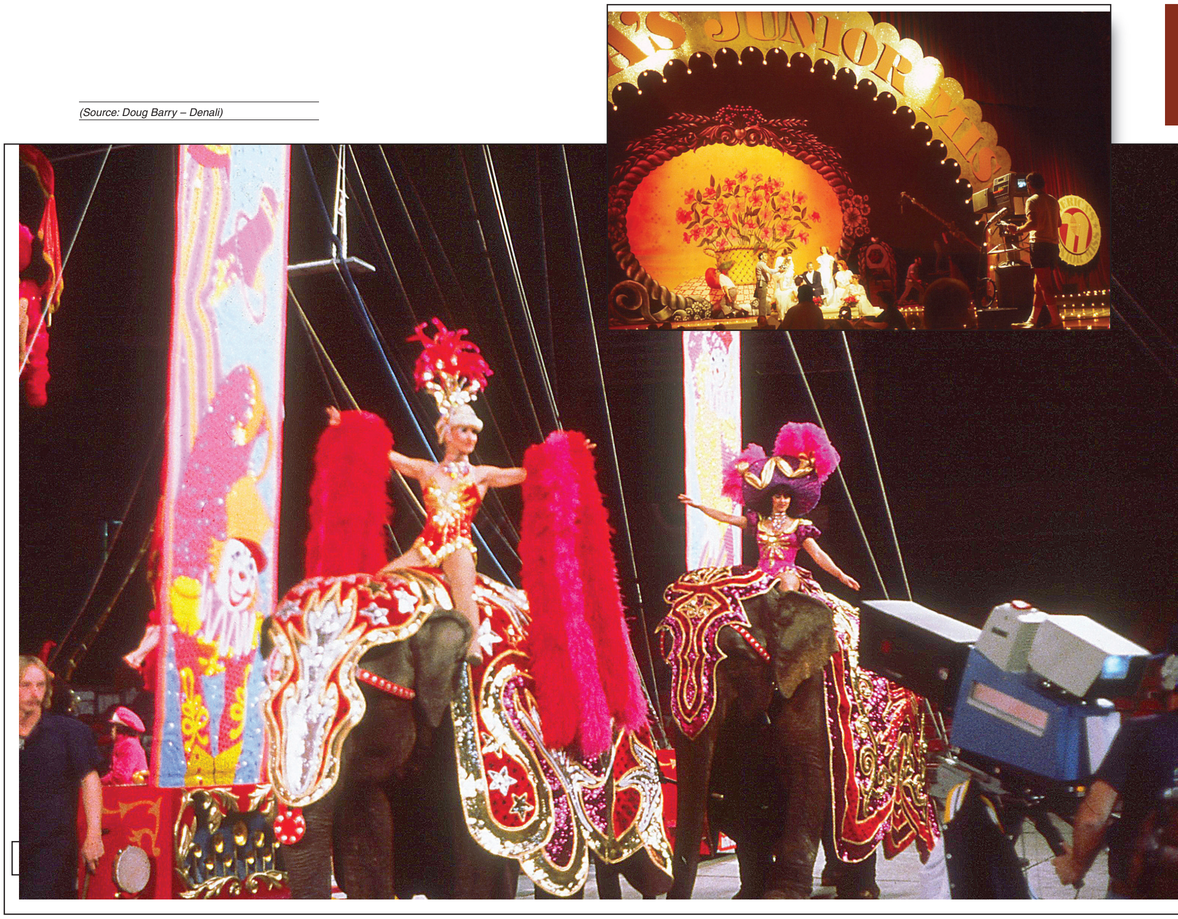
(Source: Doug Barry – Denali)



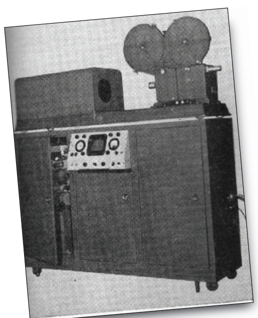


Figure 5.1 Here is a photograph of a kinescope. This device was the only way to record television before the invention of the videotape recorder (VTR). The box on the top left of the device contained a high- power, and for its time high quality, cathode ray tube (CRT) or kinescope. The film camera, top right, filmed the image displayed on the CRT and recorded the associated audio on a magnetic sound track on the film. The networks were able to develop the film fast enough so that a kinescope recording, or "kiney" as they were known, could be played back three hours after the "east coast" feed was recorded, as the "west coast" feed out of Los Angeles. These systems actually found their way onto at least an NBC and Westinghouse truck in the early 1950s.

