INTRODUCTION TO ELECTRONIC EDITING

The introduction of the Ampex VIDEOTAPE* Television Recorder in 1956 initiated what has become world-wide acceptance of magnetic tape as a television picture recording medium. The fact that the magnetic tape process alone, produces superb reproduced picture quality and is ready for immediate use upon completion of the recording, made such acceptance inevitable.

However, until the introduction of the Ampex Electronic Editor** there remained the related problems of tape editing and splicing. The critical requirements of frame sync and control track signal continuity required something more than the operator's greatest care and skill together with the most ingenious splicing equipment available.

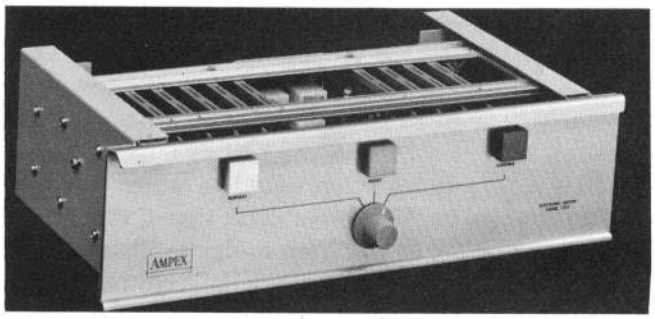


Figure 1. ELECTRONIC EDITOR

The Ampex Electronic Editor eliminates these problems and provides the convenience of a single control by which the master tape is assembled electronically from tape segments (or from other video signal sources) with complete continuity of servo control signals, and without any physical cutting and splicing of the tape. The original tape segments are not disturbed in any way during the process, and may be re-used any number of times.

An Electronic Editor-equipped VIDEOTAPE Television Recorder provides facilities and convenience in the production of television tape recordings that until now have been impossible. For example, the system may be started and stopped at any time for costume or scenery changes, insertion of commercials or new scenes, or for the correction of production errors. All of these acts are accomplished without disturbance of servo control continuity, or an appearance of any interruption during subsequent reproduction.

The Electronic Editor modifies and controls the switching logic of the VIDEOTAPE Television Recorder. Its design (employing all-solid-state electronics mounted on plug-in type etched boards) eliminates servo disturbances that arise from the "cut and splice" process, and coordinates its actions with those of Inter-Sync** to maintain the correct phase relationship between the master tape signals and the incoming new video signal. In addition it automatically allows for the distance (refer to Fig. 2) between the planes of the erase head gap, and the video record heads, by precisely synchronizing the successive applications of erase current and the video record signal, to cause the first new frame of an insertion to precisely follow its immediate predecessor on the master tape, thus maintaining complete continuity.

The degree of switching precision offered by the Electronic Editor in the performance of the complete editing function becomes manifest when it is realized

*VIDEOTAPE is the brand name of the Television Recorders made by the Ampex Corporation.
**T.M. AMPEX Corporation

