

$1.23 \times 10^{-3}$ . Since it takes 1/960th of a second for a head to describe a  $90^\circ$  arc, the accumulated time-base error during the sweep amounts to  $1/960 \times 1.23 \times 10^{-3}$  seconds which equals approximately  $1.3 \mu\text{sec}$ .

The type of scalloping distortion shown in Fig. 7 is the result of vertical misalignment of the guide. The fact that such distortion is accompanied by negligible displacement at the transition points can be shown by integrating the cumulative error  $e$  over the range defined by the active portion of the head sweep. For a vertical guide misalignment  $v$ ,  $\Delta S = \frac{Kv}{r} \sin \theta$ , and therefore:

$$e = \frac{Kv}{r} \int_{-\pi/4}^{\pi/4} \sin \theta d\theta = 0$$

Thus the total amount of information played back under conditions of vertical mispositioning of the guide is correct, although time-base errors within each head sweep may easily reach an objectionable value. If we define scalloping as the accumulated time error between  $\theta = 0$  and  $\theta = \pi/4$ , then scalloping equals:

$$\frac{1}{2 \times 960} \int_0^{\pi/4} \Delta S d\theta = \frac{Kv}{1920} \int_0^{\pi/4} \sin \theta d\theta$$

For a vertical misalignment  $v = 0.1$

mil, the scalloping will thus amount to less than  $0.015 \mu\text{sec}$  within each band. The maximum tolerable amount of scalloping, from the standpoint of subjective picture quality, may be considered to be  $0.1 \mu\text{sec}$  or less. Proper adjustment of vertical positioning of the guide prior to recording can be made by use of a standard alignment tape.

Finally, let us consider the effects, on a color picture, of the nonlinear characteristic induced in the time base by the non-concentricity which results from guide movement. Since the color system is one in which phase locking is effected at the beginning of each picture line, our principal concern is the extent to which phase shift occurs at the 3.58 mc subcarrier frequency during a single line. We have considered time-base errors caused by nonconcentricity to be sinusoidal. Vertical misalignment of the guide with respect to the drum will cause an expansion of the time base at one extreme of the sweep and a contraction of the time base at the other extreme. This will be accompanied by a maximum rate of change of the time base occurring during that television picture line which is read out at the center of the sweep. A horizontal mispositioning of the guide will result in a maximum stretch error at the center of the sweep and a maximum rate of change of time-base error during the first and last lines of each sweep. The

extent of the time-base rate errors will directly determine the amount of hue shift in a burst locked color Videotape Recorder system. Taking into account all of the variables involved in a given playback operation, and even allowing a reasonable degree of operational or setup error, the worst case of phase change within one line will be undetectable to the eye.

Since time-base distortions of the type we have been discussing can be closely controlled, especially as operating and maintenance characteristics of the machines continually become better understood by the users, it seems rather doubtful that these phase changes will ever become objectionable. However, if the expanded use of color video-tape recorders on an interchangeable basis, involving sequential duplication operations, presents detectable hue shift in the picture, the problem can be readily solved by the use of a pilot carrier system of the type which has been developed in the laboratory and which grants complete freedom from the type of defects discussed. The conversion of color machines from burst locked to pilot carrier operation would be a comparatively simple matter. Unless we find that eventual usage warrants the transition to a pilot carrier system, it is best to reserve that portion of the video-tape spectrum for other possible uses.

## Discussion of Video-Tape Recorder Operations

*Seven speakers presented these subjects at the Society's Convention in Los Angeles on April 24, 1958:*

- "Magnetic Tape for Video Recording" by ROBERT A. VON BEHREN, Minnesota Mining and Mfg. Co., 900 Bush St., St. Paul 6, Minn.
- "Engineering Planning in the Evolutionary Development of the Video-Tape Recorder" by JOHN M. LESLIE, JR., Ampex Corp., 934 Charter St., Redwood City, Calif.
- "Electronic Marking and Control for Rapid Location of Vertical Blanking Area for Editing Video-Tape Recordings" by JOSEPH ROIZEN, Ampex Corp., 934 Charter St., Redwood City, Calif.
- "Electronic Convention to Color Recording With the Ampex VR-1000 Video-Tape Recorder" by CHARLES E. ANDERSON, Ampex Corp., 934 Charter St., Redwood City, Calif.
- "Timing and Frequency Requirements for Color Video-Tape Recording" by EARL ROGER HIBBARD, Ampex Corp., 934 Charter St., Redwood City, Calif.
- "Interchangeability of Color Video-Tape Recordings" by CHARLES P. GINSBURG, Ampex Corp., Redwood City, Calif.
- "Magnetic-Tape Recording of Color Television Signals" by JEROME L. GREVER, Radio Corp. of America, Camden, N.J.

*Mr. Lewin:* Is there any hope of interchangeability between the RCA and Ampex recording?

*Mr. Ginsburg:* Ampex and RCA recognize the importance to the industry of establishing interchangeability between the video-tape recorders of both companies.

Steps are being taken to agree on various system parameters so that such interchangeability can be brought about.

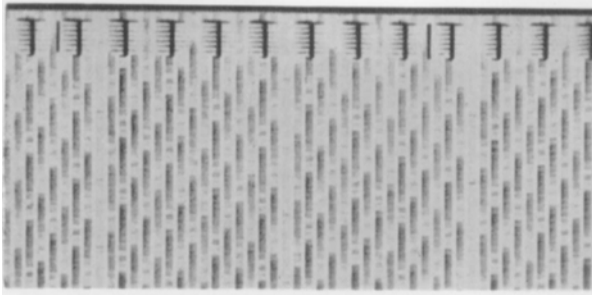
*Mr. Lewin:* In view of the rather high cost of the video tape, is there any hope of re-using the tape once it's been spliced?

