

The Video Processing Amplifier in the Ampex Videotape Recorder

By RAY M. DOLBY

Due to stringent requirements of network television, especially with regard to the shape and transient noise content of synchronizing pulses, a special "processing amplifier" has been developed to insure acceptable video waveform at the output of the Videotape Recorder. Similar in concept to a stabilizing amplifier, the new device represents a logical extension of stabilizing techniques. In addition to the usual stabilizing amplifier functions, the processing amplifier provides for complete reblanking of the video waveform and precise gating of the sync pulses, insuring that noise transients in the black direction will not project beyond reference black level during the active portion of the horizontal cycle. These operations are controlled solely by timing information in the incoming sync pulses.

THE PROCESSING AMPLIFIER in the Ampex Videotape Recorder is not an intrinsic part of the video-tape process. The Videotape Recorder will produce high-quality pictures without the processing amplifier, provided, however, that the images are viewed only on local monitors and that the output is not fed directly to network facilities. Designed to bridge this gap between the raw Videotape Recorder (VTR) output and a completely acceptable waveform for network handling, the intermediate processing amplifier is a necessary key to the practical commercial use of video tape.

Briefly, the basic purposes of the new unit (Fig. 1) are: first, to eliminate all objectionable noise in between or on the sync pulses; and second, to reblank the video signal.

Since playback video is not locked

Presented on April 29, 1957, at the Society's Convention in Washington, D. C., by Ray M. Dolby (then at Ampex Corp., 934 Charter St., Redwood City, Calif.; now at the Cavendish Laboratory, University of Cambridge, Cambridge, England).
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directly to local sync generators, timing information needed for the gating and blanking operations must be derived from the video signal itself.

Stripped from the playback video, VTR sync controls the vertical and horizontal gating generators, whose outputs are combined to energize a sync gate designed to pass incoming pulses only during those periods in which pulses should be present. Thus, transient noises between horizontal synchronizing pulses are completely blocked. The gating signal is also fed to the blanking former, which appropriately modifies the gating pulses and drives the reblanker. These operations of reblanking and of sync gating are the main ones responsible for insuring a VTR signal of good waveshape.

Trouble With Stabilizing Amplifiers

The basic difficulty with raw videotape output is that unavoidable transient noise arising from dropouts as well as head switching is found to be extremely obnoxious to stabilizing amplifiers and sync-tip clampers. Since, by design, a stabilizing amplifier clamps the picture to blanking level immediately

after the trailing edge of any pulse which enters the sync region, a picture from a video-tape machine has a very unlucky time. Specifically, several lines of the picture are shaded abnormally by every noise transient. In some cases, depending on circuitry, the sync separators in the stabilizing amplifier will be upset, and patches of sync pulses may be missing from the resultant composite video.

An experiment at CBS in Hollywood illustrates these phenomena: A test pattern was recorded on good tape, played back normally, sent through the processing amplifier, and then fed to the studio facilities, including one stabilizing amplifier. Everything was adjusted properly, and the result was a high-quality image suitable for broadcast. Then the processing amplifier was removed from the system. The finished product (Fig. 2) reveals the sentiments of most stabilizing amplifiers about raw video-tape signal.

Processing Amplifier Design Considerations

It would be most desirable to gate all-synchronizing pulses through the processing amplifier only during those times in which any particular pulse should exist. In practice, this operation is fairly easy for the horizontal pulses, but predicting the arrival of the next legitimate pulse can become hopelessly complex in the vertical blanking period.

Figure 3 shows what actually was done. The idealized gating operation for the horizontal synchronizing pulses is achieved through the use of narrow keying pulses. Then, there is provided in the vertical blanking interval a whole-sale passage for everything, including

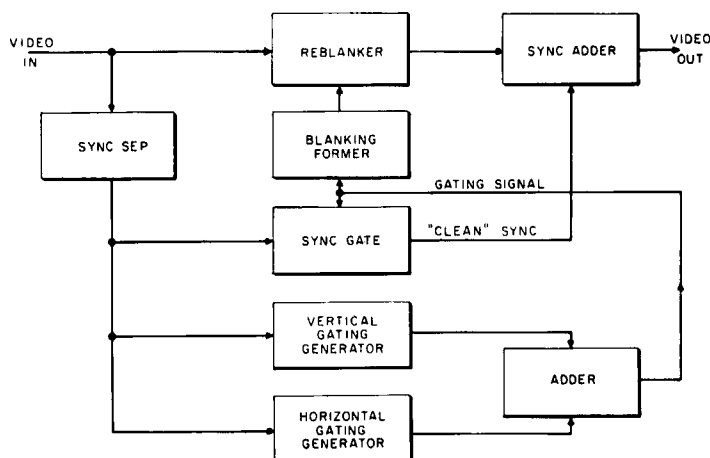


Fig. 1. Basic block diagram of the processing amplifier.