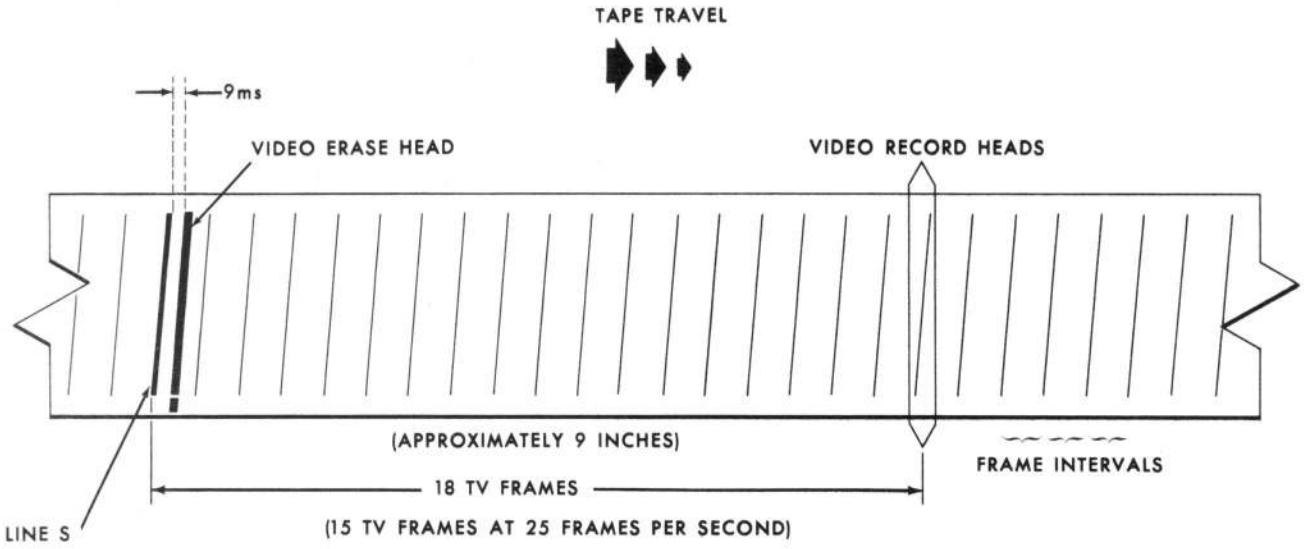


Figure 2. METHOD OF MEASURING HEAD SEPARATION

that for the first time in the history of tape or film editing, the "splice" is made while the recording medium is in motion at normal speed.

The quality of the electronic splice produced by the Electronic Editor may be observed in Figure 3 which is an unretouched oscillogram of the video, blanking, and synchronizing information in the video waveform of such a splice. Subjectively, the finished splice appears the same as a change of picture content caused by camera switching.

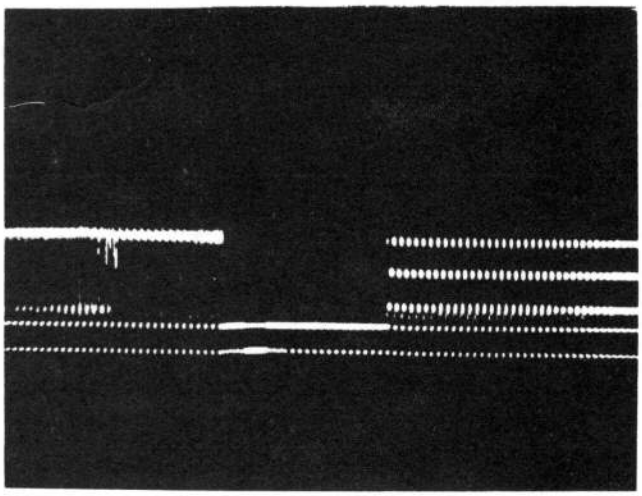


Figure 3. ELECTRONIC SPLICE WAVEFORM

The validity of the design philosophy is proved by the end product (the master tape) in which a change of picture content is accomplished with split-second accuracy, without overlap or loss of video and audio signal information, and without the requirement of any special skill on the part of the operator.

Maintenance of the correct phase relationship between the master tape signals and the incoming video signal that is to be added or inserted is achieved by the use of Inter-Sync to frame-lock the recorder system to the reference that governs the new signal.

To avoid transients that would be caused by abrupt phase changes in the capstan drive signal, the latter is originated by the 60 cps Wien bridge oscillator during both the PLAY and the RECORD editing modes. While recording an insertion, the reproduction of the undisturbed original control track signal continues and retains normal control of the oscillator.

The distance between the planes of the erase head gap and the video heads may be considered equivalent to the time required for the tape to travel from one to the other at the nominal 15 inches-per-second tape speed. This is the time for slightly less than 18 frames of the picture. Figure 1 shows this physical relationship,

*Trade Mark, AMPEX Corporation

and that exactly 18 frames defines a "line S" that is important to this discussion.

Line S marks the location of the electronic "splice," which is within the guard band immediately following the recorded video track that includes the vertical synchronizing pulses (refer to Fig. 4).

initiation of a random cue signal for the insertion. Figure 5 illustrates the conditions existing at the instant of triggering.

