing lamp lines can be moved about. However, the board carries a clear warning "Do not interplug while circuits are hot," and the human factor must still be relied upon, or the contacts will arc and constant maintenance will be required.

THE ROTOLECTOR BOARD

A simplified method of connecting lamps to dimmers has been developed in Kliegl's Rotolector board (Fig. 18-25). When this equipment is in use, each lamp circuit in the studio terminates on the board in a rotary selector. Each rotary selector is surrounded by a series of contacts, representing 12 dimmer circuits. (In most boards there are only 10 dimmers, the other two circuits being nondim circuits controlled only by switches.)

Connecting a lamp to a dimmer is simply a matter of pulling out the selector knob (Fig. 18-25), turning it to the desired dimmer number, and pushing it back in. It has been unplugged and plugged in again to another circuit. As many lamps as desired may be connected to the same dimmer by selecting the same dimmer number on the Rotolectors, provided of course that the dimmer is not overloaded.

A circuit breaker is incorporated into the Rotolector which serves three purposes: it forms a convenient on-off switch for the light unit, it serves as an individual fuse for the lamp circuit, and it prevents arcing at the contacts because it trips automatically as the selector handle is pulled out, so that all plugging and unplugging is done cold. Master circuit breakers on each dimmer circuit will open if the dimmer is overloaded.

On all the patchboards described there is no satisfactory way to keep track of how much wattage is placed on each dimmer, except by examining the entire board and totaling up the wattages of the lamps which are plugged into each. However, this information is not necessarily provided even on the Rotolector board. White china-marking pencil can be used to write the wattage or description of the lamp on the face of the Rotolector plate, but this is hardly satisfactory.

The NBC Rotolector board in Hollywood has overcome some of these difficulties (Fig. 18-26). In place of the standard white pilot light on each Rotolector, lights of different colors have been substituted to indicate the wattage of the lamp in use. (Red indicates 2,000 watts, green 1,000 watts, etc.) Beyond this, NBC has had each dimmer equipped with its own ammeter to register the current it is carrying. Provided that the

dimmer is up full, a glance at the ammeter will tell the electrician immediately whether a particular dimmer will carry any more lights or whether it is already fully loaded.

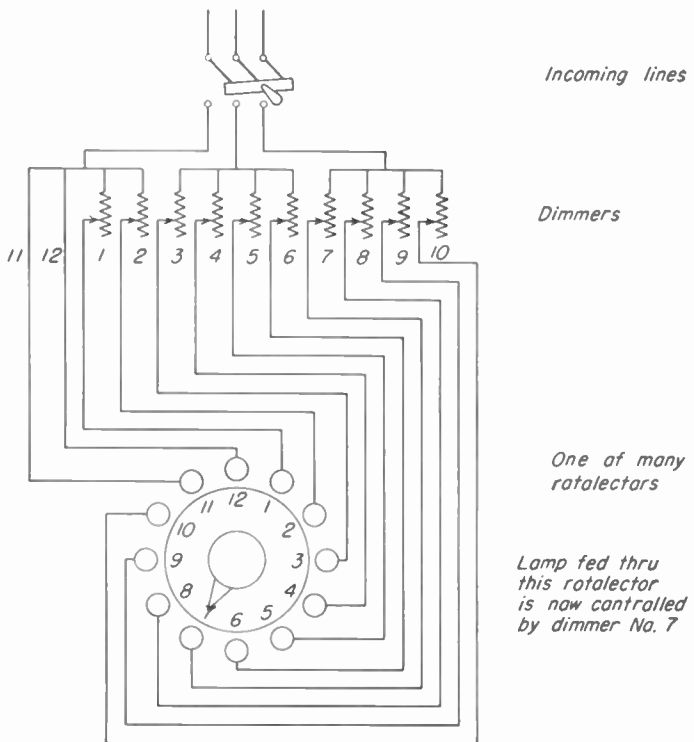
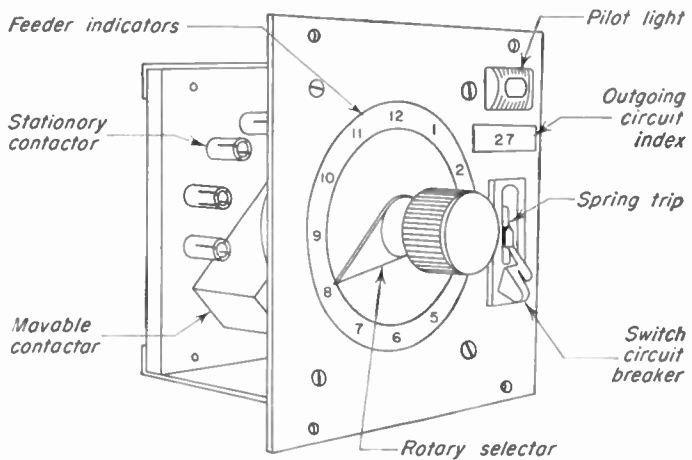


Fig. 18-25. The Rotolector unit and its relation to dimmer circuits. Each Rotolector is wired to the same dimmer circuits in this manner.

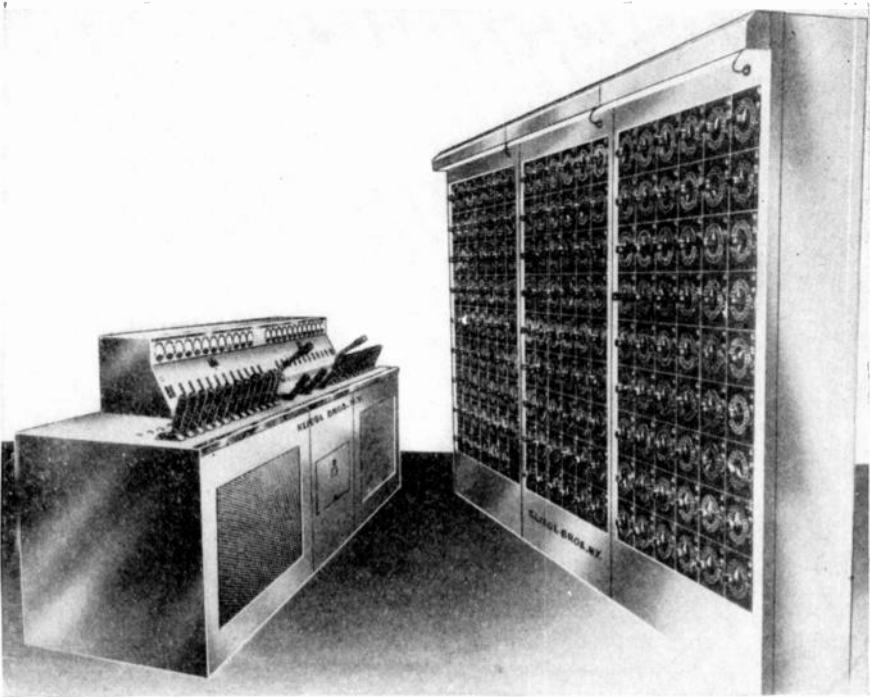


Fig. 18-26. Large Rotolector board (NBC, Hollywood). One hundred and seventy 24-contact Rotolectors are used; 24 dimmers.

PRESETTING

An important feature of the electronic dimmer board is the possibility of presetting. The operator may set in advance the level of the lights which are to be changed on the next light cue, and at the moment of the change he need move only one handle and every light changes to its next setting. The Yale Izenour board incorporates an automatic fader and 10 presets so the operator can be set up 10 changes ahead. The reactance dimmer board at Radio City is also equipped with 10 preset stages. However, in actual practice these full facilities are rarely used, even with the complex productions at the Music Hall. The electricians are quoted as having said, "If we get real lazy, we may set up four or five changes ahead." The "C-1" board offered by Century has 10 and the British board controlled by Kliegl incorporates only one preset, which should be enough for any normal operation (Fig. 18-27).

In design this electronic preset system is somewhat similar to a two-bus fading system, described in Chap. 7, Television Switching Equipment. A master fading handle "dissolves" from those lights which have been preset on preset channel 1 to those which have been preset on channel 2.

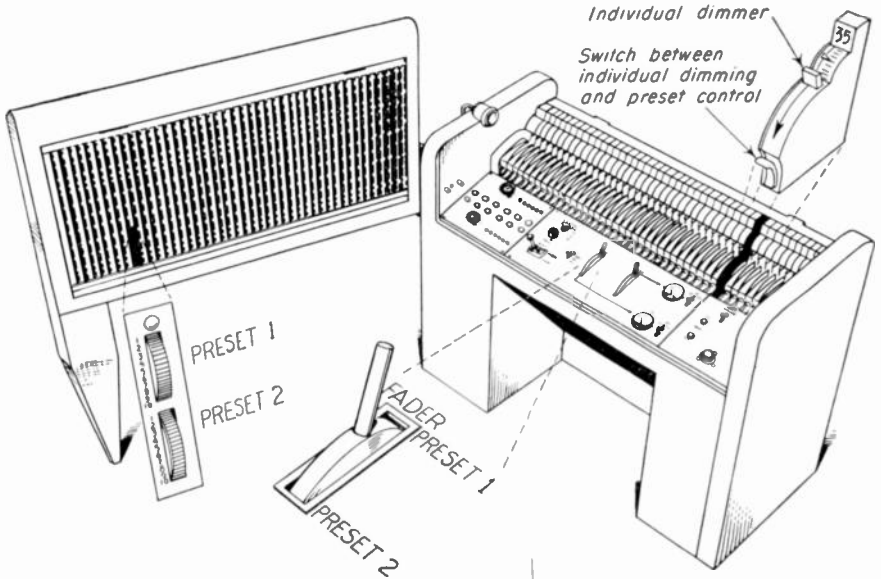


Fig. 18-27. Control board and pre-set board for electronic-tube dimmers.

Individual lights may be switched onto the preset system or out of it if desired, in which case they are operated by their own individual dimmer controls. This is important, since it would be a great waste of time to preset every light in the studio for a change involving only one or two lights. (If such a change were made by the preset method, all the lights which did not change would also have to be preset for the same level they had just had.)

SPECIAL-EFFECT LIGHTING

Firelight. The light from a flickering fire, cast on the faces of a group around the fireplace, is frequently called for. A spotlight is placed at

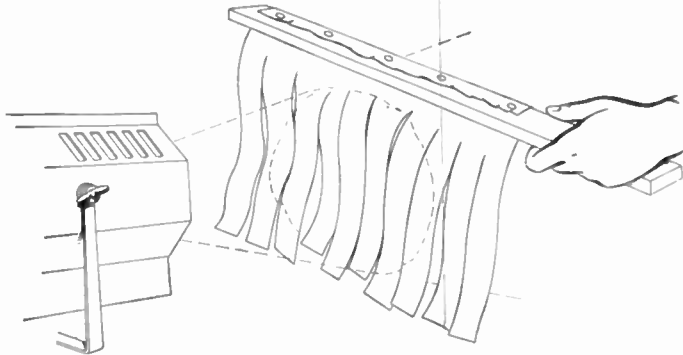


Fig. 18-28. Firelight-effect method.

floor level in the approximate location of the fireplace, to cast light upon the faces. Then a piece of cloth cut into ribbons is fastened to a stick and shaken in front of the light. This creates an uneven flicker (Fig. 18-28) which is more realistic than the Gloccamorra, which is sometimes used for this effect (Fig. 18-29).



Fig. 18-29. Gloccamorra for firelight or other uneven or flashing light.

Lightning. Very often the effect of lightning does not call for the entire set to be bathed in sudden flashes of light; only the scene out of a window or onto a terrace needs the effect. A special floodlight of very high intensity can be built by mounting half a dozen sockets on a board and lamping them with internal-reflector photoflood bulbs. These bulbs are similar to the R40's except that they burn for a shorter time and with a great deal higher intensity. All six are controlled by a single switch. Lightning is used as a back- or crosslight only, never from the front. Front lightning would illuminate everything evenly and give no better effect than turning up the gain electronically for brief flashes of overexposure.

Passing Lights and Shadows from a Train Window. The effect of passing lights calls for a smooth movement which, although spaced at random, should not be irregular in speed. It requires a rotating disk or drum in

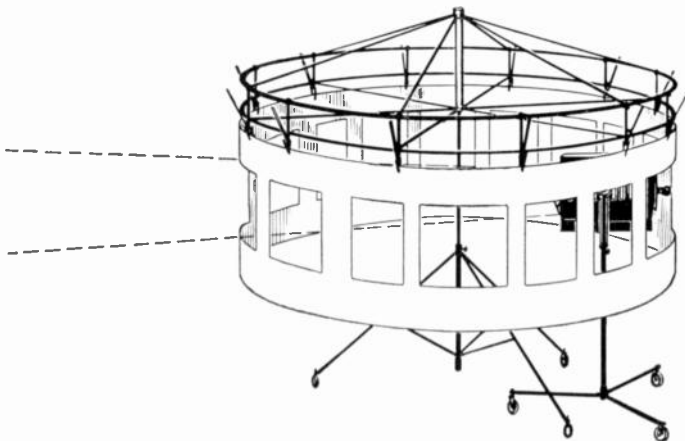


Fig. 18-30. Cyclodrum.

front of a light. The Gloccamorra (Fig. 18-29) is usable when the effect is to be seen on the faces of people sitting near the window. If it is to register instead as moving shadows across the window, it will be accomplished by rear projection on the back side of tissue paper, oiled duck, or other translucent material. The circular-disk movement of the Gloccamorra may be undesirable here; so instead a horizontal drum called the cyclodrum is used (Fig. 18-30). Sometimes the problem may be to show the lights of a moving train go flashing across the faces of people standing



Fig. 18-31. Frank Gallup on the NBC program "Lights Out."

on the platform. Either of the above devices can be used, but a drum of mirrors is more frequently employed, especially in motion-picture studios. Pieces of mirror are mounted around a vertical cylinder, and the light from a single spot is reflected off this cylinder onto the scene. Each small mirror casts its own area of light, which looks like the patches of light cast by moving windows. The intensity of this light does not have to be very great, since a moving area of light or shadow is always clearly defined.

Bizarre and Grotesque Lighting.

When the main source of light comes from an angle opposite to what is usually accepted, a bizarre effect is achieved. This means low light, from in front, either directly below or crosslighted from the side. Sinister effects, scenes in hell, grotesque characters are all enhanced by low light. The host who introduces NBC's "Lights Out" program is a typical example (Fig. 18-31) of how a perfectly friendly fellow (Frank Gallup) can be transformed into the embodiment of evil by a little acting on his part and a lot of low light. Low front light is also of very great value in creating theatrical effects involving large shadows thrown against a cyclorama behind a dancer. Chapter 12 includes a discussion of the problems involved in creating shadows and silhouettes, which has application here.

Texture Lighting. It is sometimes desirable to light an object in such a way as to bring out the texture of its surface. The reverse of this is usually true in lighting the human countenance, where the texture often gives an undesirable effect and lighting must be arranged so as to elim-

inate it as much as possible. Texture is, of course, the tiny hills and valleys in the surface. Light from the camera's angle or flat light of any kind will illuminate hills and valleys equally, and no texture will be visible. A hard light shooting across the surface from a point which is almost in the same plane will bring out every detail. The tiny hills cast long shadows just as mountains cast shadows in the light of the setting sun.

PROJECTED BACKGROUND PATTERNS

Much can be done in television lighting to provide background patterns by the simple method of front projection. In a studio which does not provide a great variety of elaborate scenery, the light man should be

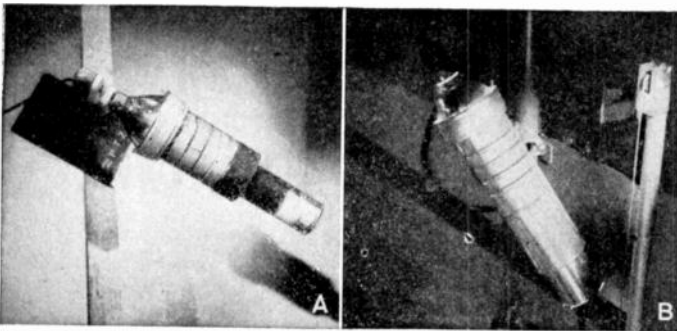


Fig 18-32. Karl Weger's fuddle projectors. (A) Projector is made of tin cans and fastened to standard clip-on shield; (B) improved projector (longer owing to different focal-length lens in snoot). In this one the projector supports the bulb rather than the other way around. Slide rests on shoulder where the two large cans are soldered together, placing it just short of the point where the rays from the PAR 38 bulb converge. Length of small can is adjusted to focus slide at the most-used projecting distance.

able to supply a change of background pattern. Karl Weger at WPTZ has developed this technique further than anyone else in the industry and is able, with a few simple units of his own construction, to create the effects of shafts or patterns of light in great variety. His principal tool is a tin-can spotlight of the projection type built around a PAR 38 spot-type lamp (Fig. 18-32). Two tin cans are used, a larger one about the diameter of the lamp, with a smaller one soldered in front of it like a snoot. The second can is as long as the focal length and as large around as the diameter of a lens mounted at the front end. Thus a projection spot is obtained, with a focal plane at the point where the two cans are joined together. A cutout pattern may be placed in this plane and it will be projected. These cutouts are called "fuddles" at WPTZ, a term which Karl Weger invented accidentally but which seems to be necessary, since nothing else will quite describe them. A fuddle is a cutout pattern which is projected more or less sharply onto the scene. Fuddles are made of thin aluminum in order to withstand the heat and can be used for innumerable

purposes (Fig. 18-33). The shadow of bars, venetian blinds, shafts of light streaming across a wall may all be projected from above and in front by means of some such simple device. A Lekolite or Klieglite spot can also be adapted for the purpose if an arrangement is made to slide a fuddle into the focal plane. The heat inside a projection spot, however, is

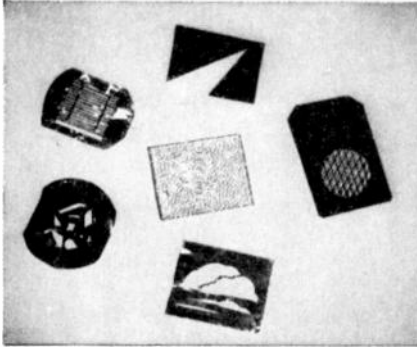


Fig. 18-33. Fuddle slides. Standard-size $3\frac{1}{4}$ - by 4-inch slides and one Lekolite slide (right) with metal lath. Upper left, venetian blind; lower left, geometric shapes (the true fuddle); top center, streak of light; center, piece of beaded glass (available in many patterns); bottom center, stylized clouds. (Photo courtesy of Karl Weger.)

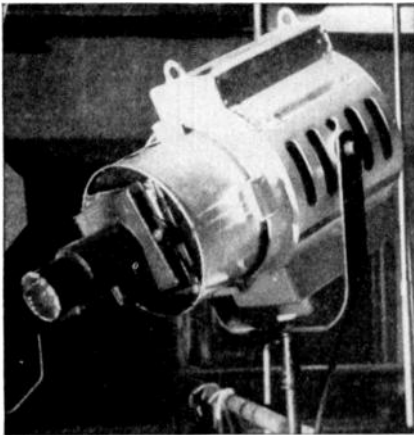


Fig. 18-34. Homemade projection spot. $3\frac{1}{2}$ - by 4-inch slide-projector head mounted by Karl Weger on a 2-kw fresnel spot. An extra fresnel lens has been added facing the original lens. The lamp-housing extension was made from a 5-gallon can. Objective lens in 4-inch-diameter magnifying glass mounted in tin cans. This projector can even use glass slides if they are cooled by an external blower. Will cover an area of $7\frac{1}{2}$ by 10 feet effectively.



(a)



(b)

Fig. 18-35. Projected shadows in WPTZ programs produced by fuddle projectors. (a) Abstract pattern; (b) streak of light. (Off-the-tube photos courtesy of Karl Weger.)

particularly great, and aluminum will not stand up very long. It has been found that metal caning (grillwork used to disguise radiators, etc.), which is available in a great variety of openwork patterns, is very useful for background patterns and holds up well in the focal plane of a Lekolite. If two of these perforated patterns are rotated against each other, an almost endless variety of changing geometrical patterns can be projected and this sparkling, changing effect is useful for abstract backgrounds



Fig. 18-36. Cucalorus used for background pattern on CBS program "Studio One."

behind singers, etc. This calls for a special lamp design, however, as it is impossible to reach the focal plane of the projection spot in order to rotate anything while the lamp is in use. Figure 18-34 shows a projection spot made very cheaply from a 2-kilowatt fresnel spot.

A cruder method of projecting background patterns involves the use of an ordinary 2,000-watt spot and a cardboard cutout known as a "cucalorus" (Fig. 18-36). Whereas this method is not as efficient as far as the intensity of the projected light is concerned, it can be used to project a larger or a softer shadow and so is equally valuable.

It has been found that a lower level of base light on the background flats can be tolerated provided that a pattern of some kind is projected onto the area. The use of the pattern thus solves two problems, retaining the low-key effect, since the major portion of the background area remains dark, and at the same time raising the level of electrical signal to the point where the total picture quality is improved.

19 TELEVISION AUDIO PROBLEMS

The relative importance of audio to video in dramatic television is a point about which there has been wide disagreement. The proper criterion to take, of course, is the end result, and it has been demonstrated many times that imperfect sound is less noticeable than imperfect camera handling, lighting, set construction, and a great many other visual elements of the program. Of course this generalization cannot apply to everything, and it is certain that those programs which are based on music or singing depend for their primary appeal on the most perfect reproduction of music which the sound department can achieve. A sacrifice of video to audio would in such cases be inevitable; in most other types of shows, however, the audio perfectionist must take a back seat.

SPECIAL PROBLEMS OF TELEVISION AUDIO

First of all, the source of sound, in television, is often in motion. Action must be free, and the microphone must be able to follow it around. Whereas in radio microphones are fixed and form the focal point of the dramatic-show production, in television they must follow along, all but forgotten by the actor, who is too concerned about his gestures, his expression, his movement, and consciousness of the changing red lights on the television cameras to think much about the pickup of sound.

A second problem is that microphones, at least in dramatic shows, must be hidden. This means that either they must be outside the frame of the picture, as with the ubiquitous boom microphone of the television studio, hovering always an inch above the top frame of the picture, or they must be disguised in some way within the scene. When the microphone is suspended overhead and moved about to follow the action, a problem of microphone shadow is created whenever the mike must pass through beams of light. This is less of a problem in the motion-picture studio because sufficient rehearsal is always available immediately before the shooting of a scene and the boom operator can usually find a route over

which to move the microphone which will not cast a shadow. In television, however, adequate rehearsal is notoriously lacking, and microphone shadows are a frequent occurrence.

The radio engineer who takes up audio handling in the television studio is usually aghast at the great distance from which a microphone must pick up dialogue. In radio, actors usually stand a foot or less from the microphone, and actors farther away than this are considered "off-mike" and sound as if they are in the background. It is seldom, however, that the microphone on the end of the television boom can reach closer than 2 or 3 feet from the actor, and often the pickup must be made from a distance of some 4 feet or more. Under these conditions room reverberations and background noise become much more noticeable, and television studios must consequently be made acoustically "dead," a problem which will be considered a few pages hence.

A fourth problem in the pickup of television sound is involved with the relation of sound to picture *perspective*. Close-up pictures require close-up sound, and distant shots must be accompanied by a quality of sound which seems to match the distance of the source. This is solved easily in motion pictures by making separate sound pickups for each shot. In television, however, shots are not made separately, but all at once, with a single microphone and several cameras, and if changes of perspective are to be made, they must be achieved during the continuous sound pickup either by moving the microphone or by altering the quality of the sound after it has been picked up.

AUDIO EQUIPMENT

The audio equipment which is installed in the typical television studio is very much like that which a large radio studio would have. There are outlets in the studio wall into which a certain number of microphones may be plugged, and an assortment of different types of microphones and various stands to hold them is provided. Each microphone outlet is numbered; a mike which is plugged into outlet 1, for example, automatically becomes mike 1 on the audio control console (Fig. 19-1).

The audio console consists mainly of a number of fading dials, or "pots" (short for potentiometer), each of which controls the volume of the microphone which is connected to it. There are other sources of sound also, besides the studio microphones (sound-film projectors, sound effects, turntables, remote sources), and these can also be controlled by pots on the audio console. The output of all these faders is mixed together into one outgoing channel, and one final "master-gain" fader at the far right of the console controls the level of this outgoing line. The fact that sound from many sources is mixed together in this manner has led to naming this portion of the sound-control apparatus the "mixer."

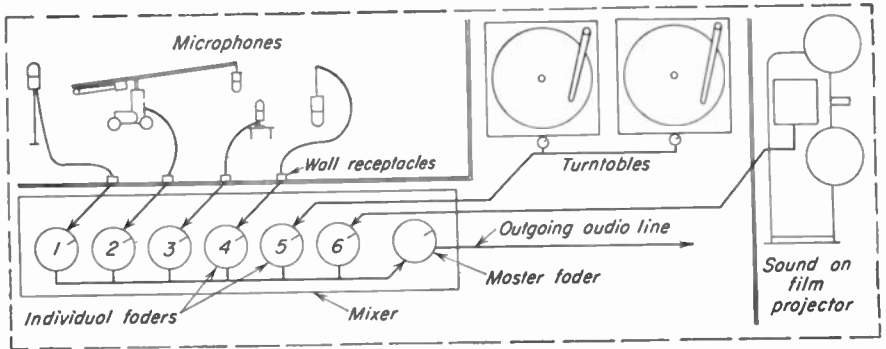


Fig. 19-1. Diagram of audio equipment in the typical small television studio.

Two turntables are usually provided in the television control room, within reach of the audio engineer, although in complex production he may have an assistant to help him with the records.

Another piece of audio equipment is usually provided nearby, the audio patchboard. This is usually a complete mystery to nontechnical personnel, looking more like a telephone switchboard than anything else, with patch cords and innumerable jacks into which they can be plugged. Actually it is a very flexible switching apparatus with which any item of equipment in the audio system can be isolated, taken out of its position in the circuit, or rearranged so as to replace some other piece of equipment which may be defective.

THE BASIC PROBLEMS INVOLVED IN PICKING UP SOUND WITH A MICROPHONE

Persons who are unfamiliar with the use of microphones are frequently amazed to notice how differently the normal sounds of a room appear when they are picked up by a microphone and heard on a loudspeaker in another room. Scuffling of feet, coughing, creaking of chairs in the back of the room are very evident and confuse the pickup of the main source of sound; street noises which would never be noticed at all in the room itself seem to be amplified out of all proportion in the microphone pickup. The main reason for this is that the microphone is inferior to the human hearing apparatus in that it consists of only one ear. All sound, to the microphone, is one-dimensional. It has no way of telling the listener in another room in which direction any particular sound is originating or (except by secondary characteristics of sound quality) how far away the source of sound may be. The binaural human apparatus can be selective. Knowing that some sounds originate outside the room, it can then eliminate these from the listener's attention. It is powerless to do this, however, when all sounds are given to it from a single source, the loudspeaker

in the other room. When the listener is in the same room with the sound itself, his two ears register different pickups of the same sounds. A sound originating at the left side of the room, for example, will sound very loud in the left ear and may not reach the right ear directly at all but be heard in that ear a split second later by reverberation from the right-hand wall. The audio center in the brain immediately evaluates this information and sends up a report to the center of consciousness that the noise took place at the listener's far left.

The result of using the monaural sound system is that studios must be carefully soundproofed to keep out street and building noises. The best radio studios are suspended by springs or rest on feet of rubber so that they are completely isolated from the rest of the building they are in and a rumble which might ordinarily find its way into the studio, transported through the rigid core of the building from elevator motors or traffic in the street, is absorbed before it can be heard. Some television studios have been built in this fashion, especially when they are situated in a newspaper building where heavy presses are running. Special acoustics are necessary in the radio studio, and silence in the background must be maintained. This is something which is very difficult to achieve in television. There is seldom a dramatic show on the the air which does not at some time or another puzzle the television viewer with various creaks, slaps, clanks, and groans, not to mention occasional small crashes taking place off screen. It is safe to say that few of these extraneous noises are noticeable to the actors or anyone in the studio. They are painfully evident to the personnel in the control room, however, and the anguished voice of the director screaming "Quiet in the studio" has on occasion escaped from a cameraman's headphones and found its way into the broadcast audio to add to the alien noises.

WHAT DETERMINES SOUND QUALITY

Sound quality is determined by a number of factors, perhaps the most important of which is the quality of the microphone and associated audio equipment. A school, for example, may install inexpensive public-address (PA) equipment for teaching purposes which would be inadequate for broadcast use. The main difference would be in the "fidelity" of its response to sounds of different pitch. "High-fidelity" equipment, is necessary for FM broadcasting and for television too, since the sound portion of television is broadcast by the FM method.