The First VTRs

When television first began, there was no way to record it. Live was live. Eventually someone realized a recording for historical reference would be nice, and they pointed a film camera at a monitor, creating a kinescope. Videotape recorders, developed by a company owned in part by Bing Crosby, were not far behind. They were huge and not very reliable, but they did the job. Today, computer hard drives provide the firepower for what has become known as storage.

BT (Before Tape)

Engineering Video Recording

In 1952 serious attempts were made at recording video onto magnetic tape. The main problem video has over audio when recording is not only the much higher frequencies involved, but also the span or bandwidth of frequencies involved. Whereas audio spanned 10 octaves, video spanned almost 20. It was difficult to develop magnetic record/playback heads that could work well across that range of frequencies. The high frequencies also required very high magnetic head-to-tape speeds, pushing 40 meters/sec. Early on, the BBC with their Vision Electronic Recording Apparatus (VERA), and Bing Crosby Enterprises each tried to cross these hurdles by designing recorders that moved tape by conventional linear record heads at extremely high speeds (100 inches/sec, 16 minutes per reel). In 1953 RCA developed an even faster consumer of tape, 360 inches/sec (with 4 minutes per reel). Ampex took a radically different approach, one that still is the fundamental method for video recording on tape. Instead of laying the information along the length of the tape, like an audio recorder, they would lay it across the tape in a continual series of strips.

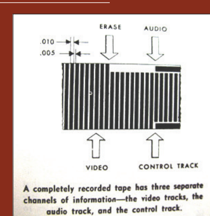


Figure 5.2 To get tape speed down to reasonable speeds, they decided not to record video as a linear strip down the tape, but as a series of strips across the width of the tape, using a rotating head. Head-to-tape speed remained high, but tape only had to be pulled past the rotating head at 15 inches/sec. The photo here, out of an Ampex manual, shows the video "tracks," along with the audio and control track. The control track controlled the speed of the tape on playback so that the rotating heads passed down the center of each video track. Modulating the baseband video onto an FM carrier solved the bandwidth problems. Peak white video was only twice as high as the lowest value, which was sync. All the other values of gray in between were within these two frequencies. The bandwidth went from nearly 20 to only two.

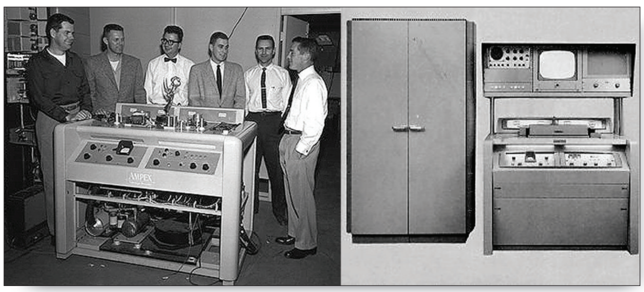


Figure 5.3 When Ampex introduced their VR-1000 to CBS executives at the NAB convention in 1956, near pandemonium broke out. Unbeknownst to the CBS crowd was the fact that they were recorded as they entered a demonstration area. Upon playback of the material, they were astonished at the quality — marginal by today's standards but unparalleled at that time. Ampex couldn't build them fast enough. Here, the Ampex design team poses around the Emmy their efforts won, which is sitting on the tape transport section of the VR-1000. (Ray Dolby, founder of Dolby Labs, is fourth from the left.) The compressors and pumps seen in the exposed underbelly were needed to control and move the two-inch videotape used. A one-hour reel weighed close to 20 pounds. The photo on the right shows the tape transport with its "monitor bridge" sitting next to the two-rack electronics cabinet. Essentially, one of the racks housed the video and audio processing circuitry, while the other housed the servo circuits.