At 15-inches-per-second tape speed, line S will move into the plane of the erase head in approximately 9 milliseconds. In order to cause erasure to begin at that

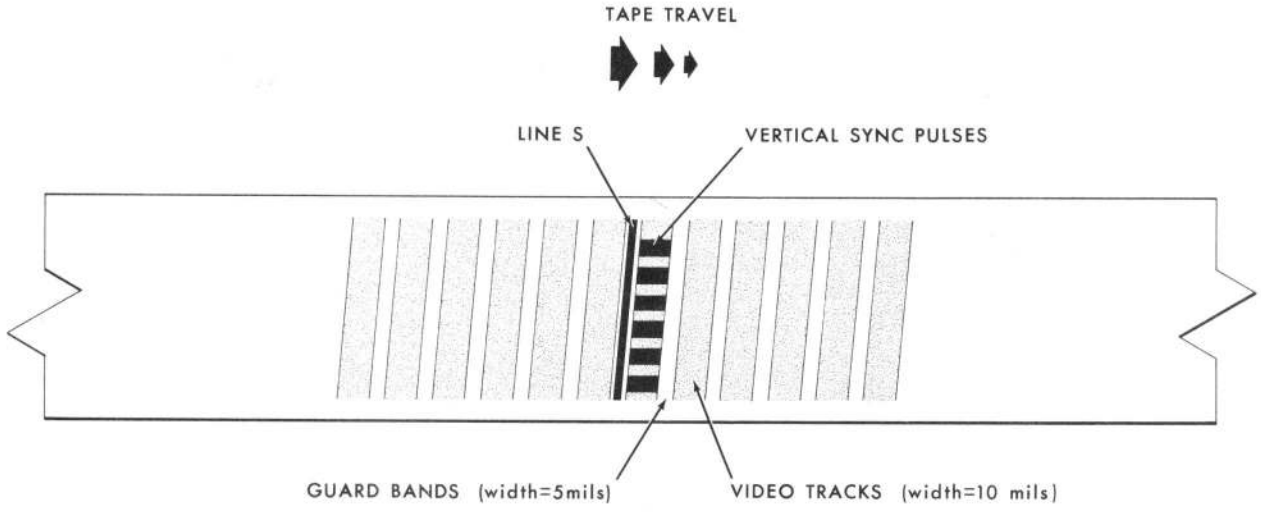


Figure 4. DETAIL OF "SPLICING" POINT

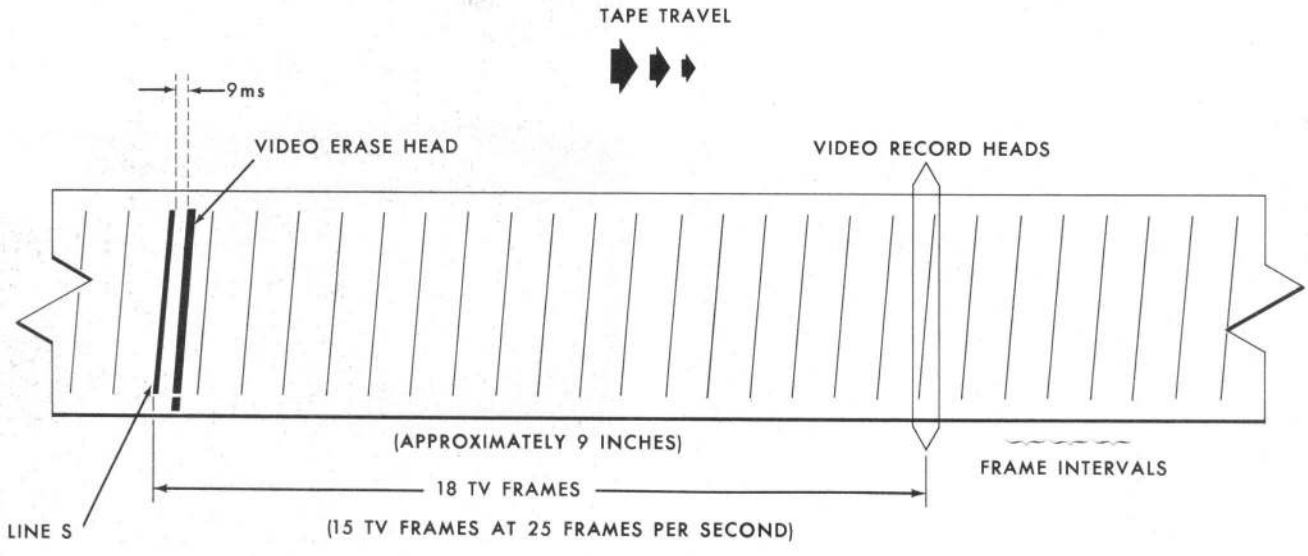


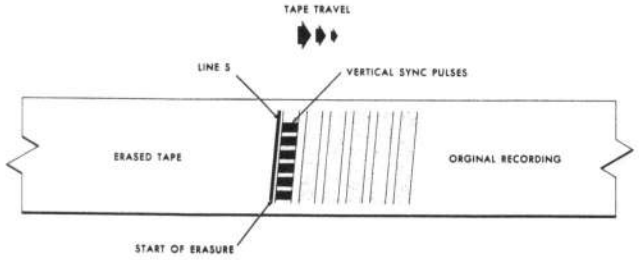
Figure 5. INITIAL POSITION OF "SPLICING" POINT