The human ear is sensitive to sounds of a wide band of frequencies all the way from about 50 cycles per second up to 15,000. (A cycle is a single vibration.) All speech is contained within the first 2,000 cycles. The next 12,000 cycles contain overtones. It is not difficult to construct a receiving and reproducing apparatus which is able to transmit intelligible

speech without handling any great range of frequencies. The telephone is an example; the dictaphone or the old gramophones can reproduce every note on the piano keyboard, but anyone who has listened to them will immediately notice that they give far from a realistic reproduction of sound. The main reason is that the sounds they carry lack the higher frequency overtones. A general idea of the sound quality possible with a microphone or reproduction apparatus can be conveyed by naming the high-frequency cutoff point (beyond which sounds are not picked up or reproduced). The higher this cutoff point, the higher the fidelity of the apparatus. The telephone cuts off around 2,500 cycles. Most small radio sets cut off at 4,000. The best AM sets on the market cannot handle more than 8,000 cycles, and AM broadcasting stations rarely bother to transmit frequencies higher than this, knowing that no one could receive them anyway. FM broadcasting, using a different method of modulating the carrier wave, readily carries the entire range of frequencies up as far as the ear can hear. Good FM sets with high-quality loudspeakers and properly built cabinets can receive and reproduce this entire range. Small low-quality loudspeakers, such as are installed in many table-top television receivers, cannot take advantage of the high-fidelity FM audio which accompanies the television picture. Thus the frequency response of first the microphone, then the amplifier and transmission circuits, and finally the method of transmission and reception will determine to a large extent the quality of the resultant sound.

There are other factors involved, however. One of these is the proportion of direct to reverberant sound which is picked up by the microphone. Reverberant sound is actually composed of echoes, which in the usual-sized room follow so closely after the direct sound itself that they cannot be distinguished from it.

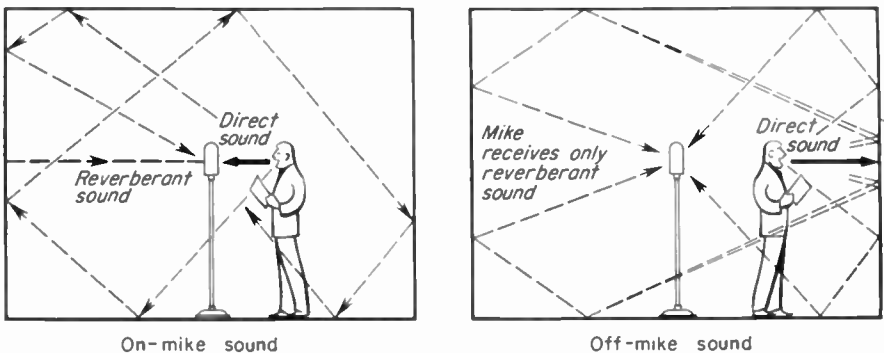


Fig. 19-2. When the ratio of direct sound to reverberant sound is high, the actor sounds "on-mike." When the reverberant sound becomes equal or greater than the direct, however, the actor sounds "off-mike."

If the microphone is close to the source of sound, the direct sound pickup will be large in proportion to the sound which enters the microphone after having bounced back and forth between the walls, floor, and ceiling of the studio. This will give rise to the effect of being "on mike." When the source of sound is farther from the microphone, the direct sound is weaker in comparison with the reverberant sound and the "off-mike" condition is noticed. In a room which has a low reverberation time (a "dead" room) the microphone can be farther from the source of sound without the pickup sounding off-mike (Fig. 19-2).

THE CHARACTERISTICS OF MICROPHONES

A microphone is an instrument for translating sound vibrations in air into variations in electrical current. Although the design of microphones is based on several different principles, each type of mike actually creates a weak electrical voltage by the physical movement of a ribbon, or diaphragm, or some other element under the vibrating force of the air. The most common types of microphone will be described presently according to the basic principles of their design.

The first factor which contributes to the sound quality of a microphone is the range of frequencies it can pick up. Some of the cheaper types of mikes, such as the carbon-button microphone used in telephones and the crystal microphone used in inexpensive home recording machines, are not capable of much over 4,000 cycles. Most of the standard microphones used in broadcasting respond to frequencies up as high as the ear can hear (15,000 cycles per second). There is considerable variation, however, in how well a microphone will respond to the low frequencies below 300 cycles.

Even though two microphones both respond to the entire frequency range, each will have its own variations in response along the scale, and the fact that one microphone is "down a little" in its response to the low frequencies or "falls off" after 10,000 cycles will make it sound quite different from another which may be up to normal response at these frequencies but is low somewhere else.

It is sometimes desirable to alter a microphone's sensitivity to low-frequency sounds. Voice actually picks up better if these low frequencies are not well reproduced. Some microphones, such as the RCA 77D (Fig. 19-3) are equipped with an adjustment screw marked *M* and *V*, meaning "music" and



Fig. 19-3. RCA 77D poly-directional microphone.

“voice.” When set at *M*, the microphone responds fully to all the bass notes and music sounds full and rich. The *V* setting, however, attenuates (cuts down) these frequencies and allows the voice to pick up somewhat more distinctly than when the bass tones are strong. Making this adjustment is sometimes called “strapping” the mike for voice or for music.

Microphones are designed to have different “directional patterns” in the attempt to make them to some extent selective. A nondirectional microphone picks up sounds coming from all directions equally well. There is no selectivity. A unidirectional microphone, however, is so designed that only the sounds which come from one direction can be picked up, at least directly, and all other, unwanted sounds are discriminated against. Some microphones are bidirectional, which means they have two live sides but are deaf to sounds originating elsewhere. The RCA 77D microphone can be adjusted to work as a unidirectional, bidirectional, or nondirectional mike (Fig. 19-4). One of the most useful microphones is called a “cardioid” because when a graph is drawn of its

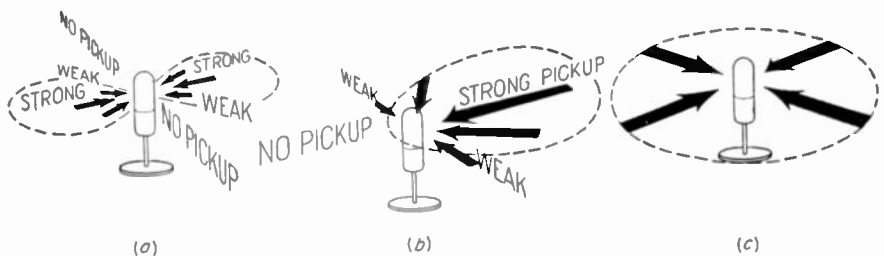


Fig. 19-4. The 77D used (a) as a bidirectional, (b) as a unidirectional, and (c) as a nondirectional microphone.

directional pattern it resembles a heart shape, actually three-directional with one dead side at the rear.

Nondirectional microphones are useful for on-the-street interviews, for example, so the interviewer does not need to be constantly pointing the microphone back and forth between himself and his guest. A round-table discussion can be picked up most satisfactorily by a nondirectional microphone in the center of the table, provided, of course, that the table is not too large. On a microphone boom, however, the nondirectional microphone is so unselective that it picks up reverberant sound from the ceiling of the studio and many other directions, and this reverberant sound is usually rather loud because the boom mike is relatively far from the subject and the gain (amplification) is up high.

The bidirectional microphone, the most common example of which is the RCA 44 (Fig. 19-10) is standard equipment in radio studios, where it finds its greatest usefulness in dramatic shows. Actors may stand on either side of the microphone holding their rustling scripts to the dead side

of the mike and can achieve the effect of going off mike very easily simply by moving around to the dead side of the mike. The bidirectional mike has found little use in television, however, except for an off-camera chorus or in a case where it can be shown in the picture and placed a very short distance from the speaker, and then it is generally used only because it happens to be on hand. On a microphone boom it would pick up excessive ceiling reflections. The unidirectional and the cardioid patterns seem to be best for boom microphones, and mikes of this design are used most often in television.

The directional characteristics of a microphone are usually plotted on a "polar" graph (Fig. 19-8). The microphone can be considered as located at the center of the circle and facing toward the top. The radii of the circle then indicate different directions from the microphone. When the response in any particular direction is high, the line of the graph is far from the center; it comes in closer to the center in directions where the response is poor.

It should be noted that the directional pattern of almost any microphone will be quite different when measured at different frequencies. Thus a mike which is nondirectional to sounds of the lower frequencies becomes a unidirectional microphone as far as sounds above 8,000 cycles are concerned.

A microphone may be made highly directional by placing it in the focal point of a large parabolic reflector (Fig. 19-5). When the parabolic reflector is then aimed at a distant source of sound, the mike should pick up only that sound which is within the narrow beam of the reflector and discriminate against all else. It has been used in radiobroadcasting, for example, to pick up the sound of a band on a football field when the band is located in the stands on the other side of the field. Parabolic mikes have been tried for music and voice pickup, especially in the television theatre, where it is difficult to place a mike boom. Placed in the balcony or on a platform in the orchestra pit, they can pick up sounds adequately which occur over 50 or 100 feet away. They have not been too satisfactory, however.

High-frequency sounds tend to travel in straight lines; they reflect well off hard surfaces and can be focused by a reflector as described above. Low-frequency sounds (below 200 cycles) are not so obliging, however. Lows go around corners, diffuse from a surface instead of reflecting cleanly, and the directivity of the parabolic microphone is practically nothing in the low-frequency range. Low-frequency sounds, well off the beam, still find their way into the microphone. The result is that when an actor speaks from a position only slightly off the beam of the mike, all high frequencies vanish, the lows continue to be heard, and the voice sounds tubby and boomy. Clearly, when there are several actors, each

of whom may speak at any time, it is impossible to keep them all equally centered on the beam, especially when they are in motion, and the resultant constant change of sound quality makes the use of this microphone impractical for such a purpose. A line microphone, or "machine-gun mike," has been tried out with the same results. This microphone

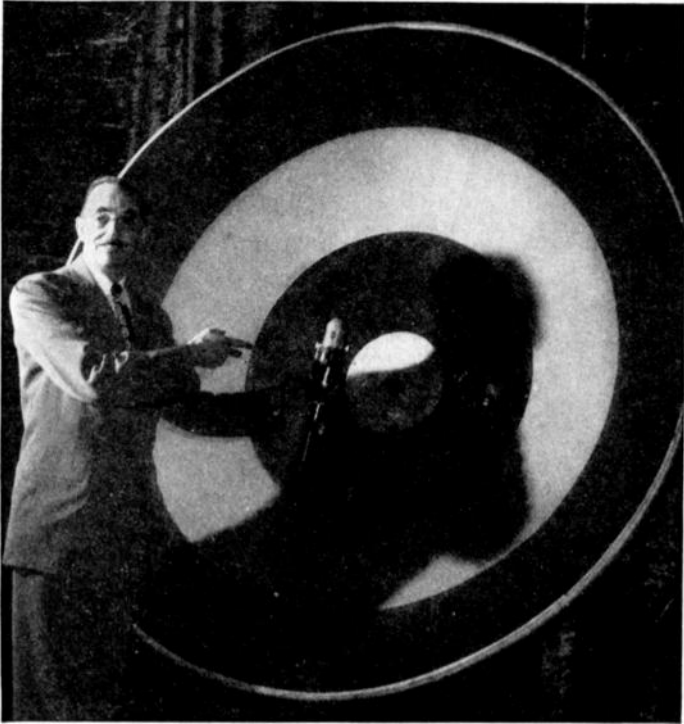


Fig. 19-5. Microphone placed at focal point of parabolic reflector for highly directional pickup.

achieves its highly directional quality by virtue of a large number of hollow tubes of varying lengths which are aimed at the source of sound and will not admit sounds coming from other directions.

TYPES OF MICROPHONES

The design of microphones has been directed not only toward wider and more accurate frequency response, sensitivity, and directional control but also toward reduced size and weight. In recent years several microphones have reached the market, representing each of the principal types which are smaller than an inch in diameter. This is desirable in television since microphones must be small to be hidden, and they must be small even if they are going to show in the picture (lest they detract from

the performers). They must be small if they are to be hung from a microphone boom so that they will cast as little shadow as possible. The fact that they are also being made lighter in weight may mean that lighter, more maneuverable microphone booms will soon be designed for the television studio. The difficulty with all these small-sized mikes, however, is that they are nondirectional. When it becomes possible to make a small microphone which is unidirectional or cardioid in pattern, it will find greater use on a microphone boom.

Dynamic Microphones. The most successful microphones are designed on the principle that movement of a wire in a magnetic field will generate a voltage within that wire. The *dynamic*, or pressure, microphone is equipped with a diaphragm which vibrates as sound strikes it, thus moving a small coil of wire back and forth within the field generated by a small permanent magnet. The very weak voltage so generated is carried over the microphone cable to the control room, where a preamplifier raises it to a useful level. Examples of the dynamic microphone are the Western Electric dynamic, the RCA 88A, and the Electro-Voice (Fig. 19-6). The last is slender, about $\frac{3}{4}$ inch in diameter, and nondirectional. The RCA 88A is an extremely rugged microphone which because of its small size, is often used where microphones must be hidden in desk drawers, etc. Its frequency response, as Fig. 19-9 shows, is not suitable for high-fidelity purposes, however.



Fig. 19-6. Small dynamic: The Electro-Voice.



Fig. 19-7. Small dynamic: The RCA 88A.

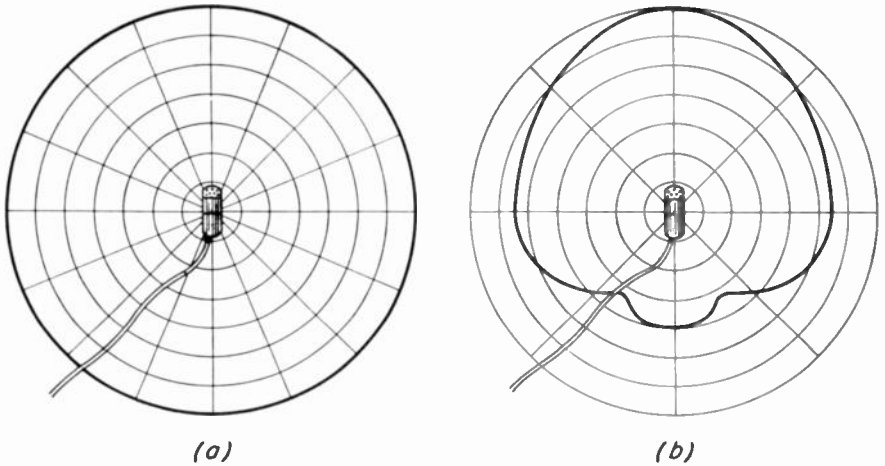


Fig. 19-8. Directional characteristics of the RCA 88A. (a) At 1,000 cycles it is nondirectional; (b) at 4,500 cycles it is almost unidirectional.

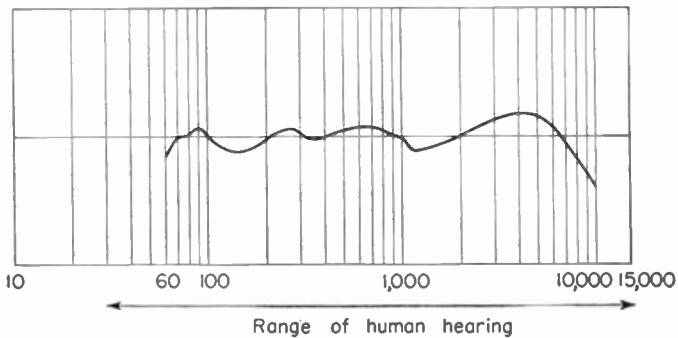


Fig. 19-9. Frequency response of the RCA 88A.

Velocity Microphones. The velocity, or ribbon, microphone has been widely used in radio studios. In this design a ribbon instead of a wire is vibrated within a magnetic field, and it is the "velocity" of the ribbon rather than the pressure on a diaphragm which creates the microphone signal. Ribbon mikes are excellent for high-fidelity pickup but are not as rugged as the dynamics just described. Since sound may reach the ribbon from either side, this type of mike can easily be made bidirectional, a pattern which is important in radio but finds little use in television. The RCA 44A, standard in radio studios, is shown in Fig. 19-10, and the RCA Bantam KB2C is shown beside it. The Bantam approximates the performance of the 44 without quite the frequency range. It is also bidirectional.

The RCA Starmaker microphone illustrated in Fig. 19-11 is a small pencil-size microphone based on the velocity principle. The diagram in Fig. 19-11 shows the position of the ribbon at the bottom of a long pickup horn. It is non-directional, as all these small microphones are, and responds well to the full range of frequencies.

Cardioid-pattern Microphones. There are two microphones on the market which can be adjusted between sev-

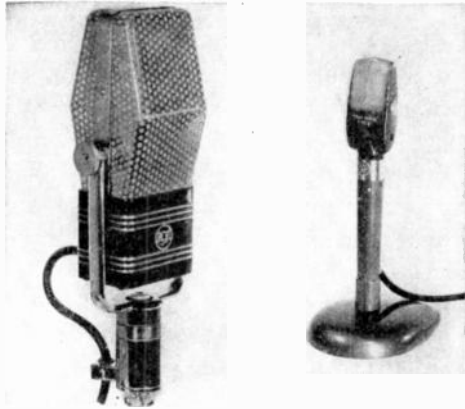


Fig. 19-10. Typical velocity microphones (bidirectional). The RCA 44A and the RCA Bantam KB2C.

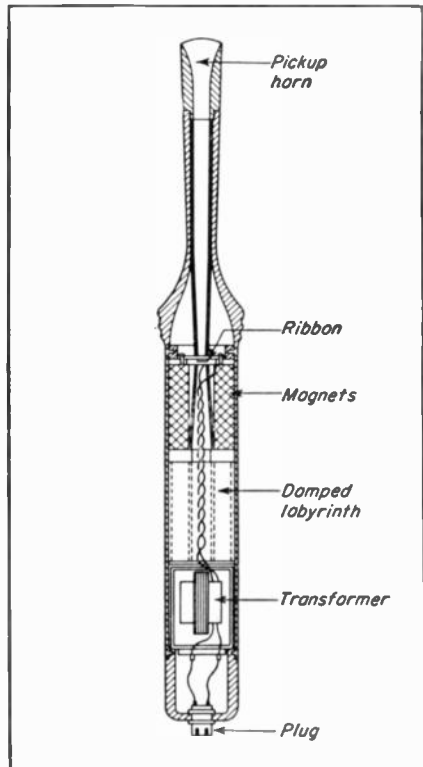
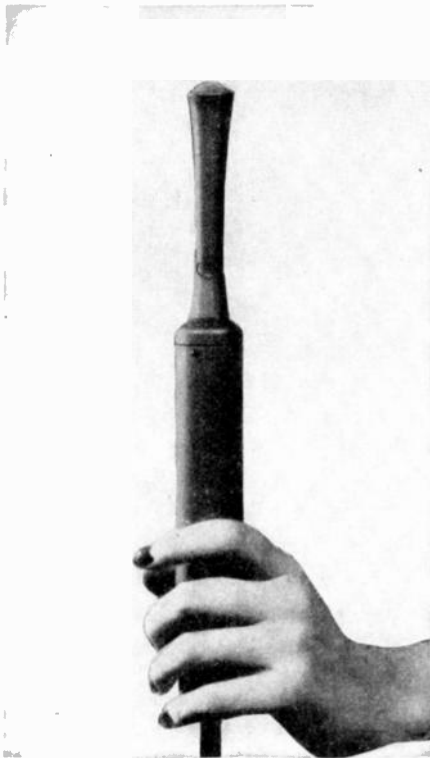


Fig. 19-11. Small velocity microphone. The RCA Starmaker.

eral directional patterns. These are the RCA 77D (Fig. 19-3) and the Western Electric Cardioid (Fig. 19-12). The second of these is in reality two microphones contained within the single housing, one of which responds to pressure in the manner of the dynamic mike, while the other is a velocity-actuated ribbon. The unidirectional pattern of the RCA 77 is nearly cardioid (heart-shaped), and both this and the Western Electric microphone, when set for the cardioid pattern, function better on a microphone boom than anything else available today. The great variety of directional patterns possible with the Western Electric Cardioid mike are shown in Fig. 19-12. When the switch is set at *R*, the ribbon only is functioning and the pattern is bidirectional. When set at *D*, only the pressure-activated diaphragm is operating and the microphone is a dynamic mike, nondirectional. The *C* position, (cardioid) is of course the most used, and both this and the other three variations on it utilize varying amounts of both the ribbon and the diaphragm element in picking up the sound.

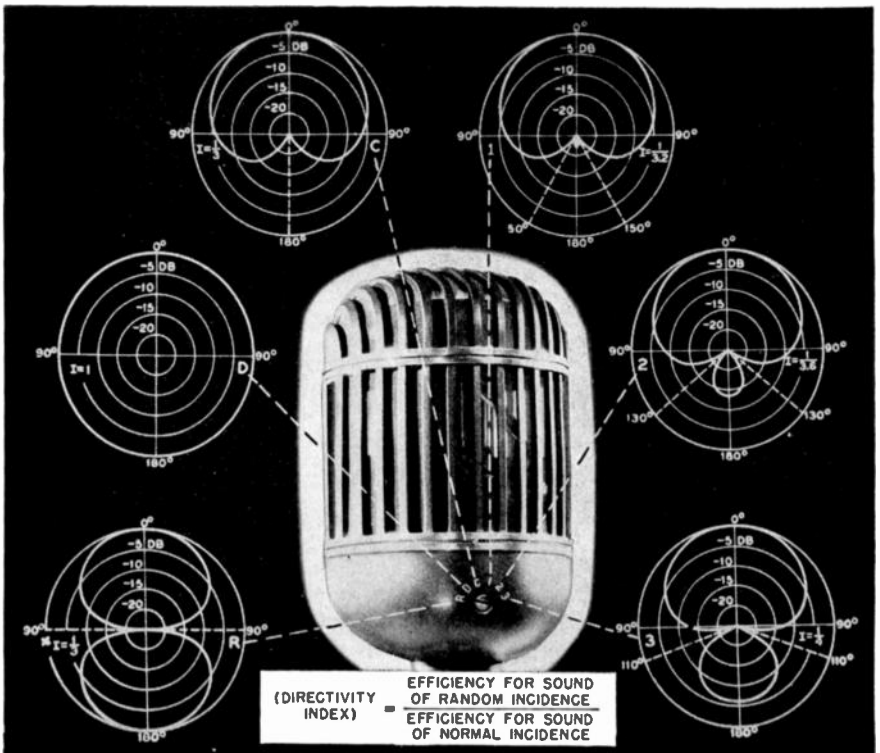


Fig. 19-12. Western Electric "Cardioid" microphone, showing variety of directional patterns.

Condenser Microphones. A third type of microphone which is neither dynamic nor velocity has become popular in recent years, called the condenser mike. The principle of this microphone is that the sound moves a diaphragm which is actually one of the plates of a condenser. As the condenser plates are moved together or apart, the capacitance changes and a current which is fed through it will vary in strength. The Altec-Lansing button-sized microphone was the first small mike which started the current trend (Fig. 19-13A). Nondirectional, it has a satisfactory frequency range for broadcast purposes. The microphone itself is only 0.6 inch in diameter and $\frac{1}{4}$ inch high, but it must be used on the end of a shaft which contains a small one-tube amplifier. A special power-supply unit must also be used, but this does not have to be closer than 400 feet from the microphone. The Altec mike has found frequent use as a hand mike for an interviewer or MC to hold. The Stephens Tru-Sonic, also based on the condenser-principle microphone, claims an absolutely flat frequency-response curve through and beyond the entire audio range. This microphone with its case, swivel, and connector (Fig. 19-13B) weighs only $4\frac{1}{2}$ ounces. It, too, is nondirectional.

MICROPHONE PLACEMENT

The most common placement of the microphone in the television studio is to suspend it overhead on the end of a boom. Occasionally a microphone is suspended above one spot, either on its own cable or by means of a cord. This is known as a hanging mike. A third placement for microphones is within the set, hidden from the camera, and a fourth type of placement is in the set, with no attempt made to hide the mike from the camera. Whatever placement is chosen, all microphones which are to be used on a single scene should be of the same model or noticeable changes



Fig. 19-13. Condenser microphones: top, the Altec; bottom, the Stephens Tru-Sonic.

of sound quality will result when the pickup changes from one to the next.

The audio man will be careful not to place a microphone close to a hard reflectant surface such as a wall or table top, knowing that the reverberant sound reflected from the close surface will be very loud in the microphone's ear and will impair a good pickup of the direct sound. Tables are usually covered with cloth when microphones must be placed on them. Sometimes a small mike such as an 88A will be hidden by laying it in a partly opened desk drawer, just below the performer. However, the drawer will impart a strange hollowness to the sound unless the mike is laid on a piece of hair felt or other heavily sound-absorbent material. Actors should be kept away from hard walls. When hard-walled sets are used, it is important that no two walls be quite facing each other, as in the case of a box-shaped three-walled set, or standing waves may be set up which will cause strange results with almost any microphone placed between them.

The directional selectivity of unidirectional microphones is so great that unwanted sounds in the background will be picked up clearly simply because they happen to be on the beam. When the microphone is directly overhead, for example, footsteps sound much louder than one might expect, and this is one of the problems connected with hanging mikes. A boom mike, too, will exaggerate rustling paper out of all proportion; the producer who must have someone open a package under a microphone will do well to wrap it in very soft paper or dampen the paper which surrounds it so that the crackling is eliminated. Dishes or hard objects on a table top are another source of trouble; the use of a tablecloth or other cover will help greatly where these are concerned.

Although the best positioning of a microphone can be obtained only when it is controlled by an operator and can be moved about and pointed this way and that, it often happens on many types of shows that dialogue must be picked up in a spot where the boom microphone will not reach. In such cases a hanging mike is used. Since such a microphone cannot be pointed toward a person who is speaking, it should have as wide a beam as possible so that almost any position within a 3-foot radius will be suitable for good pickup of sound. This calls for a nondirectional microphone or a cardioid (unidirectional with a very wide beam). There have been television dramatic shows which used a great many such hanging mikes. Perhaps the record was set in one production of "Suspense" which so filled the studio that there was no place to put a microphone boom. Paul Hale, the audio engineer, solved the problem by stringing up 16 hanging mikes to cover all the areas where dialogue was taking place. Hanging mikes are to be avoided if possible, however, since they can cover a limited range at best and any attempt to try to rehearse actors so that they will deliver their dialogue only in the right spots and facing the right directions produces very uncertain results.

THE MICROPHONE BOOM

Several types of microphone booms are in use in television studios, the most common and also the most complex of which is the Mole-Richardson boom. This is motion-picture equipment which has been taken over bodily without modification for the television studio. The other types of booms are for the most part nonextensible. They are radio equipment which can best serve in the television studio in place of hanging microphones where a little more control is needed. Several stations use a giraffe boom (Fig. 19-14) which is equipped with a hand grip for rotating and tilting the mike. A microphone can be controlled both in tilt and rotation, and it is possible to use a unidirectional mike and face it around

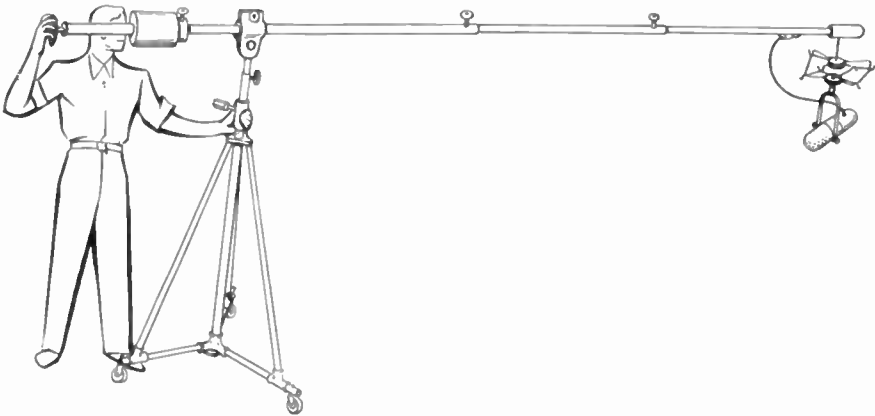


Fig. 19-14. Typical small "giraffe boom."

toward whichever person is speaking. This boom can be panned in a circle or tilted so that it will raise and lower, but extension must be done bodily by rolling the base of the boom in or out. This is by no means difficult, since the boom base is very light, and some studios prefer these giraffe booms to the more elaborate expensive or cumbersome Mole-Richardson booms.

The Mole-Richardson boom (Fig. 19-15) is capable of several simultaneous adjustments, including the extension of the boom arm. The adjustments are: (1) panning of the boom arm (360 degrees); (2) tilting of boom arm (45 degrees above horizontal to 45 degrees below horizontal); (3) extension of mike boom (from a minimum length of 7 feet 4½ inches to an extended length of 17 feet); (4) rotation of microphone at end of boom arm. Whereas these adjustments can all be made simultaneously by one operator, a fifth adjustment, height of central column, can be made before the boom is in use. The boom may rest horizontally at a minimum height of 6 feet 5 inches, or the central column may be raised so that the

boom is 9 feet 5 inches from the floor. It is ordinarily used at a height of about 7 feet. The operating platform of this model raises with the boom.