To put VTRs onto a truck was not a simple matter. Depending on options they could weigh as much as 2000 lbs. They didn't like rapid changes in temperatures. If a VTR was in record in the middle of winter and someone opened the door of the truck, the resulting blast of cold air could very well cause one or more of the machine's servos to come unlocked. The confidence recording features common on most machines today didn't appear until the 1970s. On these early VTRs, commonly referred to as quads because the rotating video head actually consisted of four separate heads, there was no way of knowing if the recording was successful until playback. These heads had to make very solid contact with the tape. The tip of the rotating heads actually pushed into and slightly deformed the tape. These heads slowly ground themselves down and scrapped off the oxide of the tape over successive passes (for playback or recording). Sometimes a piece of oxide from the tape would get lodged on the head and clog it. If this happened during record, the recording was lost. If it happened during playback, the tape had to be stopped and the head cleaned. Actually, what commonly happened, though few would admit it, was an alcohol- or freon-soaked cloth would be momentarily pushed against the rotating head to try and eliminate the clog without stopping the machine. Some would even use their fingernail in such an attempt. The danger in this was that one of the rotating heads might break, or rip up their finger. To get a quad head rebuilt cost many thousands of dollars. Even with the unreliability of these VTRs, it would be well into the '70s before trucks could carry more than a couple.

Servo Systems and VTRs

VTRs have at least three servo systems. A servo is circuitry that controls something via feedback from the thing controlled. The things controlled in a VTR are the rotation of the video head, the capstan for pulling tape (both of these not only for speed, but phase also) and the reels to maintain proper tape tension. Even with their large size, these early machines couldn't initially record or play back in color, and they couldn't be locked or synchronized to the "house" (the facility). This meant that the machine couldn't be dissolved to or from, or keyed over. At the time the VR-1000 was introduced, those types of things weren't done much anyway.

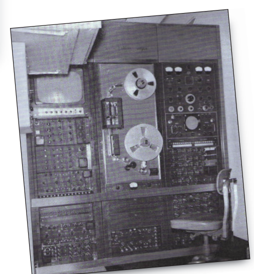


Figure 5.4 Early tape truck carried only this RCA TRT-1 and some support electronics. The TRT-1 was RCA's answer to the VR-1000.

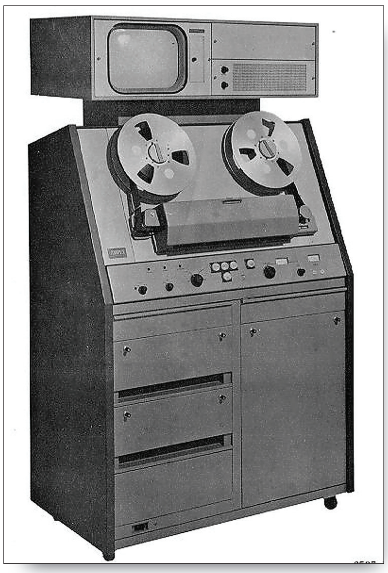


Figure 5.5 Second-generation VR-1100 from Ampex. Use of transistors made this machine compact for its time. The entire system was in this footprint. Plus, this machine could lock vertically to the house. That meant that although it still couldn't be dissolved to, it could be switched to/from with no "roll" in the video. It could also accept the Editec option (Figure 5.6). One other available option – "low-band" color (see Black-and-white vs. Color Recording).

The Solid-state Second Generation

Black-and-white vs. Color Recording

As mentioned earlier, to solve the bandwidth issue FM was used, with frequency deviation toward the high side representing high video levels, and frequency deviation toward the low side representing video low lights and sync. When color recording was introduced the deviation values had to change, as the color subcarrier and the FM deviation values would beat together otherwise, causing a moiré pattern in the video. It was decided to increase the deviation values. The problem was that the VR-1100 didn't have the bandwidth for these high values, which came to be known as "high-band." So, for this machine to record in color, deviation values lower than the ones used for monochrome were used, which was known as low-band. This produced video of slightly less quality but enabled the machine to record in color. The saying at the time was "low-band is better than no-band."