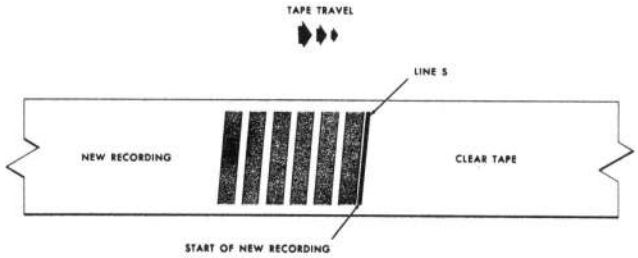
The Electronic Editor establishes the position of line S by means of a vertical gating circuit that is triggered by the first frame pulse that follows the

instant, the pulse from the vertical gate triggers a 9 milliseconds delay multivibrator whose delayed output actuates an electronic switch that routes erase current

to the erase head. The turn-ON time of the switch is 30 microseconds. Thus erasure begins precisely within the guard band (line S). (Refer to Figure 6.)

Necessarily the video record heads must not be energized until exactly 18 frames have passed their plane. This delay (approximately 600 milliseconds) is established by a binary counter system that actuates the record current gate at the end of the period. Video record curent is applied to the video record heads within 2 microseconds thereafter, which causes the insertion





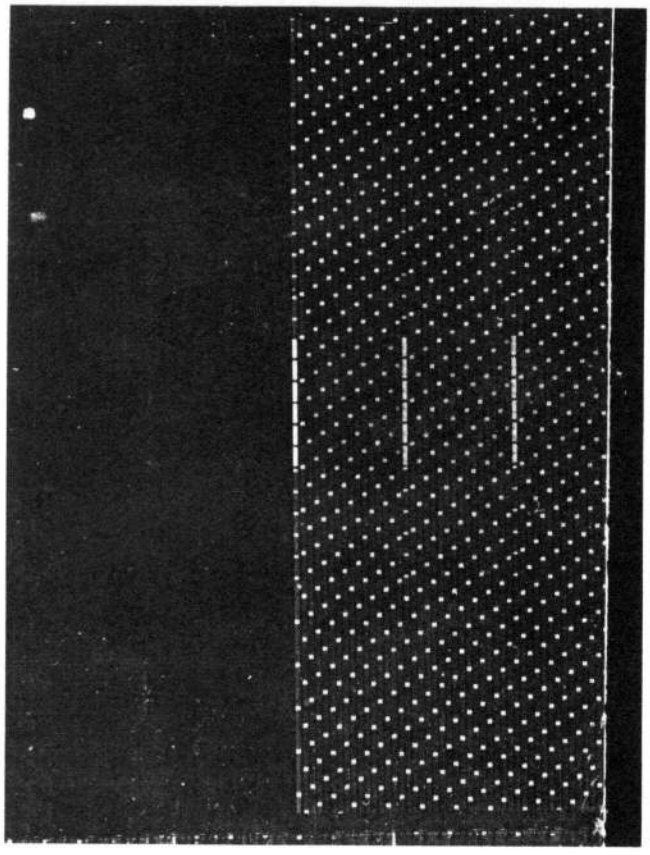


Figure 6. START OF VIDEO ERASURE

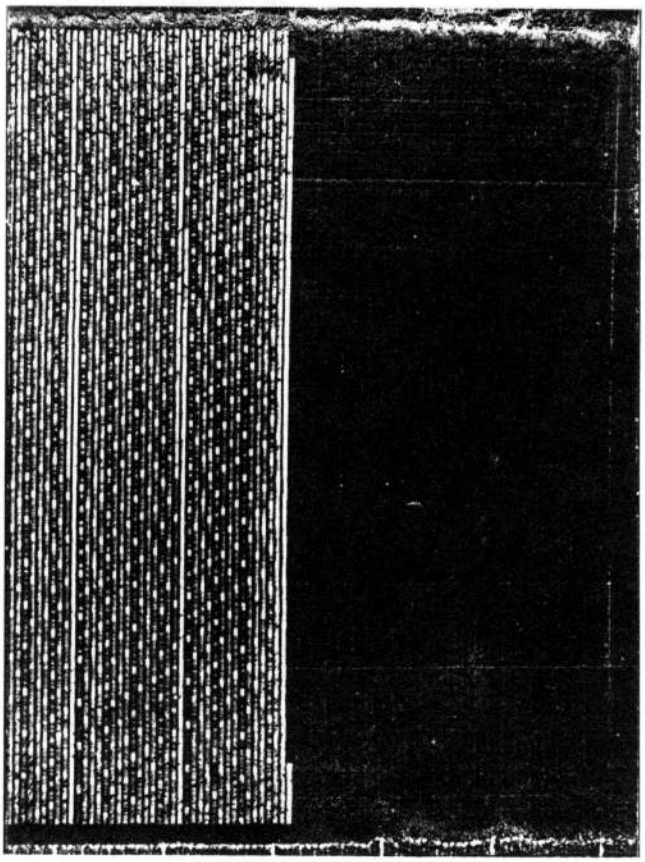


Figure 7. START OF VIDEO RECORDING

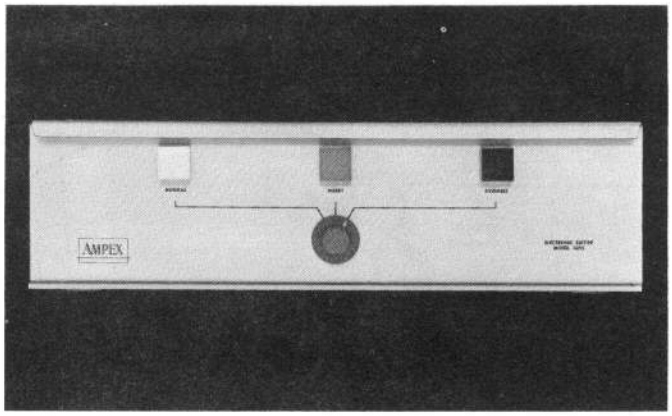


Figure 8. ELECTRONIC EDITOR PANEL

to start at the beginning of the video track immediately following line S (refer to Fig. 7).

The delay is measured with an accuracy of 0.05 percent. Figure 9 includes an enlargement of the magnetic pattern recorded on an actual tape in the area that includes a typical electronic splice. It will be noted that all of the video preceding the insertion is preserved, and that all of the original control track information remains undisturbed.

Modes of Operation