The sides of the operating platform, shown in Fig. 19-15 folded down, will open up flat, and the operator stands on the right-hand side of the boom. His right hand operates the crank which extends or retracts the boom. His left hand holds a handle (shown projecting straight up) which, when he pulls it down, rotates the microphone. Panning and tilting of the boom are also controlled with this hand, by direct effort instead of a twisting movement. All controls can be locked by large-handled setscrews, so that when the boom is being moved and there is no operator at the controls, it will not swing wildly about. The microphone cable

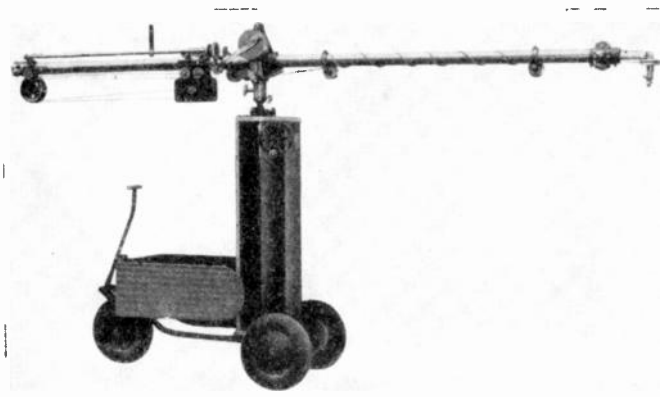


Fig. 19-15. Mole-Richardson microphone boom.

running to the boom is usually dropped down from overhead so that it will interfere as little as possible with operations in the studio. The only control which is lacking on this microphone boom is a means of tilting the mike. This has been found desirable in motion pictures, and Paramount added such a control to the boom so that the same hand which handles the crank for boom extension could also control microphone tilt. A description of how this adaptation was accomplished can be found in the *SMPA Journal* of December, 1947.

The base of the microphone boom is provided with three large wheels with pneumatic tires, only one of which is steerable. There is a tendency, at least in the smaller studios, to think of the boom base as more or less permanent and immobile. This does not have to be the case at all. In many dramatic shows the boom is wheeled about from place to place throughout the show, repositioning almost as freely as the cameras. It is possible to end one scene with the boom at one end of the studio and begin the next scene across the studio with the same microphone. Nat-

urally this calls for a very rapid move. The microphone dollyman will have the base of the dolly aligned so that he does not need to waste time in backing and steering. The audio engineer watches his script closely, and as soon as the last word is spoken, he releases the boom for its move. The director can help this process greatly and reduce the risk of losing dialogue if he will add a few seconds of silent action to the end of the first scene or to the beginning of the second.

Since this boom base was designed for motion pictures, it is not very well adapted to the television studio. It is much too large (the base occupies a floor area of about 4 by 6 feet). It is unmaneuverable, having only one steerable wheel. The operator's platform is built on only one side, so the entire base must be moved if the boom is to pan as much as 180 degrees, or the operator will find himself with no place to stand. To adapt this equipment better to the television studio some stations, such as WTVJ, Miami, have purchased only the extensible boom portion and built their own base. Thus they could provide a triangular base with three swivel casters (tops in maneuverability) and a circular platform for the operator.

The boom man must be a highly skilled operator, or the audio quality will suffer noticeably. A good boom operator must be thoroughly conscious at all times of the pictures that the cameras are taking. Since he has no view finder, he must make use of the floor monitor, which is usually placed within his range of vision, although it is frequently across the studio and pretty hard to see. In the interests of good sound pickup he must keep the microphone just as close to the actor as he can without getting it into the picture. When the camera is holding a close-up, he not only finds it possible to get the microphone closer but knows it is highly desirable for it to *be* closer for the proper sound perspective. Consequently he pays close attention to the sequence of shots, watching the floor monitor during rehearsal and constantly dipping the microphone into the picture so that he can see how close he is to the top edge of the frame. (Directors and other control-room personnel who are unfamiliar with this practice worry greatly over the constant appearance of the microphone during rehearsal.)

While the show is on the air, the boom operator listens closely to the director's instructions to the cameramen. When he hears the director say, "Ready One," he immediately glances over at camera 1 to see what lens it has in position. If it is a long lens, he knows that immediately after the take he can drop the microphone in a little. If the next ready cue is for a camera which is set up with a wide-angle lens, the boom man will immediately begin to lift the microphone up so that it will not show in the following shot. Often the cameraman will remind him to raise the boom. It is a joint responsibility of cameraman and boom operator to

keep the microphone out of the shot, and a moment's negligence on the part of either will produce the seemingly inevitable appearance of the microphone at one point at least in every show. Of course, this is not inevitable and happens less with more highly skilled operators both on boom and on camera. It is important, in this respect, that the director have his shots planned accurately and take the same shots on the air that he took during rehearsal. On the unrehearsed show, of course, the boom operator must play safe at all times, keeping the microphone out of range of even the widest angle shot the director is using since he may receive little warning of a take (the ready cues may be followed immediately by the take cues). A proper match of sound and picture perspective is also of less importance in this type of production. Some boom men keep a cue sheet of moves and microphone positions which they make during rehearsal and refer to during the air show. Others rely on memory and the cues which they receive through their headphones from the audio engineer.

It is necessary for the boom operator to hear several things at once in his headphones. He must monitor the program sound in order to know whether or not his microphone is picking up the sound properly. He must hear the director so that he can keep track of the cameras which are about to be used, and he must be given certain cues by the audio engineer. This is accomplished by a split headset, one earphone of which carries program sound, while the other carries control-room cues. It is generally set up so that the director's line feeds into this earphone at all times except when the audio engineer has something to say, at which time he throws a switch and comes in on the director's line.

It is often desirable to ask an actor to delay his speech a split second while the mike boom swings across the set to reach him, but this is rarely successful. It is even difficult to expect an actor to remember not to speak out of set, away from the boom. Many audio men feel that such technical limitations should not be placed on the actor—that if the actor wants to speak away from the microphone it is up to the audio department to place another microphone or move the boom base so that this dialogue can be picked up. This is a very generous view, but not altogether realistic. There are certain microphone techniques that the performer simply must learn, just as he must learn acting techniques and adapt these to the camera. One of these is not to talk into the floor. No microphone can pick up sound which is directed down, unless it happens to be hidden under the rug, while the overhead boom mike will receive an echo-y reflection from the floor as a result of dialogue which is spoken in this direction. Another technique the actor must learn is not to turn his head quickly and speak immediately in another direction. This puts a tremendous strain on the reactions of the boom operator. Since the mike is generally

kept a foot or so in front of an actor for best dialogue pickup, when the actor suddenly turns, the mike must quickly move 3 feet or more in order to stay in front of him. A split second must be allowed for this movement, or the first words delivered in the new direction will sound off-mike.

THE OPERATION OF THE AUDIO CONSOLE

By and large the audio-console equipment used in television studios is identical with that used in radiobroadcasting. A large studio, however, will make many changes and adaptations to this standard equipment, and, in some cases, specially designed television audio consoles will be installed. The NBC television audio console is described at the end of this section as an illustration of what can be done in designing special audio equipment for television. The RCA Consolette will be described first. Although not the latest model it is probably the most commonly used console, and other equipment will be related to it (Fig. 19-16).

The first thing the student operator learns about the audio console is that the fader dials, or "pots," in the middle of the panel each controls a separate source of sound. These are called interchangeably "pots," "faders," "attenuators," "fading dials," "mixer positions," or "mixers." There are six, in this particular console, four of which are normally connected (normaled) to four studio mikes. The last two are reserved for sources of sound other than the studio microphones, such as sound-on-film projectors, turntables, or remote lines coming into the studio from outside. Any one of eight such sources of sound may be connected to each of these last two faders by means of rows of push buttons on the upper right-hand corner of the console. These push buttons are labeled "mixer 5 input"

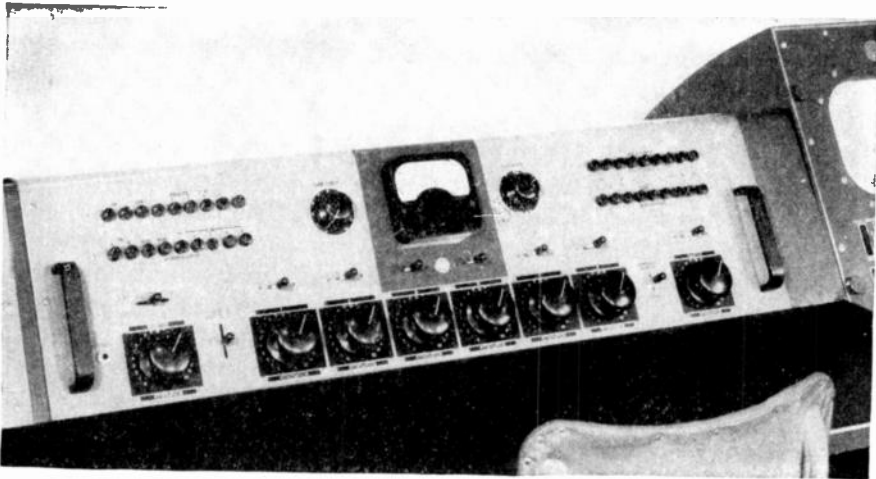


Fig. 19-16. RCA Consolette. Typical small console.

and "mixer 6 input." Since these buttons control only two pots, only two of these incoming lines may be used at once. It is important to know, in relation to these selector buttons, that mixer 5 takes precedence over 6, and if the same button should be pressed in each row, mixer 5 would carry the sound while mixer 6 would have nothing. It is as though the incoming lines entered the console from above, passing through the top row of buttons (mixer 5 input) and terminating in the bottom row (mixer 6 input).

Two other pots are included on the face of the console, separated from the middle six. The one to the left is only a control for the level of the monitor (control-room loudspeaker) and normally has nothing to do with the broadcast program. The pot on the far right is called the "master gain" and controls the total output from the console. All the signals from the other channels are mixed together and go out through the master gain on their way to the audio transmitter. If the master gain is set at a low point, all the microphones will have to be turned up high on their individual pots for the proper outgoing level of sound. If the master gain is set high, each individual pot can be opened only a small way before the outgoing level is too high. This may be a disadvantage, since most pots are built with a series of contact points over which a rotating arm rides, and a low maximum setting of the microphone pot may mean that the sound will reach full volume in only a few steps each of which will mean quite a noticeable change in volume. A low master-gain setting and a high maximum setting on the microphone pot, however, will make it possible for the same amount of increase in volume to take place in a large number of steps, so many that the difference between each of them is indistinguishable.

An important part of this or any other console is the volume-indicator meter mounted at the top of the panel. This is an exact measure of the volume of the outgoing signal. If this meter were not there, it might easily be possible for the audio engineer to fool himself by establishing a high volume level on his control-room loudspeaker and then holding down the volume from all his microphones so that it sounded correct to him, yet was too low to be distinguishable at home. The meter is calibrated in volume units (VU) as well as in per cent of modulation. As speech or music is picked up by a microphone, the needle jumps back and forth, registering each peak of volume. The audio man watches these peaks and keeps them generally below the 100 per cent mark on the dial. Speech must peak at least at 80 per cent, or the viewer at home will be leaning forward to adjust the sound on his set. Peaks of more than +1 or +2 volume units are likely to set into operation at the transmitter certain automatic equipment, known as limiters and compressors, which protects the transmitter from overloading but results in distorting the

sound. A peak that is too high will sound raspy or buzzy instead of being a good clear sound.

It is a small television studio which can limit itself to only 4 microphones, as this console normally provides. Some complex shows have used as many as 16. If more mikes are necessary, at least 2 more are provided for in this console by feeding them through a switch and into the fourth position mixer. The switch is located just at the right of the pots, between the sixth mixer and the master gain. When this switch is in the middle position, as shown in the illustration, microphone 4 is feeding through the fourth position pot in normal manner. If the switch is thrown up, however, another mike (labeled on the panel as a remotely located announce mike) is switched into the fourth mixer and mike 4 is disconnected. If the switch is thrown into the lower position, still another microphone, labeled as a local announce mike (placed perhaps in the control room itself), is switched into the same circuit and the first two are inoperative. It is only radio-station operation that gives rise to the remote- and local-announce-mike labels: actually any microphone used for any purpose can be attached to this switch provided that it is plugged into the right wall receptacle in the studio.

TURNTABLE OPERATION

Most television studios are equipped with two turntables, each of which must be provided with the necessary pickup heads, filters, and other controls so that it can play the great variety of types of disk recordings which are on the market today. Besides this it must have a heavy-duty motor and a large flywheel so that its speed of rotation is even and the highest quality reproduction is possible at all times.

Records may play at one of three speeds, 78 rpm (revolutions per minute) for standard home phonograph recordings, $33\frac{1}{3}$ rpm for broadcast transcriptions, standard record library material, and the relatively new microgroove long-playing records, and 45 rpm, which is the large-hole RCA home phonograph variety. Only the latest and most flexible equipment includes this last speed.

The audio engineer will handle records only in the smallest studio. Usually he is so busy with watching the action and controlling his console that handling of the records is delegated to an assistant engineer or record spinner. This operator must check many things as he puts a record on the turntable. First he must determine the speed at which it should be run and set the speed control on the turntable to accord with it. Then he must look to see whether it is a lateral or vertical recording and set the lateral-vertical switch. Finally he must "cue the record up" so that it will start immediately at the beginning of the music when the director calls the cue. Cuing up the record is done with the aid of a small cue

speaker or, if this is a disturbance in the control room, with a set of headphones. The proper turntable is switched into the headphones, and the record man listens as he spins the record around on the turntable by hand. When he hears the music start, he backs up the record until he finds the exact point at which the needle first encounters modulation and then backs the record up another half a turn (in the case of $33\frac{1}{3}$ recordings). With 78-rpm records this is two turns. In many studios it is the audio

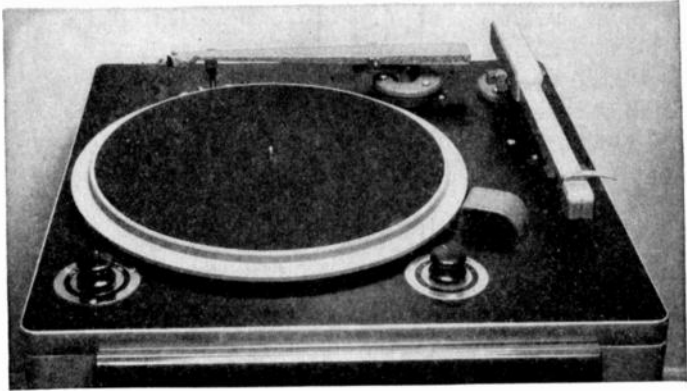


Fig. 19-17. Typical control-room turntable. Two pickup arms are included; the one at the back is a special lightweight arm for long-playing microgroove records. Left knob, speed selector; right knob, lateral or vertical cut selector.

man who then starts the record, opens the appropriate pot, and feeds it onto the line.

When he hears the director say "Stand by with the music," the audio man reaches over and starts the turntable running but immediately puts his hand on the record so that it will not turn, letting the felt-top turntable spin under it. At the same time his other hand is ready on the mixer knob which controls that particular turntable, holding it in the "off" position. At the cue "Hit the music," he releases the record and watches as it makes the requisite number of turns. Just before it completes its two turns, or half a turn as the case may be, he turns up the pot and the first notes of music go out loud and clear without any record noise or needle scratch before them. If the record is not backed up the proper number of turns, the pot may be opened before the record is up to speed and the very undesirable effect known as the "wow" will be heard. A wow makes any music sound like the opening note of a siren.

In some setups the record spinner has complete control of the turntables, having two individual pots on a little mixer of his own and feeding the output of this into one of the last two mixer positions on the audio console. This console position is then left open during the show, and all

turntable control is done by the record man. This is a preferred procedure since it relieves the audio man of this responsibility and also releases one of his all too few mixer positions for other uses.

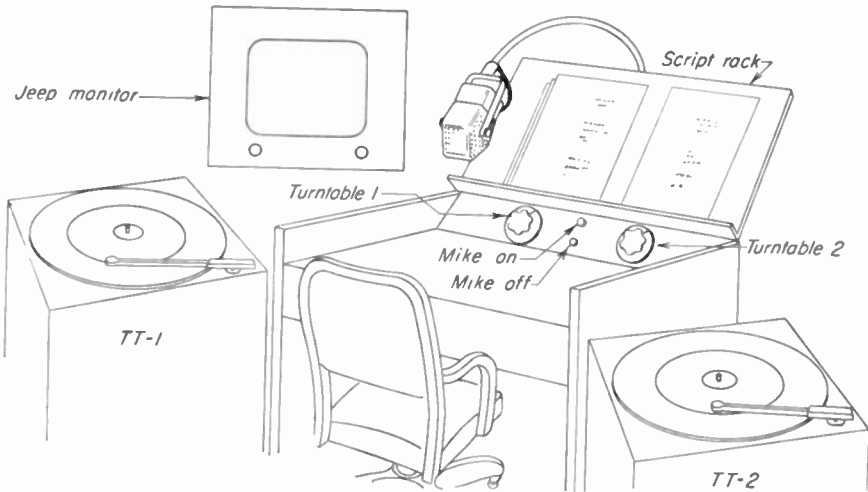


Fig. 19-18. Turntable equipment set up in announce booth.

AUDIO SPECIAL EFFECTS

There are two special audio effects which are used frequently wherever dramatic shows are produced, the sound-effects filter and the echo chamber. Controls for both of these are built into the console in elaborate equipment but must be added in the case of the RCA Consolette and most other small consoles.

The sound-effects filter is a device which can be adjusted to cut either high- or low-frequency sounds (or both) out of a microphone signal, so that the sound will seem to come from a telephone or will take on an unreal, dream, or otherworldly quality. Two controls are provided on a filter (Fig. 19-19), one for low-frequency and the other for high-frequency

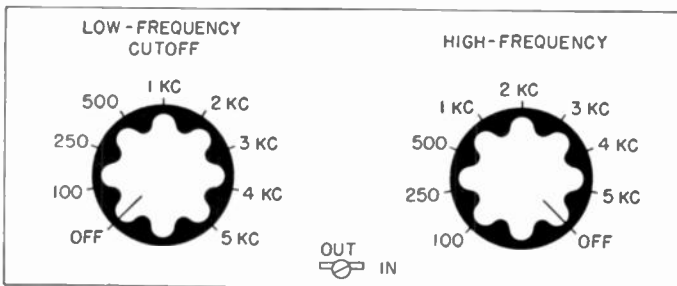


Fig. 19-19. Control panel of typical sound-effects filter.

cutoff. Each of these is calibrated in frequencies, and it is possible to obtain a great variety of filtered sounds by cutting off varying amounts of low or high frequencies. For example, if the low-frequency cutoff is set at 250 cycles, frequencies lower than this are not heard. If the high-frequency cutoff is set at, say, 2 kilocycles, frequencies above this point are eliminated. Thus only that portion of the sound which falls within the 250- to 2,000-cycle range will be transmitted, and it will sound like a telephone voice or a short-wave radio.

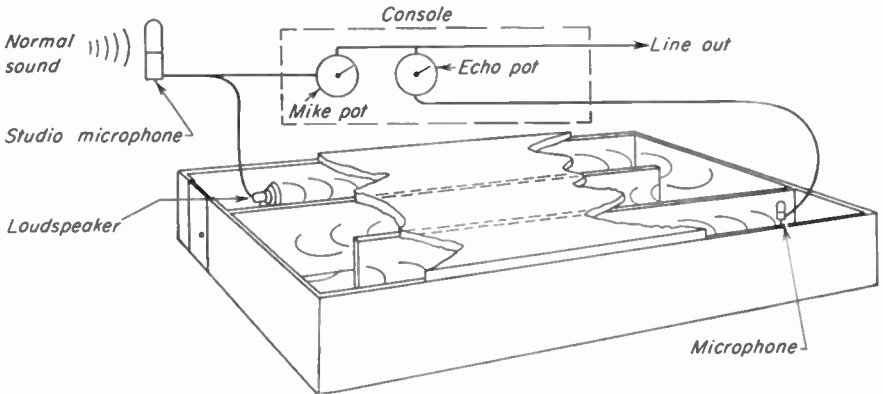


Fig. 19-20. Typical echo chamber.

The echo chamber is a method of obtaining the echo and reverberation of a large hall or underground cavern when the original sound may be picked up by a regular studio microphone. The echo is added later by feeding the sound into a loudspeaker which is mounted in a concrete room, preferably long and narrow, usually in the basement of the studio building. At the other end of this chamber a second microphone picks up the sound again, this time richly enhanced with echoes, and feeds it back again into the audio console. By running the direct sound through one fader and the echo through another, the two may be intermingled in any proportion and any desired degree of echo can be obtained. Sometimes just a touch of echo will improve the sound of a musical pickup or add importance to an actor's speech (Fig. 19-20).

TELEVISION AUDIO CONSOLES

Both the CBS and the NBC networks have built special television audio consoles. As of the present writing there is nothing on the market of this nature. The audio consoles designed especially for television by the general engineering department at NBC and installed in several of the Radio City studios are the ultimate, so far, in special equipment for television audio.

A glance at the console shown in Fig. 19-21 will at first reveal that there are 12 individual microphone faders. There are no switches. At the end of this description an example will be given in which it will be shown how even this large number of mixer positions can be exceeded in a fairly complex network show. Whereas 12 microphones are normaled into individual faders, there are another 11 microphone circuits included, which, by means of two keys on the lower right of the console, can be interchanged with other mikes on one or another of the 12 faders.

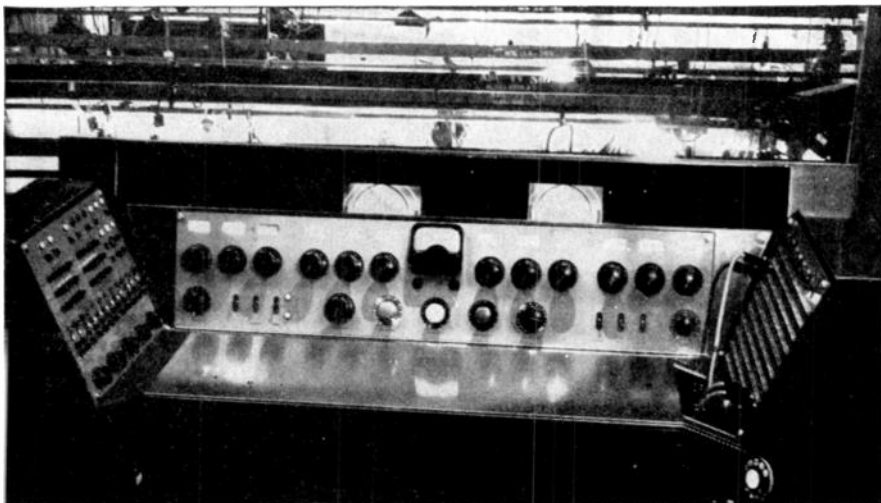


Fig. 19-21. Special NBC audio console.

In the center of the control panel on a lower row are five master faders. Only one of these is the master gain, the one on the right. The middle three are *submasters*, the use of which will be described presently. The one at the left is called the "nemo master." The word "nemo" was coined by NBC many years back to apply to any incoming line originating at a remote source. Two remote lines can be connected to this gain control. These may be used for sound from a film projector or the output of another studio or remote pickup point which is being integrated with the studio show.

The value of the submaster is that a number of microphones which are to be used together can be opened at once or closed at once. A musical program may employ a large orchestra, necessitating a pickup with several mikes, yet the musicians may not be playing throughout the program. If these several mikes, which always work together, are put on one submaster, they can be taken out all at once. In a dramatic program the pickup of dialogue on a set may take several microphones also, and when

the scene is over and a new scene begins, the audio man may have only a few seconds in which to turn them all off and turn another group in the next set all on. The use of submasters makes this considerably easier to do. The output of all the submasters feeds through the master gain.

To make it possible for the audio man to keep track of which faders are in operation and which are controlled by each submaster, a color system is used. The knobs of the three submasters are colored red, white, and green. Behind a little window over each individual fader are three lights of the three colors. The left-hand panel of the console (Fig. 19-22) carries 12 vertical rows of push buttons, a group of 4 for each mixer position. One of each set is red, one white, one green. The fourth in each row is an

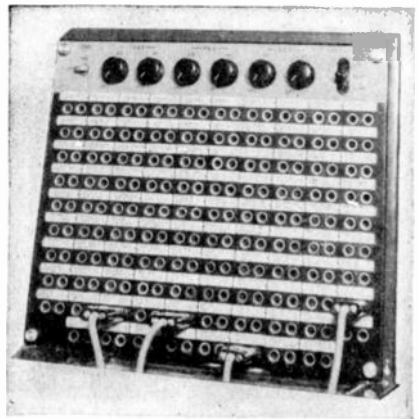
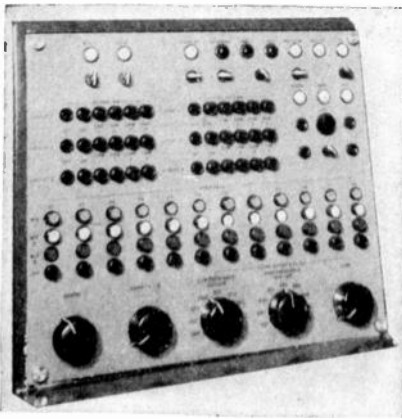


Fig. 19-22. Left panel of NBC television audio console. Right panel (patchboard) of NBC television audio console.

“off” button. These are the selectors which determine the submaster to which a microphone will be connected. If the off button is pushed in the F7 row for example, fader 7 is not connected to any of the submasters and feeds directly through the master gain just as in the operation of any console. No light appears in the window above fader 7. If, however, the red button is pressed in the fader 7 row, a red light appears in the window above the fader and the microphone on this position will be controlled by the red submaster, as well as the master gain. When all the microphones have been assigned submasters, there will be a number of red lights, a number of white, and a number of green lights above the fader controls. All the reds can be faded out by turning down the red submaster without affecting the remaining microphones. Turning down the submasters or turning down the individual faders will not turn off the lights behind the windows, however. These will disappear only when the off button corresponding to their number has been punched on the left-

hand panel of the console. The lighted panels above each microphone pot are faced with ground glass on which the audio engineer can mark a name or number which will identify the microphone to him. Such indications as boom 1, boom 2, chorus, commercial, etc., will provide quick and positive identification, which is very important in a complex show when so many microphones are in use. As a further aid in this direction a light has been placed behind a plastic panel on which each fader knob turns. This light will go off only when the pot is completely turned off. Thus the audio man is always conscious of each microphone that is open without having to scan the entire console and check each pot. The CBS-designed TV audio consoles, while not at all as complicated as those of NBC, go a step further in this one respect and make each fader knob of transparent plastic with a light inside it, so that the whole knob lights up when it is in operation.

MICROPHONE EQUALIZING

Another feature of this console is a method of changing the frequency response of the microphones at the console itself. The procedure of "strapping" a microphone for voice or for music has been described earlier in this chapter. Many microphones have switches on them which enable the user to select either a full low-frequency response for music pickup or an attenuation of the low frequencies, which is more desirable for voice. Very often in television it is necessary to make such a change during the program, when the microphone is inaccessible. Accordingly, the mike is left on music (full lows), and the change is made by means of a small knob above the patchboard at the right of the console. Three equalizers are provided so that three microphones may be controlled at one time in this manner. Each of the equalizers has two knobs, one of which will attenuate (cut down) the low frequencies coming from the microphone, and the other of which will control the highs.

MATCHING SOUND AND PICTURE PERSPECTIVE

It has been stated before that sound perspective and picture perspective should match and that the main factor in sound perspective was the distance from microphone to source of sound. The best way to match the two, then, would be to move the microphone closer in for close-ups and farther back for long shots. This is not always possible, however, and the NBC console has included a method of producing almost this same effect by different means. Not only does a closer microphone pick up less reverberation, but it also picks up more highs and more lows. The method used here is to increase the "presence" of the sound pickup at the moment when the cut from medium shot to close-up is made by suddenly

cutting in a little more low and high response and boosting the sound level a certain amount. Since there is no change in the component of reverberant sound, this is not an entirely accurate effect but it does help to keep the sound pickup as realistic as possible.

A microphone which is to be controlled in this manner must be switched in quality exactly at the same moment at which the cameras are switched from medium shot to close-up. If the change in sound quality should come a few moments after the visual cut, the effect would be noticeably bad. For this reason it was necessary to tie in this audio switching with the switching of cameras. When a microphone is properly patched in, and preset on the top bank of buttons (Fig. 19-22, left), it will automatically switch to a filtered condition every time a particular camera is switched onto the air.

