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Audio and Video Special Effects

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VISUAL EFFECTS

Electronic Switching Special Effects

In television video practice, the term "special effects," by accepted usage, is applied to techniques for creating visual effects which are beyond the capabilities of an elementary video switching system which provides only signal selection and additive superimpositions, or "lap dissolves." The purpose of special effects may be either to achieve an artistic objective or to aid the communication of information. Electronic special effects can also be of economic advantage when they permit realistic simulation of pictorial material that would otherwise be prohibitively expensive.

The major category of electronic special effects is the use of electronic switching, or "keying," for simultaneous display of portions of two or more video signals by a pattern division of the raster. Other types of visual special effects are largely techniques for introducing distortions of the picture image, by either optical or electronic means.

Keying Techniques

Since the television picture is transmitted by time-sequence scanning, it is evident that appropriately timed instantaneous switching between two video signals can produce the visual effect of a geometric division of the raster area so that portions of each picture are displayed. Conventional electronic switching techniques readily permit the switching interval required. Methods of using this technique are categorized by the source of the signal which determines the pattern of the display. In the most elementary application, the "wipe," keying waveforms are generated by pulse circuit techniques to create geometric patterns. It is also possible to obtain keying waveforms of any desired pattern by processing video signals from conventional camera equipment. The simplest form of this technique uses an independent camera trained on silhouette art work of the desired pattern, so that the resulting video signal closely resembles a pulse keying waveform and requires a minimum of processing. The most advanced application is matting, in its most popular form, "chroma-key," where the keying signal is derived from one of the two video signals to be combined. This permits placing a subject visually into any background scene desired.

The arrangement of equipment components for these three forms of electronic switching effects is shown diagrammatically in Fig. 1.

Keying Amplifier

The circuit which is fundamental to any special-effects switching system is the keying amplifier circuit itself. Functionally, this circuit takes three input signals, the two video signals and the keying pattern signal, and produces an output video signal which combines the two video signals in accordance with the area division established by the keying pattern signal. The keying pattern signal is assumed to be a two-valued function, or pulse signal. Switching circuits usually, however, include a clipper in the key-signal input channel to remove any noise or shading components that may be present. This permits the use of camera-generated signals developed from silhouette artwork without further prior processing.

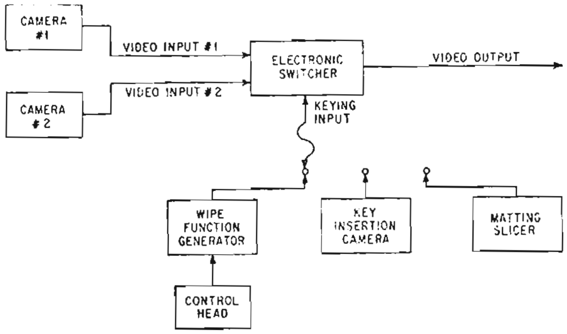

Fig. 1. Electronic switching special-effect system.

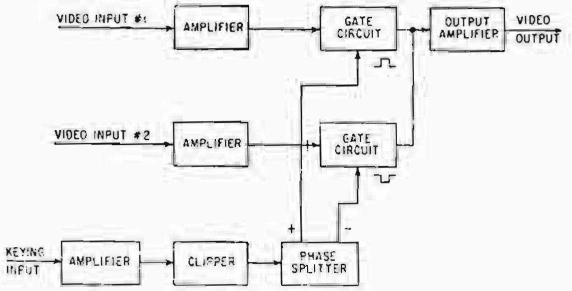

Fig. 2. Electronic switcher-typical circuit plan.

A typical circuit arrangement (Fig. 2) employs a pair of solid-state switches as gate circuits. The keying signal, after clipping, is phase split so that it can be applied in opposite polarity to each of the two gate circuits. The gate outputs are paralleled and fed to the output amplifier. Auxiliary circuitry for clamping is essential to ensure constant clipping levels. The opposed-polarity keying pulses must be precisely matched to avoid a gap or overlap at the instant of switch; this is one of the key problems facing the designer.

Until the early 1970s, the history of keying amplifier design development was one of striving for the fastest possible transition, so that the boundary between the two portions of the signal would be sharp and invisible. As a corollary to this objective, the keying signal is derived from a very narrow slice of the keying video signal. A disadvantage of this inherently high gain gating approach is, in the chroma-key application, when the keying video signal is noisy or in any way ambiguously defines the location of the keying boundary, a severe and unpleasant edge-noise or "boiling" effect is evident at the keying boundaries in the chroma-key output signal. The availability of improved semiconductor components and circuit techniques in the early 1970s has made possible a better approach to keying amplifier design, in which the gate circuits of Fig. 2 are replaced by a two-input linear transfer circuit of equivalent performance. With such a transfer circuit, the keying action in the chroma-key application can be derived on an essentially proportional basis from the keying video signal, and the resultant output chroma-keyed picture is free of edge-noise effects even where the edge is ambiguously defined. An effective illustration of the performance of such a circuit can be shown by the keying of cigarette smoke. Another advantage of the proportional keying approach is that it permits the option of a "soft wipe," in which the boundary between two signals, instead of being sharp, provides a dissolving effect or soft edge of any desired thickness. The system architecture of video switching systems employing proportional keying, furthermore, is considerably simplified, since the proportional keying element is used for lap dissolves also, thus avoiding the need for the switched selection of alternative processing paths which characterized earlier designs.

Wipe Function Generation

A wide variety of keying patterns can be electronically generated by conventional pulse circuit techniques. Such signals are applied in two general ways: (1) for a transition from one picture to another and (2) for a static display of portions of two (or more) pictures.

The term "wipe," which originated as the description for the most elementary form of geometric transition (in which a dividing barrier sweeps across the raster with the new picture appearing behind it as it progresses), is applied as a generic term to any system for electronically generating patterns of raster division. A "split-screen" is, in effect, a stationary wipe. Transition wipe effects include not only a linear sweep of the inter-picture boundary, but also the iris form of motion, in both single and multiple patterns, and in more elaborate systems, rotating boundaries are also provided.

For the transition application, a variety of patterns are commonly employed, the simplest being the horizontal (Fig. 3) or vertical wipe. Diagonal wipes (Fig. 5) are also common. More complex wipes are possible with wedge and irregular shapes. The box (Fig. 6), the diamond, and the circle are the most common shapes for the iris type of motion. A wide variety of more complex patterns can be electronically generated, including "venetian blind," "checkerboard," multiple circle, star, triangle, etc.

Of the static patterns which are employed to display portions of two or more pictures simultaneously, the horizontal split screen (Fig. 3) is the simplest and is frequently used. Another popular pattern is the wedge (Fig. 4), in which a rectangular segment in one corner of the picture is keyed off, usually for insertion of the face of a commen-

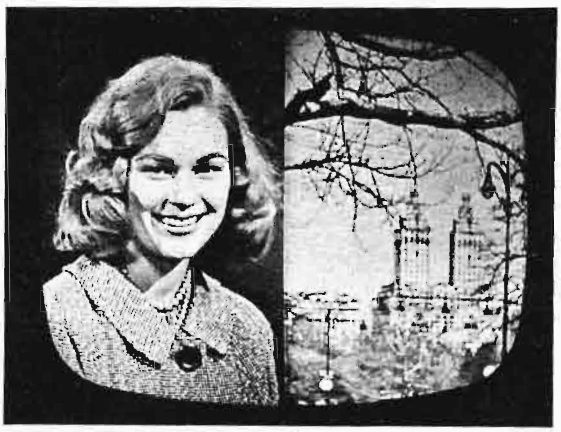

Fig. 3. Horizontal wipe or split screen.

Fig. 4. Wedge insert.

Fig. 6. Wipe and split-screen effects.

tator. A vertical split screen is sometimes employed to insert written material in a strip at the bottom or top of the picture. On occasion, for planned news coverage, more than two signals have been combined, and as many as five pictures have been combined to display simultaneously the faces of news commentators or public personages from widely scattered locations. When pictures are so combined from different locations, it is, of course, necessary to phase-lock the sync generator at the coming location. When pictures from more than two points are combined, the sync generators from each contributing source must be phased and held in synchronism with that of the final mixing facility. In the earlier years, this was achieved by a chain system whereby all contributing points beyond the first processed the signal, adding its contribution and phasing its sync generator to the incoming feed. More modern practice is to employ one of the available remote feedback techniques for individually controlling the phase of each remote sync generator from the mixing facility, so that all signals are fed directly to the mixing facility and are processed there.

Circuitry for the generation of wipe keying signals usually employs certain principles that are common to all practical designs. A block diagram is shown in Fig. 7. In the typical system, vertical and horizontal waveforms are generated as elements for the synthesis of keying signals. The simplest patterns use horizontal and vertical sawtooth and triangle. The typical commercial wipe function generator also employs multiple-frequency and parabolic waveforms for a variety of complex wipe function patterns. The wipe pattern is generated from a master waveform, which may be a combination of basic horizontal and vertical waveforms, by double clipping (or "slicing") to develop a pulse signal whose timing will depend upon the clipping level. The motion is thus imparted to the pattern for transition effects by manually changing the clipping level through the amplitude range of the entire master waveform. Some patterns require independent clipping of two waveforms with following mixing and clipping (in effect, logical mixing) of the two resultant pulse signals. Additional combinations of mixing circuits and basic signals make possible an extremely wide variety of patterns. In elaborate systems, the major design problem becomes the switching arrangement for selection of a large number of signal combinations. Fig. 8 shows a typical selection control panel for a contemporary wipe function generator.

Fig. 5. Diagonal wipe.