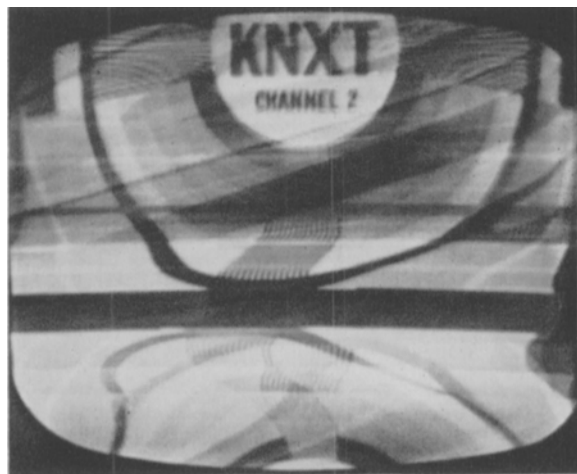


Fig. 2. Appearance of VTR picture after subsection to stabilizing amplifier—without processing amplifier.

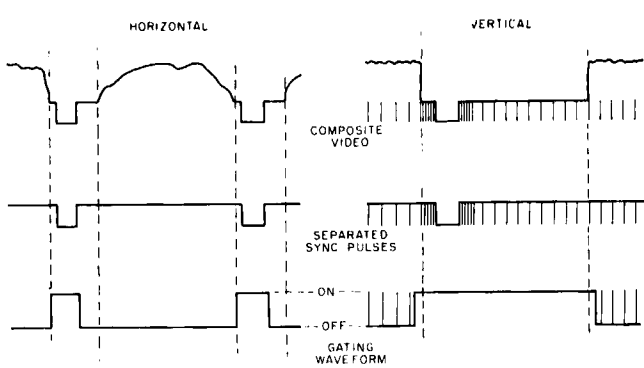


Fig. 3. Timing relationship between sync and gating pulses.

noise. Justification for this procedure lies in the fortunate circumstance that during the vertical blanking interval noise pulses will cause stabilizing amplifiers to clamp, harmlessly, to blanking level only; therefore if noise is allowed to pass in this interval no difference will be seen in the picture.

In most stabilizing amplifier applications simple black clipping to remove the old synchronizing pulses and to clean up the front and back porches has proved to be satisfactory. But in the case of the Videotape Recorder there are, unfortunately, residual carrier components (remaining from the FM modulation-demodulation process) and other high-frequency noises on the sync pulses and blanking pedestals of the demodulated output. These high-frequency components give a fuzzy appearance to the back porch. Since any attempt

to remove the fuzz with a black clipper will destroy setup to such an extent as to cut into the black portion of the video signal, the classical method clearly is not a satisfactory means for reforming the blanking pedestal.

The answer to this problem is to reblank the video signal, and the existence of the vertical and horizontal gating generators makes the formation of suitable blanking signals very easy. An examination of the required blanking signal and of the composite gating waveform shows that it is necessary only to delay the trailing edge of the gating signal a few microseconds in order to provide all of the necessary blanking information. Figure 4 illustrates the time relationship of the composite video and the reblanking pulses. The vertical re-

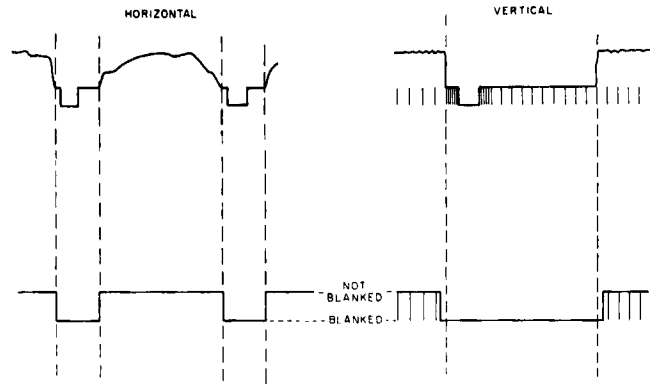


Fig. 4. Timing relationship between video and reblanking pulses.

blanking pulse begins approximately half a line before the original blanking pulse began, and the end of the new blanking pulse occurs just after the end of the original blanking pedestal. In the horizontal period, the reblanking pulses are seen to coincide exactly with the timing of the original blanking pedestal.