The single control of the Electronic Editor is a 3-position mode selector switch. During editing periods it is turned to the INSERT, or the ASSEMBLE settings, depending upon whether new subject matter is to be inserted in an existing master tape, or new subject matter is to be added at the end of an existing recording. During non-editing periods it is turned to the NORMAL setting.

The INSERT setting permits correction of production errors, or the insertion of additional or changed subject matter at selected points in the master tape. For example, it may be desired to change a commercial, or to insert one or more at chosen locations in the program. Again, it may be desired to change one or more scenes.

The ASSEMBLE setting permits the assembling of selected tape segments together with new video subject matter into a completely edited new master tape. Thus a fully edited master tape may be produced, if desired, by the use of but one camera and one VIDEOTAPE Television Recorder.

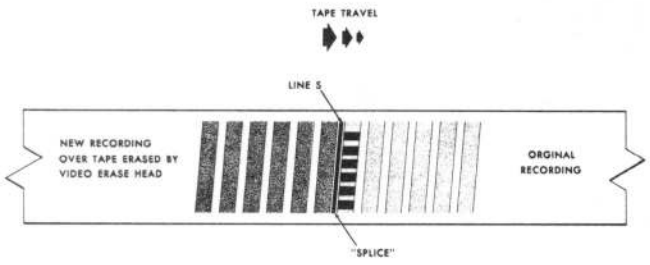
During either operating mode, the time-controlled sequential switching of erase current and video (described above), is initiated by actuation of the system RECORD pushbutton, which results in the "in-going" electronic splice. (Refer to Figure 9.)

When an insertion is made, it must be terminated at a particular time, which requires a second, or "out-going" splice. The Electronic Editor switches OFF the incoming video information and the erase current on an automatically controlled time schedule that is the opposite of the "in-going" splice time schedule. The insertion is terminated by actuation of the STOP pushbutton.