A frequently included convenience feature is a positioning system by which horizontal and verti-

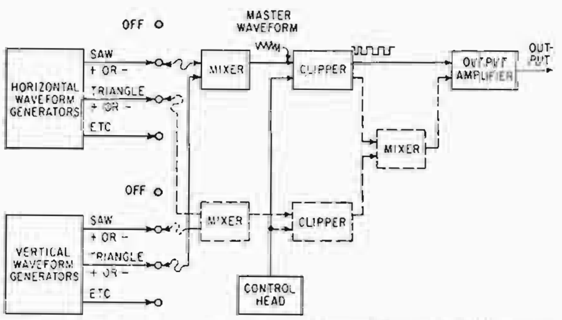

Fig. 7. Wipe function generator-typical circuit plan.

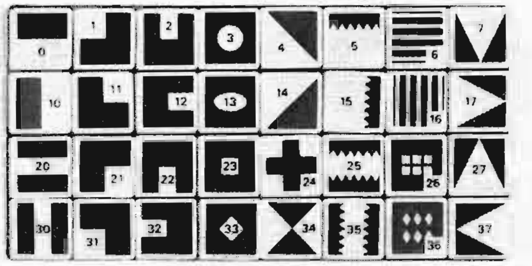

Fig. 8. Typical wipe selection controls (Courtesy Grass Valley Group, Inc.).

cal drive pulses are delayed under manual control, typically with a joy-stick, to locate the wipe pattern easily on any part of the raster. An occasionally employed technique for elaborating on the conventional wipe pattern is to phase-modulate the keying signal at an audio frequency rate by a few microseconds, producing an animated shimmering effect in the final pattern. Special modes of operation are often built into wipe keying systems, such as a "soft wipe" option, which is feasible when the proportional keying technique is used and "borderline," in which a prominent boundary line of deliberately visible thickness (either black or at a specified luminance and chrominance level) is substituted for the normally invisible keying boundary. Fig. 9 shows a typical repertoire of controls for a variety of special functions in a special effects system.

Keyed Insertion

Where there is desired a split-screen or wipe pattern of an irregular shape that cannot readily be generated electronically, it is necessary that the keying signal be produced by an image-scanning process. Conventional camera equipment can be used for this, either live or film.

The major application of keyed insertion has been for trick "split-screen" effects. There has been limited use for transitions, generally using a live camera with a zoom lens to produce the pattern motion. Film animation is another possible source for moving patterns, but its cost has seldom been considered justifiable. Fixed keyed-insertion patterns are usually derived from live cameras with silhouette artwork or with film cameras using projected slide or opaque material.

Any camera signal requires double clipping, or "slicing" to eliminate noise and shading components before use as a keying signal. The switching circuit will normally include sufficient clipping, but in some systems the key-insertion signal is fed through a portion of a wipe signal generator circuit to process it adequately.

The component pictures and results of a key insertion process are shown in Figs. 10 to 13. Fig. 10 is the background camera, showing a map of the United States. Fig. 11 is the key-insertion camera, a silhouette outline of the state of Missouri. Fig. 12 shows the picture from the subject camera. In the final product, the subject appears within the state outline in Fig. 13.

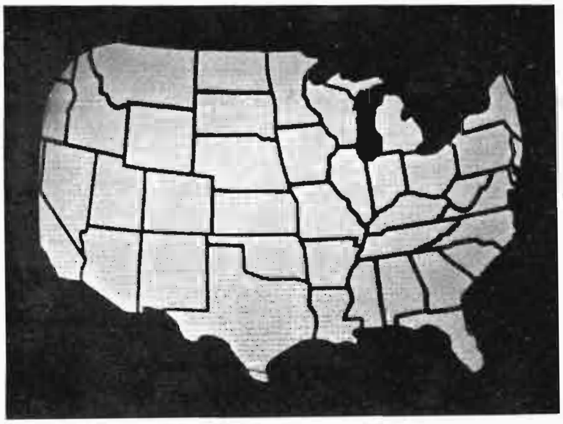

Fig. 10. Background camera picture.

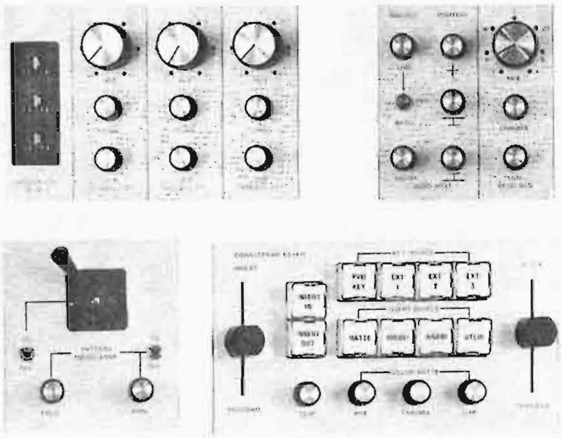

Fig. 9. Electronic special effects auxiliary function controls (Courtesy Grass Valley Group, Inc.).

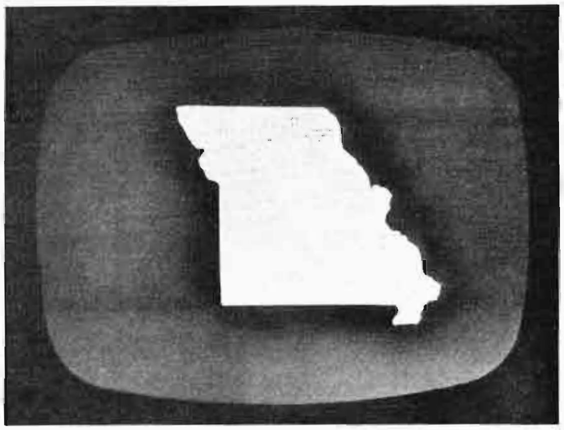

Fig. 11. Key-insertion camera picture.

Fig. 12. Subject camera picture.

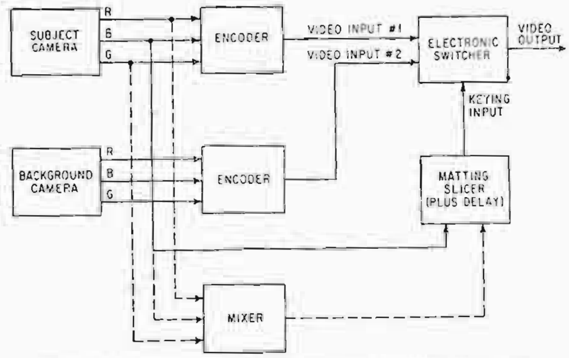

Fig. 14. Color matting system-block diagram.

Matting and Chroma-Key

The object of the matting process is to insert a subject (usually human) into a background scene, sometimes for a trick effect but usually for the purpose of creating the illusion that the subject is actually in the scene. When skillfully applied, the process can offer an advantage of economically creating effects that would otherwise be prohibitively expensive.

In the era of monochrome broadcast television, matting was achieved occasionally by placing the subject against a black background and slicing the resulting video signal. The process was, however, very difficult to control, requiring extreme care in lighting, costuming, and staging to produce a scene with reflectance values adequate for key slicing. With the advent of color, however, the added dimension of chrominance proved to be a crucial aid to the process, and the chroma-key technique has since come to be widely used in commercial television broadcasting.

The usual practice is to use a backdrop of a bright primary color, sufficient to produce full "white" level in the corresponding channel of the system. The primary to be used is selected on the criterion that it be complementary to the predominant color of the subject. Since human subjects are most often used, blue is usually the optimum backdrop color. With mixing techniques, color other than primaries, such as cyan, can also be used. An essential precaution is to avoid any use of colors approximating the backdrop color in the costume of the subject.

Fig. 13. Final key inserted picture.

The matting-system layout in color differs from monochrome only in the keying-signal source and processing, as shown in Fig. 14. The two video inputs to the electronic switcher are the encoded signals of the subject and background pictures. Instead of the subject signal itself as an input to the slicer, however, the desired primary component, before encoding, is used. This may be either an actual primary, such as the blue signal, or a matrixed combination.

In the diagram of Fig. 14, it will be noted that the unencoded RBG signals are routed directly from the camera to the chroma-key equipment. It is essential that the signal input to the slicer be of sufficiently wide bandwidth to permit the accurate definition of the keying boundary (although this requirement is somewhat alleviated if proporportional keying is used). This means that cameras which deliberately reduce the bandwidth of the chroma signal, such as certain types of four-tube cameras, cameras which employ special signal transmission techniques to operate with miniaturized camera cable (such as "Triax"), and the low cost two-tube and one-tube cameras used in low-budget closed-circuit applications, do not lend themselves well to chroma-key application. Another consideration relates to the need which may sometimes arise to chroma-key into an encoded signal, where access is not possible to the original camera RBG video outputs, such as at a point remote from the camera location, or with a tape-recorded signal. The RBG outputs of a conventional decoder are typically not of sufficient bandwidth to permit chroma-key. With

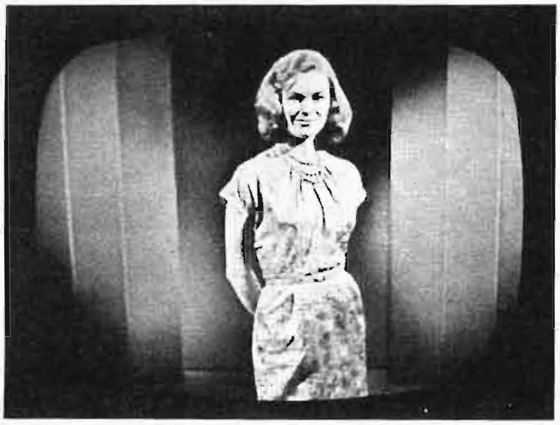

Fig. 15. Normal picture.

wideband decoding employing the comb filter technique, however, sufficient bandwidth is obtained to permit "in-line" chroma-keying, and equipment for this purpose became commercially available in the early 1970s.

Camera-Induced Effects

Horizontal and vertical scanning are easily reversible by the installation of DPDT toggles switches directly in the yoke circuit of a camera. The effects made possible are the geometric inversion of the picture and horizontal reversing, which can be used for superimposition of mirror images. There is a basic design problem in color television cameras for the achievement of this effect in the maintenance of registration; typically, some registration setting controls must be duplicated if registration is expected to be maintained without readjustment between the two conditions.