The change in quality is made by switching the microphone through a special-effects filter. The lows and the highs are reduced for the distant perspective, and the gain is slightly reduced at the same time. Switching the filter out of the circuit again restores the full frequency response and raises the level slightly, to provide an effect of greater presence for close-ups. Provision is made for the use of two special-effects filters, although only one is actually built into the console, and each of these has three circuits through which microphones can be fed and switched on and off the filter by means of the video switching. Thus a maximum of six microphones can be set up at once for this kind of control.

A typical audio problem in television dramatic shows concerns the telephone conversation in which the cameras switch back and forth, sometimes holding on one end of the line for a few speeches, sometimes switching on every speech. The sound must follow the picture accurately. While camera 1 is on, picking up Joe at one end of the line, microphone 1, which picks up Joe's voice, must sound normal, while mike 2, picking up Al at the other end of the line, must be heard on filter. However, when we switch to camera 2 on Al, we must hear microphone 2 in normal sound and mike 1 on filter. Ordinarily this is a feat of prestidigitation and mind reading by the audio operator, unless the director adheres strictly to his script, with which the audio man has had thorough rehearsal. With the video switching feature in the NBC console, however, this situation is no problem to the audio engineer, and the director can feel free to change his cutting from what he followed in rehearsal without throwing the sound out of synchrony. Microphone 1, which must sound filtered only when camera 2 is on the air, is punched up to work with camera 2, while mike 2, which must be on filter when camera 1 is on, is punched up to go on filter every time camera 1 is switched on the air. Thus a cut from one end of the phone conversation to another will always result in a

simultaneous reversal of the filter effect. One filter is all that is necessary, since both mikes should be filtered identically, and they work alternately. Mike 1 could be patched into the first line of punch buttons (marked filter 1, circuit 1), while mike 2 could be patched into the second row (marked filter 1, circuit 2).

A typical complex production on which this board is used is the Kate Smith show. Audio may originate in at least a dozen locations on this show, some of which must be covered by more than 1 microphone. In the example given, audio engineer Neal Smith has used 17 different microphones, plus two remote sources and one studio turntable. Since the console has only 12 positions, some of these microphones were alternated with others, so that 2 of the mixer positions could be used for more than 1 microphone.

On position 1 the applause mikes were placed. Four microphones are used for applause, situated in different parts of the house, and all fed together through one preamp and into the one mixer position. Four extra pots were added, through which each microphone could feed. This is "low-level mixing"—"mixing," since each microphone may be adjusted individually in volume without the others being affected, and "low level," because the mixing is done before the signal has been amplified. If audience mikes are fed through this mixer, it is possible to choose applause from selected portions of the house and turn down the upper-balcony mikes if the teen-agers in that part of the audience let their enthusiasm run away with them and begin to whistle and yell. The audience mike position, No. 1 on the console, was placed on the white submaster. No other microphones were used on the white submaster.

The next four positions were devoted to microphones covering the house orchestra in the pit, one mike position each for the sax section, the rhythm section, the strings, and the brass. All these orchestra mikes were placed on the green submaster.

The remaining seven console positions were all placed on the red submaster. These comprised several stage locations, as listed below, and two boom microphones.

An on-stage orchestra was still to be provided for. This involved two additional microphones. However, this orchestra never played at the same time that the house band played; so two of the positions (positions 4 and 5) ordinarily connected to house-orchestra mikes were used for these extra microphones. This was accomplished by utilizing the special keys at the right of the mixer panel. Each of these keys has two positions, and these appear on the patchboard. Both keys were used in the "up" position (position 1) until the part of the show where the on-stage orchestra played, at which point both keys were thrown into the "down" position

to connect mikes 13 and 14. This orchestra, just like the house band, was then controlled on the green submaster.

Two remote, or "nemo," sources were also included in this program, nemo 1 being a feed from NBC master control, nemo 2 from a sound motion-picture projector operating into a studio image-orthicon camera back stage. There is one mixer position for nemo feeds, located next to the submaster faders on the lower row at the far left. Called the "nemo master," it will carry one or another of two possible nemo feeds depending on the position of the "nemo switch" just beside it. When the nemo switch is in the center position, nemo 1 or nemo 2 will be chosen automatically according to the video switching. As soon as the TD punches up his nemo 1 picture, the sound will automatically cut in at the same time.

20 REMOTE PICKUPS

The remote pickup of sports and other events outside the studio sometimes accounts for a third of a station's total schedule. Remote programs are usually quite long in comparison with studio shows and of course require very much less in the way of preparation and rehearsal. This is because the program material of most remotes is not built by the station staff. Shows are transmitted which already exist, which would be put on in any case, television or no television, for the benefit of an assembled audience.

Almost any kind of show, event, or sport which is interesting enough to attract an audience of spectators will make a good television show as well. A slow game like cricket, however, with a very limited appeal in this country, is a possible exception. The advantage of all such events is that they take place in a limited area, where the cameras can be stationed and, like the spectators, see everything. An event which covers distance (like a boat race or a golf tournament) is more difficult to pick up, and often two or more remote crews with duplicate equipment must be stationed at strategic points along the route.

Many stations have experimented with specially produced remote programs. During 1946 and 1947 CBS-TV had closed its studio temporarily but continued to produce a wide variety of studio-type programs from various remote locations. More recently some full-fledged dramatic productions have originated from interesting locations around New York. The "City at Midnight" series during the winter of 1949-1950 was an important step in this direction. The Ford Theatre production of "Subway Express," with action on and around subway trains, was done from the IRT car barn, with as much freedom and polish as most studio productions, plus a tremendous gain in realism and actuality (Fig. 20-1).

The importance of the *place* in which a program originates cannot be overemphasized in the analysis of television programming; one of the special characteristics of this medium is its ability to convey actuality. The

audience is able to be in two places at the same time. But the audience will have this feeling only if the distant place is real. The more you make of the location, the more fascinating the pickup will become. It is relatively uninteresting, for example, to tune in a ball game and never see anything but the diamond or to watch the pickup of a speech and see nothing but a close shot of the speaker.

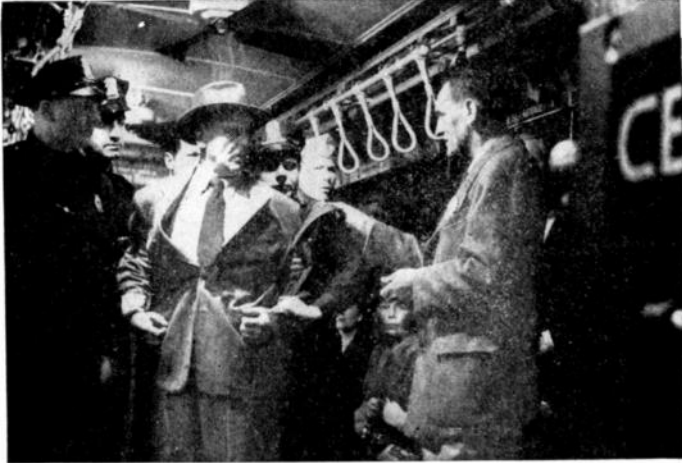


Fig. 20-1. "Subway Express," dramatic show produced on "Ford Theatre" and originating from IRT car barns in New York City.

FIELD EQUIPMENT

The accompanying diagram illustrates in a simplified fashion the relationship of the essential units of equipment when they are set up for a remote pickup. Two cameras and two microphones are picking up the program; in this particular case, one of the mikes is placed near the cameras, presumably for interview purposes, while the second is back by the control equipment for the commentator (announcer), who sits in front of a jeep monitor, so that he can watch the shots as he describes them (Fig. 20-2). The point at which the camera-control units, switching unit, and audio unit are placed is called the "control point." This is most often in the mobile unit truck, although it can as well be set up in a darkened corner or a small room under the stands. Many different intercommunication hookups are used. In most cases the director is in constant communication with the cameramen at all times. The video relay link and audio phone line back to the studio are indicated, plus two "cue lines" for phone communication, one for engineering and one for production. More often only one such line is used for all purposes.

Minimum operating personnel engaged in a two-camera remote pickup

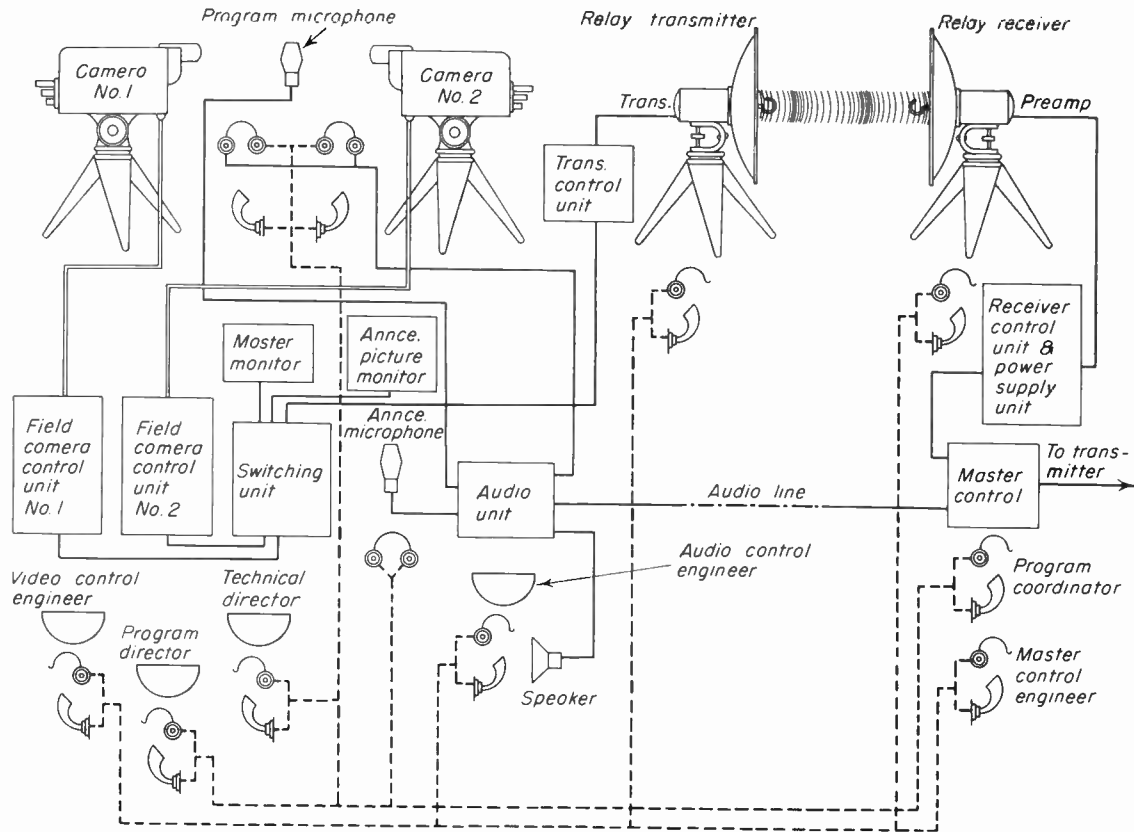


Fig. 20-2. Diagram of essential units for two-camera remote pickup.

such as the one diagrammed here are as follows: two cameramen, video engineer, switcher, audio engineer, supervisor (has no operating duties and so is not shown), program director, and back at the studio in master control at least two more people (usually an engineer and a production man) devoting part of their time to the same broadcast. The posts at the relay transmitter and receiver are not continuously manned; the intercom is necessary at this position only when lining up the relay link.

CAMERAS AND CONTROL EQUIPMENT

All television manufacturers make field camera equipment. These units are portable and have been equipped with carrying handles for one- or two-man transport. They can be set up or broken down in relatively short order and transported in any type of conveyance that affords at least a little protection against the shocks of the road. In most operations, however, permanent positions are found for the control equipment in the mobile unit truck so that interconnecting cables need not be detached from one program to the next.

RCA FIELD EQUIPMENT

Figure 20-3 shows the complete equipment (except cables) for a two-camera field pickup. A simple diagram (Fig. 20-4) will serve to make the relationship of these units clear. Each camera sends its signal to a camera-control unit, which in turn feeds the switching system, from which the selected signal is then fed to the relay transmitter. A master monitor also receives this selected signal. Power-supply units which produce the necessary currents of various voltages feed each camera-control unit, the switching unit, and the master monitor.

The sync (synchronizing-pulse) generator is the heart of the television system. It performs three vital functions. (1) It provides the *driving pulses* that keep the electron beam in the camera tube scanning back and forth at the correct rate across the picture. Driving pulses to synchronize the horizontal movement of the beam are produced at the rate of 15,750 per second, and vertical driving pulses are produced at the rate of 60 per second. (2) It provides the *blanking pulses*, which turn off the beam between each line so that it will not scan during the return trace. (3) It provides a *synchronizing signal* (usually referred to simply as sync) which is added to the camera signal in the switching system, producing what is known as a composite signal. The camera signal before this point is considered pure video. These sync pulses control the operation of the receiving sets, ensuring that they stay in exact synchrony with the scanning of the camera. The RCA sync generator is composed of two units, the pulse former and the pulse shaper. Field equipment of the other manufacturers is similar.

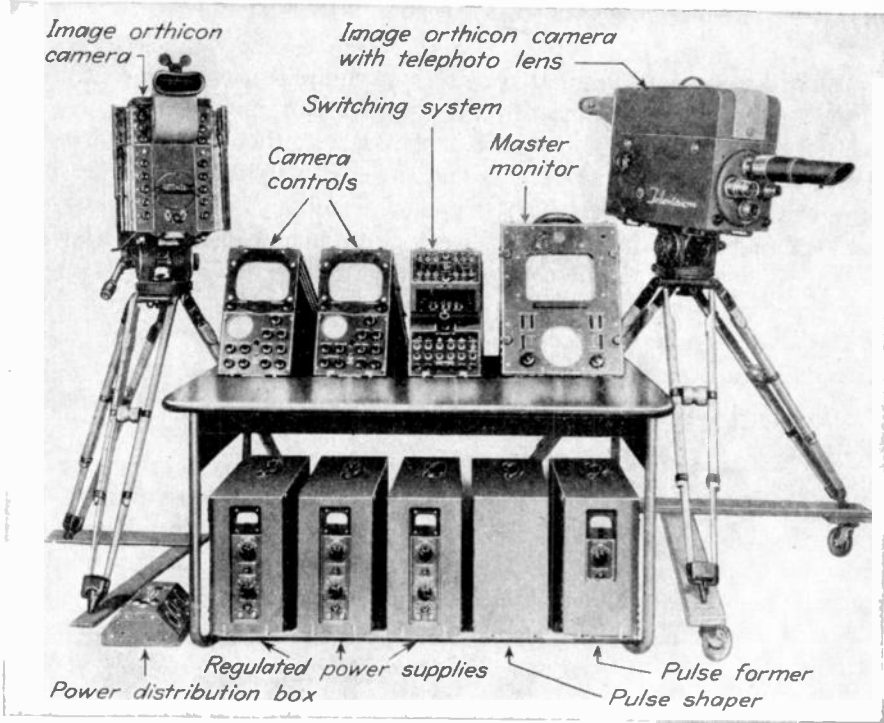


Fig. 20-3. RCA field pickup equipment.

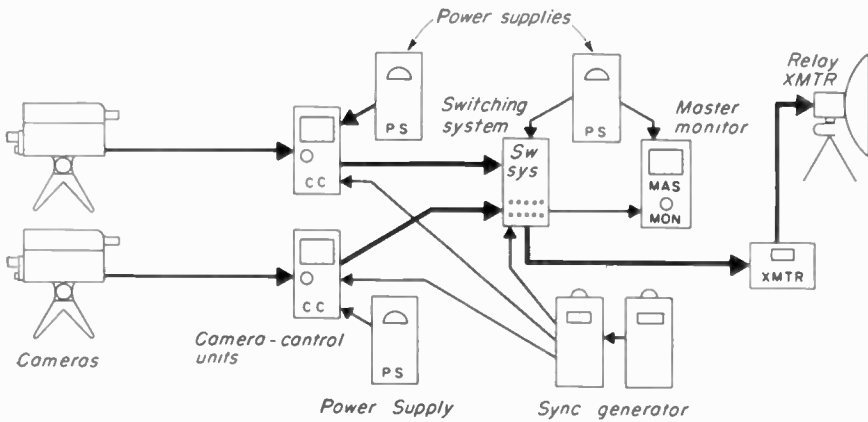


Fig. 20-4. Diagram of video equipment only for two-camera remote pickup. (RCA equipment shown.)

VIDEO LINK TRANSMISSION

The program signal originated by remote equipment must be sent back to the station and rebroadcast over the regular transmitter. This can be done over ordinary telephone wire if necessary, although if the distance is more than a few hundred feet, so much signal will be lost that the picture will not be usable. The telephone company will run a special parallel-conductor wire, similar to receiver antenna lead-in wire, which is capable of carrying an adequate signal over much greater distances.

For permanent installations, regular coaxial cable is necessary. This is also a two-conductor wire, one of which is a cylinder which completely surrounds the other. Since both conductors thus have the same axis, it is called coaxial. Light coaxial cables are now available at a few cents per foot.

When a great variety of pickups are anticipated, many of them at quite a distance from the studio, it is necessary to invest in a microwave relay link (Fig. 20-2). The relay link consists of two parts, a transmitter and a receiver. To all appearances they look exactly alike. The transmitter must be placed on a high point no farther than 400 feet from its control point and must have line of sight to the receiver.

The transmitter itself is contained in the small cylinder, or "ash can," which is fastened to the back of the large "dish." The transmitted signal is not broadcast directly, however, but goes into a rectangular tube, called a wave guide, which is hooked around so that it finally releases the signal facing back toward the dish. The mouth of the wave guide is in the point of focus of the reflector; so it beams the signal out just as the reflector of a searchlight forms a beam of light. When a 4-foot reflector is used, all the energy is concentrated into a narrow beam of 3 degrees or so, increasing the effective strength of signal at any point in the beam by a factor of 5,000 times over what it would be if the signal were broadcast equally in all directions. The nominal power output of the transmitter is then only $\frac{1}{2}$ watt, while the effective strength is that of a 500-watt transmitter.

A 6-foot parabolic reflector will bring this factor up to 11,500 times (or an equivalent power output of 1,150 watts). Of course the receiver on the other end of the link is built in the same way and works in reverse, concentrating 5,000 times as much signal into the mouth of the wave guide as if no reflector were in use. The total "gain" of the system, then, is 25 million times in the case of the 4-foot reflector, and 132 million in the case of the 6-foot reflector.

When the 4-foot reflector is used, the maximum range of the link is about 25 miles. A longer jump can be made possible by using the 6-foot dish. Both these reflectors make beautiful sails in the wind and must be

securely lashed down, or a sudden gust may send them crashing into the street. A solution for this problem was found in Cleveland, where winter storms off Lake Erie not only threaten to blow any projecting objects off the tops of the buildings but coat with ice anything that stands immovable. Plastic domes devised to protect radar antennas during the Second World War (Radomes) were found to be very useful for this purpose and were later adopted by others as standard equipment where permanent exposed positions must be used (Fig. 20-5).

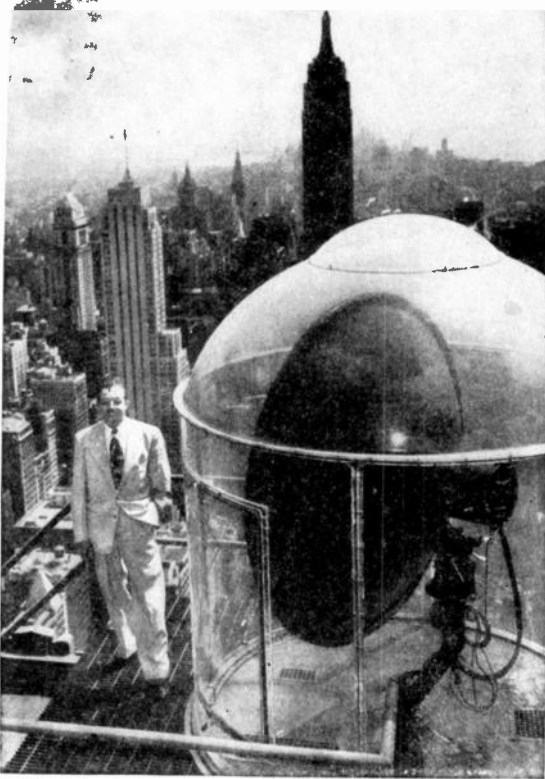


Fig. 20-5. Plastic Radome protects microwave receiver atop Radio City from wind and weather. Shown in picture is O. B. Hanson, NBC vice-president and chief engineer.

Some stations have found that smaller reflectors are useful for short distances and don't catch the wind so badly. WTMJ-TV had several 3-foot reflectors built for them by Milwaukee Metal Spinning Corp. One time in Cincinnati, an engineer forgot to put the wave guide on as he was setting up the transmitter. Of course the parabolic reflector was then inoperative because the signal was radiating directly from the front of the transmitter. Since the distance was only a few blocks, the signal was

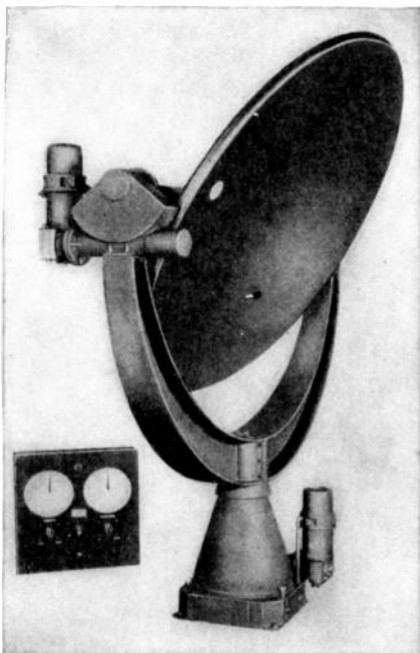


Fig. 20-6. Houston-Fearless remote control for microwave receiver.

entirely usable. Many stations now do not bother with the reflector and wave guide at all for extremely short distances.

Since the beam which the link transmitter produces is only 3 degrees wide, it must be carefully aimed at the receiver (which is usually placed part way up the regular transmitting tower). The receiver, too, must be aimed directly into the beam in order to receive the strongest signal. This means that an accurate method of aiming each dish must be provided. Sometimes they are mounted on regular camera tripod heads, so that they can be panned or tilted with complete freedom. When the equipment is being lined up, the engineer in master control must watch the picture and direct the aiming of both receiver and transmitter.

(The single cable running to these units carries intercom circuits.) Some stations pay their engineers for steeplejack work (\$10 a trip to go up the tower and adjust the receiver dish). Others have acquired equipment for remote control which permits this operation to be done from below. A remote-control mount is offered by RCA for this purpose (Fig. 20-6).

When the remote location is first surveyed, a position for the relay-link transmitter must be chosen which will provide a direct line of sight to the link receiver back at the station. If this is impossible because of high buildings, hills, or other obstructions, sometimes a double jump is used

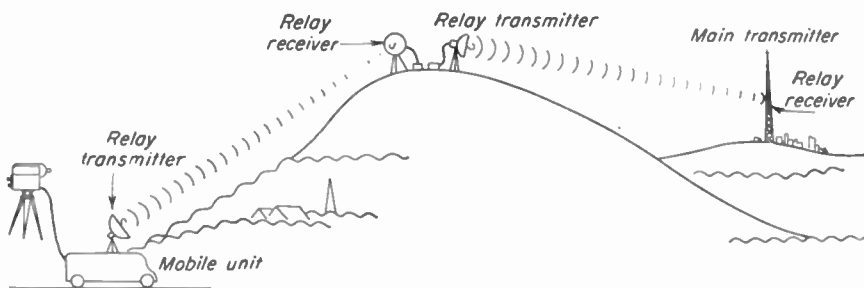


Fig. 20-7. Double jump—necessary when line of sight is lacking.

(Fig. 20-7). Most of the larger stations have more than one set of microwave relay equipment. A second receiver and transmitter are positioned at some intermediate point which can see both the remote point and the station, and the signal is relayed a second time from there. This is often necessary when the relay link is used from a point in the downtown section of a city. Tall buildings interfere with line of sight, and it often takes more than the maximum 400 feet of cable to put the relay transmitter on top of one.

Sometimes a double jump is not necessary even though there is no line of sight between the link transmitter and its receiver. A very high-frequency carrier is used for the microwave link, and these ultrashort waves reflect very readily off a variety of surfaces, especially when the surfaces happen to be wet. CBS-TV sent in the picture from Ebbets Field for a couple of seasons without having to build a tower above the stands for line of sight to their main transmitter on the Chrysler tower. Experimentation revealed that if the beam were pointed in almost the opposite direction and bounced off the side of a Brooklyn warehouse, it brought in a consistently good signal (Fig. 20-8). The signal was good until the third season, when the warehouse changed hands and its new use required that all the windows be left open. This sufficiently reduced its reflecting properties so that a tower finally had to be constructed to provide the direct line of sight.

Not long ago Station WABD in New York had difficulty with their

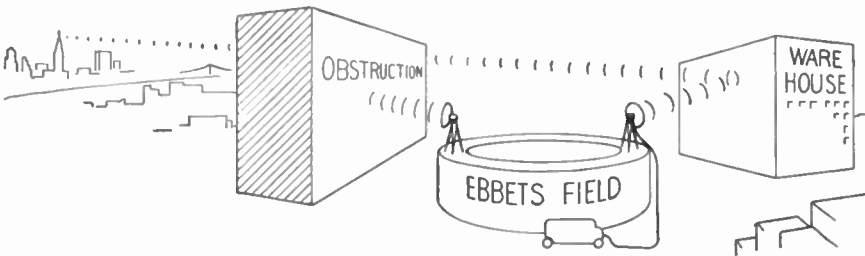


Fig. 20-8. Reflecting the beam, another method of getting the signal in when line of sight is lacking.

wrestling pickup from Ridgewood Grove arena. Week by week the picture seemed to deteriorate. Finally something had to be done about it. They tested the transmitter in another spot, and the picture came in fine. Back on the roof of the arena it was weak again. Then they got out the original maps which are usually worked out in detail for a long jump such as this. The maps revealed that the beam narrowly missed the top of a hill somewhere in Queens, on its way to New York. Arriving at the hill, investigators found that a large, new apartment building had been going up there, right in the path of their beam. While the building had been

only a frame, there was no particular obstruction; but as the brick walls rose, the picture had begun to weaken.

AUDIO EQUIPMENT FOR REMOTES

The discussion of equipment will be brief here, since a more detailed description of audio consoles, microphones, etc., is found in Chap. 19, Television Audio Problems. This will be more a listing than an explanation.

The portable audio control equipment which has been most often used consists of two units, the OP6 and the OP7. The OP7 is a portable mixer

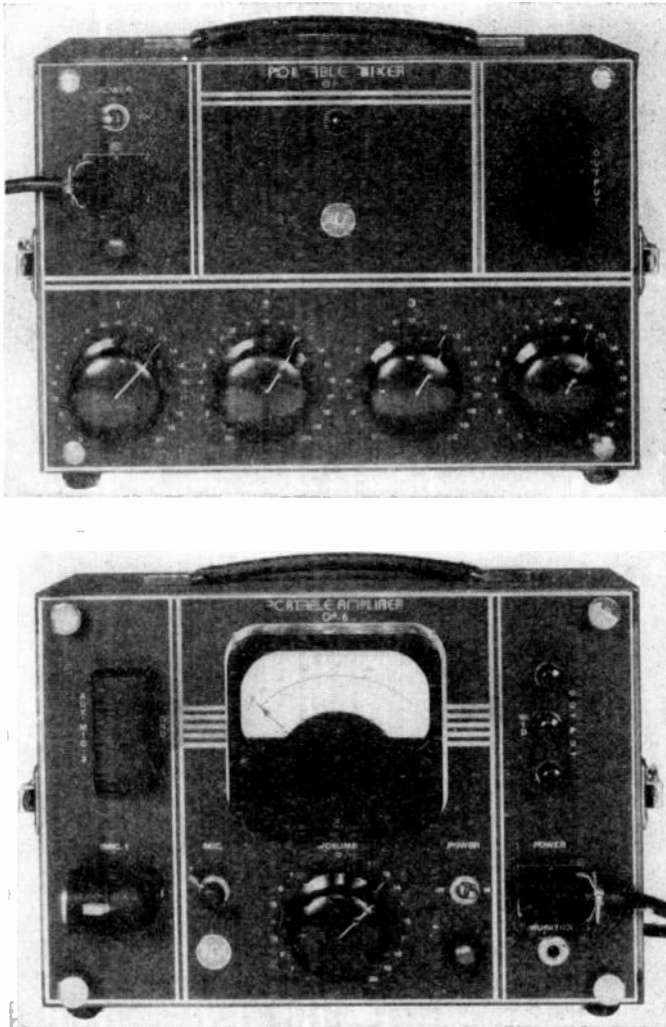


Fig. 20-9. RCA OP7 and OP6 portable audio-control equipment.

with inputs for four microphones. The OP6 (called a portable amplifier) is fed from this and contains a line amplifier and master gain as well as a volume-indicator meter (Fig. 20-9).