There was earlier mention of the fact that successful electronic editing requires continuity of the servo control signals. The master tape in which an insertion is to be made includes a continuous recorded control track. To leave this servo information undisturbed, the Electronic Editor system includes a special erase head (replacing the original full-width erase head), which permits erasure of the video tracks but does not erase the control track. It also provides erasure of both tracks during NORMAL, and ASSEMBLE modes, each of which require the recording of a new control track signal.

NOTE

The special erase head is illustrated in Figure 10. It will be noted that the cue channel and the audio track areas on the tape are not erased by this head. Erasure of these channels is accomplished by separate erase heads. The Editor controls the application of erase current to the audio erase head simultaneously with its control of the special erase head. The cue erase head control is on the Right Control Panel.



ELECTRONIC "SPLICE" CONFIGURATION

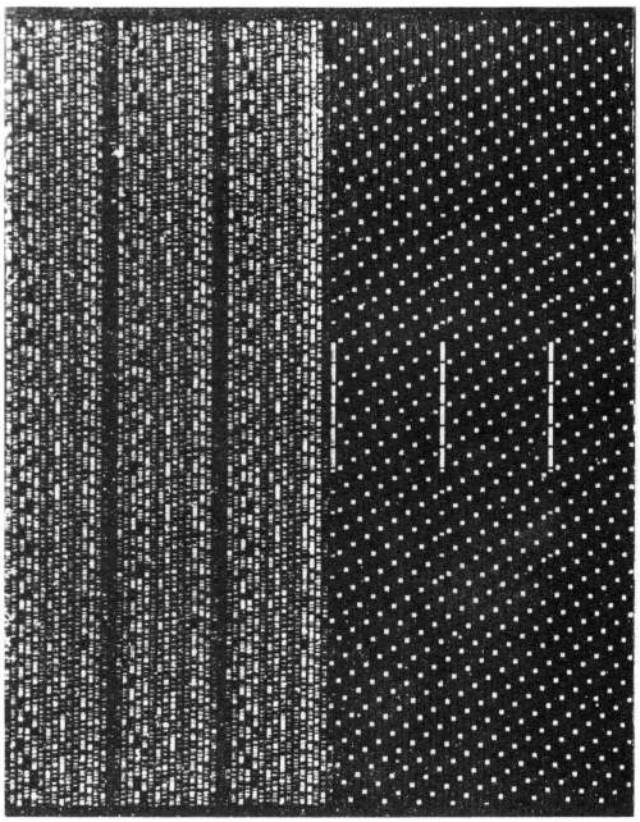


Figure 9. ELECTRONIC "SPLICE" CONFIGURATION

The gap of the special erase head is 5 mils in width, optically straight, and inclined 33 minutes of the arc from the perpendicular. This places it exactly parallel with the recorded video tracks.

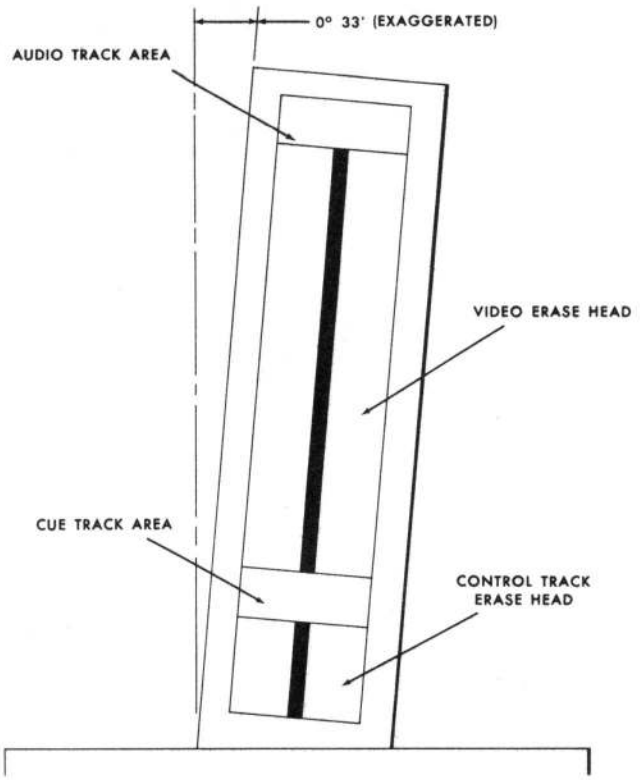


Figure 10. DETAIL OF ERASE HEAD ASSEMBLY

SPECIFICATIONS

Performance

NORMAL Mode: Standard System Performance Specifications are not altered in any way.