Ripple

The superimposition of an audio-frequency component on the camera horizontal scanning current causes a rippling motion in the picture which can be used dramatically to suggest dreams, fading of consciousness, etc. A frequency close to 60 Hz or its harmonics produces a suitable motion effect. The effect is illustrated in Figs. 15 and 16 showing normal and rippled pictures, respectively.

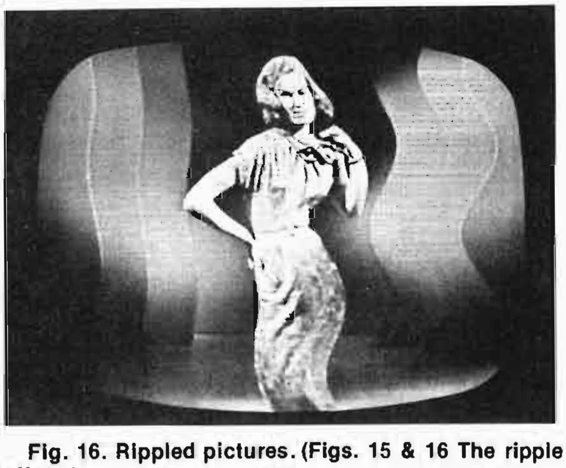

Fig. 16. Rippled pictures. (Figs. 15 & 16 The ripple effect.)

Deliberate Signal Distortions

Nonstandard operation of camera controls provide a limited capability for special video effects. With photoconductive pick-up tubes, "puddling" from beam starvation will generate an odd-looking lag effect, and simple underexposure with excess gain will produce smear. Such effects were more readily available and more frequently employed in the monochrome era, when the image orthican tube offered much more versatility in that regard. Another type of distortion which may be achieved electrically is the manipulation of the color signal. A device called the "colorizer" permits transformations of chrominance and luminance values so as to produce a transformed, unnatural appearance. Another technique sometimes employed for a dreamlike, or psychedelic effect, is "video echo," wherein a camera is trained on a monitor displaying its own output. By adjustment of framing, this can be arranged to produce a variety of multiple image effects, which, particularly if combined with chroma-key, can produce a wide repertoire of surrealistic images. A film produced on videotape for theater release entitled "200 Motels" was a virtual *tour de force* of video special effects, employing all the techniques mentioned herein.

Electronic Title Generation

The continued lowering of costs for digital electronics in the 1960s introduced the feasibility for economic generation of alphanumeric characters for television titling purposes. Such equipment was introduced on a limited scale in the period 1964-1966, and was first implemented as a commercial product in 1968.

The earliest versions of such equipment, for economic reasons, were able to offer character font styles considerably short of that desirable for ideal graphics quality, but nevertheless adequate. Likewise, the earliest versions employed a fixed character matrix, instead of the more desirable proportional spacing. By the 1970s a variety of classes of character generation equipment had become available, ranging from the lowest cost class offering the features of the earlier-introduced equipment, to the most sophisticated class offering high-quality or variable-choice fonts with

Fig. 17. Low resolutions (Courtesy of Datavision, Inc.).

Fig. 19. High resolution, proportional spacing (Courtesy of CBS Laboratories).

proportional spacing. Figs. 17, 18, and 19 show, respectively, representative fonts available in the three classes of equipment, in ascending order of quality and cost.

In addition to display of static titles, sometimes on call from random-access digital memories, electronic titling equipment can include certain special animation features, such as the horizontal "crawl" effect, where a continuous, long message travels in a single line across the screen from right to left, or a vertical "roll" effect, where a continuous page copy travels upward through the raster.

The insertion of titles into the video signal in monochrome television was achieved in the most elementary fashion by direct superimposition, followed by white clipping to remove the necessity for reducing the level of the primary signal to avoid excessive combined signal level. Since color telecasting and the use of keying amplifiers have become commonplace, titles in contemporary practice are invariably inserted by keying, and most systems provide means for selecting any desired brightness level and color for the inserted title.

An important enhancement of the visibility of inserted titles is through the use of edging, which is achieved on an "all-around" basis by using horizontal line delay techniques such as are employed in vertical aperture equalization equipment. The most elaborate editing systems permit a choice of all-around, horizontal, vertical, or "drop-shadow" edging. Figs. 20 and 21 show the improvement achieved by the application of all-around edging.

Electronic Graphics Generation

As an adjunct to electronic titles, there have been limited efforts to use similar digital tech-

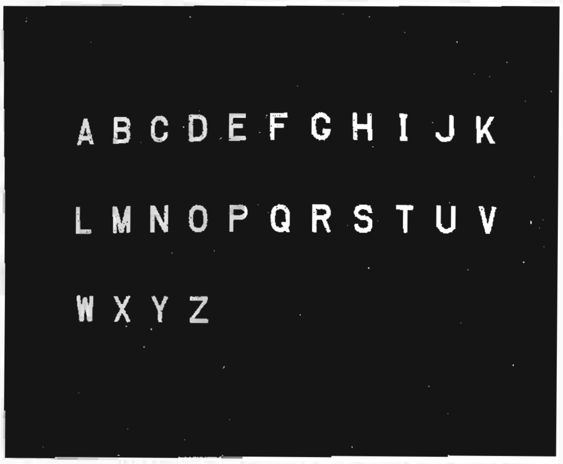

Fig. 18. High resolution, nonproportional spacing (Courtesy of CBS Laboratories).

Fig. 20. Without edging (Courtesy CBS Laboratories).

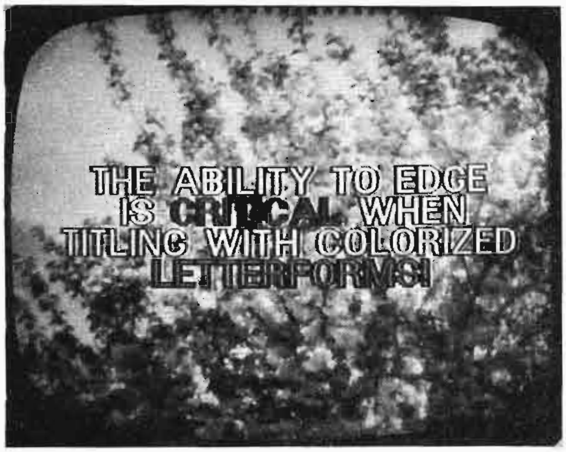

Fig. 21. With edging (Courtesy CBS Laboratories). (Figs. 20 & 21 Edging enhancement of electronic titles.)

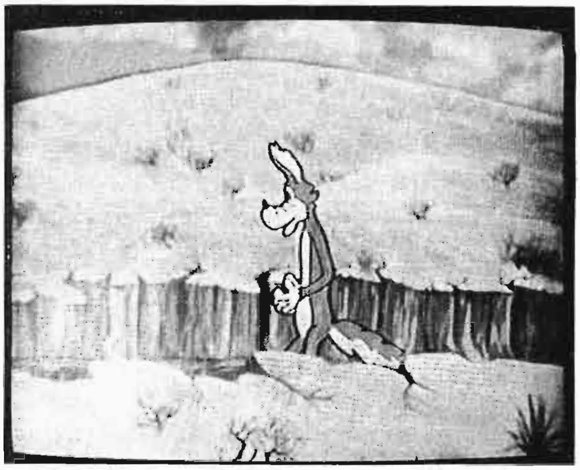

Fig. 23. Computer-generated cartoon character (Courtesy of Computer Image Corp.).

niques for the generation of graphic material. Such technique can be used, and has to a limited degree, for such presentations as maps, bar charts, and graphs.

A technique available to broadcasters for animated graphics generation employs raster scanning manipulation to produce animated and preprogrammed geometric distortions and transformations of prepared artwork and visual images. This system has been widely employed in television commercial production and for program billboards. Fig. 22 illustrates a typical appearance of an image processed by this system. Perhaps the ultimate in video special effects is represented by systems which generate full-scale animated action entirely under computer control. Such systems had been speculated upon in theory for many years and were beginning to make their appearance in broadcasting by the mid-1970s. Fig. 23 illustrates a typical product of such a system as of that time.

Fig. 22. Raster manipulation title effect (Courtesy of Computer Image Corp.).

Optical Effects

Many very interesting effects can be achieved by interposing various optical devices between the subject and camera lens. Images can be multiplied, rotated, inverted, flared, distorted, and arranged in a variety of different patterns. Among the devices used to perform these effects are several types of prisms, kaleidoscopes, and etched lenses.

Multifaceted Prisms

One group of prisms is referred to as the "multifaceted" prism because of the multiplicity of plane surfaces on the face of the optical element. These prisms are placed between the subject and camera lens and produce one subject image for each plane surface on the face of the element and in a pattern corresponding to the arrangement of the surfaces. A diagram of a simple prism which produces these images is shown in Fig. 24. The center Section C consists of an optical flat which passes reflected light rays from the subject S without deviation to the camera objective lens, which in turn focuses it in the normal manner on the focal plane at C'. Rays from the subject S are redirected by the wedge section at A at such an angle as to be received by the camera lens and focused on the focal plane at A'. In a similar manner, the subject is redirected by the wedge

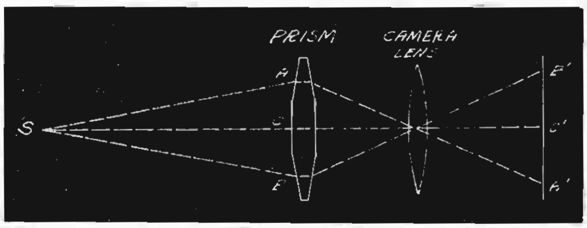

Fig. 24. Three-faceted prism.

Fig. 25. Multifaceted prism.

Fig. 27. Kaleidoscope.

section at B to focus a third image on the focal plane at B'. Fig. 25 shows a picture taken with a little more complex prism of this type, with five wedges surrounding the central facet.