RCA also offers a single-unit remote amplifier (BN2A) with three input channels, one of which can be switched between two microphones which are not to be used simultaneously (Fig. 20-10). This is about 25 per cent more expensive than the OP6 and OP7, and although the single unit feature is important for radio work where this is the major piece of equipment that must be brought to the scene of the pickup, in the case of tele-

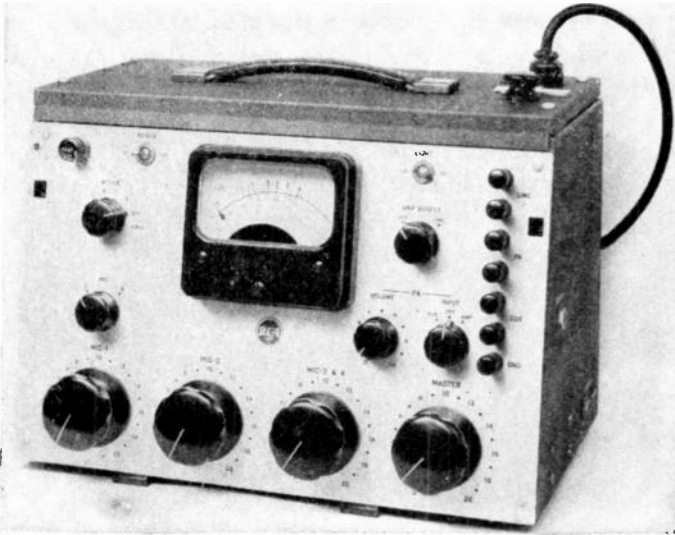


Fig. 20-10. RCA BN2A single-unit portable audio-control equipment.

vision it will usually stay in the truck anyway and extreme portability is not too necessary. In the event that a complicated audio pickup must be made from outside the studio, an OP7 can be fed into one of the microphone channels of the BN2A, thus providing six regular channels and a seventh which can alternate with the sixth on one channel. General Electric makes a similar single-unit portable mixer and amplifier.

It is very rare that a remote pickup calls for the use of a microphone boom, unless it should be a dramatic pickup of some sort, either from the stage of a theatre, for example, or a special dramatic production from a remote location. However, a telescoping mike boom is a very heavy and clumsy piece of equipment to move around and is best left in the studio. Smaller booms are available, such as the RCA Magic Lock or the Display Lighting "giraffe" boom, which are light enough to be portable and can be rolled in and out by the operator in following the actors. Hanging or concealed mikes are frequently better in covering this type of show.

When a dramatic illusion is not involved, it does not matter whether or not microphones show in the picture. Stand mikes are occasionally used; for interviews the hand mike is often best, especially when these take place in crowded and noisy places. Holding the microphone close to each speaker has the advantage of raising the volume of direct sound in relation to the background noise.

Occasionally a microphone will be used in a parabolic reflector for picking up sound from a considerable distance away. The mike is placed in the focal center of the parabolic dish and receives a greatly amplified sound from a very narrow field. Such microphones are very useful at football games for picking up the sound of a band across the field or the voice of a cheerleader down below the stands. They have been tried in theatres to replace the microphone boom, the theory being that an operator could pan from actor to actor from a position in the balcony and pick up sound much as the audience does in the theatre. The quality of sound picked up by this means is very strange, however, hollow-sounding, and apt to distort voices which come in from an off-mike position.

Another piece of audio apparatus which is occasionally used in connection with special-events remotes is the "radio microphone," or "walkie-talkie" (Fig. 20-11). In addition to a crystal microphone, this unit has a small 0.2-watt AM transmitter capable of sending out a signal for a few hundred yards. Any receiver covering the correct wave band can pick up the signal and feed it into the audio mixer. This is a radio development and is not too well suited for television, since it is difficult to pass such a large unit back and forth between interviewers and guests. Even with a single announcer it is found distracting. A more practical solution would be to place the transmitter in a small pack on his back or at his side and separate the microphone from the unit. In this way a small chest or throat mike would pick up the announcer, and interviewees could be handled with the usual hand mike.

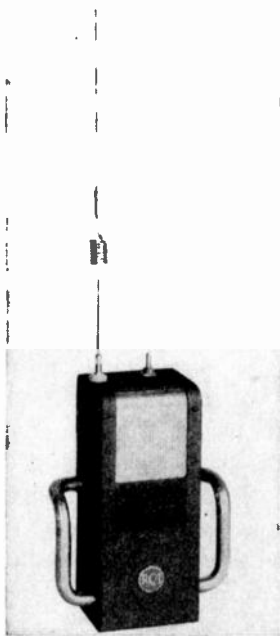


Fig. 20-11. RCA "radio microphone."

A useful piece of audio apparatus which has been found valuable in radio remote work is a special type of cable reel which enables the microphone to be used even while the cable is

reeling up or unrolling from the reel. Ordinarily while the inside end of a reeled-up cable may be plugged into the audio equipment so that the entire cable need not be taken off the reel, it must be disconnected again if more cable is to be payed out, because the center of the reel must turn just like the outside. The Port-o-reel* eliminates this problem by providing a continuous sliding contact at the center of the reel.

THE MOBILE UNIT TRUCK

Every station that can boast a set of image-orthicon field equipment will also have some kind of special conveyance for carrying it around. This will vary from luxury busses, in which the investment is justified in large part as station promotion, down to simple station wagons and light pickup trucks, which can be used for hauling props and many other purposes as well. Some of the stations have adapted large house trailers for the purpose. Each of three major manufacturers offers a specially adapted truck with various built-in features that make it almost a traveling studio.

A well-designed mobile-unit truck must serve several purposes:

1. It must provide a means of transporting at least the major part of the operating personnel.
2. It must provide a quick and convenient means of transporting the television equipment from station or headquarters garage to and from remote location.
3. It must provide a control room with adequate desk space for operating personnel and some standing room for additional assistants or important visitors.
4. It must provide a well-organized storage system for all necessary equipment so that any item can be quickly located and will not be damaged during transit.

* Made by the Industrial Electrical Works, 1509 Chicago Street, Omaha, Nebr.

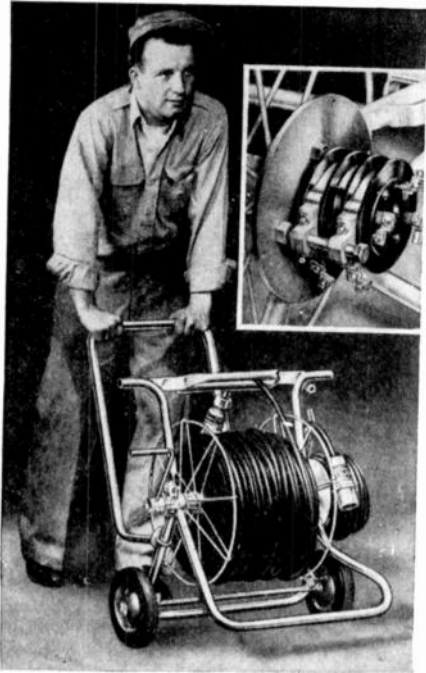


Fig. 20-12. Porto-reels for power and microphone cable. The microphone may be used while the reel is in operation.

5. It must provide space for equipment maintenance of a simple sort; a small workbench with a few tools will suffice.
6. It must provide a suitable platform and working space for cameras on top of the truck, to be used as a vantage point at parades and special events when other convenient camera positions are lacking.
7. With all this space provided inside the vehicle, the over-all length must not be so great that the truck is not maneuverable in traffic or in towns with narrow streets and sharp corners.
8. It must be cooled in summer and warmed in winter. Insulation of the floor, walls, and roof is necessary for both purposes; a heating system must be installed; and if a cooling system cannot be afforded, at least forced-draft ventilation should be provided.
9. If the truck is large enough, it may also provide a position for an announcer or commentator with a small desk and jeep monitor.
10. The truck is generally considered a traveling advertisement for the station; and the appearance of the outside, plus the shipshape condition of equipment and personnel during operation, is a constant medium of station promotion in the local market.

There have been several types of trucks and busses adapted for television mobile units, and a great variety of interior layout designs. None of these meets every requirement satisfactorily, but each has something to recommend it.



Fig. 20-13. RCA mobile-unit truck.

RCA MOBILE UNIT (Fig. 20-13)

The simplest and the most common truck in the industry is put out by RCA. This mobile unit is built into a Chevrolet 1½-ton truck of the school-bus type. It is also the smallest of the various trucks which will be described. There are smaller trucks in use, but they are inadequate unless used in connection with other vehicles; so they are not called upon to fulfill all the functions that have been listed here.

The control-room section of the truck is at the rear, where the various camera-control units, switching system, master monitor, and audio equipment are set up in console form. The truck elevation (Fig. 20-14) shows how the power supplies, sync generator, and other units requiring little attention during operation are placed just beneath. Only three chairs are provided, and this is of course not adequate unless the producer does his own switching. If a switching engineer is used, the other two chairs must be occupied by video and audio engineers and the director is required

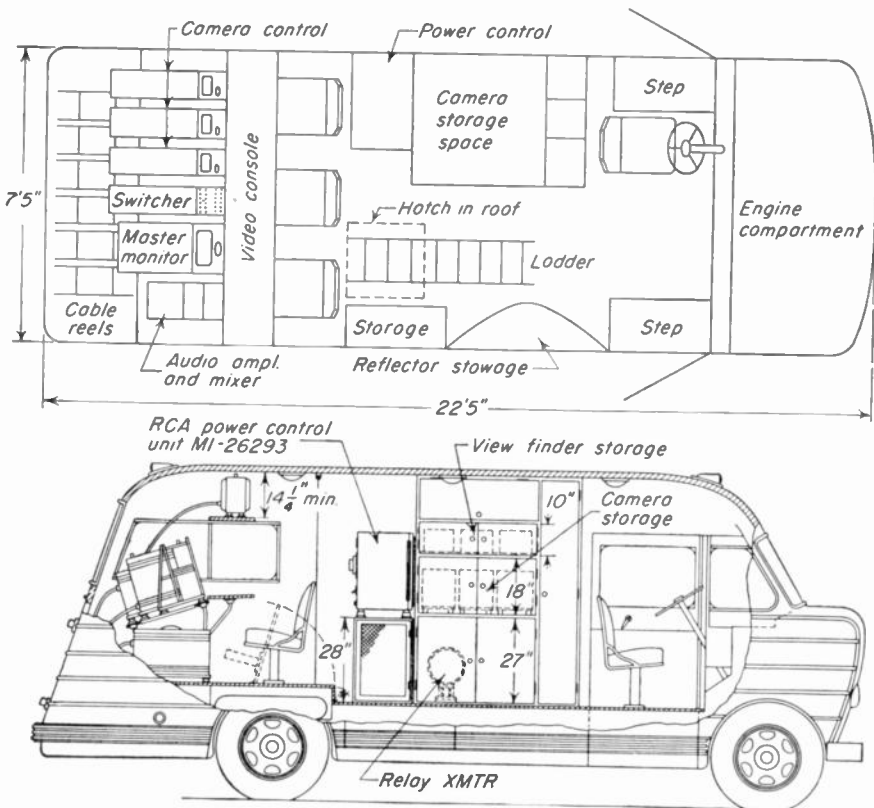


Fig. 20-14. Plan and elevation of RCA mobile-unit truck.

to stand behind. A production assistant must then stand behind him, and the truck soon becomes hopelessly congested.

The video console faces a large back window, on the theory that the truck could be backed up to an event; so this would serve as a kind of control-room window. Actually, the author knows of no case where this window has been found necessary or has even been put to good use; the truck can only rarely get right up next to an event but is usually parked behind the stands or in a side street. The rest of the truck is used for storage of cameras, view finders, relay-link transmitter, and other equipment that cannot be left permanently set up in the truck.

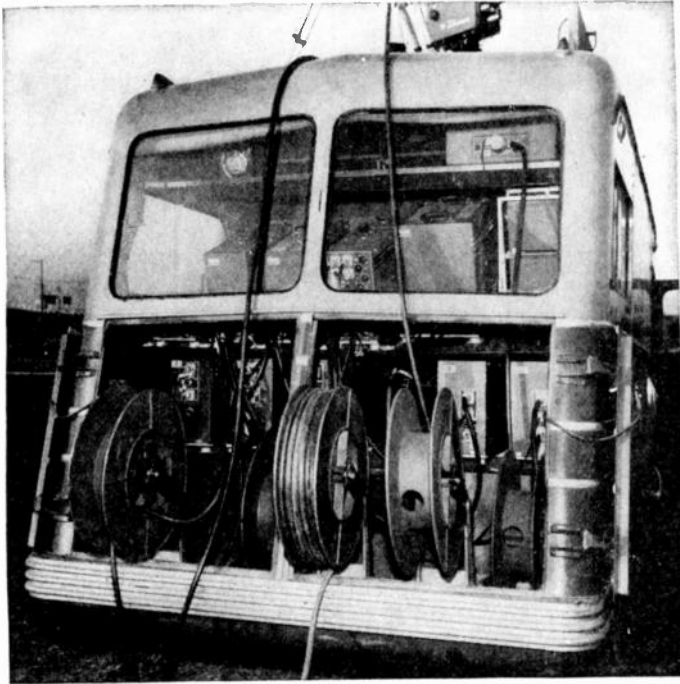


Fig. 20-15. Back of RCA truck.

Wide doors open at the back of the truck (Fig. 20-15), where a series of cable reels are mounted for the long camera, power, and transmission cables that are required. Each reel will hold 200 feet of cable, and there is space for six reels. Any further cable (and more is often necessary) must be carried on the floor of the truck or in someone's car.

GENERAL ELECTRIC MOBILE UNIT

The General Electric mobile unit is adapted from a 2½-ton Linn truck which, although only about 10 inches longer from bumper to bumper than the Chevrolet just described, seems considerably larger inside (Fig. 20-16). A chair can be provided for the program director, for example, and there

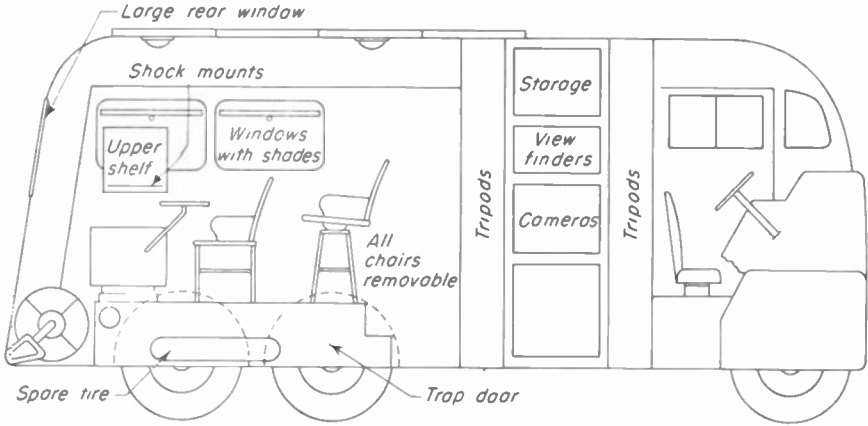


Fig. 20-16. Plan and elevation of General Electric mobile unit.

is considerably more standing space behind him. Storage space and cable reels are similar, and the station which installs this unit can have the choice of an interior ladder and access door to the roof or an exterior ladder if desired. People who have used the Linn truck mention only one or two drawbacks. The Linn front-wheel drive means that there are only two driving wheels to pull the truck out of soft places (the Chevrolet has four rear driving wheels), and parts and service for a Linn may be more difficult to find in some parts of the country than if the truck were of a more popular make.

WBKB TRUCK (Fig. 20-17)

The need for more space influenced WBKB to design and build two remote trucks which formed a pattern for many of the specially built units today. A third again as long as the Linn, their second truck was built from a General body on a Ford chassis. A rear door was provided for easy accessibility, and a rack for five cable reels could swing across the opening. A workbench was provided against the side. Video- and audio-production desks were placed midway of the truck, and open shelves along the side (see cross section of truck) made it easy to slip the cameras and view finders into the special shock mounts that are made by the manufacturer for the purpose. (In trucks which have deep cabinets for camera storage, it is very difficult to get the cameras in and out when the shock mounts are used.)

A feature of this setup is that relay switching was employed, with two sets of switching buttons, one on the regular switching system at the engineer's console and another remote set at the director's position. To give the director control over switching, the engineer punched a remote-control button.

One inch of glass-wool insulation was installed in the floor, walls, and

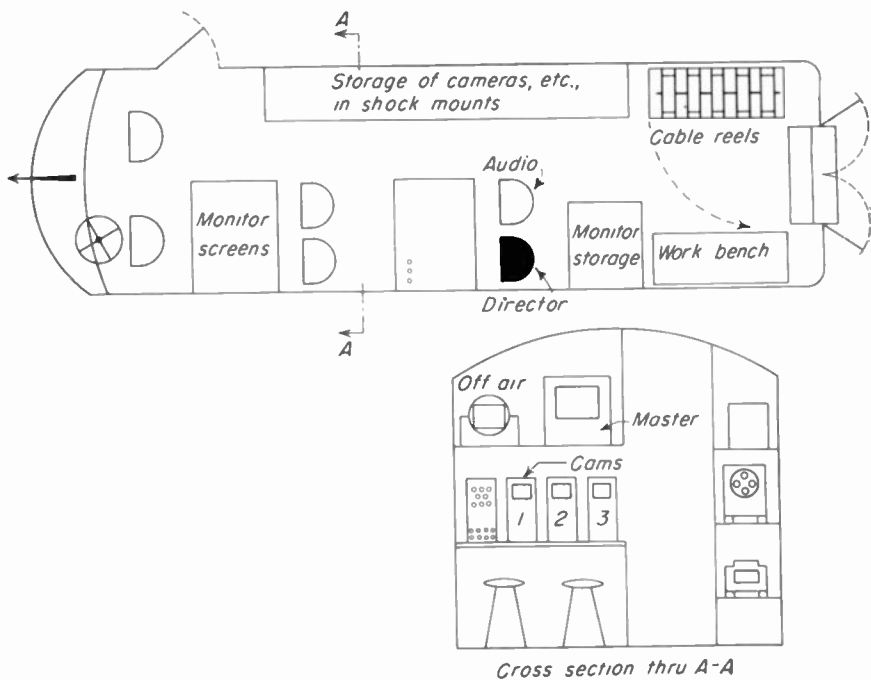


Fig. 20-17. Plan and cross section of WBKB truck.



Fig. 20-18. WLW-T adapted bus.

roof, making this truck a much more comfortable working space during Chicago winters than previous trucks had been. A cooling system was also considered and eliminated only when it was found that the cost would be prohibitive.

WLW-T ADAPTED BUS

An ACF Brill bus was adapted by the Crosley station in Cincinnati for one of the best mobile units that had yet been constructed (Fig. 20-18). Subsequently the other Crosley stations in Ohio (WLW-C in Columbus, and WLW-D in Dayton) followed suit, as did a few other stations such as WKY-TV in Oklahoma City. Du Mont is now offering a fully appointed "telecruiser," custom-built, in almost the same flexible body and chassis.

The WLW-T truck was not custom-built but was made over from an existing bus. All but eight of the seats were removed. This was the first truck that could carry the entire remote crew comfortably. Elsewhere private cars have been relied on extensively, or station wagons have been acquired for the purpose (Fig. 20-19).

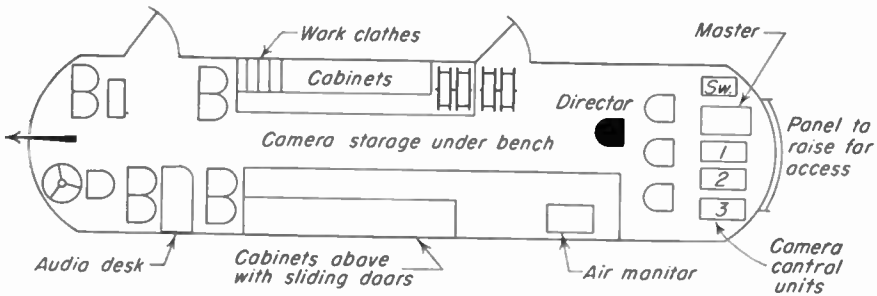


Fig. 20-19. Plan of WLW-T adapted bus.

EXTRA HEIGHT

Extra height is very often a necessary thing in remote work, sometimes for satisfactory camera placement, sometimes to obtain line of sight to the main transmitter for the microwave link. Stackers and fork trucks have been used sometimes for camera vantage points, the advantage of these devices being that the camera can be mounted at ground level and hoisted 10 or 15 feet in the air. Where these devices are used, it is usually because they happen to be handy at the scene and can be utilized without added expense. The fork truck makes an excellent camera dolly with the added possibilities of vertical movement but is of value only on remotes when the microphones are used close to the announcer and the noise of the truck motor will not pick up.

To lift the microwave dish as high as possible, some ingenious methods



Fig. 20-20. Six representative mobile units. Tap left, WEWS, Cleveland, adapted Spartan House trailer. Top right, KPIX, San Francisco, adapted Ford truck. Center left, WKY-TV, Oklahoma City, adapted Flexible bus. Center right, NBC "crash" unit includes audio and video transmitters and gas-driven generator. Lower left, WDTV, Pittsburgh, Du Mont Telecruiser. Lower right, KNBH, Hollywood, Linn truck.

have been attempted. WSPD-TV solved the problem many times by calling up the Toledo fire department and borrowing the hook-and-ladder truck. The city fire department generously sends them out the truck with a man to run it, and the microwave dish can be raised to a height of 80 feet. It is not always possible to borrow equipment like this, and the station is obliged to build some kind of tower as quickly and as cheaply

as possible. Wooden platforms are often constructed for camera positions, but these are usually considered permanent installations and are neither particularly quick nor cheap to put up.

Several manufacturers make a kind of tubular scaffolding of which very solid towers can be built in a few minutes' time. "Upright scaffolds"* made of aluminum alloy are particularly well adapted to this purpose. Figure 20-21 shows an upright scaffold put up by KNBH in Los Angeles for camera placement at a tennis match. Two men can put up this light-weight scaffolding in five to ten minutes' time. Each section folds together into a flat package weighing only about 60 pounds. Several



Fig. 20-21. "Upright scaffold" used for camera placements at Hollywood event (KNBH).

stations have invested in this type of scaffolding. WTMJ-TV in Milwaukee has a tubular aluminum Safeway tower which can be assembled to the height of 60 feet in an hour or so. There is almost no limit to the structure which can be built with tubular scaffolding. Figure 20-22 shows a 70-foot tower put up by WXYZ-TV for their special telecast of the 1949 Motor City Open Golf Tournament in Detroit. Contractors will erect scaffolding like this for special jobs, but enough sections to build small towers for camera placement can easily be carried to and from the scene and stored in relatively little space. The scaffold shown in Fig. 20-21 when folded up and stacked away should occupy a space not over 2 by 4 feet and 6 feet high.

* Upright Scaffolds, Bank of America Bldg., Berkeley 4, Calif.



Fig. 20-22. Seventy-foot tower of scaffolding erected by WXYZ-TV, Detroit.

GAS-DRIVEN GENERATORS

Very often the mobile unit will be asked to make a pickup from a location where there is no available supply of alternating current. To broaden the scope of remote pickups, many stations have invested in a 5-kilowatt generator permanently mounted on a small trailer. The trailer can be hauled behind the remote truck or any other vehicle and placed a few hundred yards from microphones so that the noise of its gasoline motor will not interfere with the sound pickup. A fairly even frequency of current is necessary to run television equipment since all the synchronizing and driving pulses are based on the 60-cycle alternating current (a-c current reverses its direction of flow 60 times every second: hence 60-cycle). If the frequency is not accurately controlled and goes down to 58 or up to 62 cycles, receivers may lose sync and the picture occasionally will roll up the screen.

WCAU-TV in Philadelphia has had one of these generators in operation for several years and finds that frequency control is maintained as long as the generator is not overloaded. It is not satisfactory, for example, to operate more than two cameras; three will overload the generator just enough to lose the steady frequency.

PROBLEMS OF REMOTE PICKUPS

In planning the pickup of remote events, many things must be taken into consideration. So much preplanning and setting up have to be done at the usual remote that stations often estimate that a "one-shot" pickup from beginning to end costs \$300 to \$500. Of course when the problems can be solved once for a long series of pickups from the same place, the unit cost becomes far less. Most of this cost is man-hours, surveying the location, arranging for the necessary rights, stringing cable overhead where it will not interfere with the movement of crowds, etc.

On the other hand, some stations have found that simple one-camera

remotes can be handled by only two men, reducing the cost to very little indeed.

THE POWER-SUPPLY PROBLEM

Approximately 5 kilowatts of power is necessary to operate the remote equipment. Five kilowatts means a 50-ampere current, which can usually be obtained from the entrance equipment of a nearby dwelling or field house, since a 60-ampere line is provided for most installations. This much current cannot be taken out of a lamppost or a wall socket, since these lines are generally fused for 15 to 30 amperes and the wires involved would heat up dangerously or even melt if 50 amperes were put through them.

The person who is surveying the remote location will hunt up the main fuse box and entrance switch, usually in a cobwebby basement, and check to see whether or not it is rated at 60 amperes capacity. When the remote pickup is made, the power cable is then connected either by heavy spring alligator clips (which are illegal in some localities) or by lugs which can be screwed or bolted to the incoming lines.

LOCATION OF CONTROL POINT

The location of the control point is dependent on several factors, one of which is cable length again. Camera cables may not exceed 1,000 feet in length. If the transmitter control unit is kept in the truck or at the control point, then only 400 feet of cable is allowed from control point to transmitter. Finally, the available power-supply cable (which is the heaviest and most expensive of the cables involved) will determine how far distant the control point can be from the source of power.

Usually the control equipment will be kept in the truck, and selection of a control point will involve only finding a suitable place to park the truck where it will be in the shade, removed from crowds, and close enough to things so that tremendous amounts of cable are not necessary. If the truck cannot be parked near enough to the scene or if cables cannot be run to a suitable parking spot, then the equipment must be taken out of the truck and a special control point established elsewhere. This cannot be outside, because the monitors must be shaded, so that a picture can be seen. If there is no nearby room, a canvas can be stretched overhead to make a kind of tent for the purpose. It is not necessary for the operators at the control point to see the event itself or have any further communication with the cameramen than the regular talk-back earphone setup. At ball parks a small room or office can usually be found under the stands for this purpose.

THE RELAYING OF AUDIO AND VIDEO SIGNALS BACK TO THE STATION

The problem of relaying the signal back to the station is of vital importance and should be considered very early in the survey of the location. This is usually done on topographic maps of the locality before going out to the location, to make sure there are no obstacles in the way between the transmitter and receiver of the proposed microwave link.

Audio is usually sent back from the remote point by telephone wire in the same manner as a radio remote. The telephone company on a few days' notice will install special wires to terminate wherever necessary. Audio link transmitters of the microwave type are not on the market, nor has the Federal Communications Commission allocated wave bands for that purpose. Experimentation has been done, however, in the combining of sound and picture into one transmission, so that both signals may modulate the one microwave carrier which already is used for video alone. When this is possible, it will allow a somewhat greater freedom in the use of remote equipment.

PERMISSIONS, RIGHTS, AND CLEARANCES

A great share of the time involved in preparing for a remote pickup is spent on securing the right permissions and legal clearances for the job. Some municipal governments are less involved in red tape than others. Police permission must be obtained for parking the truck on the street, or private permission for parking it elsewhere. If any construction of platforms or special poles or rigging is to be done in connection with the running of the cables, city or private permission must be obtained. Fire laws are involved in most of this planning.

COORDINATION WITH THE STUDIO

It is necessary that the producer of the remote program have sufficient communication with the studio so that proper coordination of beginning and end of transmission will be possible and filmed commercials which must originate at the studio will be smoothly integrated. For this purpose a second audio line is provided as a cue line. The technical director at the remote is always handy at the end of this private line, and the other end usually terminates in the station's master control room. It will be used for engineering purposes as the equipment is set up, particularly in aiming the microwave transmitter. Immediately before and during the broadcast the private line will be used for production purposes. There is usually a production man in master control (called the "coordinator" or the "broadcast supervisor"). It is his responsibility to coordinate the beginning and ending of the remote program with whatever other program

material or spot announcements are to be run from the studio, and especially to direct the running of the film commercials which occur during the broadcast of the remote.

To enable the remote crew to coordinate better at their end of things, an air monitor is provided so that the actual program which the station is putting on the air can be watched in the remote truck. This is of course nothing more than an ordinary receiver and antenna set up in the same way as any other home receiver.