Circuitry

Figure 5 is a basic outline of the circuitry required to perform the operations seen in the previous illustrations.

From the output of the machine, a 1-v video signal is fed to the input of the processing amplifier, after which it is amplified and given a preliminary clipping operation which removes black-going spikes projecting below the

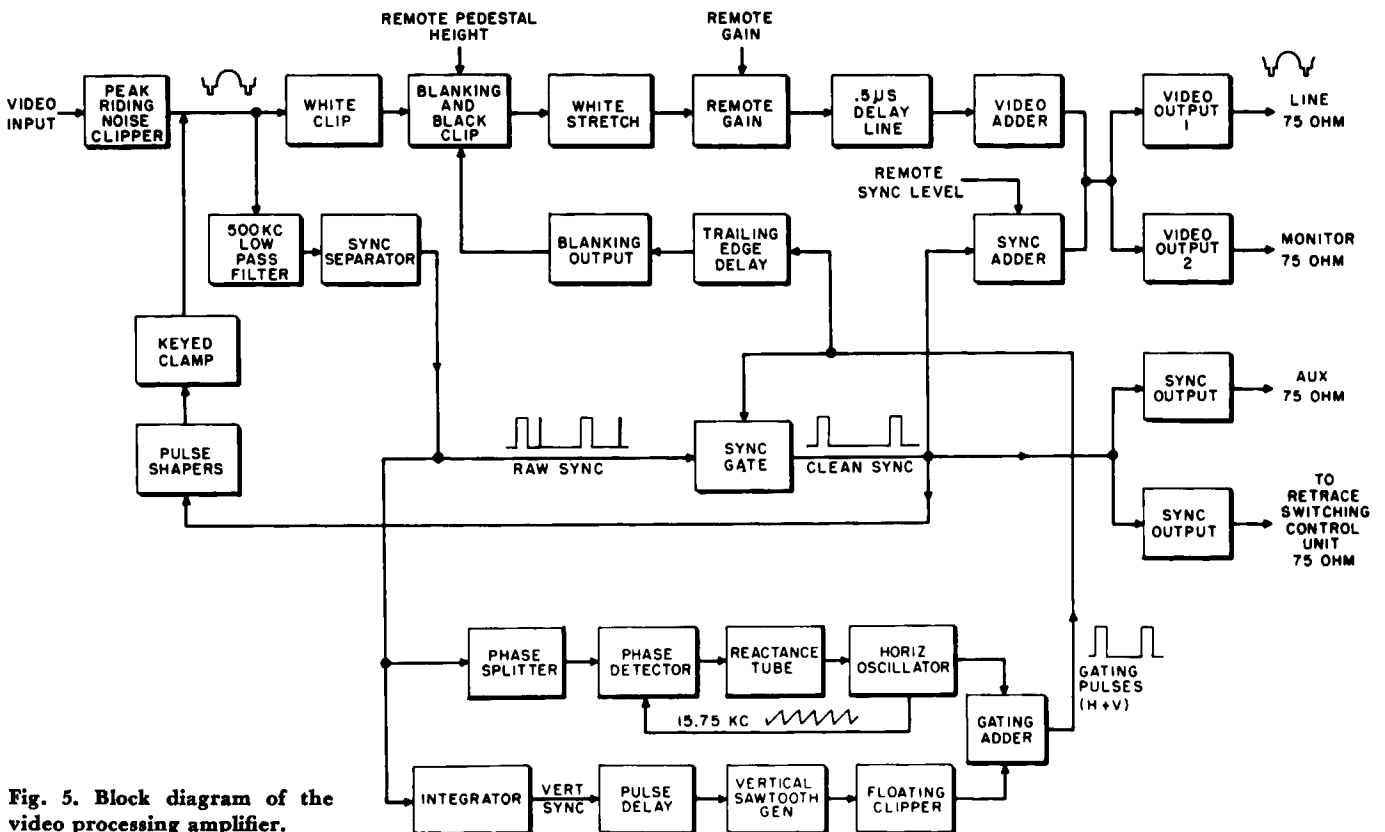


Fig. 5. Block diagram of the video processing amplifier.