Dove Prism

Another effect is produced with the Dove prism. It is placed in front of the camera objective lens in such a manner that its longitudinal axis coincides with the optical axis of the objective lens. Rotating the Dove prism around its longitudinal axis will then cause the image in the focal plane to rotate. Fig. 26 shows this rotation in progress. It is interesting to note that for every degree that the Dove prism is rotated, the picture image rotates 2°. In this manner, turning the Dove prism through 90° will cause an upright picture to rotate 180° and become upside down. Another 90° rotation of the Dove will complete the 360° rotation of the image and bring it back to its original upright positions.

Kaleidoscope

One of the oldest optical effect devices is the kaleidoscope. By utilizing the basic arrangement of the two mirrors which form a V and shooting through the V with the leading edge of the intersection (bottom V) framed in the center, studio scenes and performers may be shown in a variety of kaleidoscopic configurations. The number of images produced will depend upon the angle formed by the two mirrors and can be determined by dividing 360° by the angle. For example, if the angle is 60°, six images will be formed. Fig. 27 shows a picture taken with a kaleidoscope whose mirrors formed a 45° angle. While smaller angles will produce more images, it should be noted that there will be a greater difference between the sharpness and contrast of the unreflected image at the top and the last generation of reflected images or image at the bottom. Even though front-surfaced mirrors were employed in the kaleidoscope used to produce the

Fig. 26. Dove prism.

Fig. 28. Hartley lens.

illustration, there is a noticeable difference between the top and bottom images.

Etched Lenses

Another type of effect can be produced with etched lenses, Fresnel lenses, and fine-meshed screens. Ordinarily, great care is taken to avoid scratches on the lenses, but in this particular case, lenses or optical flats are etched on purpose with some pattern such as a series of concentric circles, dots, or crosshatching. The etching is fine enough to cause little interference with picture quality but yet deflect highlights in such a manner as to produce odd patterns of light flare. The picture shown in Fig. 28 illustrating the effect was taken with a Hartley lens attachment.

Projected Backgrounds

Projection can be used to provide backgrounds where photographic authenticity are essential, and on news and special-events types of shows to produce graphic or pictorial illustrations. In this latter group, the purpose is to "tie in" narrator and picture illustrations in one camera shot.

Rear and Front Projection

Projected backgrounds are both rear projected and projected from the front. When they are front projected, the projector is placed overhead and directed down on the front of the background screen at an angle. While this eliminates the need for space behind a screen, it results in some loss of playing area immediately in front of the screen where the actors cannot play without interfering with the beam of projection, as illustrated in Fig. 29. In addition, some "keystoning" will result from the axis of projection forming less than a 90° angle with the plane of the screen, and this may require a compensating predistortion of slides or provision for an optical correction.

While rear projection must of necessity be used with translucent screens, front projection can and customarily is used with opaque screens. These are often matte screens, and because of their superior diffusive characteristics, the "hot-spot" problem normally associated with rear projection, in which the center is bright, is not experienced. Cameras can dolly from one side to the other without apparent change in the light distribution of the projected picture.

Projection Lenses

To present the camera with the most uniform distribution of rear screen illumination requires the use of projection lenses of long focal length. Unfortunately, these lenses require long paths of

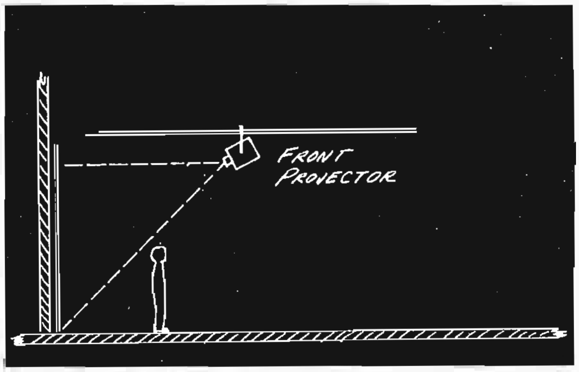

Fig. 29. Front projection setup.

projection and consume much space behind the screen. When space limitations make this impractical, front projection may provide a better solution.

Slide Sizes

The most commonly used slide sizes for studio projection are 3¼ X 4 in. and 4 X 5 in. Generally, larger slides are easier to cool but the difference here is not significant. Equipment employing slides smaller than 3¼ X 4 in. is generally intended for the visual-aid field and, except for use with the miniature screens, has little application for background projection.

Screen Materials

The picture quality of rear projection depends to a considerable extent upon using the proper screen material. Fig. 30 shows characteristic gain curves for three different materials. These were derived by directing a collimated light source perpendicularly onto the rear surface and measuring brightness on the front surface at angular inter-

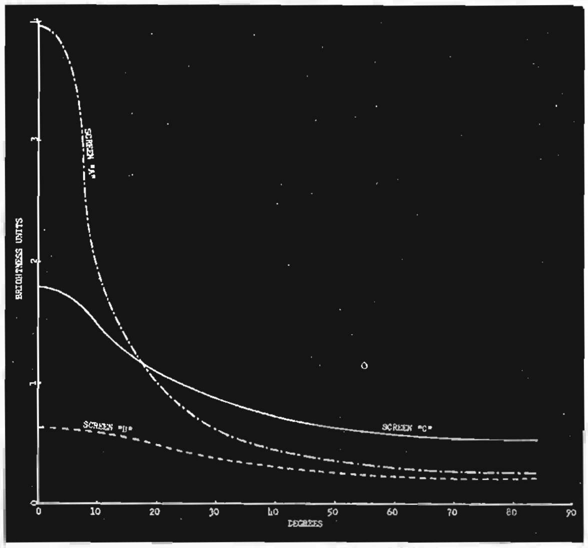

Fig. 30. Diffusion characteristics of screen materials.

vals from the perpendicular to the plane of the screen. Inasmuch as all three materials exhibited symmetrical characteristics, the curves are applicable to angles in all directions from the perpendicular to the plane surface of the screen.

From these curves it can be noted that Screen "A" will produce the brightest picture and with narrow-angle lenses on both the projector and camera, this quite obviously is the material to use. Should it be necessary to use a wide-angle lens on the projector and shoot the screen at short-range with a wide-angle camera lens, a severe "hot-spot" will result. If the camera is moved laterally, the "hot-spot" will follow, centered around the projection lens if it could be seen through the screen from the camera lens position. To minimize this "hot-spot problem, it may be necessary to use Screen "C" material with less gain but a smaller brightness change with change in angle. If the "hot-spot" is still troublesome, it may be necessary to resort to Screen "B" material with less than unity gain but minimum change with change in angle. Screen "B," however, will require about five times as much projection light as Screen "A," and if this is not practical, certain trade-offs may have to be made, such as reducing the size of the projected image.

Another consideration is reflectance. It is quite obvious that the reflectance must be diffuse, or nonspecular, to prevent the camera from picking up set lights, but in addition, it is desirable that the reflectance be kept low in order to maintain picture contrast. To reduce reflectance, a black bobbinet is sometimes placed in front of the screen. While this reduces reflectance, it also reduces transmittance, but in a ratio of 2:1, inasmuch as the reflected ambient must pass through the bobbinet twice compared with once for the rear projected illumination. Whether this is good practice depends to a considerable extent upon the ultimate use. If the screen is used where spill light can be controlled, adequate contrast may pose no problem and the higher light transmittance would be preferred. Where this control over spill light cannot be maintained, then the sacrifice of transmittance for lower reflectance may be a good trade-off.

Beyond the optical requirements, the physical characteristics of the materials are of some consequence. It is customary to expect rear screens to be shifted around like studio scenery, and for this practice it is desirable that screens be made of light-weight, reasonably rugged materials. Some of the plastics have been found suitable. Another excellent material is latex, but it is somewhat more fragile than the plastics. Just how durable the material must be is something that can best be decided after the actual application is known.

Lighting for Rear Projection

In addition to good equipment, the proper employment of studio lights is also essential to the successful use of rear projection. It is important that "key light" be kept off the screen. To do this it is necessary for the actor to play a distance at least equal to his height in front of the screen just as he would—or should—with other background scenery. Barn doors or other light-blocking means should be used to keep backlight off the screen and efforts made to minimize the impingement of fill light.

Shooting Rear Projection

Good projection and screen equipment having been used and the set lighted properly, there still may be evidences of the "hot-spot" which will prove troublesome unless the screen is shot properly. Referring to Fig. 31, the best way to shoot a scene from Projector A is along the axis of projection with Camera A. To Camera B, the right side of the screen would appear bright and the left side dark. If it is known that the preponderance of shooting must be done with Camera B, then Projector A could be moved to the location of Projector B. Focus would have to be split, and keystoning might have to be corrected. The same rule also applies to elevation.

AUDIO EFFECTS

One of the most critical requirements of sound effects in television is synchronization with the picture. Lack of synchronization may detract from the credibility of the effect as well as the performance. This may result in an ineffective scene and even annoyance to the audience.

For radio, the critical requirement is realism. With only the help of dialogue, the effect must sound sufficiently authentic that there can be no doubt left in the listener's mind as to what is happening.

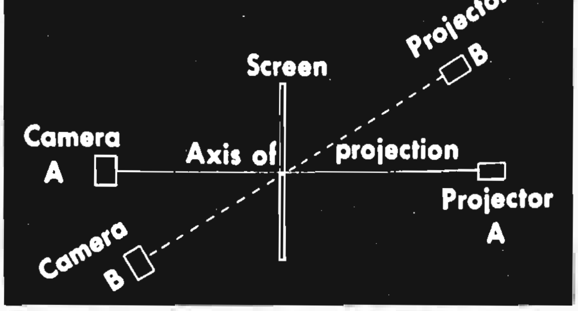

Fig. 31. Shooting on axis of projection (plan).

In television, there are four basic types of effects which must be considered. First are the on-camera effects—effects one would expect to hear with a picture. As the picture would show the telephone bell or handset, the audio would transmit the bell ringing and, when the telephone is answered, the sound of the cradle being lifted. There are many other such on-camera effects which may have to be performed by sound effects.

