Techniques in Editing and Splicing Video-Tape Recordings

Editorial Note: Shortly after the Ampex VR-1000 Videotape Recorder was made commercially available, it became apparent that, because of special problems, development of a satisfactory method for editing and splicing video tape was of immediate importance. The two following papers (each slightly condensed) describe the steps leading to the development of the Ampex splicing method. The first paper, presented at the 1957 Spring Convention in Washington, D.C., outlines early experiments and problems encountered. The second paper discusses in detail the method finally adopted.

Factors Affecting the Splicing of Video Tape

By KURT R. MACHEIN

Video tape can be spliced, but techniques applicable to photographic film or recorded audio tape are not suitable for video tape. Splicing and editing of video tape are possible and practical but are a special process quite unlike the splicing of photographic film or audio tape.

Audio-tape recording consists of one longitudinal recording and the only conditions which must be observed in splicing are tape speed and head alignment, but the factors involved in splicing video tape are much more complex and the requirements much more stringent. Video-tape recording consists of three different recordings: (1) transverse picture information; (2) longitudinal audio recording; (3) longitudinal control track. The spatial relationship existing among the three recordings is of great importance and must remain constant within certain tolerances if the recorded program is to be properly reproduced.

In cutting and splicing video tape, certain conditions are necessary: (1) At the transition of the splice, the head which starts to play back the first track after the splice must find this track sufficiently well positioned in the lateral direction to allow the machine to recognize the vertical interval without confusion. (2) The spatial relationship between the control track on the first tape and that on the tape to which splicing is to be done must be such that the capstan servo amplifier is not subjected to sudden phase shifts which might throw the servo out of control. (3) The tracking error generated at the moment the splice passes the video head must be small enough so that the new tape tracks smoothly and excessive noise will not appear in the picture.

Figure 1 is an enlargement of the upper 0.7 in. of a video tape showing the composite signal. The unrecorded audio track, erased by the audio erase head, appears as a wide longitudinal stripe along the upper edge. Vertical synchronization pulses appear at intervals of 16 video tracks. In splicing, the cut must be made inside a 5-mil space next to a vertical synchronization pulse.

If, at the moment a splice passes the rotating head during reproduction, a tracking error of not more than 20% is to be permitted, the accuracy of splicing must be ±2 mils, since one track is 10 mils wide. Tracking is accomplished, during reproduction, by observation of the phase of the 240-cycle control-track signal. Plus or minus 2 mils corresponds to a peak-to-peak error of 23° for the 240-cycle signal. In other words, each tape splice must display a phasing error not exceeding 11.5° on the control track.

An examination of the problem indicated that the most suitable point at which to cut the tape would be the transverse track which carries the vertical blanking interval. This occurs on the tape at $\frac{1}{4}$-in. intervals and is slightly longer than one scan of a transverse track. The recording is not normally visible on the tape so it was necessary to devise a method by which the required track can be identified.

One approach investigated for this purpose involved the electromagnetic detection of a prerecorded editing pulse by means of a reproducing head whose output was dependent only on amplitude of magnetic flux, and independent of the rate of change of flux. An editing pulse

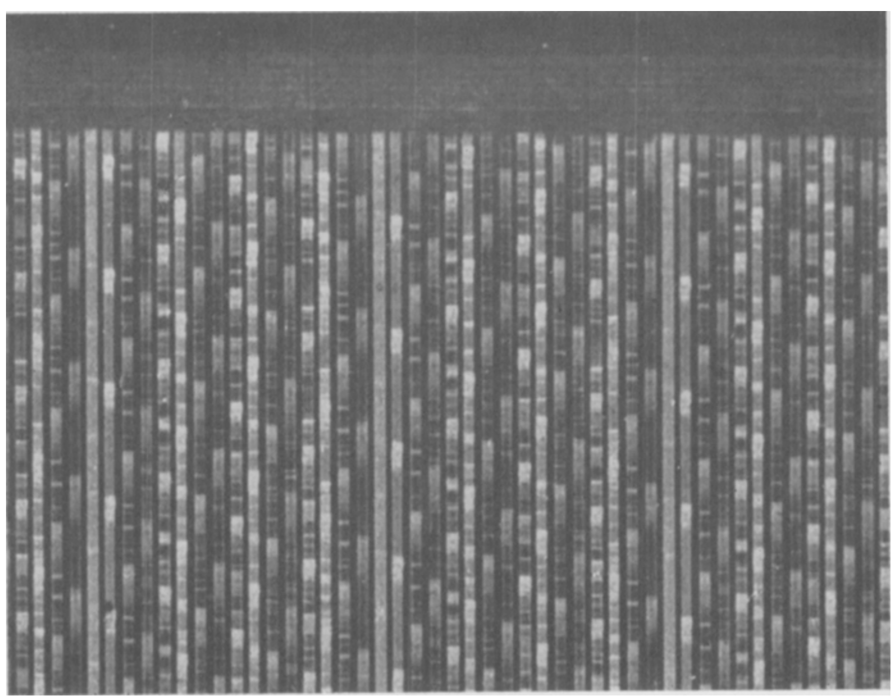

Fig. 1. Upper 0.7 in. of a "developed" video tape. The recording contains the entire composite video signal.