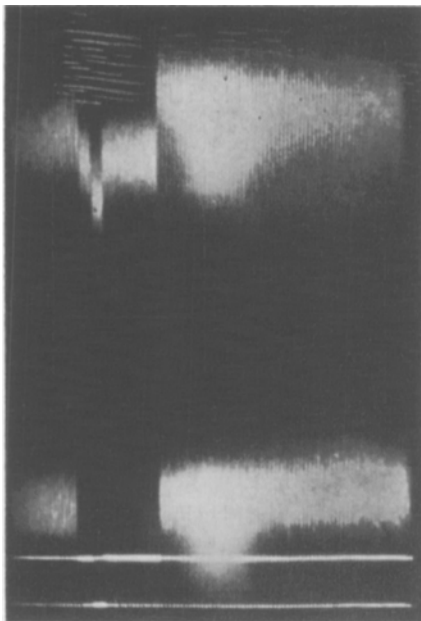


Fig. 6. Oscilloscope of processing amplifier input and output with noisy signal — expanded portion of vertical period.

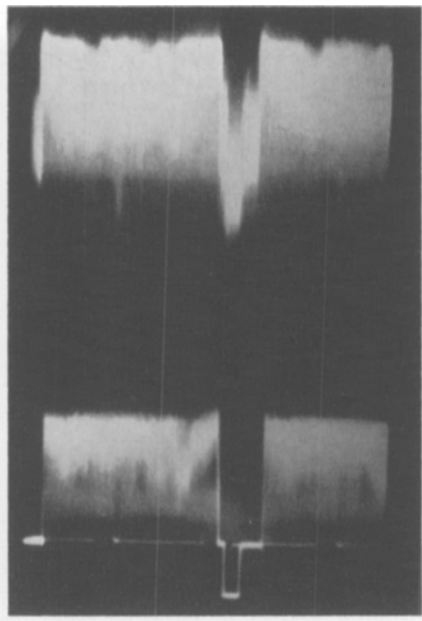


Fig. 7. Horizontal waveforms. Conditions same as Fig. 6.

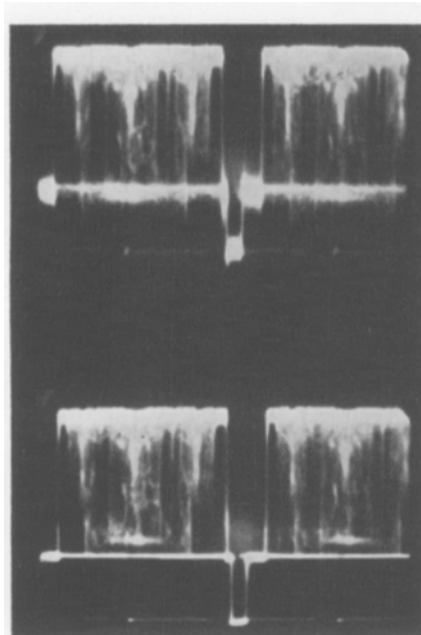


Fig. 8. Output of the VTR demodulator and subsequent output of the processing amplifier.

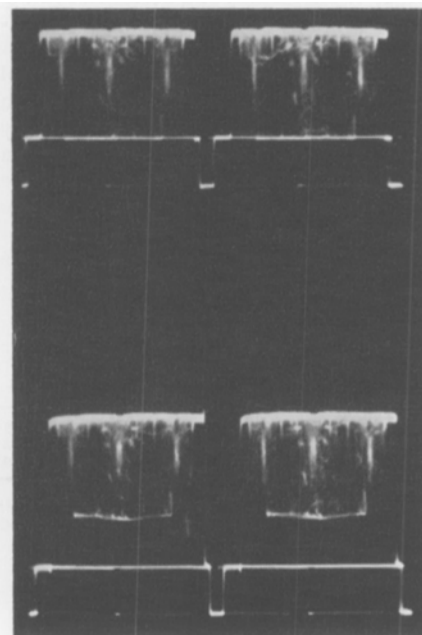


Fig. 9. Performance of processing amplifier in restoring setup to video signal with insufficient setup.

negative tips of sync. Clamped by a comparatively soft clamp only to restore the d-c component, the composite video is subjected to the white clipper and to the blanker and black clipper. The video signal, then without sync, is next applied to a direct-coupled white stretcher, a 6BJ6 variable mu tube. Similarly, the remote gain tube is a 6BJ6 with variable bias on the control grid. The use of variable bias permits remote operation through an accessory unit and switching relay which transfers control away from the main chassis.