Second are the effects that are off camera. These effects are very much like radio effects, and must be quite creative in themselves. They must paint a picture strictly by audio. For instance, perhaps a scene calls for the arrival of a person in a car. Let's assume that one of the actors might be looking out a window from inside a house. The viewer hears an off-camera car drive up, actually a sound effect. The actor reacts and the camera stays with him. The car stops; the car door opens and closes; the car drives off. The next things that are heard are footsteps and a knock on the door. So far everything that was heard was done by sound effects. When the actor opens the door, a second actor is standing in the doorway. The actor had been there all the time, but the audience got the story. It was all done with sound effects.

The third type of effects are those that are used for background or to set a scene. For instance, if a scene opens outdoors or on a street, one would expect to hear some traffic sounds—especially if it is a city street. It might be a side street, and a car might never drive past, but as long as the camera is outside, the viewer would expect some sound. In a night scene outdoors in the country, night sounds such as crickets would be heard. All these various effects help to set the scene.

The fourth type of sound effect in TV which is completely different from radio is the type where the sound man must create a sound track for a silent film. This is done on programs such as documentaries, utilizing a number of clips of film and/or tape. It is up to the sound-effects man to get a viewing of this film and then put in these effects while the film is taped or aired "live." Quite obviously, synchronization is very important. Often, time is short and so the sound-effects man needs equipment that is considerably flexible. In the following pages some of this equipment is described.

Sound-Effects Console

Television and radio production requires a wide variety of sound effects. Some of these effects are produced manually, some electrically, and some from recordings of the actual sound. In order to reproduce and amplify these various effects, turntables, amplifiers, and associated equipment are necessary. An example of a console (Fig. 32) designed for this purpose is one used at CBS.

Fig. 32. Sound-effects console (Courtesy of CBS).

The Turntables

The console consists of three variable-speed turntables and four pickup arms. The variable speed is very desirable for sound-effects use. Most of the sound-effects records are cut at 78 rpm, but by being able to change record speed it is possible to get a variety of effects from the same disc. For instance, with a sound-effects record of a car running, the variable speed allows the sound-effects man to vary the speed during a chase scene or to even slow down and stop the car. Records played at 78 rpm can give other effects at slower speeds. For example, a waterfall record can be made to create an explosion at slow speeds.

The Pickups

The four pickups used are so designed and installed that any two arms will work on at least one table, so that all four arms can be used at once. This is valuable for cross fading and continuing the same effect for a long period of time such as a car running, a train-wheel click, etc. In addition, two different cuts of the same record can be played at the same time or quickly cross-faded. Another effect is to play a smaller record of one effect on top of a larger record, in essence, having a fourth turntable. Still another effect is to place two pickup arms in the same groove. By so doing an echo can be obtained, as one arm is one-quarter turn behind the other arm. The type of pickup used is a crystal with a replaceable steel needle.

Amplifiers

Each pickup is equipped with its own preamplifier with a self-contained equalizer. The equalizer can raise or lower the treble end. This is useful for sound effects to be able to change response to suit arising conditions. It is possible with this setup to play voice cuts of records made overseas and

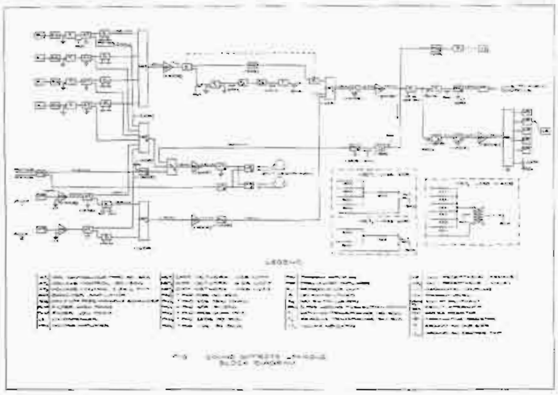

Fig. 33. Sound-effects console block diagram.

make them more understandable than if they are played on so-called Hi-Fi reproducing equipment. These preamplifiers are fed to a mixing network along with two other inputs. The two other inputs can handle a microphone for acoustical or manual effects such as doors, telephones, bells, etc., or one of these other inputs can use an input coil instead of a preamplifier. Then it is possible to use additional high-level inputs such as other turntables, and audio tape cartridge units. The individual controls have a cueing position on the fader so that a cue can be found rapidly even though the console is feeding other effects on the air. This is very useful when last-minute changes have been made or a marked cue has been lost during an air show. As shown in the block diagram, Fig. 33, there is a booster amplifier between the mixing network and the master volume control.

Filters

A sound-effects filter of the low-pass—high-pass type is used for an overall effect. This device has roll-off frequencies of off-100-250-500-1,000-2,000-3,000-4,000-5,000 on the high-pass and off-5,000-4,000-3,000-2,000-1,000-500-250-100 for low pass.

Conclusion

To show how a sound-effects man is actually set up to do a show using this turntable, see Fig. 34. First of all, the output of his console is fed on a line directly to the control-room audio console. He checks levels by using a tone record when he checks in. Usually his fader in the control room is left open, and he is responsible to see that only those sounds that go to the control room are the correct sounds. The line that feeds the control room carries all his effects—recorded, acoustical, or electronic. In order to work this equipment remotely from the studio, the sound-effects man needs first of all to wear earphones so that in one

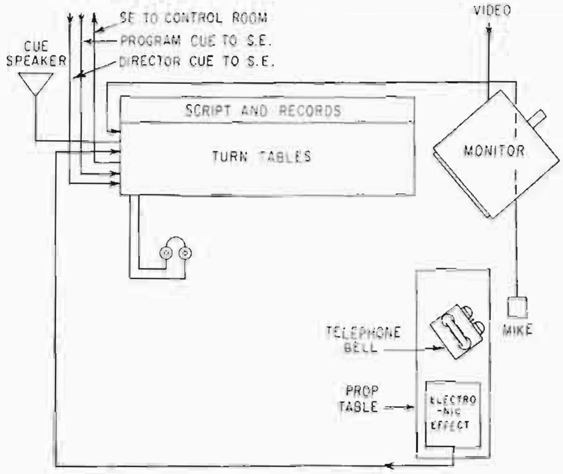

Fig. 34. Simplified circuit showing how a sound-effects console is connected to control room.

ear he hears program cues which includes his own effects. In the other ear he can select either director's cue or boom cue, as he must anticipate every cue. He has to be ready for it when it appears on the screen and synchronize with the visual effect. At this point he could use several heads: one to watch the monitor, one to watch the script so as to prepare the up-coming effects, one to watch the VU meter, one to watch what he is doing at the moment he is making a particular effect. He must ride all his own gain including his own mike and be able physically to fade on and off manual effects. He must make sure the level to his speaker is enough so the actors can hear the effect but not so high as to cause feedback to his own mike.

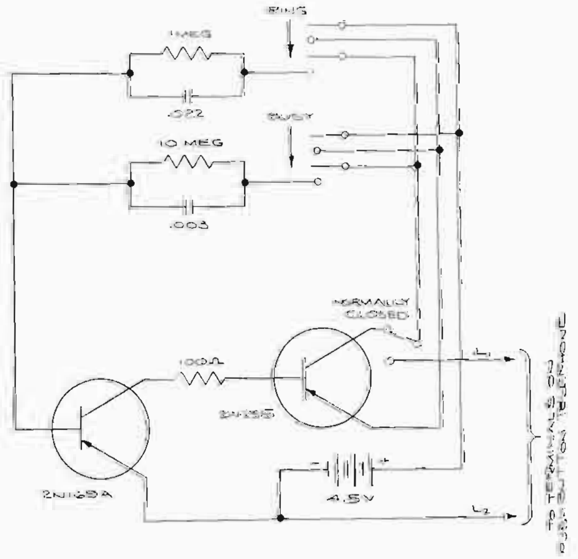

Fig. 35. Internal telephone sound circuit with busy and ringing effect.

The Telephone

Telephones are widely used in TV dramas as well as in radio. In Figs. 35 and 36 we see a sound-effects telephone which has gained wide acceptance in the industry. This design accomplishes the following effects:

Telephone Ringing in the Line or at the Other End. Here there is no bell sound, but it is the sound the caller would hear in his earphone as the second party's telephone is being rung by the telephone company. It is operated by the sound-effects man.

Various Types of Clicks. The clicks are used to indicate connecting parties together or a distant receiver being hung up. This sound would be heard by the caller who would be on camera. It is operated by the sound-effects man.

Busy Signal as Heard by Caller. This is operated by the sound-effects man in any rhythm the director desires.

Additional Telephone Effects. In addition to the telephone device shown, the CBS sound effects department has recently developed additional methods of generating and amplifying the necessary effects for telephone use with transistors. Circuit data are given in Fig. 37 shown when a battery supplies the power for the two-tone generator circuits, key click, and bell-ringer effect (Fig. 38). This is all contained in a modern handset with the handset mounted on the batteries. This particular type of bell set sounds very modern, so it can really be used only with a modern telephone prop. All the above effects are performed on the sound-effects microphone, and it is up to the sound-effects man to achieve the right perspective according to the picture. This is done not only by a change in volume as the picture gets tighter on the telephone ringing but also by bringing the instrument closer to the sound-effect microphone. Other telephone effects are achieved in a variety of ways.