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(Revised paper received on September 29, 1958.)

derived from the incoming video signal and recorded on the control track, and thus bearing an exact and clearly defined relation to the picture information on the transverse video tracks, could then be detected, independently of tape motion, by the flux sensitive head mounted on an editing device. For very accurate indication of the edit pulse position, the rise time and duration of the pulse must be short, and it was in this connection that the flux-sensitive head approach lost its appeal. The magnetic field of the short pulses was not large in comparison with the earth's magnetic field, and consequently the use of flux-sensitive heads would have required a very careful adjusting process in order to achieve a null with respect to the noise source. Magnetic fields generated by the recorder would also have to be taken into consideration.

Other experiments were conducted to determine which of several methods would be the most satisfactory in developing the magnetic tracks into contrasting, easily visible images.

In working out the method which was later adopted, experiments were conducted using various liquids containing carbonyl iron in suspension. These were the requirements: (1) the liquids used must in no way affect the Mylar backing or the oxide binder on the tape; (2) the liquids must be of a volatile nature; and (3) after splicing, the image produced must be easy to remove, wet or dry, by a simple "wipe" process.

With this method, when the tape is immersed in the liquid, iron particles precipitate on the tape in a selective manner, the density of the deposit being approximately proportional to the magnetization of the tape at this point. After the tape dries, an optical image, which shows the signal path and the impressed variations on it, becomes visible.

Figure 2 is a photomicrograph of the lower 0.7 in. of a video tape showing carbonyl iron particles tracing magnetic patterns. This pattern displays only synchronization pulses in the absence of video information. The recorded 240-cycle control track is seen at the lower edge and horizontal synchronization pulses are seen as small square markings along the video tracks. Three vertical bars define two complete fields, or one complete frame of picture.

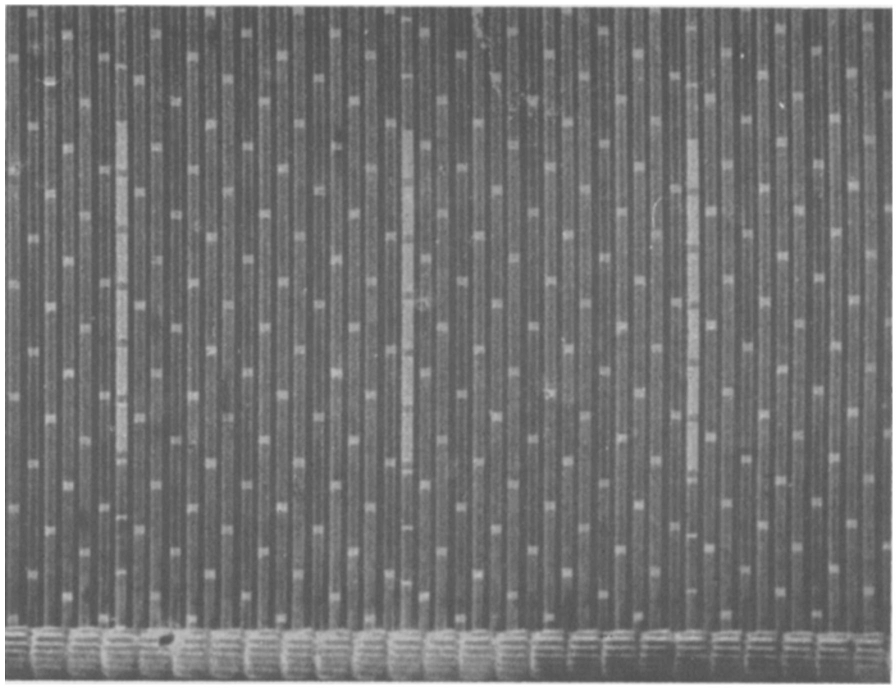

Fig. 2. Photomicrograph of a "developed" video tape. Carbonyl iron particles trace the magnetic pattern. The image was developed and completely dried in less than 3 sec.

With an optical device of approximately 10 powers, the vertical blanking interval can be distinguished from the horizontal pulses and the rest of the video information. The vertical blanking interval appears on the tape as a solid track, starting in the lower third of a single transverse track and lasting for approximately the length of one track. Since the position-servo of the recorder keeps the beginning of the blanking period within very close tolerances to plus-or-minus one horizontal line, a cut between the two tracks carrying the vertical interval can be made if accuracy of ± 1 mil is maintained. The second tape, which is spliced to the first, is cut in a similar manner.

Further experiments have demonstrated the soundness of this approach. In the laboratory, a number of splices were produced in this manner, using conventional thin, high-strength splicing tape. The splices passed the video head without disturbing the picture on the screen. The slight increase of the thickness and stiffness acts as a small additional load on the head drum, momentarily slowing down the speed. This speed variation is quickly corrected by the servo amplifier after the splice has passed. There is a slight tendency for the picture to rock a little horizontally for a half second or less.

Other splicing methods under consideration at various times included the use of a ferric compound solution which would be swabbed on the tape and a reagent added which would allow a selective plating process to occur. The precipitated ferric particles thus released would trace out the magnetic impressions. Another method involved the use of a dye with a high ionic affinity which would leave a deposit in proportion to the tape signal amplitude.

The goal during all this experimentation was to achieve a simple, accurate, practical splicing method which would meet industry requirements arising with the expanding use of video-tape recording.