Until recently it was impossible to make a dissolve between a remote picture and a studio picture. It was impossible to superimpose news bulletins, for example, originating in the studio, on pictures coming from the remote point. Two sync generators are involved, and it was not possible to keep them working in synchrony with each other. The field equipment has its own sync generator, providing the sync pulses that keep the receivers working in time with the remote cameras, and the studio has another sync generator, sending out similar pulses to keep the home receivers working in time with the film-pickup camera which is picking up the news bulletin. If a dissolve is made between these two picture sources or if the dissolve is held (a superimposition), two sets of sync pulses will be going to the receivers at once. If these are not together, the receivers will have to choose one or the other and one picture will be seen to roll constantly up or down the screen. Even a direct cut from studio to remote may catch the new sync pulses at an in-between point, and the receiver picture will roll once up the screen until the receiver gets locked in synchrony again. Consequently all transitions from studio to remote, or vice versa, were made by a fade to black and a fade back in.

The manufacturers have met this problem with a device called the sync lock, or the "Gen lock" in the case of RCA, which locks together the pulses of the two sync generators. The method is to lock the studio sync generator as a slave to the field sync generator as a master. Some stations have built their own equipment to do this. Only where such equipment is in use, however, is it possible to superimpose studio and remote pictures, lap-dissolve, or make a direct cut from one to the other.

THE SURVEY

To summarize the various points made above, a typical survey form is included. This form was prepared by Oliver Fulton, engineering supervisor at WPIX and is intended to be filled out by the engineer and production man who make the original survey of the remote location. Every possible question is included. If any real problems arise, the chances are they will be pretty well solved during the process of the survey, and any unsolved problems will be indicated as such under general remarks at the

end of the form. This form is adapted from the one used successfully at WNBT and has served WPIX for many hundreds of surveys and pickups:

DATE _____ WPIX REMOTE PICKUP SURVEY

1. Location _____
2. Address _____
3. Type of events _____ Date first pickup _____
4. Contact people and phone Nos. _____
5. Nearest phone to location _____
6. Control point (truck position or otherwise) _____
7. Camera 1: cable length _____ ft Location _____
8. Camera 2: cable length _____ ft Location _____
9. Mikes: cable length _____ ft Location _____
10. Mike parabola position _____
11. A-c power available volts _____ amp _____ Phasing _____
12. Power-cable length to control point _____ ft. Tie-in fixtures required _____

13. Lighting available (foot-candles) _____
14. Additional lighting needed, description _____
15. Power available for lighting, voltage _____ current _____
Location _____ Cable requirements _____
16. Power construction required (details) _____
17. Electrical contractor employed by location _____
18. Platform construction required (details) _____
19. Contractor employed by location _____
20. RL and PL termination location (radio line and private line) _____
21. Person Phone Co. can contact for information _____
22. Video transmission facilities: Phone Co. input _____
Coax length _____ ft. Microwave head location _____
Microwave control location _____ Cable lengths required _____
Camera, coax, PL bridge, a-c power _____
Note: if second microwave hop required, fill out second survey sheet where applicable for this location.
23. Location of off-air receiver antenna _____
24. Location of announce monitor _____
25. Coax _____ ft or antenna location _____
26. Miscellaneous equipment needs: camera dollies, control table, etc. _____

27. General remarks _____

Signed _____

Engineering
Production
28. Show sketch below (include camera, control, or truck positions and locate power, PL and RL, and microwave). Use other side if necessary.

METHODS OF COVERING THE MAJOR SPORTS

The problems of camera placement, choice of lens, etc., have been purposely omitted from the preceding section because they belong more properly under the more creative production problems of picking up the game. It is, of course, impossible to cover all the types of remote events which have been picked up by television crews. Some of the most interesting

problems have been faced when one-shot pickups of unusual events have been made. A more detailed discussion of the standard games will serve, however, to establish the basic principles, which can then be applied in individual cases as the need may arise.

WRESTLING AND BOXING

The pickup of wrestling and boxing is perhaps the simplest of the various sports, although this does not mean that the director can relax and take it easy on this type of show, any more than any other. He still must be "Johnny on the spot" with the right shot at the right time. His job is simplified, however, by the fact that he rarely has to direct the cameramen, since there is but one pair of fighters to watch, and he can devote his attention to proper switching between the shots.

Only two cameras are used for wrestling and boxing, and these are usually placed on special platforms, either above and behind the spectators if it is a small arena or in the aisle if the arena is large. The placement of the camera far back in a large arena is to be avoided since long lenses must be used. A long lens exaggerates any lack of smoothness in camera handling, and vibrations of the camera platform are readily seen in the picture. If the camera position is high as well as distant, the long lens will have a further undesirable effect. Long lenses condense depth. The fighter in the ring will be condensed in height if seen from a high angle and will look like an unimpressive dwarf.

The cameras cannot be placed too close to the ring, or they will be in the way of spectators. If the cameras are placed low, in the aisles, the ropes and corner post are in the way. Sometimes a camera has been placed at ringside and has produced an extremely dramatic low-angle shot, but this cannot be done everywhere since at some rings the camera will be shooting up into the lights.

WBKB was able to put up a platform for two cameras in the aisle about 10 feet from the corner of the ring, without blocking anybody's view, and high enough so that the corner post would not interfere. The advantage of such a close position is that big close-ups are possible without the use of such a long lens that the following of action would be very rough and uneven.

The announcer is usually placed at ringside in the pickup of these two sports, but it is very important on which side of the ring he is placed. If he is on the opposite side from the cameras, for example, he will have a difficult time keeping left and right straight in his own mind (the fighter on the left of the screen will be seen on his right, etc.). For this reason and also to make it possible to show the announcer and an occasional interviewee, he is almost always placed on the same side of the ring as the cameras.

RACING (flat racing, harness racing, stock car racing, etc.)

In the pickup of racing the action takes place on a very large stage, sometimes a half mile long. All races run counterclockwise in this country, which means that the action is left to right on the screen in the foreground and right to left in the back stretch. Admittedly, it is impossible to be close to the entire action. The finish line is the place to be, of course; and the press box at the race track, as well as at any other grandstand, is placed in the best position to see the important moments of the action. Whereas it is usually possible to obtain space in the press box or on the roof of the press box if it is strong enough, this is not always the best vantage point for the television camera. In racing, just as in any other sport, the high-angle assures coverage of everything, but at the sacrifice of dramatic pictures. Tiny horses moving across the screen, seen from above like toys on a table top, are not at all impressive, as they would be from a low angle near the track, sweeping toward the camera, looming larger in the shot as they come. The shot of the horses as they go down the back stretch is almost universally bad, making them look like the moving ducks in a shooting gallery.

The placement of cameras at all remotes is dependent upon a great many other factors than simply the best position for the best possible pictures. The design and construction of the grandstand may be a determining factor, as well as the policy of the owners in regard to the use of



Fig. 20-23. WKRC-TV camera on grandstand roof at Cincinnati race track.

cameras and the quality of pickup they are prepared to allow the television station to make.

Methods of programming the races will dictate to a great extent the placement of cameras. A camera may be placed in the paddock, for example, and devoted to the before-the-race examination of the horses. Of course it is better if this camera can also be used for another purpose also so that fewer cameras will be required.

Action on the race track takes up only a small portion of the time of a race-track remote, and the producer must be prepared to pick up something of interest to the viewing audience while there is nothing on the track. In harness racing there are usually some horses on the track warming up, and the announcer can ramble on about past performances and interesting angles of the sport; but in flat racing the track is dead between one race and the parade to the post for the next one. A camera in the paddock will give the viewers what they would be looking at if they were actually at the track; and when this fails, the producer will usually try to ring in some interviews with the race-track officials, celebrities in the audience, etc. A New York station has programmed a full-fledged quiz game, with panel of contestants and master of ceremonies, for the interval between harness races.

If a camera can be used for more than one purpose, maximum efficiency is attained. Thus at the race track in New Orleans, WDSU-TV has placed one camera on the clubhouse porch, where it can be used on the race itself and can be turned around for interviews against the lush background of the exclusive clubhouse. CBS at Jamaica Race Track on Long Island has used a camera in the paddock and later dollied it out on the lawn to watch the crowds surging to the rail. One camera is always placed high on the top of the grandstand for horse racing and is used as the basic camera for the major portion of the race. CBS placed a camera at Jamaica down at the rail near the finish line and used it for the finish of the race as the horses came down the final stretch into the camera. This camera was also useful for good shots of the crowd during the race, long shots of the grandstand before the race, and a close-up of the bugler calling the horses to the post.

WBKB in Chicago used a different technique, something that producers have talked about for a long time. A camera was placed in the infield so that an adequate shot would be obtained of the action in the far stretch. Stringing wires across the track was of course impossible; so about 600 feet of camera cable was snaked through a conduit under the track. Running cable to a camera on the far outside of the track could be done, but the direction of motion of the horses would be reversed and the audience might become confused as to the position of the horses on the track,

proximity to the finish line, etc. By keeping all cameras on one side of the action, this confusion is eliminated.

Of course the technique of cutting from one camera to another had to be very carefully considered in this setup. Figure 20-24 illustrates the positions of the three cameras that WBKB used. The routine of cutting was as follows: After the start, camera 1 followed the horses as they moved from left to right down to the "clubhouse turn." Before they were definitely going from right to left on the screen, a cut was made to camera 2, placed closer to this turn and able to see the action in this portion of the track. In camera 2's shot the action turned and was soon moving from right to left on the screen. At this point the infield camera could take over and follow the action all around the back stretch. Just as the horses began to round the far turn, the director had to cut back to camera 1,

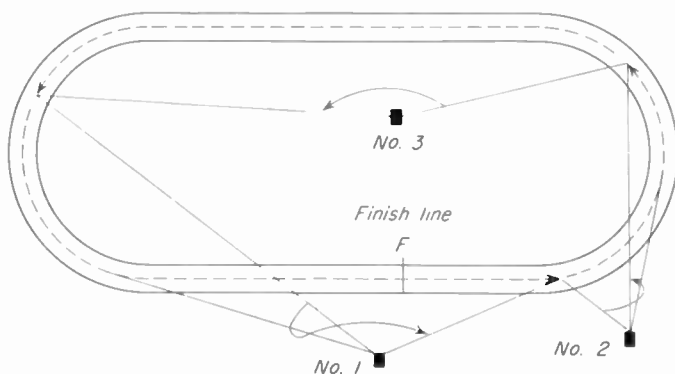


Fig. 20-24. WBKB race-track pickup with camera in the infield. Range of usefulness of each camera is shown.

however, so that the action would be right to left in both shots at the moment of the cut. If the horses had been allowed to round the turn too far, however, a good cut would have been impossible. Whereas the horses would still have been going right to left for the infield camera, camera 1 would have shown them moving from left to right.

At the finish of the race it is usually considered best to hold the camera on the finish line after the winner crosses to show the other horses come in. Of course, this cannot be done with too close a shot, or the following horses will flash through with such a blur that they will be unrecognizable. Sometimes a single shot of the winner is used up to the finish line, and a cut is made to a wider shot as the other horses come through. Too close a shot on the contest at the finish of the race defeats its own purpose, however, since the important thing is to watch how the horses approach the finish line, and both the horses and the approaching line have to be in the shot for a certain length of time for this to be entirely satisfactory.

If there is no contest for first place, often the camera will forget the winner and concentrate on the contest for second place.

A typical cutting routine in race-track pickup can be exemplified by WDSU-TV at the race track in New Orleans (Fig. 20-25). Only two cameras are used; camera 1 is on the clubhouse porch, about 100 feet to the left of the finish line and only half as high as camera 2, which is placed in the press box on the top of the grandstand. Camera 2, with a 25-inch lens, takes the start of a typical race (far side of the track) and carries the horses on around the far turn except for a section of the back stretch, when a group of live oak trees in the infield of this particular track obscures the horses from camera 2; and camera 1, which is lower and can see under the trees, is briefly cut in with a 13-inch lens. Number 1 then changes lenses to a 135-mm and is cut into the sequence as the horses come down the

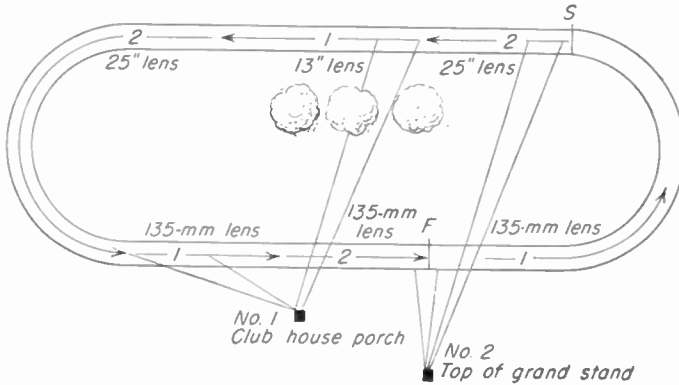


Fig. 20-25. Cutting routine for WDSU-TV two-camera pickup at New Orleans track.

straightaway until they are nearly opposite the camera. Then camera 2, which is closer to the finish line, takes over with the same lens, carries them to the finish line, and holds as they all go through.

FOOTBALL

Football is one of two major sports where an intimate knowledge of the game is a very valuable attribute for both director and cameraman. Some of the new developments in the game of football leave the position of the ball a mystery to all concerned for several moments after the beginning of a play, and the cameraman is often no exception. If he knows more about the game, he can better anticipate the plays and be ready with the right lens or follow the right player more often.

The television director's primary responsibility is to show the audience what they want to see, when they want to see it, and to leave no confusion in their minds about it. The greatest sin a director can commit is to fail

to show the audience what they know is happening, what they would be looking at if they were there. Yet this is surprisingly easy to do. Sometimes it is mere sluggishness; sometimes, lack of a cover shot; sometimes it is a confusion caused by too much cutting.

Most stations use two cameras on football and place them together on the 50-yard line, usually in the press box or up on the roof at the top of the grandstand (Fig. 20-26). A position halfway up the stands is often used, just above an entrance, where there will be no one to jump up suddenly and wave his arms in front of the lens. KTTV once used four cameras on football, two on the press-box roof, and two halfway up the stands,

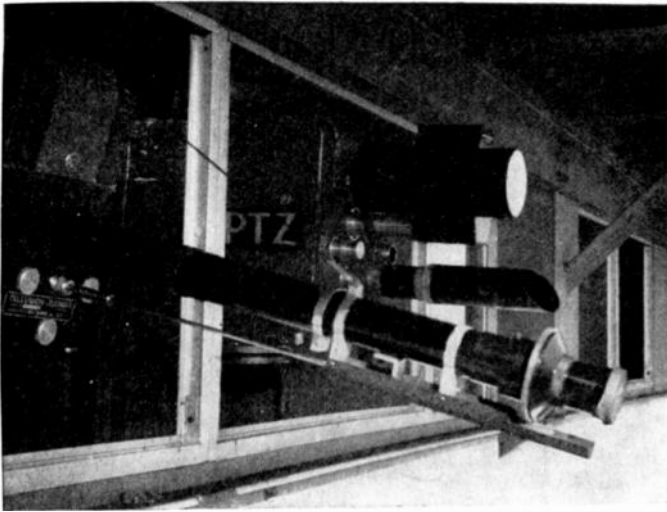


Fig. 20-26. Two cameras in press box during WPTZ pickup of Army-Navy game. Zoomar lens on foreground camera, early model of Reflectar on camera in background.

one on each 40-yard line. That was before they had acquired a Zoomar lens. One camera with a Zoomar can do the work of two at a football game.

The extreme height of most football stadium press boxes makes the shot down on the field more nearly vertical than horizontal. Often the closest part of the field is more than 300 feet away. The disadvantages of high-angle shooting and long lenses (both mentioned under Wrestling and Boxing) combine to make a pickup from this camera position alone rather uninteresting and undramatic. Don Hallman has used three cameras at Briggs Stadium in Detroit, one in the high press box on the 50-yard line, one halfway up the stands on the 25-yard line south, and one only 10 feet above the field placed on the 40-yard line north. Many remote men are convinced that placing cameras higher than 20 or 30 feet (unless

no better positions are available) is a mistake. Thirty feet is high enough to see the action separated on the field, so that near players do not block off the view of farther action; higher camera positions serve only to dwarf the players and increase the necessary focal length of the lenses. The camera on the field is a particularly valuable thing from the dramatic point of view. It is only from the low angle that the player really looks impressive; and plays occurring on the near side of the field, especially when they happen to come close to this camera, make the most exciting and dynamic shots in the game.



Fig. 20-27. WPTZ camera on field mounted on studio mike-boom base.

The use of the camera on the field was improved by WPTZ in Philadelphia when they mounted a camera on a microphone-boom base borrowed for the occasion from the studio (Fig. 20-27). High enough to give the camera an excellent vantage point over the heads of players, linesmen, etc., it interfered with spectator vision and could be used only when the game was not in progress. It could be quickly rolled into place, however, and picked up some excellent shots of the stands and of celebrities in the audience.

The ultimate in field-level coverage is the camera mounted on a jeep. This too has been talked about for many years, but in the 1950 season KTTV in Hollywood actually put the idea into practice. The jeep was converted to a "camera car" by bolting on a channel steel support which extended a foot or so out from the back, on which could be mounted the

rotating turret of a studio Sanner camera crane (Fig. 20-28). Although this camera was not used for trucking shots, it could easily keep abreast of the line of scrimmage and a very dramatic low shot down the line was obtained which could be used just before the start of each play.

The jeep camera is practical only where the stadium has a wide track between stands and field and where the stands are high enough so that the camera will not interfere with spectators' view of the game. The jeep ran close to the field, dragging the camera cable behind it. When it turned around, it swung wide and turned toward the field, while the cable was laid back toward the stands out of its way.

The Zoomar lens, which first began to be used in football and baseball in 1947, is now practically indispensable in covering these sports. The



Fig. 20-28. KTTV camera mounted on jeep by Sid Sanner and Joe Conn.

great advantage is freedom from cutting. The moment of the cut is always a moment of confusion, especially if the director isn't too sure where the ball is and has to punch buttons trying to find it. The cameraman with a zoom lens may zoom the lens in or out at any time, without running any risk of confusing the viewer. Even if the cameraman should lose the ball and zoom in on the wrong player, he can always zoom back out to a wider shot and go into a close-up again only when the position of the ball is clear. On a forward pass, the camera can go in for a close-up of the passer as he fades back, stay with him if he decides to run instead, or zoom back out into a wider shot as he passes the ball. Without a zoom lens, either the pass would have to be carried on the same lens, which would mean a very rapid panning with the ball and considerable confusion about where the ball had gone, or a wider shot would be used,

with the risks of confusion involved in the cutting. Cameramen must learn, incidentally, to control their first enthusiasm at handling a Zoomar and refrain from zooming it at top speed. A smooth and controlled zoom, although a little slow, is much better than a lightning swoop that carries the audience in breathless flight across the field. The one serves only to show the audience what they want to see; the other calls attention to the camera and the viewer's kinesthetic sense.

BASEBALL

By far the most complicated of all the sports, and one of the most difficult to direct in the field of television, is baseball. When things start

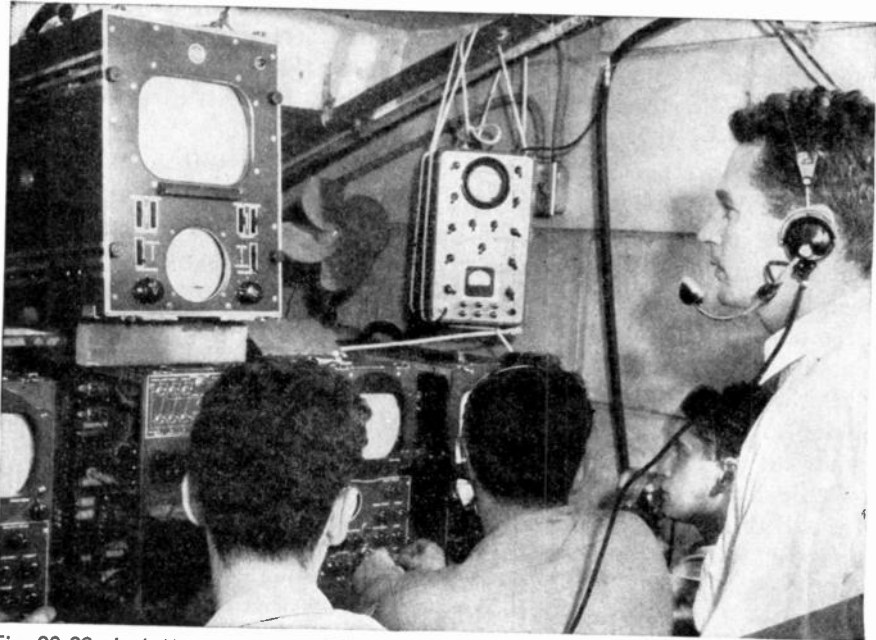


Fig. 20-29. Jack Murphy, veteran TV sports director, calls the shots on the WPIX baseball coverage.

happening in this sport, they happen so fast that there is no time for instructions to be given. Director and cameramen must have all their moves worked out and rehearsed in advance and must operate together with flawless teamwork. An infield play, for example, batter to short stop to first, will be over in about $3\frac{1}{5}$ seconds. There is no time for anyone to hesitate or wait for instructions. Here more than anywhere else, the director and the cameraman must know the game. It has been said that they are as much a part of the television ball game as the players on the field. They must know what plays are likely to be made, where

particular batters will hit the ball, whether or not the pitcher on the mound is good at picking off base runners, whether he makes batters hit pop flies or whether they usually hit into the dirt.

A few top-notch television directors, like Herbert Swope, Jr., became expert at directing baseball through very intense study of the game. Some of the best baseball directors, however, have been players themselves.

Nowhere else does the slow-witted or excitable director show up to poorer advantage than in baseball. Action happens rapidly, often in many parts of the field, and the director must be quick with his cuts. But more than this, he must be calm. An excitable director is almost worse than none at all. Cameramen have been known to pull their earphones off rather than listen to a lot of inarticulate screaming. Others have reported (and they were baseball cameramen) that they dread working with certain directors but look forward to working with others because they themselves do such a better job (Fig. 20-29).

A few seasons ago a brand-new station in Boston with a brand-new crew found itself obliged to make the pickup of the World Series game for the benefit of what was then the East coast network. There are directors and cameramen in the industry who have been doing baseball for years and are still improving. Few would have wanted their first attempts on the cable. It was inevitable that the Boston station took a roasting in the press. The management wisely refused to reveal the identities of director or cameramen, mentioning rules against "personal publicity." Critics of the same stations' baseball coverage today tell a somewhat different story.

Confusion or dullness or both result from poor handling of baseball. If the director plays it safe, sticks to the wide-angle lenses, he won't miss the action so easily; but the players will be so tiny on the screen that the audience will yawn. If, on the other hand, he gets too reckless with the long lenses, he can get caught trying to follow action that is too fast and can confuse the audience by switching without proper orientation. *Variety* complained of claustrophobia on the Boston games: too many close-ups, too slow to pan with the ball, "a monotonous and cramped depiction of a ball game." The baseball director is between two evils. If he is too conservative, the show will be dull; if he is reckless, confusion will be the result. Precise switching, accurate teamwork, quick reaction can do much to make a ball game interesting. But the director must have his cameras in the right places, or his problems are multiplied.

The Placement of Cameras. About half the stations which televise baseball use two cameras. The other half use three. Some stations have used four or five cameras, but in such cases one was devoted entirely to

the commercials. There is no doubt that three cameras are better than two, and those stations using two would probably prefer three if it were economically possible. However, the crew at WPTZ in Philadelphia, considered by many to make the best pickup in the industry, used only two cameras for many seasons.

The placement of cameras will depend primarily on the design of the particular ball park where the pickups are to be made. Some of the smaller parks have single-tier stands. Some are oriented differently, and the direction of the afternoon light will be a factor in camera placement. In most ball parks, a press box is already available where space can usually be found for one or two television cameras, and the position of this press box will determine the kind of shots the cameras can get. In

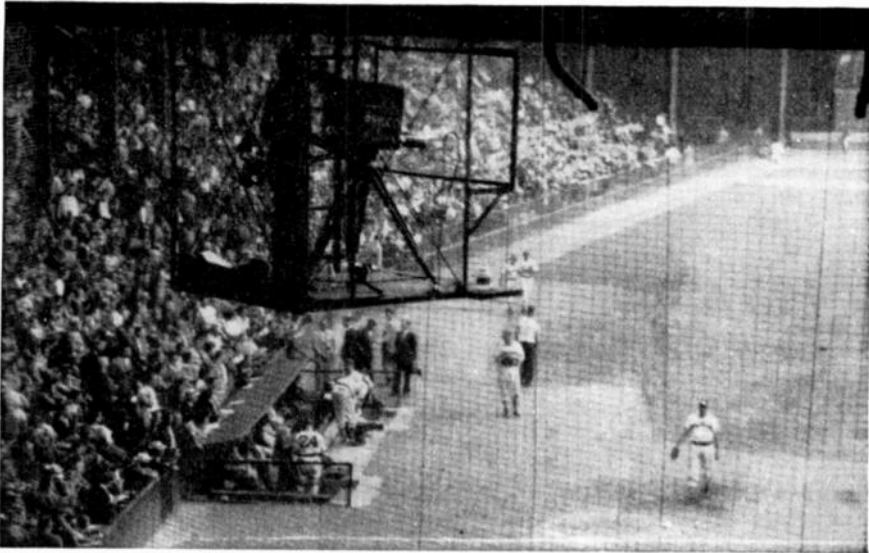


Fig. 20-30. WPTZ's camera 1 at Shibe Park, Philadelphia, in cage under upper stands.

some cases special platforms have been built for the cameras; WPTZ and WEWS have both built crow's nests underneath the upper stands, to place the camera at the best height (Fig. 20-30).

The Cover Shot. As a general rule the first camera is placed where it will give the best "cover shot." This is the basic shot of the ball game, and the greater part of the load rests on this camera. A director will usually have this shot on the screen during more than half the total time of the game. The cover shot will generally include the pitcher and the batter-catcher-and-umpire trio at the plate. It is used for almost every pitch and can quickly become a pan shot into the outfield in case of a hit.

In the case of an infield hit, many directors use no other shot and simply pan the camera with the ball as it is picked up and thrown to first. If the Zoomar lens is used, the cameraman may zoom in to a closer shot either on the player who nails the ball or on the play at first. Sometimes he will do both, zooming back slightly to a wider angle as the throw is made to the first baseman. The best cover shot is obtained within a rather narrow range of camera positions. It must be somewhere behind home plate and not too high in the air.

The cover shot must be taken by a camera behind home plate, or it will be impossible to include both pitcher and batter in the same shot.

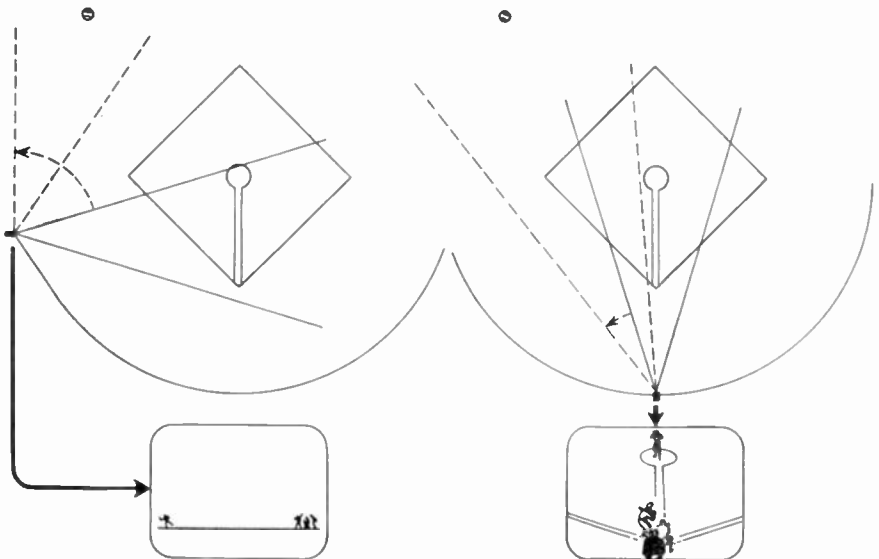


Fig. 20-31. Cover shot taken from third base compared with cover shot taken from behind home plate.

To be sure, a wide-angle shot from the side of the ball park would show them both, but they would look like ants. In case of a hit, a camera behind home plate does not have to pan as far to follow the ball to the outfield as a camera on either side line would have to do. Figure 20-31 compares the arc in which a camera behind home plate would have to pan to follow the ball to left field, with the amount of panning a camera at third base would have to do.