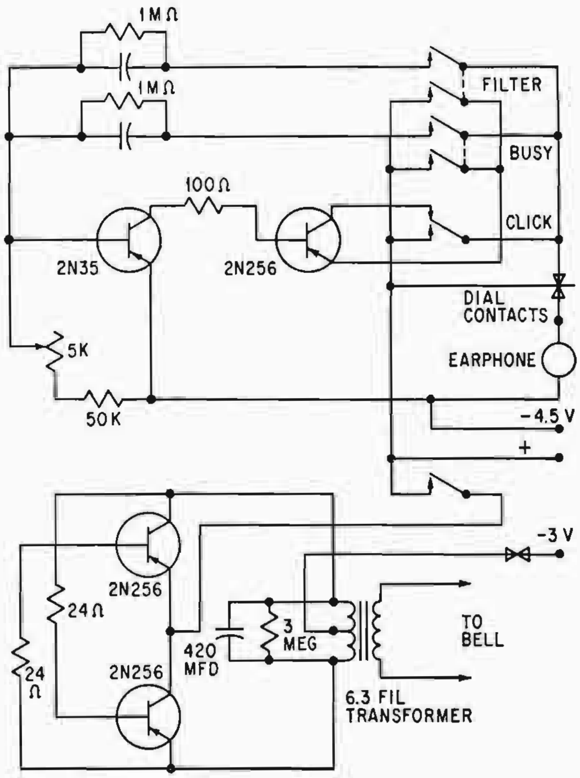

Fig. 37. Circuit of electronic telephone.

Fig. 36. Push button telephone with interval telephone sounds.

Fig. 38. Electronic telephone.

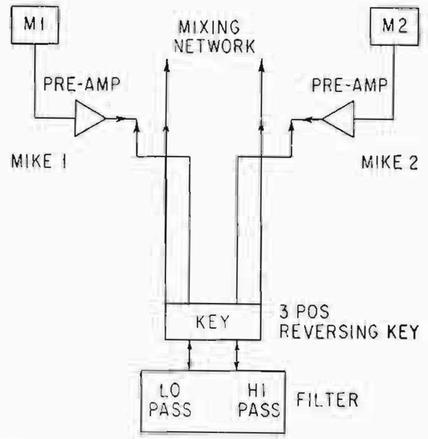

Fig. 39. Circuit showing hookup of two-way telephone filter effect.

Telephone Filter. For instance, a so-called telephone filter uses a normal microphone which is fed through a sound-effects filter. The sound-effects filter is usually a low-pass—high-pass type which in essence then becomes a bandpass filter. This means that the low frequencies and extreme high frequencies that can be heard normally are cut off with the sound-effects filter, so the effect is that a person is talking over a telephone or the voice is "filtered." Quite often in TV as well as radio the actors switch places or reverse their "on" and "off" camera positions, in which case the filter mike has to be reversed also by the audio man. This can be done with one filter unit and a reversing key that requires the output of the two mikes that are being used to be reversed. The reversal takes place at the output of their respective preamplifiers (see Fig. 39). Another possible method is that the filter is switched by the switcher on certain camera takes. This is a video interconnecting system with the audio filter. This would actually be set up for each program as needed. This method helps eliminate errors.

Practical Telephones. Another device that is needed in TV is a "practical" telephone for the actors talking on the telephone—both on and off camera. These telephones are made practical by actually (Fig. 40) connecting the receiver part of the telephone handset to a cable that can connect directly to program cue. So the actors then can hear themselves as well as all the program and the other end of their telephone conversation even though they may be quite a distance apart. Occasionally a switchboard can be used in a show which is not practical except for inserting the telephone plugs. In this case, the sound-effects man would have to supply all the necessary buzzers and bells that the switchboard sound might need. It usually is simpler to add the sound effects than it is to try to make the switchboard practical.

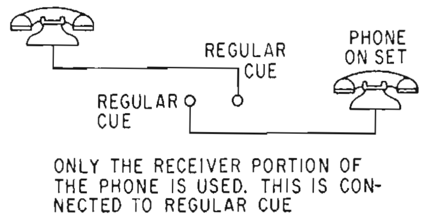

Fig. 40. Circuit showing hookup of practical telephones.

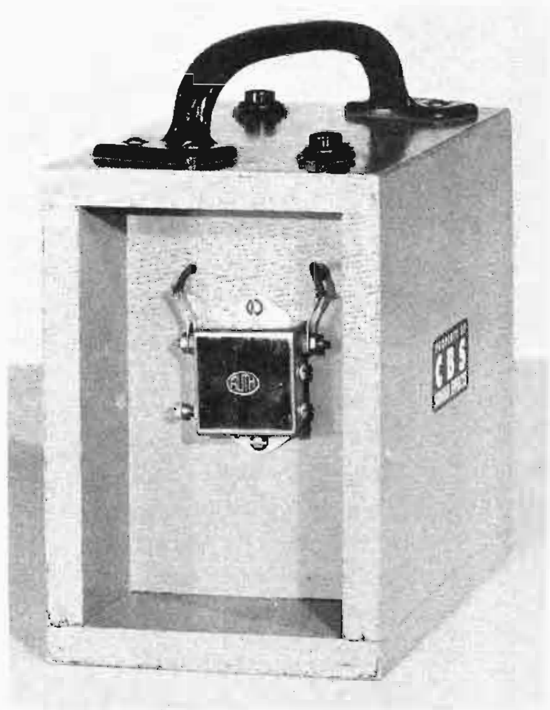

Fig. 41. Doorbell with self-contained batteries.

Bells, Buzzers, Chimes

A device that is widely used in TV is the sound of a doorbell or door buzzer and occasionally a chime. Once a particular bell or chime is selected for a set, this unit has to be always available whenever this particular set needs it. Door buzzers are made up in such a way that a selection of various ones is available (see Figs. 41 and 42). The buzzers and bells are mounted on wooden boxes which also contain the operating batteries. They are shock-mounted on rubber also. Several types of chimes, door chimes especially, are always in demand. Fig. 43 shows one type.

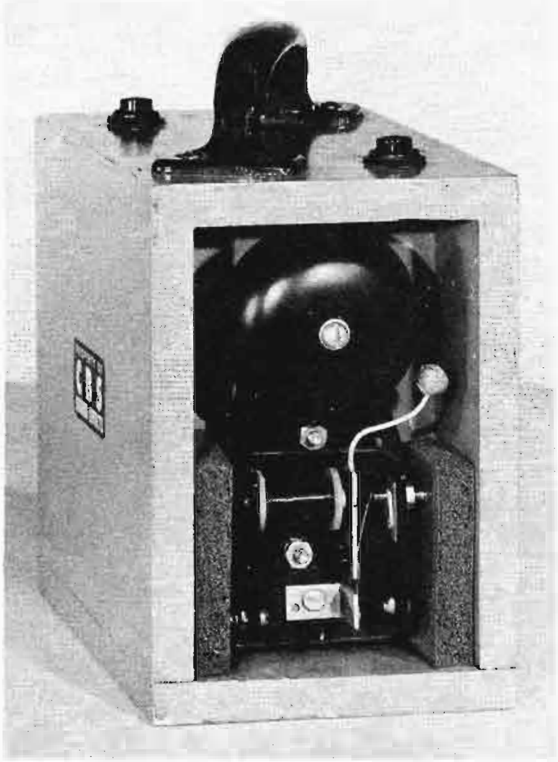

Fig. 42. Door buzzer with self-contained batteries.

Reverberation

Definitions

There are various ways of producing "echo" and reverberation. These two terms are used synonymously, but actually they are different. Echo is a distinct delay that reproduces the original sound once or several times over. Reverberation is a continuation of the original sound with no separation between the original sound and the continuation.

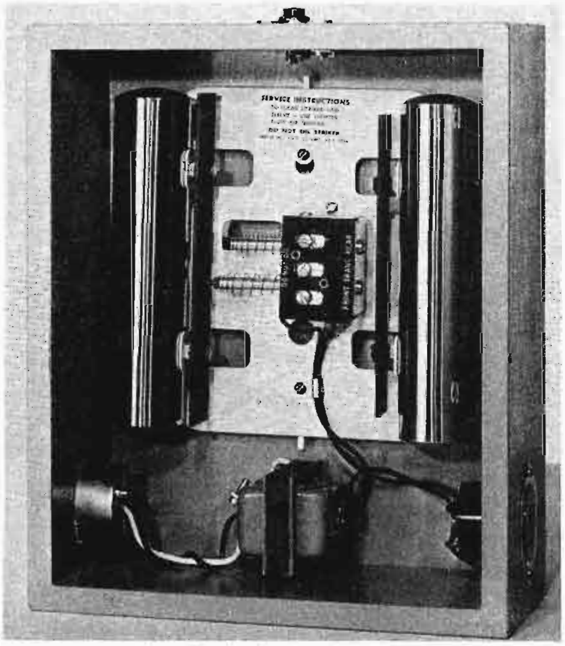

Fig. 43. Dual electric chime.

Reverberation Units

Devices for the creation of artificial reverberation have been developed which replace the traditional acoustic echo chambers used heretofore in television, radio, film, and recording studios. They utilize the physical properties of metals to achieve their effect.

It is known that a steel sheet, excited by an impulse setting up oscillations, will deliver reflections which increase in density with time, and that sound reflections in a three-dimensional room become more dense as a function of the square of the time. It is also known that the human ear is unable to recognize the difference between these two operating modes.

Through the use of appropriate steel and critically chosen dimensions, it is possible to produce a plate which possess an adequate number of self-resonances. The length and frequency response of the decay time produce an artificial reverberation effect, which is not possible to differentiate from that obtained from a three-dimensional room. One such device is the EMT Reverberation Unit (Fig. 44).

Cartridge Tape Machines

Cartridge tape machines are now playing a major role in sound effects mixing and postproduction sweetening.

New cartridge machines that have gained wide industry acceptance are machines using "NAB" cartridges. Another type which is in use is the Mackenzie unit as shown in Fig. 45. These devices permit easy mixing, tightly-cued synchronized effects, such as audience reactions, thunder, gunshots, explosives, etc.