Next, a $\frac{1}{2}$ μ sec delay line appears in

the chain of events, the purpose being to delay the video signal by the same amount as the synchronizing pulses have been delayed in their circuits, so that the timing relationship of the video signal and synchronizing pulses will be proper. After this point, the gated sync pulses are added and controlled either remotely or locally. Output from the machine is obtained through two identical feedback amplifiers with independent gain and output impedance controls.

Synchronizing pulses are obtained from a point near the clamp, after which

they are sent through a 500-kc low-pass filter which removes carrier components in the signal as well as very short transient noises. The pulses then go to the sync separator, consisting of several triode amplifiers, all of which have been designed to provide very dependable operation under noisy sync conditions.

The raw synchronizing pulses, including noise, are then exposed to the selective action of the 6BN6 sync gate. The clean synchronizing pulses, which are the original pulses amplified and clipped in several stages, are then fed to the sync adder and to the two sync outputs. The clean pulses also energize the keyed clamper.

The horizontal gating generator is a sync controlled AFC circuit which generates pulses just slightly wider than the sync pulses themselves.

Also utilizing the raw synchronizing pulses, the vertical gating generator separates vertical information from the remainder with an integrator. The pulse delay delays timing information in the vertical synchronizing pulse for about 680 μ sec, forming the end of the vertical gating pulse. But the leading edge of the vertical gating pulse is derived in a special sawtooth generator which delays time information in the previous vertical synchronizing pulse for almost one field. The horizontal and vertical gating pulses are combined in the gating adder and are fed to the suppressor grid of the 6BN6 sync gate. In addition, these gating pulses are sent to the reblanking former, which delays the trailing edges a few microseconds, forming the composite blanking signal, as described earlier. Blanking itself is accomplished by a diode clamp circuit.

Performance

To test the efficacy of the processing amplifier in treatment of signals much more noisy than it would be required to handle from the Videotape Recorder, an extremely bad air signal was taken from a tuner and fed to the input. Figures 6 and 7 show "before and after" examples. Figure 6 is an oscilloscope of vertical waveforms corresponding to the input and output of the processing amplifier. The input signal is seen to contain practically all the noise that could possibly exist, the output corresponding to what would be expected from previous discussions. The view shown in Fig. 6 is a magnified portion of the vertical period.

Figure 7 shows the horizontal waveforms under the same conditions. Here again, the gating of the synchronizing pulses and the reblanking operation reconstruct the video signal into an acceptable form. The processing amplifier can be easily set up to match the output signal to either standard levels of pedestal and