The height of the cover camera is important also. If the camera is too low, there is too little separation between near and far parts of the field, foreground players may obscure the action behind them, and the audience does not get a good view of the game. If the camera is placed too high, there is so much separation that a very wide-angle shot must be used to bring both batter and pitcher into the field of the lens. Again

the players are too small in the shot. The angle of elevation is the important thing, as Fig. 20-32 indicates. If the stands are far back from the plate, a higher camera position will give the same shot except that a longer lens is used. Of course, too long a lens from a low position behind the plate will tend to condense the distance between pitcher and catcher, and the effect will be ludicrous. If the camera is 50 feet back from the plate, it should be about 20 feet high. If it is as far as 75 feet from the plate, it can be as high as 30 feet without making the use of too wide a lens necessary. There is great variation in the positioning of this camera, however, owing to conditions peculiar to each park. Few stations say they are entirely satisfied that their cover camera is in the ideal position.

In some cases a camera behind the plate is impossible. The foul net may interfere. If the camera can be placed within a few inches of the

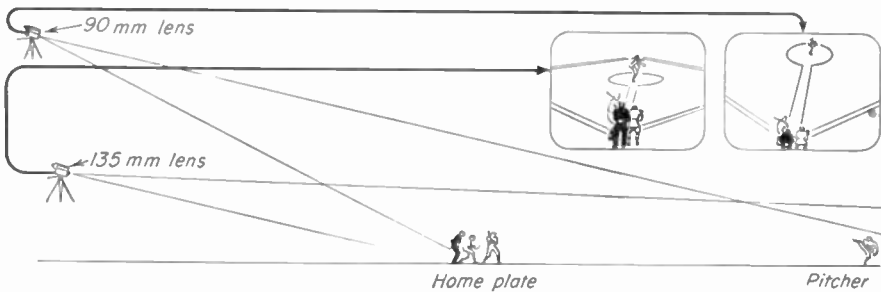


Fig. 20-32. Effect of camera height on cover shot.

net, the mesh will be so far out of focus that it will not show in the shot. In some ball parks, stations have installed sheets of unbreakable "hercule" glass in front of the cameras when they are so placed. In a single-tier stand the only two choices of camera position may be at the front of the stands, almost at ground level, or on the top of the grandstand roof, usually more than 75 feet high, neither of which is usable. In cases where the cover shot must be taken by a camera on the third- or first-base line, the director may often give up trying to show both batter and pitcher in one shot and must use two shots for every pitch, a close-up of the pitcher for the windup and delivery, and a shot of batter, catcher, and umpire as the ball reaches the plate.

The most publicized deviation from this more or less standard method of covering baseball was the famous Phil Wrigley method worked out by the Chicago Cubs' front office. Both WBKB and WGN-TV in Chicago were offered the Cubs games free if they would use Wrigley's method. This involved placing one camera just beyond third base and the second far out in the left field stands on the other side of the field (Fig. 20-33a). Bill Eddy's theory to support the Wrigley method held that this angle

was better because the ball was coming toward the lens in most plays instead of going away. The cameras were farther from the action at the bases, however, than in any other setup ever used. The press reported that televised baseball in Chicago was rather dull and uninteresting, which some observers believe may have been the original intent. One aspect of the WBKB coverage does not fit this theory, however. The placement of their third camera marked the first use of a camera on the

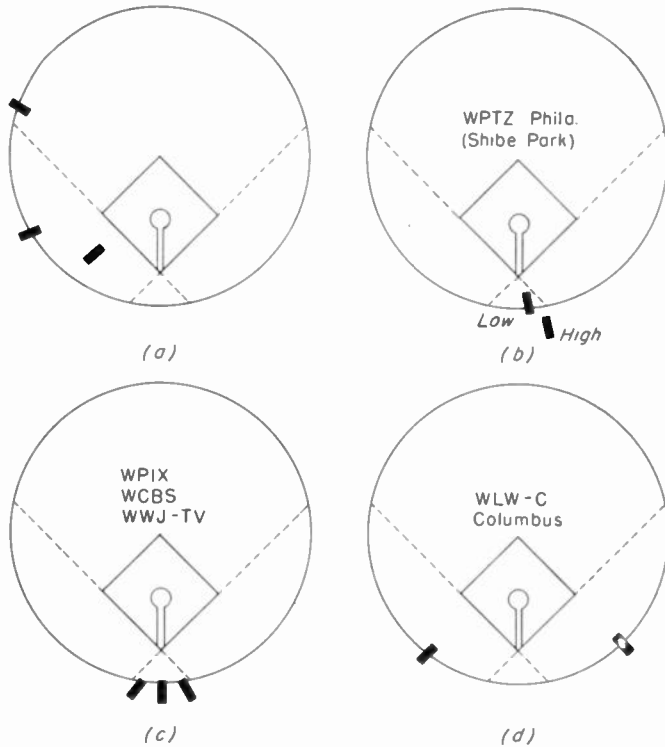


Fig. 20-33. (a) Camera placements in Wrigley method of baseball pickup. (b) Camera placement in WPTZ baseball pickup in Shibe Park, Philadelphia. (c) Three cameras placed behind home plate as used by WCBS, WPIX, and WWJ-TV. (d) Widely separated camera placements used by WLW-C, Columbus.

ground level, and the dramatic shots obtained from this low angle were a real addition to the art of picking up baseball. In recent seasons WBKB has moved up its far camera so that all three cameras are now along the third-base line.

An interesting variation on the standard behind-the-plate cover shot was in use for several seasons by KSTP in Minneapolis. The ball park was small, a factor which made for better coverage because the cameras

could be closer to the action and shorter focal-length lenses could be used. The cover camera in this setup was operated without a cameraman. It was placed behind home plate, about shoulder height, peering through a small hole in the fence. It was said to give a sensational shot, showing the pitch almost from the batter's point of view (subjective camera). It was even reported that one could see the ball break in a curve. Keeping the camera on one shot all afternoon had a tendency to burn the picture permanently into the tube, but the crew were always able to erase the image afterward. With no cameraman to pan the camera, this shot could not be used to follow a hit unless it should go directly into center field.

The Second Camera. The placement of the second camera is disputed. Some believe it should be widely separated from the first so that it can get a different angle on the action. If it is placed near first base, for example, where most of the action in a ball game occurs, it can get good shots of these plays without having to employ too long a lens. Some directors believe that this camera should be placed on a line with third and home so that it can cover action along this base line.

The majority opinion, however, favors keeping the two cameras together, either side by side or one above the other so that they both get the same angle on the field. This makes cutting easier on the audience. Switching cameras is a necessary evil, because during the moment following the switch the viewer must reorient himself to his new point of view.



Fig. 20-34. Two CBS cameras cover the play at Ebbets Field from behind home plate. An early photo, this picture shows the cameras in use without electronic view finders.

If the shot is from a different angle, it takes him longer to grasp its meaning. He may confuse one player with another or third for second base, for example. This period of confusion may last only a fraction of a second, but it is enough to lose a fast play.

If the second camera is placed next to the first, it can also be used for a cover camera in case of failure of the first (a rare occurrence, but something that the sponsor will consider). If camera 2 is placed directly *above* the cover camera, it will probably be most useful. The setup that WPTZ uses at Shibe Park in Philadelphia with such good results is of this type, one camera low and one camera high directly above it (Fig. 20-33*b*).

The Third Camera. The same considerations apply when a third camera is placed in the park. Most stations will place it with one of the other cameras or both of them if the first two are together. WPIX, WCBS in New York, and WWJ-TV in Detroit are among the stations which use three cameras behind home plate at the front of the upper-tier stands, and no farther separated than the extension of the first-base line on one side and the extension of the third-base line on the other. A third camera, placed in line with home and first, will be able to get certain shots, such as a front close-up of a left-handed hitter (Fig. 20-33*c*), while the other two cameras can show only his back. It can look down into the first-base dugout and show the scramble for foul balls on that side of the field.

If all three cameras are not behind the plate, they will be placed either between home and first or between home and third. Only rarely is a camera placed beyond first or third base. The Wrigley system described above had two cameras beyond third; WEWS in Cleveland does a consistently fine job with one of its cameras beyond first base. In general, it can be said that if three cameras are placed along the third- or first-base line, they will not be spread beyond a position directly behind home plate. This will keep them all on the same side of the pitcher-batter line. The one exception during the 1951 season that the author is aware of is WLW-C in Columbus, which placed one of its two cameras opposite first base and the other about halfway down the third-base line. Although the author received no comment on the pickup which this station turned in, it is his guess that the game was pretty hard to follow. From neither of these camera positions is a good cover shot possible; so the director probably tried to cut from pitcher to batter on every pitch. Because of the reverse angle, however, both pitcher and batter would be facing to the same side of the screen, and runners on either the first- or third-base lines would change screen direction with each cut (Fig. 20-33*d*).

Some of the stations have placed their third camera down on ground level, either next to the third-base dugout, as in the case of WBKB, or next to the first-base dugout like WOR-TV in New York. When a fourth camera is available, one has been placed at each dugout. This low angle is very valuable from the dramatic standpoint and puts a punch into the game which no other shot can do. The ground-level camera gives the best possible angle on the batter as he steps up to the plate. From the low angle he is silhouetted against the stands, his expression is clearly visible, and the shot may even be used occasionally to show him swinging at the ball. For this purpose the position near the first-base dugout is best, since most batters are right-handed. This camera may also be used on a close-up of the pitcher and on action on the bases when necessary and is particularly valuable for close-ups of nearby players, team managers, coaches, and action on the near side of the field. WBKB once used a mirror in front of their camera to reflect an image of the players in the nearby dugout, although off-guard shots of the players in relaxed moments were not always flattering to the team involved. This camera was also mounted on a Ritter dentist-chair lift for quick adjustment of height. It was found that the most dramatic shot was taken from ground level; so a hole was dug in the ground for the cameraman to stand in, a practical measure except in rainy weather, when the cameraman stood ankle-deep in water and cursed the whole idea.

Other Cover Shots. An important consideration in the placement of cameras is the possibility of obtaining cover shots showing both ends of an action, or two or more actions which happen in quick succession, without the need of switching cameras. The standard cover shot is valuable, for example, because both the pitch and the swing, and often the flight of the ball as well, can be covered without cutting.

A camera behind third base can get a good shot across the diamond with the pitcher in the foreground and the runner leading off base in the background. When there is a man on first who likes to steal, the pitcher's windup may develop into a pitch to the batter or he may fire the ball to the first baseman. At the very last moment in the delivery, after which the pitcher cannot change his mind and throw to first, the runner is off. It enhances the drama of the situation greatly if both pitcher and runner can be shown simultaneously on the screen. Thus if the director has a camera behind third, he can cover both ends of this situation, and the action which may result, without cutting. A camera placed beyond first base and shooting toward third can obtain this same kind of shot, with the runner in the foreground and the pitcher in the distance. The only other way to show both the pitcher winding up and the runner trying to

rattle him is to use two cameras in a split screen shot. To include both the pitcher and first base, a shot from any other position in the park would have to be so wide that the players would be too small to recognize.

Switching Sequences. Two schools of thought govern baseball directing. One favors the cut; the other opposes it. A simple infield play (pitcher to batter to shortstop to first) could be covered in one shot or in two or even three separate shots. Jack Murphy at WPIX, one of the top baseball directors in the industry, does it with one shot, usually with a Zoomar lens, at least during daytime games. Most directors pan with the ball on their basic cover shot and cut to a closer lens only for the play at first. Harry Coyle at WABD would do it with three takes, the cover shot to show the hit, a close-up on the shortstop throwing to first, and a close-up on first, for the play. Remember, the time necessary for a runner to cover the distance from home to first is only $3\frac{1}{5}$ seconds. These cuts have to be very quick.

In the case of an outfield play, the same thing holds true. The cover shot which is taken with a Zoomar lens can pan out to the outfield with the ball and zoom into a fairly big close-up of the fielder going for it. Without the Zoomar, the usual routine is to cover the fielder with the second camera and a very long lens (17 to 20 inches) and cut to a close-up of the catch as soon as it is evident which player will have the ball. The Zoomar when fully zoomed gives a shot equivalent to that of a 22-inch lens and in the wide-angle position about the same shot as a 135-mm. If a wider angle is necessary for the cover shot, an additional lens element may be added, which will give an angle somewhat wider than the 90-mm will take in (approximately equal to a 75-mm focal length), but this at the same time reduces the maximum focal length to 13 inches. In this case the director may have to cut to a shot on a 17- or 20-inch lens for close-ups of the fielders after the Zoomar has zoomed as close as it can go.

In panning with the ball, it has been found impossible to keep it visible throughout the pan, except with the best luck; and any attempt to follow it up in the air and back down will result only in a blurred pan in which nothing can be seen at all. The cameraman usually pans out to the section of the field where the ball is going, and the next time the ball is seen is just before it enters the fielder's glove.

As soon as the ball is fielded and thrown back in, the field of view must again widen. The Zoomar will do this smoothly, concentrating again on a close-up of whatever play should result. Lacking the Zoomar, the director may cut back for the throw-in to his cover camera with the original lens and expect the second camera to make a quick switch of lenses and whip down to the base for a close-up of the play.

When there are men on base, this situation is more complicated and the

advantage of having a third camera is quickly felt. If there is a man on first, for example, a possible play at second is indicated and perhaps a relay to first for a double play. In such a case the third camera will be instructed to follow the runner, while the other two cameras cover the play at first in the regular manner. If there is more than one man on base, the play is usually made on the more advanced runner and the third camera will concentrate on him. Under most conditions the director will keep his cameras on the ball at all times; but when there are advanced runners likely to score, he may cut away from the fielder and the throw-in to show a runner rounding third or crossing the plate. That is certainly what the observer at the game would do. It may be that there is room for more cutting back and forth at moments such as this, provided that the viewer is kept properly oriented.

A variation from the usual methods is found at some stations such as KTSP and WEWS, both of which use setups having two or more cameras on the first-base line. These stations throw in an extra shot which is severely criticized by many people in the industry. They concentrate on the runner going toward first, immediately after the hit. In the case of the first of these two stations, KSTP, the cover shot is on an unattended camera which cannot pan with the ball. The director must cut to something because the play has left the screen. Since the fielder is not yet under the ball in the outfield, he cuts to a camera near first to show the runner streaking for the base. It is probably an effective shot; but, say the critics, who cares about the runner? Everyone knows where *he* is going. When the viewer finally does see the fielder catch the ball, it is a big close-up taken by the third camera and the viewer has no orientation, no way of knowing who the fielder is, or where. The announcer must supply this information since the picture cannot.

During the World Series of 1949 the New York stations came out with a new method of covering the situation where a runner is taking a lead off first base. Du Mont solved this problem by matting out a small area in the upper corner and inserting a round image from the second camera, showing the runner on first. (For details on the technique of matting, see Chap. 12.) Others did a similar thing by off-setting the turrets on both cameras, so that the picture was evenly divided down the middle, with pitcher on one side and runner on the other. The press reported some "fans in the *bistros*" a little confused by the shot; but, on the whole, it was liked by the television audience. Credit for the first use of this technique should go to WTTG in Washington, who several years earlier under Les Arries were using an off-set-turret split screen on all their remote shows, with the announcer in the upper right-hand corner of the picture speaking directly to the television audience and at the same time looking down on the field of combat in the lower left-hand corner.

An excellent picture article on baseball in television was published in *Broadcasting News* of September, 1949. In connection with this article a survey was made of all the stations then covering baseball. A follow-up article was published a year or two later based on a similar survey. Some stations changed their methods after the first season, usually in the direction of closer grouping of cameras. Some have changed only very slightly over several seasons.

THE MET OPENING

The pickups made by the American Broadcasting Company of the openings of the Metropolitan Opera when, on one occasion, 12 cameras were used, were among the most elaborate in television history.

In the 1950 pickup one camera was stationed outside the entrance to show the limousines arriving, and another was placed just inside the entrance lobby. Four cameras were used in the auditorium, one of which was placed in the commentator's box and alternated between long shots of the stage and close-ups of Milton Cross between the acts. One camera was placed in the aisle at the side, one in a box overlooking the stage, and one was placed in the orchestra pit with its lens at stage level. This camera turned out some of the best shots.

Two cameras were placed backstage and contributed what amounted to the most interesting part of the program—interviews conducted by the show's director, Margaret Webster, with members of the cast and staff. These two cameras were also used during the performance, which meant there were a total of six cameras on the show itself.

The remaining four cameras were divided between two locations for intermission coverage. The first pair was in Sherry's Lounge, where a group of celebrities at a couple of tables tried hard to be gay and witty while a cordon of special guards struggled in the background to keep the surging crowds away. The last two cameras covered the traditional "opera quiz" in the "greenroom," a panel show with a group of experts answering verbal questions.

Each part of the show was handled by a different director, from a single control room where 12 camera-control units were lined up against the wall in an unbroken row. A special 12-position switching system was built to handle this particular remote. Five of the cameras were equipped with the extremely fast 7-inch Balowstar lens. However, since the broadcaster had no word in the use of lighting, the contrast range was often far too much for the image-orthicon tube to handle and all the spurious effects that television is heir to were clearly in evidence.

THE BOAT RACE ON THE THAMES

One of the most complicated pickups ever attempted was made by the BBC Department of Outside Broadcasts under Peter Dimmock on the

occasion of the 1950 boat race between Oxford and Cambridge on the Thames.

Twelve cameras were used in picking up this event, one of which was mounted in a 24-foot launch and followed the crews the entire length of the 4½-mile course. In addition to this camera in the bow, the launch also carried both sound and picture microwave transmitters and a gasoline generator for power.

Six directors were employed on this show, at five different control locations (one director was stationed with a single camera and did no switching). The picture from the first control location (at the start of the race) was sent directly by cable to the main transmitter, but the other units microwaved their signals into a central control point, which, like a master control, chose the output of one unit after another as the race progressed and sent it on to the transmitter. The camera in the launch

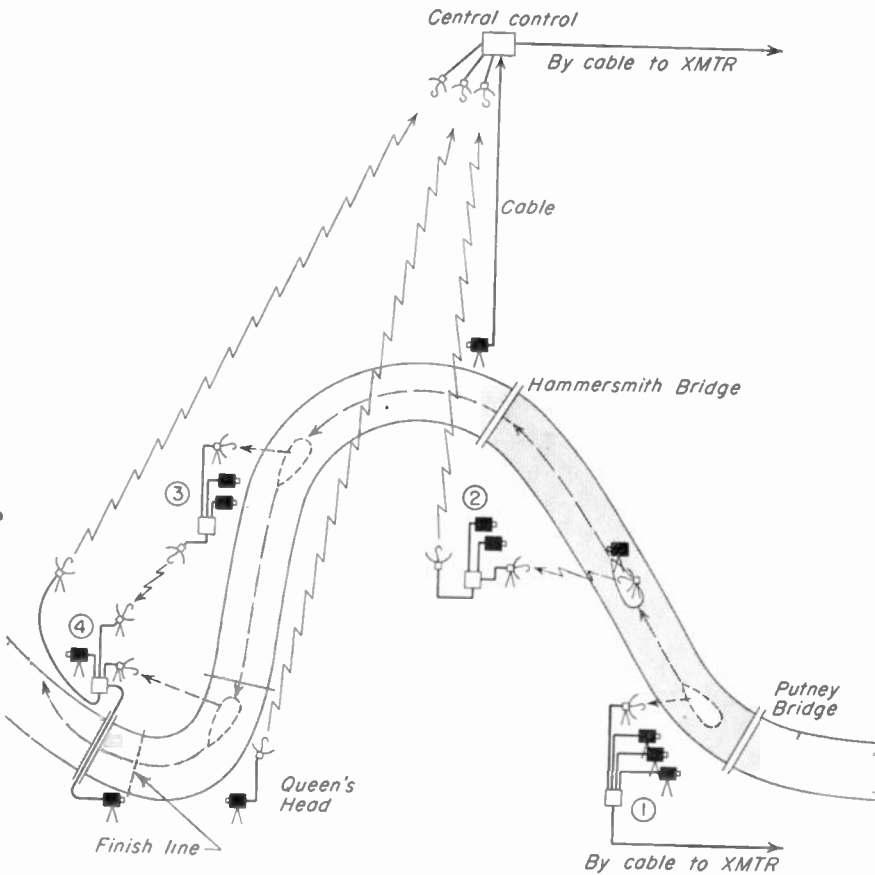


Fig. 20-35. Layout of cameras and control points for BBC pickup of Oxford-Cambridge boat race on the Thames.

became part of each unit as it passed, since each unit had a receiver to pick up the transmissions from the launch.

The map in Fig. 20-35 indicates three cameras stationed at Putney Bridge (the start of the event) which were controlled at that point as the first unit. The second unit was composed of two cameras on the roof of the 80-foot-high Harrod's Warehouse. The next pickup point contained only one camera, stationed across the river beyond Hammersmith Bridge and fed directly into central control by cable.

The third control location was at Chiswick Wharf, where two cameras plus the pickup from the launch were relayed into the fourth control position because line of sight to central control was lacking. At control position 4 the program from unit 3 entered the switching system through a remote or auxiliary position and was integrated along with the other local camera signals and sent by microwave into central control.

A second lone camera was placed on the opposite shore at Queens Head and was microwaved directly into central control. The fourth control position handled one camera opposite the finish line and another at the boathouse where the crews pulled in to shore.

The commentary came almost entirely from the launch, with the exceptions of interviews and description at Putney Bridge before the start of the race and again at the end when the crews came ashore. The launch carried an air monitor so that the commentator could watch the program. A cue line was also maintained to the launch from the central control point so that the central director could warn the commentator to prepare the audience for a change in camera viewpoint. Cue line was also maintained between central control and each camera-control point, and of course each camera director was in communication in the usual way with the cameramen within his own unit.

This remote pickup took six months to plan and to accumulate the necessary equipment and three weeks' work to set up. Some of the mobile units were in place as long as five days before the event so that the equipment could be set up and thoroughly tested.

THE 1952 CONVENTIONS

Probably the most complex remote pickup ever attempted was the coverage of the 1952 political conventions in Chicago. Between 40 and 50 cameras were in use by the three networks picking up the conventions, 7 of which (the cameras which covered Convention Hall itself) were pooled between the three nets. Each network had its own master control room into which this "pool" coverage (directed by a pool director from a pool control room) was fed. In addition each net had its own studios in Convention Hall, one or more mobile units making pickups



Fig. 20-36. Control room for the pool pickup. Monitors for seven cameras and a spare, plus master monitor, on lower level. Portable audio equipment left foreground and specially built 12-position two-bus switching system in center.

around town, and several cameras at the Hilton Hotel, where the various political headquarters were located, and also took regular feeds from the studios of their associated Chicago stations. NBC personnel took the time to tally up, after one particularly busy hour, and found that they had used 19 cameras from 13 different locations.

Each of the networks kept one of their own cameras operating in the convention amphitheatre. ABC placed a camera in their radio booth showing the radio commentator in the foreground and the convention floor beyond. Such a camera was valuable, despite the full pool coverage, for (1) providing a close-up on a commentator carrying walkie-talkie equipment who was making an exclusive interview on the Convention floor and (2) providing a long shot for a "break-

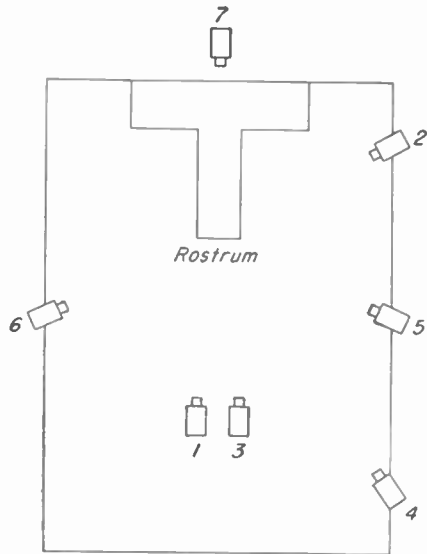


Fig. 20-37. Diagram of camera positions for the pool coverage. Cameras 1 and 3 were moved to position shown for Democratic Convention. Republicans had refused to allow this obstruction, and these two cameras had been placed next to 5 and 6.

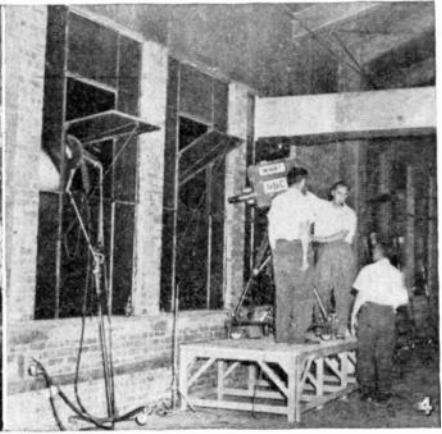
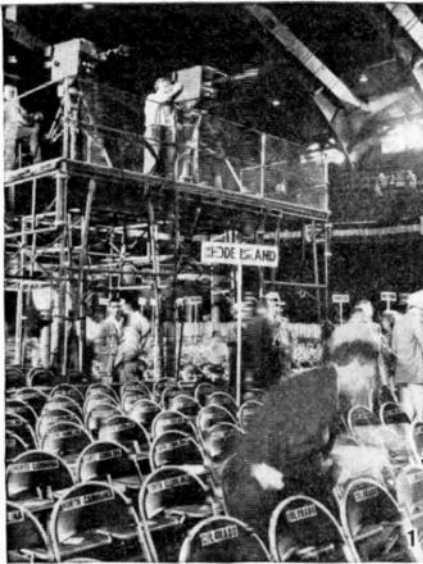


Fig. 20-38. (1) Camera platform erected in center of hall for Democratic Convention so that cameras could obtain head-on view of speakers at rostrum (see No. 6).

(2) NBC "crash" unit (complete with audio and video transmitters and power unit) set up for remote at Chicago River. This truck was fully mobile—could, and did (for demonstration), transmit while rolling. Actual motorcades where truck was to be used in transit proved too fast for truck to handle. NBC began each Convention day with a one-hour remote from a different part of the city.

away shot" which was used just prior to leaving Convention Hall and the pool coverage for a studio commercial or a pickup from some other location. NBC kept an extra camera available for remote pickups from inside Convention Hall. Thus when a state caucus was held in a corridor or something took place just outside the building, this extra camera could be quickly rolled into position and pointed out a window or into a corner, and about five minutes after being plugged in, would be ready for use. ABC sometimes made it in two minutes after notification.

CBS and NBC each had three cameras, and ABC had two located in the Hilton Hotel, where they were able to cover press conferences, interviews at the various political headquarters, and arrivals and departures, sometimes on as little as 10 minutes' notice. The hotel was laced with cables up and down the corridors, stairways and dumb-waiter shafts, running along ceilings, railings, baseboards, literally everywhere. Cameras were almost constantly in transit from one floor to another, necessitating a thorough familiarity on the part of all with the short cuts and back passages of the hotel.

At one point during the Democratic Convention a pool pickup from Washington provided each network with a remote coverage of President Truman at the airport boarding his plane to come to Chicago. Just at the moment when this action began, however, Truman's alternate at the Convention was addressing the floor, telling the Convention how the President had instructed him to vote. Obviously this was no time to take the audience away from the Convention floor. The solution was to take a picture from Washington while retaining the sound from Chicago. The loss of an announcer in Washington was not serious since the picture

(3) Important part of radio and TV coverage was on-the-spot interviews from the Convention floor. NBC's attempt to use hand-held TV camera (modified Vidicon, RCA's industrial camera) proved unsuccessful. Picture was dark and of poor quality under what was, for the Vidicon tube, substandard lighting conditions.

(4) NBC's extra camera set up to cover arrival of candidate outside of Convention Hall. Several scoops have been pointed out the windows to illuminate the exterior scene.

(5) CBS made good use of the GE wipe amplifier, placing the commentator in a wedge at the corner. This avoided audience frustration from either hearing a voice and not knowing whose it was, or watching a commentator and wondering if anything was being missed on the Convention floor.

(6) NBC consistently improved the pool coverage by identifying visually speakers and people in the crowd. Use of sync lock (by all nets) made it possible to dissolve to or from the pool coverage or superimpose titles or symbols on the pool picture.

(7) Circle aids audience in locating Richard Harkness, whose voice was being heard.

(8) Close-up shots of delegates, people in the galleries, etc., added much color to the pool pickup. At one slow point in the proceedings someone held up handbill which was placed on chairs each day: "Remember—you may not know it, television may be showing a close-up picture of YOU!"

told the story clearly enough, while the picture from Chicago was no great loss since the speaker had already been shown. Thus it happened that just as Truman's alternate announced Stevenson in Chicago and the Convention burst into wild applause, Truman was seen waving with both arms to the crowd at the Washington airport as he boarded the plane. The viewer was made to feel present in three different places at the same time. Few moments in the history of television have so dramatized the immediacy of this medium.