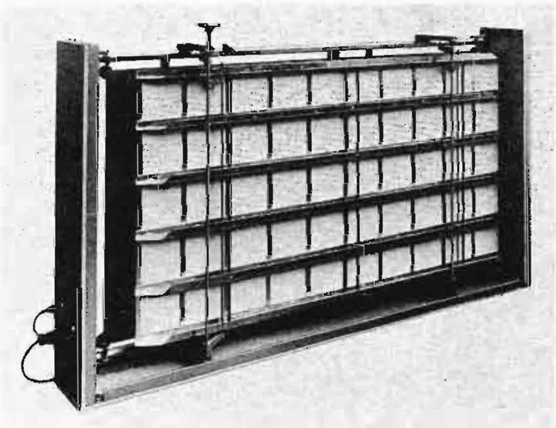

Fig. 44. Reverberation Unit (Courtesy of Gotham Audio Corp.).

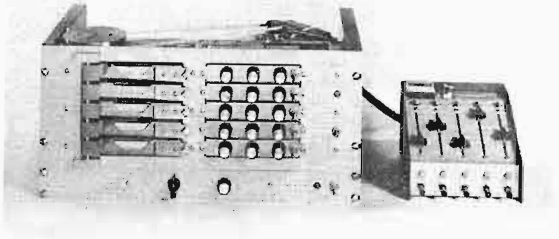

Fig. 45. Mackenzie cartridge unit.

Fig. 46. LP turntable.

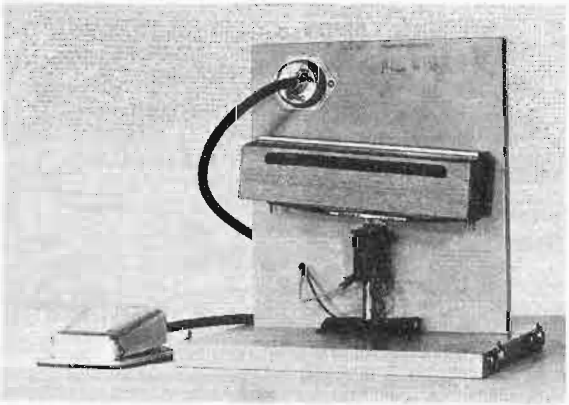

Fig. 47. Electric "bat crack" showing foot pedal.

Other Electronic Effects

With LP records, a more desirable type of turntable was designed to be used by the sound-effects man. Inasmuch as sound-effects men are called on to play various types of music records as well as sound-effects records, especially for backgrounds, cafes, nightclubs, etc., this particular design was a must. This table uses a good four-speed turntable and a properly balanced and weighted arm so that LP and EP's can be played with good quality. For cueing purposes it is equipped with a transistorized amplifier that feeds a small speaker encased in the turntable case. This is shown in Fig. 46.

The "Boing"

One type of electronic "boing" that is widely used is in effect a guitar string that is stretched over a magnetic pickup. The pitch is varied by a handle on one end. Fig. 48 shows this device. Another type that is used is the ordinary Jew's-harp. This takes an artist to play it, however.

The Electronic Bat Crack

During the baseball season a good bat crack for sound effects is a necessity. The electric bat crack

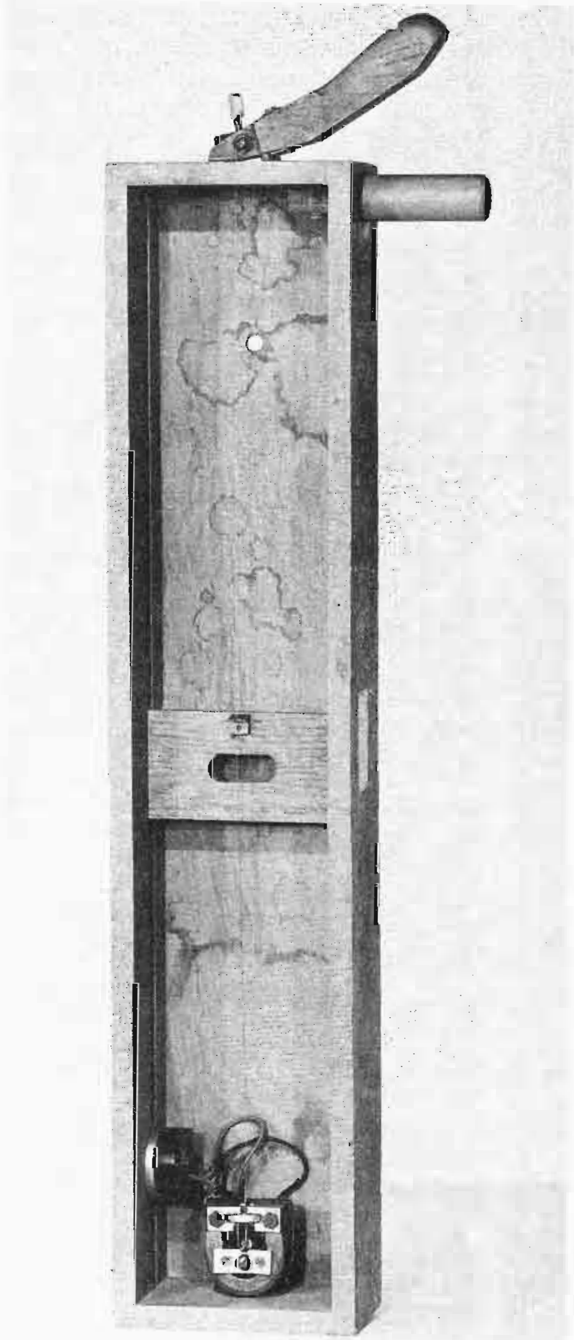

Fig. 48. Sound-effect "boing" showing steel string.

(Fig. 47) is a device using a solenoid and tempo block operated by a foot switch. All the sound man must do is watch the monitor, and by stepping on the switch at the precise moment, he gets an effect of a bat crack. At the same time he hand operates his crowd-reaction records.

Oscillators

Various types of oscillators are used in sound-effects work. Usually there is a demand for tones of all types. So everything from beat-frequency oscillators to single-tone self-operated types are called for. One type that found favor was the neon oscillator, shown in Fig. 49. This particular device was used mainly because it would not change pitch over a program but would remain on pitch. This was important as it blended with organ music.

Manual Sound Effects

The Door

The sound-effects door (Figs. 50 and 51) plays a major role in TV production. Since this is a visual medium, the sound effects might look unnecessary. However, this is not the case. Quite often a door will open and close which will not be "on camera." Consequently the sound should be heard as indicated in the script. Otherwise, the story will not have continuity or meaning. Then quite often a door that is on camera or is visual may not sound like a door, or it may have the wrong latch on it or may be too far away from a mike to pick up the actual sound. In this case, once again the sound-effects door has to "fill in" the vacant sound. Occasionally a simple effect such as a knock on a door may cause a set to move or shake while on camera. Here once again the sound-effects man does the actual knocking, even though the actor may go through the motions.

Fig. 50. Sound-effects door (front) showing door latch, chain, and acoustical chamber for resonance.

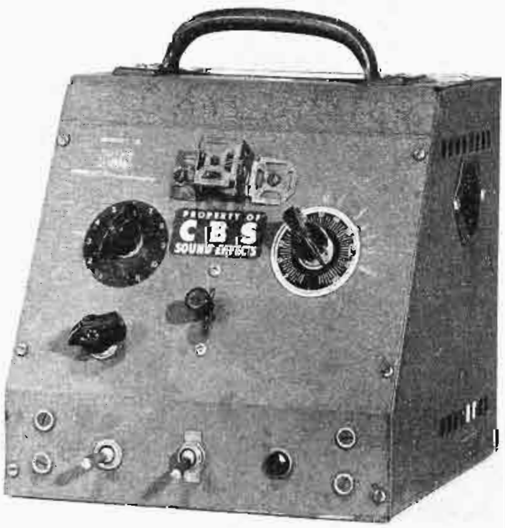

Fig. 49. Neon oscillator for sawtooth tone.

Horses' Hooves

Coconut shells are used as much in TV as in radio depending on the script. Almost any effect which lends realism and can be controlled is actually much better done "live." Rubber plungers can also be used. Actually making a horse effect calls for good rhythm and coordination, and only a few people are gifted this way. When used with dirt or gravel as shown in Fig. 52, dirt should be wet down to avoid dust.

Door Squeak—Wooden

A wood squeak is caused by two dry pieces of wooden material rubbing together. A form of one type is shown in Fig. 53. Actually one end is in a

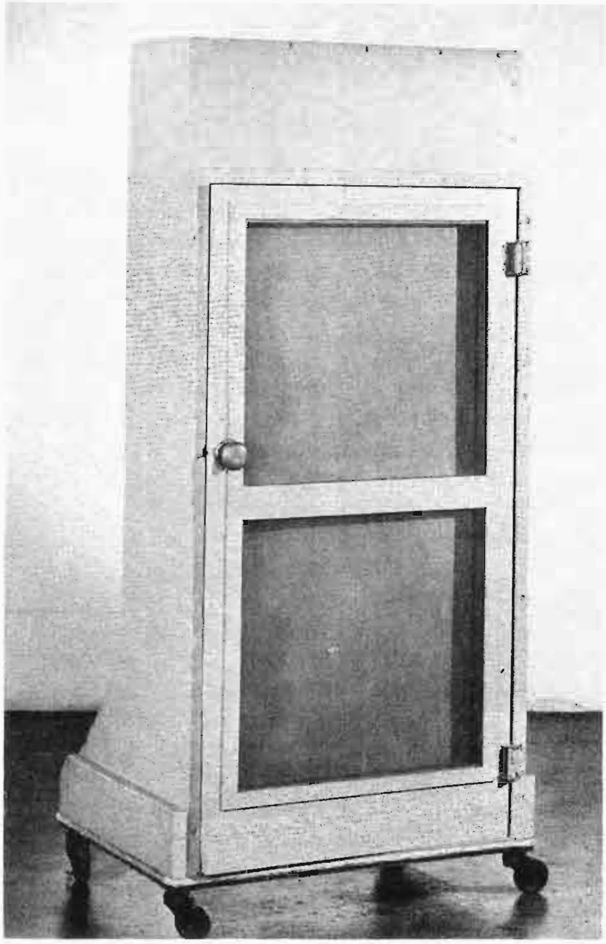

Fig. 51. Sound-effects door (rear) showing screen door.

dowel shape. This is moved in another piece of wood, preferably hardwood, and the squeak is adjusted by tightening down on the dowel. This must be adjusted to get a proper squeak. The whole assembly can then be put on a door with a

Fig. 52. Horses' hooves in dirt box—using coconut shells.