INSERT Mode:

1. The transition (or splice) between original video information and new video information shall occur in the guard band immediately following the video track that contains the vertical sync interval coinciding with the initiation of a new frame.
2. The transition (or splice) between new video information and original video information which follows, shall occur as described in 1.
3. The inserted video information shall conform with standard system performances specifications.
4. Upon visual development, the splice shall be found to have taken place as described in 1.
5. The transition from original audio to new audio (coincident with new video) shall occur

approximately 0.5 second before video record current is turned ON.

6. The transition from new audio to original audio shall occur approximately 0.5 second after video record current is turned OFF.

ASSEMBLE Mode:

1. The transition (or splice) between original video information and new video information shall occur in the guard band immediately following the video track that contains the vertical sync interval coinciding with the initiation of a new frame.
2. The added video information shall conform with standard system performance specifications.
3. Upon visual development, the splice shall be found to have taken place as described in 1.
4. The original recorded control track (if any) is replaced by a new control track whose phase discontinuity at the splice point is well below the magnitude that would cause disturbance of the tracking servos.

Power Requirements

The power requirements of the Electronic Editor that are furnished by the Inter-Sync Power Unit are as follows:

+10 volts at 150 ma, maximum ripple content 10 millivolts

−10 volts at 230 ma, maximum ripple content 10 millivolts

In addition the system 24 volt Relay Power Supply furnishes 24 volts relay power at a maximum of 150 ma.

SWITCHING LOGIC

The basic electronic units that make up the Electronic Editor are in each case well-known classic circuits, and include delay multivibrators, flip-flops, AND gates, binary counters, and pulse formers. Their application to the design is shown on accompanying block diagram (Figures 11 and 12) to which the reader should refer occasionally during the brief discussion of switching logic that follows.

Upon the initiation of RECORD mode, a one-shot multivibrator provides a 60 milliseconds time delay that allows the record relays to operate before flip-flop #1 is triggered (or set). When the latter has occurred, AND gates #1 and #2 are placed in the "ready" state.

A pulse that marks the trailing edge of the third vertical sync pulse of each frame interval (received from the Inter-Sync unit) is shaped by a pulse former, and applied to the second input of AND gate #1. (It is also applied to the second input of AND gate #3, which is not placed in the "ready" state until the insertion is terminated.)

AND gate #1 passes the first (and each successive) frame pulse to adjustable one-shot delay multivibrators #1 and #2, which are triggered by it. The trailing edge of the pulse produced by multivibrator #1 is delayed 9 milliseconds (with respect to the frame pulse), and applied to erase flip-flop #2, which then turns ON the electronic video erase switch.

When the insertion is terminated by actuation of the STOP pushbutton, flip-flop #5 is set, causing AND gate #3 to open and pass the next frame pulse that occurs to adjustable one-shot delay multivibrator #3. The 9 milliseconds delayed output of the latter is applied to flip-flop #2 whose state is reversed by it, causing the electronic video erase switch to be turned OFF.

NOTE

The output of flip-flop #5 is also routed to one input of AND gate #4, which is discussed later.

Examination of the block diagram will show that the frame pulses that pass through AND gates #1 and #3 respectively, are applied to adjustable one-shot delay multivibrator #2. The trailing edge of the output of multivibrator #2 is delayed 525 microseconds. These delayed pulses are routed through a series of 6 binary counters, which count-off exactly 18 frames.

Following the initiation of an insertion the output of binary #6 is applied to the second input of AND gate #2, opening it and thus passing a trigger pulse to R.F. flip-flop #3. The latter then turns ON the rf switch which applies the video record signal to the video heads.

At the termination of the insertion the first output of binary #6 is applied to AND gate #4 triggering rf flip-flop #3, which turns OFF the rf switch.

The second output of binary #6 is applied to flip-flop #4 setting it exactly 18 frames after the video record current is turned OFF. This action causes the audio signal track to continue to be cleared up to the moment that the audio record signals are turned OFF.

The output of flip-flop #4 is also routed through a nominal 2 seconds delay to the STOP relay. This delayed STOP action allows the system audio functions to revert to normal before the system stops, and eliminates the appearance of unwanted transients on the audio track.