INDEX

A

Accent light, 342, 344
Acetate, frosted, 259, 260
"Alice in Wonderland," 281
Alignment, camera, 24, 25
Altec-Lansing mike, 395
Amplitude modulation, 386
Animatic, Dunning, 170
Animation, 248-262
 bodily movement, 255-257
 mechanical, 252-254
 one-step, 244-251
 rear-lighted, 255-257
 stop-motion, 248-249
Apeco machine, 164
Arc light, carbon, 346
Arries, Les, 457
Art work (*see* Graphic materials)
Artificial black level, 294
Artificial perspective, 219-224
Aspect-ratio adjustment, 25
Audio console, operation of, 401-403
Audio equipment for remotes, 422-425
Audio oscillator, 294
Audio patchboard, 384
Autotransformer dimmer, 368
Autrastat, 368

B

Back, Dr. Frank G., 66
Back light, 343
"Back porch" in oscilloscope, 293
Background light, 343
Backgrounds, painted, 312
Balop, animation in, 252-254
 by General Electric, 175-176
 at KSD-TV, 178

Balop, multi-stage, 180 186
 single-stage, 179
 at WAVE-TV, 181
 at WTMJ-TV, 178
Balowster lens, 62
Banner, Bob, 120, 270
Banner's "smokehouse," 270
Barn doors, 357
Base (basic) light, 133, 341
Baseball coverage, 447-458
Battens, counterweighted, for lighting,
 358-359
 in scenery, 305
Bayonet mount, 58-59
Beam control, 293
Beam projector, 352
Beard stick, 331, 335
Beer, frosting with, 268
Beier, Carl, 138
Belanger, Paul, 281, 291
Bernhard Magnet lettering, 161
Beseler opaque projector, 180
Bidirectional microphones, 388, 389
"Big Top," 137
Black on black, 294
Black level in oscilloscope, 293
Black screen in rear projection, 235
Blanking in camera control, 293
Blanking level in oscilloscope, 293
Blanking pulses, 416
Blizzard effects, 263
Blood, simulated, 275
Blue screen in rear projection, 235
Boat race on Thames, 458-460
Bodde rear projection screen, 235
Bodily movement animation, 257-259
Boom base, 399
Boom mike, 397-401
Boom operator, 399-400

Borax flakes as snow, 263
 Border lights, 339
 Boxing coverage, 439
 Breakaway furniture, 273-274
 Breakaway glass, 273
 Breaking vase or window pane, 276
 Bretz box, 75-76
 Bretzaligner, 139
 Bretzicon animator, 259-262
 Bretziframe, 163
 Bridge in electronic amplifier, 284
 Bright, Bob, 219
 Broadcast supervisor, 436
 Brushes in scene painting, 326
 Bull's-eye view finder, 17

C

Cake make-up, 331, 334
 "Cameo Theatre," 203, 297
 Camera access through scenery, 317
 Camera alignment, 24-25
 Camera angle, 29, 30
 Camera chain, 5
 Camera-control unit, 5, 24
 Camera crew, 5
 Camera director, 12
 Camera Equipment Co. tripod head, 37
 Camera field, 134
 Camera monitor, 5
 Camera mounts, 40-56
 Camera movement, 29, 34-40
 vs. cutting, 94-95
 Camera position, virtual, 200-201
 Cameraman, responsibility of, 14
 Cameras, 15-56
 reflex-type, 20
 Canted shot, 33-34, 204
 Carbon arc, 346
 Carbon-button microphone, 387
 Carbon dioxide, frozen, 271-272
 Cardioid microphones, 388, 393-394
 "Carmen," 137
 Casein paint, 326
 Cassirer, Henry, 259
 Cel-flex paint, 246
 Celluloid for Vue-Graph, 246
 Chicken feathers for snow, 265
 Circle of confusion, 81-82, 85-86
 "City at Midnight," 413
 Claras, Dorothea, 259
 Clinch iron, 323
 Close-up, 30
 Coaxial cables, 418
 Cobweb effects, 274
 Color response, 125-132
 Color in scene painting, 376

Composite shots, 219-241
 Concentrated arc lamp, 239
 Condenser mikes, 395
 Confetti for snow, 263
 Continuous-motion projector, 190
 Control boards, lighting, 369-376
 Control point for remote pickups, 414, 435
 Control room, 5
 methods of operation, 88-89
 multiple, 6
 Coordinator in remote pickups, 436-437
 Copy area, 134
 Corner post, 305
 Cornflakes for snow, 263
 Counterweighted crane dolly, 51-56
 Cover shot in baseball, 449-453
 Cradle head, 37
 Crawl titles, 147-149
 CRO, 293
 Cropping, on picture tube, 134
 of titles, 162
 Crosslight, 344
 Crystal microphone, 387
 Cucalorus, 381
 Curtains, 306-307
 traveler, 306-307
 Cutawl, 323
 Cutout shot, 224-226
 Cutting, principles of, 87-104
 to or from a super, 112-113
 Cyclodrum, 377
 Cyclorama, 306

D

DeCaprio, Al, 120
 Defocus transition, 103
 Demott, John, special effects, 263-269, 276
 Depth, of field, 82-86
 of focus, 81, 83
 Diaphragm of microphones, 391
 Diaphragm openings, 78-80
 and depth of field, 83-84
 Dimmers, 367-376
 electronic-tube, 369
 reactance, 369
 resistance, 367
 Dimmock, Peter, 458
 Direction of light, 341
 Directional microphones, 388
 Director-switching system, 88-89
 Display Lighting "giraffe" boom, 423
 Dissolve, 101-102
 to black, 102-103
 with RCA field switching system, 109-110

Dissolve, to or from a superimposure, 113
 "Dr. Jekyll and Mr. Hyde," 250
 Dolly, counterweighted crane, 51-56
 crane or boom, 45-56
 Du Mont pedestal, 45
 Fearless Panoram, 46-51
 Television Associates, 42
 Dolly pusher, 11
 Dollying, 38-39
 Double jump, 420-422
 Dousters, 197-198
 Dove prism, 34, 210-214
 Drapes, 306-307
 Drill, electric, 323
 Drill press, 323
 Driving pulses, 416
 Drop, background, 305
 Drop-in and drop-out, 142-143
 Drop-over, 252-253
 Drucker, Rolf, 284
 Drum, 144-145
 Dry ice for smoke, 270
 Du Mont Cinecon projector, 190
 Du Mont mixer, 107, 114-116
 Du Mont pedestal dolly, 45
 Du Mont Super Speed projector, 188-189, 236
 Dunning Animatic, 170
 Dutchman, 305
 Dyna-beam, 356, 357
 Dynamic microphones, 391
 Dynode spots, 24, 122

E

Eastman Kodaslide projector, 171-173
 Echo chamber, 405, 406
 Eddy, Bill, 216, 269, 362
 Edge flare, 153
 Edge light, 344
 Editing (*see* Cutting)
 Effects, switching, 108
 (*See also* Special effects)
 Electra-Zoom lens, 67-68
 Electro-Voice, 391
 Electronic controls on cameras, 292
 Electronic effects, 277-295
 Electronic matting, 281-282
 Electronic pointer, GE, 288-289
 Electronic switch, 284-285
 Electronic-tube dimmer, 369
 Electronic wipe, 282-283
 Ellipse of essential information, 135
 Embossograph, 159-160
 Emery, Bob, 258
 Epsom salts, 268

Equalizing of microphones, 109
 Essential area, 131
 Explosion effects, 274-275
 Exposed area, 134
 Exposure, 22
 Exterior sets, 313-314
 Eye light, 344

F

f stop, calculation of, 78
 Fade-in and fade-out, 102-103
 Faders in audio console, 401
 Fading bus for video switching, 107-108
 Falling petals, 276
 "Fall-off" in rear projection, 232
 Fearless Panoram dolly, 46-51
 studio pedestal, 43
 tripod head, 37
 Fee, David R., 284
 Feedrail, 359
 Ferrier, Joe, 251
 Ferriergaph, 251*n.*
 Field equipment, 414-417
 Field of view, 29, 30
 Figlozzi, Don, 156
 Fill light, 342
 on cameras, 365
 Film chain, multiple use of, 191-193
 Film control room, 8
 Film editing, 87
 (*See also* Cutting)
 Film loop, 232
 Film-pickup camera, 8
 Filmstrip projector, 176
 Filters, fog, 273
 neutral-density, 79-80
 red and blue, in animation, 251
 Fire, in fireplace, 268
 projected, 267
 in studio effects, 266-268
 Firelight effect, 376
 Five-bus switching system, 119-121
 Flameproofing, 308
 Flannelgraph in animation, 249
 Flash paper, 275
 Flat (scenery), 301
 Flat light, 338
 Flexitron, 294
 Flipper for title changing, 116
 Floodlight, 348
 Floor coverings, 310
 Floor painting, 223-224
 Floor plans, 319
 Floor units for lighting, 354, 365
 Fluorescent light units, 347-349, 351
 Flying of scenery, 305

- Flying-spot scanner, 190-191
 Focus, 20-22, 80-82
 splitting, 84
 Fog effects, 268, 271-273
 Fog filter, 273
 Foliage, 313
 Follow shot, 39
 Food, appetizing appearance of, 276
 Food substitutes, 276
 Football coverage, 443-447
 Foot-candles, 345
 Footlights, 340
 Fortuny, Mariano, 354
 Fototype, 158-159
 Fountain brush, 247
 Fox, Joe, animations, 252-254
 Framing, 30
 of graphic materials, 149-150
 Framing guides, 162-163
 Fred Waring Show, 120, 263, 270, 277-278, 308
 Frequency modulation, 386
 "Front porch" in oscilloscope, 293
 Front projection, 237-241
 with shadowgrams, 237-239
 Frosted acetate in animation, 259
 Frosting with beer and epsom salts, 268
 Fuddles, 379-380
 Fulton, Oliver, 437
 Furness, Jim, 276
- G
- G-5 control, 27
 "Garroway at Large," 136, 216, 315, 322
 Gas-driven generators, 434
 Gear head, 37
 "Gen" lock, 437
 General Electric balop, 175-176
 General Electric electronic pointer, 288-289
 General Electric mobile unit, 428
 General Electric montage amplifier, 286-289
 General Electric slide projector (PFC-3), 174-176
 General Electric switching systems, 118-119
 General Precision Laboratories cameras, 16, 21-24, 81
 General Precision Laboratories 16-mm arc projectors, 237
 Ghost effect, 278-281
 with mirrors, 207-208
 Giraffe boom, for light, 364
 for mike, 397
 "Gizmo" montage amplifier, 284
 Glass shot, for fire effect, 267-268
 motion-picture, 225
 Gloccamorra, 377, 378
 Gloria Swanson Show, 146
 Glycerin for rain effects, 265, 275
 Goboos, for lights, 357
 space illusion, 225-226
 Gold, Bert, 146
 Goldwasser, Larry, 281
 Gould, George, 284
 Graph, animation of, 251-252
 Graphic materials, 136-170
 framing of, 149-150
 preparation of, 140-155
 reproduction of, 163-164
 special effects with, 242-262
 style and technique, 154-155
 Gray scale, 126-130
 in preparation of art work, 152-153
 Gray Telojector, 172-173
 Grease-base make-up, 331, 334
 Ground glass in mysterious writing, 248
 Ground row, 307
 Guillotine for title changing, 149
 Guns, 275
 Gyro head, 37
- H
- Hair pieces, 333, 335
 Hale, Paul, 396
 Hallman, Don, 444
 "Hands of Mystery," 32
 Hanging mikes, 395-399
 Hayes, Howard, 49, 50
 Healion, Bill, special effects, 266
 Herculite glass in baseball coverage, 451
 Hidden mikes, 395-396
 High-angle shots, 31, 32
 with mirrors, 200-202
 High-fidelity equipment, 385-387
 High-key light, 345
 Highlights, 132
 High-peaker, 26
 Holden, Chuck, 149, 247, 251, 255-256, 269, 274
 Holland, Harold S., 63
 Horizontal wipe in montage amplifier, 286
 "Hot spot" in rear projection, 232
 Houston-Fearless counterweighted crane, 51-54
 Huhn, Austin, special effects, 266, 269
 Hyperfocal distance, 81*n.*
- I
- Icicles, 275
 Illusion of space, 219-241

Image accelerator, 26, 34, 291-292
 Image-inverter prism, 210-214
 Image-orthicon tube, 122-125
 for film pickup, 188-189
 Image splitters, 180-181
 Impractical scenery, 304
 Incandescent filament, 346
 Incandescent gas, 346
 In-setting, 300
 Intensity of light, 341, 345
 control of, 367-376
 Intercommunication, 414-416
 Internal-reflector lamps, 348, 350
 Iris shutters, 356
 Izenour, George, 369
 Izenour board for light control, 375, 376

J

Jack (scenery brace), 301
 Jamming the pedestal, 294
 Johnson, Wayne R., 283-284

K

Kaleidoscope, 216-218
 Kensol hot press for lettering, 160
 Key light, 342
 Key signal in montage amplifier, 285
 Kicker light, 344
 Kinescope recording, 2
 Klieglight, 356, 380

L

La Belle automatic projector, 173
 Layout paper in animation, 250, 251, 259
 "Layovers" in animation, 246
 Lazy tong for lighting, 361
 Lekolite, 355, 356, 380, 381
 Lens angle, formula for, 61-62
 Lens diaphragm, 22-24
 Lens turret, 22
 matting with, 227-228
 Lenses, 57-86
 Balowstar, 62
 care of, 86
 Electra-Zoom, 67-68
 field-camera, 60
 long, 68-73
 normal, 73-74
 parts of, 58-59
 perspective in, 68-73
 Reflectar, 62-63
 standard TV, 59-68
 telephoto, 76-78
 wide-angle, 68-74

Lenses, Zoomar, 64-67
 Lettering area, 134
 Lettering in titles, 155-161
 Light levels, 345
 Light meter, 345
 Light sources, 346
 Light tower, 363-364
 Lighting, 337-381
 motion-picture, 340, 343
 instruments, 347
 stage, 339
 Lightning effect, 377
 "Lights Out," 282, 283, 378
 Limbo, 4
 Line microphone, 390
 Lining up camera, 24-27
 Linnebach lantern, 238-239
 Lipstick, 331, 334
 Long shot, 30
 Loop of film, 232
 Loose-pin hinges, 302
 Low-key light, 345
 Low-level mixing, 411
 "Lucky Strike Hit Parade," 214, 296
 Lumen, 345
 Lycopodium burner, 274-275

M

McBride, Pat, 44
 McCleery, Albert, 297
 "Machine-gun mike," 390
 MacNaughton, James, 219, 223, 325
 "Magic Lock" portable boom, 423
 Magnesium flash powder, 274-275
 Magnets in animation, 258-259
 "Magnitoons," 258-259
 Make-up, 328-336
 application of, 332-334
 minimum, for nondramatic performers,
 334
 straight, how to apply, 336
 Manual mixing, 116
 Mascara, white, 333
 Master control, 8
 Master gain on audio consoles, 402
 Master monitor, 5
 Materials, for scene construction, 323,
 324
 for television make-up, 331, 334-336
 Matte celluloid in animation, 259
 Matte shots, 226-228
 Matting, in baseball coverage, 457
 electronic, 281-282
 with lens turret, 227-228
 Max Factor's pancake make-up, 331, 334
 "The Medium," 204

- Medium shot, 30
 Metal caning for lighting effect, 381
 Metropolitan Opera, coverage of, 458
 Microphones, 387-396
 placement of, 395
 radio, 424-425
 Microwave receiver, remote control of, 420
 Microwave relay link, 418, 436
 Mike boom, 397-401
 Mike-boom base for camera mount, 445
 Mike-boom operator, 11
 Milk of magnesia powder, 275
 Mirrors, 200-214
 for canted image, 204
 cylinder of, for lighting effect, 378
 front surface, 260
 for ghost effect, 207-208
 half-silvered, 208-209
 high-angle shots with, 200-202
 for image inversion, 210-214
 kaleidoscope, 216-218
 multiple-image, 216-218
 in periscopes, 202-205
 properties of, 209-210
 sliding, 192-195
 for split screen and wipe, 206-207, 244-245
 in superimposures, 207-208
 transparent, 208-209, 242-245
 for water reflection, 205-206
 "Mr. I-magination," 231, 268
 Mittens letters in titles, 161
 Mixer positions on audio controls, 401
 Mobile-unit trucks, 425-433
 Modeling light, 342
 Mole-Richardson mike boom, 397-399
 Monitor, preview, 106
 Montage amplifier, 283-289
 Motion-picture lighting, 340, 343
 Motion-picture studios, 3
 Multiple-image prisms, 215-218
 Multiplex radial saw, 323
 Multiplexer, 171-173, 193, 194
 Multiscanner, 199
 Murphy, Jack, 447
 Murrow, Edward R., "See It Now," 294
 Mysterious writing, 246-248
- N
- Nagaele, Tom, 150, 153-154
 Nemo master gain, 407
 Neutral-density filters, 79-80
 News, visualizing of, 249-251
- O
- Objective camera, 28
 Offenhauser, Bill, 261
 Oil, crystal, for fog effects, 272-273
 Olden, Georg, 153-154
 On-the-air monitor, 5
 One-way glass, 208-209
 OP6 and OP7, audio controls for remote pickups, 422
 Opaque projectors, 177-186
 Opaques, methods of mounting, 161-166
 Open flame, 267
 Operating jobs, 11
 Optical view finders, 17-18
 Orth-focus control, 24
 Oscillograph, 293
 Oscilloscope, 293-294
 O'Toole, Tommy, 177
 Overscanning, 25
 Ozalid machine, 164
- P
- Pablum as snow, 263
 Paint frame, 325
 Pan lights, fluorescent, 349
 Pancake make-up, 331, 334
 Panning, 34-38
 Pantograph for lighting, 361
 PAR 38 lamps, 350, 379
 Parabolic reflector for microphones, 389-390, 424
 Parallax error, 17
 Parallel, 307
 Parallels for lighting, 340
 Passing lights effect, 377
 Patchboard, audio, 384
 for lighting, 370-373
 Paul, Byron, 137
 Paul Whiteman Revue, 52, 219, 325, 326
 Pedestal, jamming of, 294
 Pedestal control, 293
 Pedestals, studio, 42-45
 "Pepper's Ghosts," 207-208
 Periscope, 202-205
 Permissions for remotes, 436
 Perspective, artificial, 219-224
 in lenses, 68-73
 Photoflood bulbs, 351
 Photomurals, 312
 Photostats, 163-164
 "Piano Patter," 214
 Picture area, 134-135
 Picture quality, 22-23, 339
 Pipe grid for lighting, 357-359
 Platforms, 307

Plug, 302
 Point-source lamp, 238
 "Polar" graph, 389
 Polarity, reversal of, 289
 Political convention, 460-464
 Polystyrene as snow, 264
 Pop-ins in animation, 249-251
 Porro prism, 210-214
 Port-o-reels, 425
 Potato chips as snow, 263
 Pots in audio console, 401
 Power rail, 359, 360
 Power-supply problem in remote pickups, 435
 Power tools, 323
 Powerstat, 368
 Practical scenery, 304
 Presetting of dimmers in lighting, 375
 Pressure microphone, 391
 Preview monitor, 5
 Preview switching, 106-108
 Previewing, on master monitor, 106 107
 Prism, for canted effect, 34
 dove, 34, 210, 214
 image-inverter, 210-214
 multiple-image, 215-218
 porro, 210-214
 process screen, in rear projection, 234-235
 Projectall, 179, 199
 Projected fire, 267
 Projection equipment, 171-199
 Projection operations, 197
 Projection spots, 355-357
 Projectionist, 11
 Projectors, 171-199
 Bodde, 235
 Du Mont Cinecon, 190
 Du Mont Super Speed, 188-189
 Eastman Kodaslide, 171-173
 film, 186-199
 filmstrip, 170
 General Electric balop, 173-176
 La Belle automatic, 173
 rear-screen, 236-237
 remote control of, 197-199
 Selectoslide, 198-199
 Super Projectall 300, 199
 theatrical effects, 231-232, 267
 Trans-Lux Teleprocess, 236
 Visualeast, 245-247
 Vue-Graph, 245-247
 Prop men, 298, 299
 Prop shoppers, 299
 Pull-off for title changing, 143-144
 Pull-outs in animation, 250, 254-255

Q

Quadriplexer, 196-197
 Quality of light, 341

R

Racing coverage, 440-443
 Radio microphone, 424-425
 Radomes, 419
 Rain glamé, 266
 Rain in studio effects, 264-266
 Rankin, Arthur, 154
 RCA Bantam KB2C microphone, 392 393
 RCA 88A microphone, 391-392
 RCA flying-spot scanner, 190-191
 RCA 44 microphone, 388-389, 392-393
 RCA mobile unit, 427-428
 RCA 77D microphone, 394
 RCA Starmaker microphone, 393
 RCA switching system, field, 108 110
 studio, 110-113
 RCA tripod dolly, 41, 42
 Reactance dimmers, 369
 Rear-lighted animation, 256-257
 Rear projection, 229-237, 297
 screens, 232-237
 Record spinner, 11
 Reflector lens, 62-63
 Reflection, laws of, 209-210
 methods of cutting down, 132-134
 specular, 353
 Reflector, lighting, 353-354
 Reflex-type cameras, 20
 Remote control, of lights, 362, 369
 of projectors, 197-199
 Remote pickups, 413-464
 Reproduction of art work, 163 164
 Resistance dimmers, 367
 Resolution chart, 25
 Return, 305
 Reverberant sound, 386-387
 Reversal, of polarity, 289
 of scanning, 289-290
 R40 lamps, 350, 364
 Riggs, Otis, 320, 321
 Rim light, 344
 Rocks in scenery, 313
 Rose, Dick, 146
 Rotolector board, 373, 375
 Roy Rogers Smoker, 275
 Rubber Mask Grease Paint, 332, 334
 Russell, Connie, 217
 Ryktarick, Richard, 321

S

S distortion, 26
 Saber saw, 323

- Safe area, 134
 Saltpeter, 269, 275
 Sanner, Sid, 44, 54, 446
 Sanner dolly, 54-56, 446
 Saturating black, 294
 Saw, multiplex radial, 323
 saber, 323
 Scanned area, 134
 Scanning reversal, 289-290
 Scaffolding in remote pickups, 433-434
 Scene design, 318
 Scenery, construction of, 322-324
 paint for, 326
 painting of, 324-326
 personnel for, 298
 practical and impractical, 304
 quick-change methods of, 314
 storage of, 327
 trick, 315-316
 Scopescope, 228-229
 Scoop, floodlight, 350
 focusing, 352
 long-range, 352
 Scotch tape, 249, 309
 hinge, 261, 270
 Screens, rear-projection, 232-237
 scenery, 309-311
 standard units of, 301
 Scrim, 315
 "See It Now," 294
 Selectoslide projector, 173, 198-199
 Set elevations, 319
 Set pieces, 308
 Setup in oscilloscope, 293
 Sets, 296-327
 cardboard, 309, 324
 permanent, 299, 324
 solid, 308, 324
 77D polydirectional microphone, 387-388
 Shading, 26
 Shadow box, 242, 262
 three-stage, 243-245
 two-mirror, 243-245
 two-stage, 242-243
 Shadowgrams, 238-239
 Shadows, projection of, 211-242
 Sherwin, Ray, 150
 Silhouettes, 240-241
 "Silver Theatre," 133
 Sky eye, 306
 Sky hook, 361
 "Small Fry Club," 258
 Smith, Dick, 328, 330, 332, 334
 Smith, Neal, 411
 Smoke in puffs, 274-275
 Smoke candles, 269
 Smoke effects, 268-270
 Smokehouse, 270
 Snow bag, 264
 Snow drifts, 264
 Snow effect, 263-264
 "Soaker hose" for rain effect, 266
 Soap flakes as snow, 263
 Soapsuds, lasting, 275
 Sound, reverberant, 386-387
 Sound-effects filter, 405
 Space, illusion of, 219-241
 Spaghetti-board titles, 157
 Special-effect lighting, 376-381
 Special effects, audio, 405
 with graphic materials, 242-262
 as visual transitions, 103-104
 Spectrolite, 251
 Spirit gum, 333-335
 Split screen, electronic, 281 282
 with mirrors, 206-207
 Spotlights, 348
 for fill light, 366
 fresnel, 354
 Sprinkling cans for rain effect, 266
 Square-wave blanking pulse, 282
 Staeker, 32
 Stage brace, 301
 Stage lighting, 339
 Stage wagons, 315
 Stagehands, 298
 Staging director, 12
 Standing waves in audio problems, 396
 Staple gun, 323
 Steaming pots, 276
 Stein's lining color sticks, 331, 335
 Stephens microphone, 395
 "Stop the Music," 67, 248
 Strap hinge for scenery, 304
 Strapping of microphone, 388, 409
 Stretching in electronic effects, 291
 Strip lights, 351, 352
 mercury-vapor, 352
 Studio effects, 263-295
 (See also Special effects)
 Subjective camera, 28
 Submaster gain, 407
 "Subway Express," 413-414
 Super Projectall 300, 199
 Superimposures, cutting to or from, 117
 dissolving to, 118
 in electronic effects, 277-281
 with mirrors, 207-208
 Supplementary area, 134
 Survey in remotes, 437-438
 "Suspense," 396
 Swish pan, 35
 Switcher system, 12
 Switching, preview, 106-108

Switching sequences in baseball, 456
 Switching systems, dual fading-bus type,
 107-108
 five-bus, 119-121
 General Electric, 118-119
 mixer type, 107
 RCA field, 108-118
 RCA studio, 110-113
 three-bus type, 108
 Swope, Herbert, Jr., 448
 Sync level in oscilloscope, 293
 Sync lock in remotes, 437
 Synchronizing problems in film projec-
 tion, 186-188
 Synchronizing-pulse generator, 416-417

T

7' stops, 80
 Technical director, 6, 11, 13, 88
 Ted Steele Show, 214
 Tele-Line system of light control, 363
 Telescriber, 247-248
 Telojector, 172-173
 Telop, 184-186
 Telop strip mounting, 166
 Template in scene construction, 322
 Tenting, 133
 Test pattern, 25
 Texture lighting, 378
 Theatrical effects projectors, 231-232,
 267
 Three-bus switching systems, 113-114
 "Through the Crystal Ball," 281
 Thyatron tube, 369
 Tilt shot, 34-35
 Titanium tetrachloride, 268, 270
 Titles, devices for lettering, 155-161
 lining up, 139-141
 methods of changing, 141-149
 unusual use of, 136-137
 "Tom Corbett, Space Cadet," 213, 284
 Tonal response, 130-134
 Tools, for scene construction, 323, 324
 for scene painting, 326
 "Toon-a-vision," 246
 Tower for lighting, 363-364
 Tracing cloth in animation, 250-251, 259
 Tracing paper in animation, 250-251
 Trans-Lux projector, 233-234, 236
 Trans-Lux rear-projection screen, 235
 Transmitted area, 134
 Transparent slides, 167-170
 Travel shot, 39
 Traveler curtain, 306, 307
 Tripod dollies, 41-42
 Tripod head, 37

Tripp, Paul, 231
 Trol-E-Duct, 359
 Trucking shot, 39
 Twofold flat, 304

U

Unidirectional microphone, 388 389, 396
 Usable area, 134

V

Variac, 368
 Velocity microphones, 392-393
 Velour in ghost effects, 280-281
 Velour paper in animation, 249
 Vertical camera movement, 39-40
 Vertical wipe in montage amplifier, 286
 Video engineer, 5
 Vidicon camera, 26, 194, 199, 462
 View finder, 15-20
 bull's-eye, 17
 electronic, 18
 exterior, 15
 optical, 17-18
 sports, 15
 Viewing boxes, 75-76
 Virtual camera position, 200-201
 Visualeast projector, 245-247
 Vitascopes, 229
 Volume-indicator meter on audio con-
 soles, 402
 Vue-Graph projector, 245-247

W

Wade, Bob, 326
 Wagner, Dean, 305
 Walker, Joseph, 67
 Walkie-talkie, 26, 424-425
 Water-house stops, 78
 Wave-form monitor, 293
 Wave guide, 418
 WBKB truck, 429-430
 Webber, Martin, 155
 Wedge wipe, 282-283, 286-288
 Weger, Karl, 214, 217, 226, 237, 244,
 379, 380
 Western Electric Cardioid mike, 394
 Western Electric dynamic mike, 391
 Western Union concentrated arc lamp,
 238-239
 Whirligig, WPTZ, 217-218
 White level in oscilloscope, 293
 Whiz pan, 35
 Wigs, 333, 335
 Wild wall, 316

474 TECHNIQUES OF TELEVISION PRODUCTION

Windmill for title changing, 145-146

Winkler, Carlton, 294

Wipe, 104

 electronic, 282-283

 with mirrors, 206-207

 in montage amplifier, 286

 in shadow box, 244-245

Wipe-in in animation, 254-257

WLWT adapted bus, 430-431

Wow effect, 404

WPTZ whirligig, 217-218

Wrestling coverage, 439

Wrigley method of baseball coverage,
 451-452

Z

Zirconium arc lamp, 238-239

Zoeckler, Charles, 315

Zoomar lens, 64-67

 in baseball, 450-456

 in football, 446