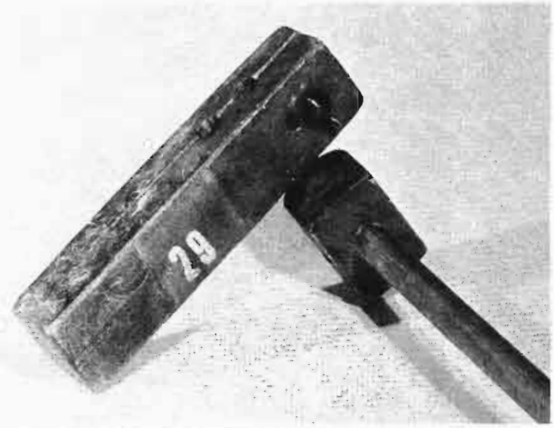

Fig. 53. Wood squeak for sound effects.

temporary C clamp. This squeak can then be operated by a sound-effects man as in Fig. 54. This way the squeak does not have to follow any rigid pattern but can be different each time. One door for *Inner Sanctum* was actually built for just that show. So that no other show would use this door, it was kept locked. When the show moved from one network to another, the door traveled with it.

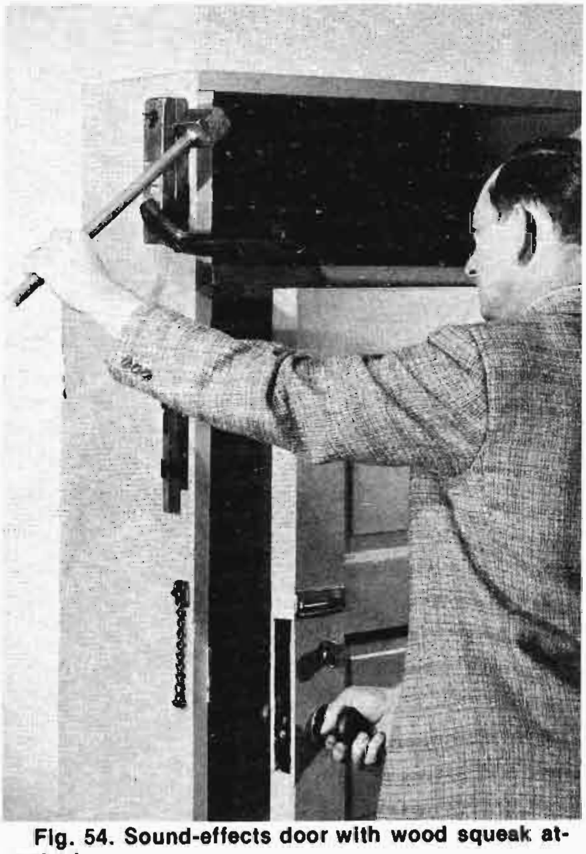

Fig. 54. Sound-effects door with wood squeak attached.

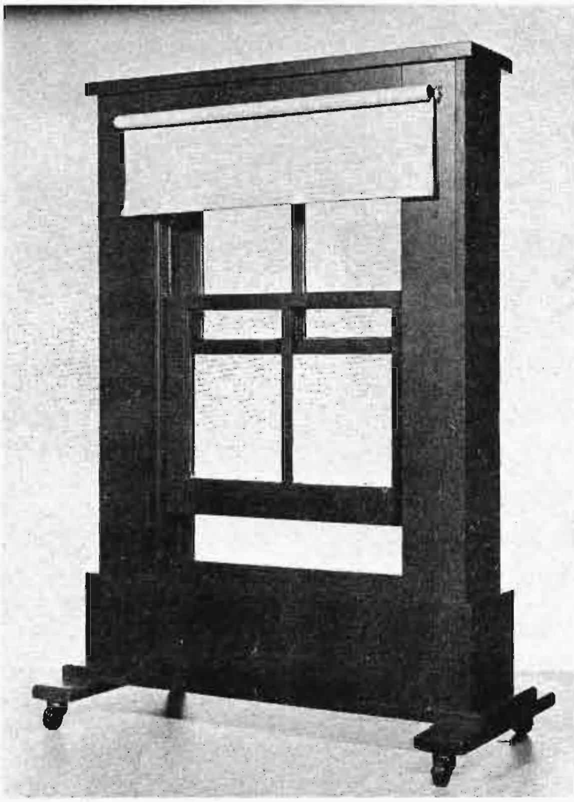

Fig. 55. Sound-effects window showing shade.

Audio and Video Special Effects

The Window

A device which is used quite frequently is the window. This is shown in Fig. 55. One window is hung with regular sash cord while the other uses chains to give a different effect. There is also a place for a window shade, as occasionally such an effect is needed.

Floor Boards

Most studios use concrete floors and tiles. There is also a demand and need for wooden floor boards that are portable. A wooden floor board is used, of course, to emphasize footsteps, especially when there is no dialogue present (see Fig. 56). Quite a few directors insist on footsteps, so all sound men carry an extra pair of shoes for sound effects with hard leather heels. Footsteps are not used so much in TV as radio, however, as it is possible to see movement, and any fast movement such as running can actually be picked up with the actor doing the effect.

In addition to wooden floor boards, sound-effects men are called on to simulate walking on sidewalks. A marble slab about 12 by 24 in. can be used for this as shown in Fig. 57. Movement is expressed by walking in one spot up and down. Sound-effects men are also called on to do footsteps on gravel, sand, snow, metal floors, brush—and you name it. Note in Fig. 58 steps on a gravel bag. The gravel is contained in a double canvas bag so that the sound will come out but not the gravel. This way there is no mess or spilled gravel on the studio floor. However, if the director insists, the bags can be opened easily and the gravel can be spread out on a canvas over a larger area. In a similar manner bags can also contain cornstarch to get an effect of walking on snow, or a small cardboard box of cornstarch well wrapped can give the same effect very close to the sound-effects microphone. The box is squeezed by hand.

Fig. 56. Footsteps on a wooden floor board.

Fig. 57. Footsteps on a stone slab.

Fig. 58. Footsteps on gravel (in bag).

Occasionally an effect of walking in brush or through trees is called for, in which case broom straw is used. This can be done by hand or can actually be walked on if there is sufficient room.

Stairs

Wooden stairs are called for occasionally, and a set is shown in Fig. 59. If these are not available, there is a simulated effect which it can get from a floor board or a slanted board as shown in Fig. 60. Since the board is slanted, it is impossible to walk flat on it, so the foot slides onto it, as in the case of stairs, and the heel sound is not heard—only the sole of the foot.

Prop Table

A very important item that is used on practically every show is a prop table. Prop tables have

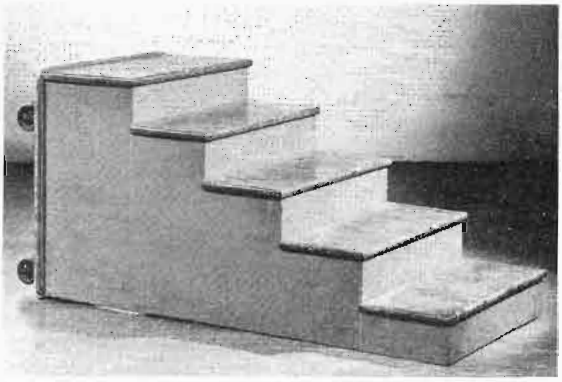

Fig. 59. Sound-effects stairs (portable).

Fig. 60. Footsteps on a slanted board for stairs effects.

been designed in a number of ways. This table has a cork top so that it is quiet and durable. The height is a matter of practical mike placement on one side and the height of the sound man on the other. Besides holding props, this table can be used for such things as a body fall with elbows and arms landing on it.

Glass Crash

This shows a type of manual glass crash that actually breaks a piece of glass. Window glass is supplied in an 8 by 10 size, and when one or two sheets are placed in this frame, it can be broken by pushing down the lid of the machine (see Fig. 61).

Fig. 61. Glass-crush machine.

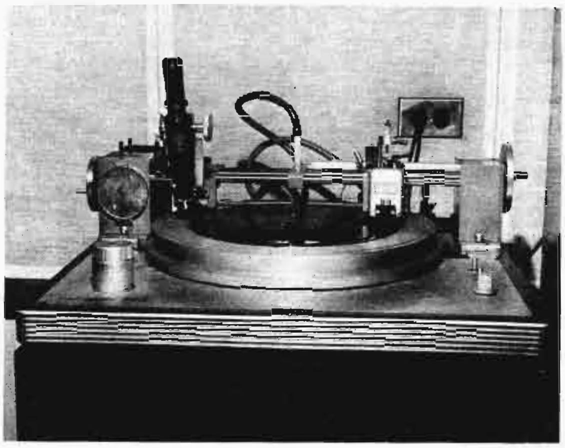

Fig. 63. Cutting lathe.

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With the successful Apollo space flights, the sounds of outer space are with us, and a great deal of work has been done to preserve them for use in future television shows. Miles of tape will be evaluated and new records will be made. However, the sounds of the past, although disappearing from the scene, must also be retained. Rarely do we hear a steam train's mournful whistle, the rattle of a horsedrawn wagon, the clanging of a trolley car, and many more mood-setting sounds. These records have to be stored (Fig. 62) and be readily available for immediate use. Since tape allows a great deal of information to be kept in a small area, entire master libraries have been made up. Everything is catalogued and numbered so that, whenever necessary, a disc can be cut on the lathe (Fig. 63). Use of tape and the lathe makes it possible to blend combinations of records to a desired form. Acetate discs are not as permanent as pressed discs, but if cared for and handled properly, a great amount of use may be obtained.