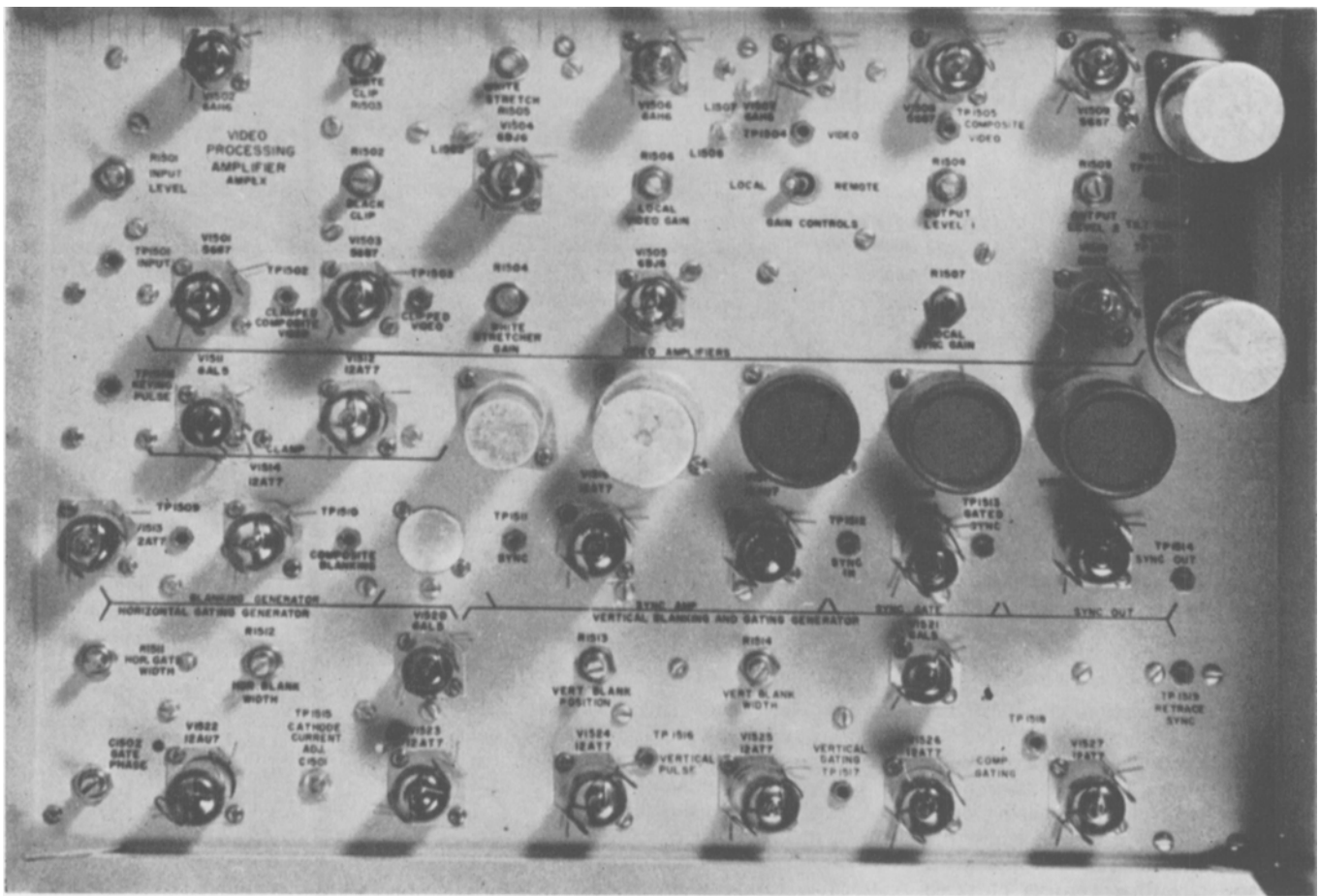


Fig. 10. The video processing amplifier.

sync or to the levels existing in the input signal.

Figures 6 and 7 are intended only to demonstrate the maximum capabilities of the processing amplifier; Fig. 8 is an indication of actual performance with video-tape signal as input. While they are fewer than in the previous illustrations, faults in the VTR waveform are easily noticed. There is the characteristic carrier "grass" (noise) on the front porch, synchronizing pulse, and back porch, and, although they may not be seen in this picture, noise transients do exist. The output synchronizing pulses are clean and well defined, yielding a signal completely compatible with network practices.

In practical use of the new unit as a stabilizing amplifier, another virtue in addition to signal clean-up is realized. Figure 9 is an illustration of the ability of the device to restore setup to a video signal with insufficient setup. A composite video signal will, after repeated subjection to stabilizing amplifiers, lose the normal setup. Furthermore, the usual stabilizing amplifier loses its ability to

clean up the back porch after setup has been destroyed, for if the black clipper cuts deeper into the blanking pulse, the black tips of the video signal also will be distorted. Provided with a local and remote pedestal height control, on the other hand, the processing amplifier will recreate any desired amount of setup. The bottom half of the figure gives an idea of what is possible.

The New Unit in Use

The processing amplifier (Fig. 10) has been in commercial use in the Ampex Videotape Recorders since November 1956, when Television City (CBS), Hollywood, began the first regular programming with magnetic tape.

While the unit was designed specifically for the Ampex Videotape Recorder, its adaptability to other uses has become obvious. Suitable applications for the processing amplifier can be inferred from its performance in relation to the video-tape signal. As a stabilizing amplifier, the unit probably

would find its greatest value on the receiving end of a network broadcast for re-formation of blanking pedestals and general cleaning up of the synchronizing pulses. In addition to usual studio applications for conventional stabilizing amplifiers, the new unit might also have value as a device to restore noisy air signals for isolated communities which rely only on air relay of television for local redistribution.

It is expected that, eventually, as video-tape production demands become less pressing, attention can be turned to making the processing amplifier available as an entity.

It seems reasonable enough to restore a noisy signal by reblanking and sync gating through the use of appropriate pulses derived from the signal itself, but it had never before been necessary to produce such a device. The advent of the Videotape Recorder precipitated the design of the necessary circuits; the processing amplifier emerged as the consequence of the given requirements.