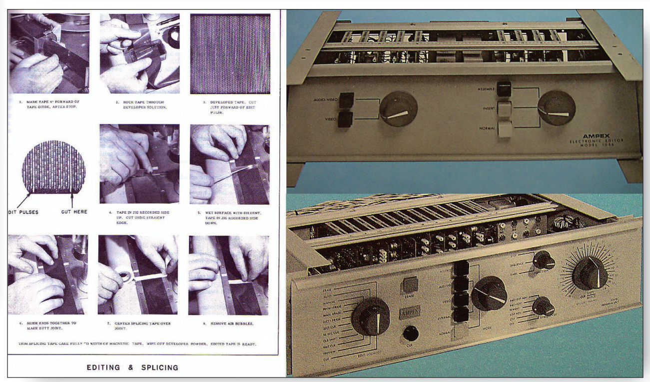


Figure 5.6 At first tape was physically spliced up and reassembled like film. And just like film, the frame boundaries had to be found to make the cut. With film you could see where one frame ended and the next began. With videotape you had to use a special solution or magnetic powder that showed magnetic hysteresis changes on the tape. A trained eye could then identify where the television frame boundaries were. The steps to make a physical tape splice are shown on the left. The right photos are of the first two generations of electronic tape editor. Both were mounted inside the front lower part of the videotape recorder. This meant all editing was done only in front of the machine. The first generation was totally punch and pray. In other words, you manually put the machine into record at the point of the desired edit, and prayed that everything went right with the talent, crew and machine. The second-generation editor had preview capability. These systems let you assemble or insert edits.

Assemble and Insert Editing

VTRs lay down a control track along the edge of the tape to tell the machine playing back the tape how fast to pull tape by the rotating video heads and how to phase the rotation so that the video heads traveled down the center of the track and not in between tracks, known as mis-tracking. In assemble editing, the VTR erases and lays down new control track when edit record is entered. Insert editing is when the VTR uses the existing control track already on tape and just records new video or audio on the tape. Assemble editing is used when new material is to be added, or appended onto the end of a recording on tape and the rest of the tape is blank. Insert editing is used where new video or audio is to be "inserted" in between existing shots.

Figure 5.7 *Here is a third-generation "high-band" recorder in an ABC tape truck. (Source: Bill Freiberger)*

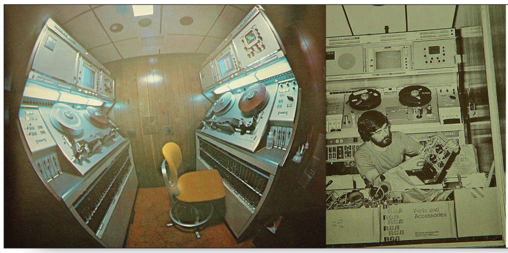


Figure 5.8 *These are photos of RCA's competition to the VR-2000, the TR-70. As can be seen, like the Ampex model, the electronics below the TR-70's tape deck are readily accessible. Unlike Ampex, RCA built a special frame for the electronics. Also unlike the Ampex approach, where you could add accessories along the way, going up from a bare-bones recorder, the high-end RCA VTR came with most of the bells and whistles as an integral part of the system.*

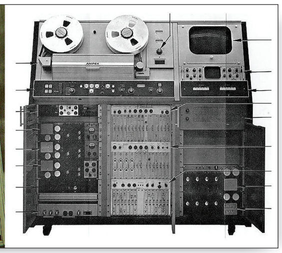


Figure 5.9 *The right photo is another shot of the VR-2000 showing all its subsystems exposed. The machine essentially had three half-height racks below the tape transport to house the electronics. The frame in the top center rack handled video recording and playback. The two frames below it were for servos. The left rack held what would be known as a time base corrector (TBC) today. The video playback heads, being mechanical in nature and under servo control, were always dithering (speeding up or slowing down) around the desired speed. Because of this, video being played back was varying in time, with an incorrect time base — hence the need for the time base corrector. The right rack housed power supplies. One reason the electronics are so accessible is that they needed adjustment often. This machine could be exactly locked to the house (known as "intersync") so that it could be dissolved to or keyed over, and be a part of other effects. Up until this time, a VTR on a truck was mainly there to record. Now a VTR in playback could be treated like any other source because it was locked to the other sources available.*

As we have seen in this section, VTRs underwent a size, weight and stability evolution, just as cameras did. As we will see in the next section, VTRs soon became common on trucks, but we will also see that the videodisk has threatened the VTR's existence for over 35 years. ■