*Mr. Roizen:* Yes, although it requires a

*Other participants in the discussion which followed the group of papers were:*

- RALPH E. LOVELL (Session Chairman), National Broadcasting Co., 3000 West Alameda Ave., Burbank, Calif.
- GEORGE LEWIN, Army Pictorial Center, 35-11 35th Ave., Long Island City, 1, N.Y.
- J. BARRY WATKINSON, Cascade Broadcasting Co., P.O. Box 702, Yakima, Wash.
- RALPH R. WELLS, Columbia Pictures Corp., 1438 N. Gower St., Hollywood.
- WALTER BACH, Berndt-Bach Inc., 6900 Romaine St., Hollywood 38.
- RALPH DODDS, Creative Productions, P.O. Box 765, Burbank, Calif.
- ROLF A. SETTLE, KQED, 525 Fourth St., San Francisco, Calif.
- HELMER W. ANDERSEN, CBS Television, 6121 Sunset Blvd., Los Angeles.
- DAVID S. HORSLEY, 3929 Kentucky Dr., Hollywood 28.
- ROBERT G. NEUHAUSER, Radio Corp. of America, Lancaster, Pa.

little skill to splice together two tapes from different machines so that they will go through without showing any discontinuity in either the sync or video information. If you record over the splice you wouldn't even know it went through the machine. In other words, if you erase the tape and re-



Edge of 2-in. RCA video tape with two edit pulses.

record, you never know the splice is there because the condition of recording and playback then becomes the same.

*Mr. Lewin:* There is not enough distortion occurring at the splice point to cause even a little disturbance?

*Mr. Roizen:* No, because the splice point consists of  $\frac{1}{4}$  in. of backing tape. That quarter inch represents  $\frac{1}{60}$  of a second of picture information so it would take an eagle eye, if the picture did not roll, to even notice that it went through. If you hooked up an oscilloscope with a delay circuit, etc., and caught it at the right moment you could tell a slight difference, but beyond that there's nothing that you can see in a re-recorded tape after the splice has been made.

*Mr. Lewin:* It's a little hard to reconcile that with experience in audio recording where invariably a little "bloop" due to the splice will be heard.

*Mr. Roizen:* If you record over a piece of audio tape that has been spliced together, do you hear the splice go through?

*Mr. Lewin:* If you put a continuous tone over a splice you'll certainly get a little "bloop."

*Mr. Roizen:* Yes, but I suppose it's as difficult to sell tapes with continuous tones as it is for us to sell monoscope patterns that we use all the time to show the deficiencies of our picture.

*Mr. Lewin:* But you do have to record continuous tones.

*Mr. Roizen:* Well yes, I realize this, but I think it's a matter of minor importance to video tape. We certainly don't throw away tapes after we cut them apart, they are too expensive!

*Mr. Watkinson:* I have seen those maladjusted monoscope patterns many times but never had it explained whether they were made with a monitor with a free running horizontal oscillator or with a horizontal oscillator that was trying to remain in sync.

*Mr. Ginsburg:* Those pictures were all made using Conrac monitors with standard time constants. In relation to the repetition rate of the discontinuities generated by moving the female guide, the monitor time constant may be considered infinitely long. No distortion of the displacement patterns is caused by the time constant being too short.

*Mr. Watkinson:* That's what I was curious about—some monitors would tend to follow that.

*Mr. Ginsburg:* That would be true only in the case of a monitor with no AFC. Virtually all station monitors and home receivers would ignore the discontinuities. In other words, the discontinuities would not be minimized by the time constants in the monitors or receivers.

*Mr. Wells:* One paper carefully described the insertion of pulses so that the tape can be spliced. Does the RCA system have something like that?

*Mr. Grever:* We have a slightly different system but it's basically the same. You will recall that the control track was a series of little horizontal lines; actually those are the back edge of the sawtooth, at a 240-cycle rate. Every half an inch there was one frame pulse, this being slightly different from the Ampex system which has pulses every quarter inch, every field. The pulses on that particular slide I showed were every  $\frac{1}{2}$  in. or every frame.

*Mr. Wells:* Are they similar to the Ampex in that they have a much higher amplitude so that they'll show in the horizontal?

*Mr. Grever:* No, in this case you see a regular spaced line horizontally, and you look for a Roman numeral III, you might say, because every half an inch there's an extra line right in the middle between two other lines and they stand out as little groups of three. You position the frame mark in the splicer in such a way that the cut is made in the vertical blanking interval.

*Mr. Lovell:* In view of the interest in this subject would it be possible to show that slide? There's a great deal of interest in the subject of editing and it warrants just a little further attention.

*Mr. Grever:* Now (referring to the illustration) there can be seen: the vertical blanking, a 240-cycle pulse, and the little "three" that I talked about. It may not be too sharp in this particular photograph, but this one is displaced an exact distance from this track. A cutter, who would use an optical principle to center over the pulse, would cut right through the tracks containing the vertical blanking interval.

*Mr. Lovell:* The displacement between the soundtrack and the picture heads is  $9\frac{1}{4}$  in. It is felt by some editors that this is much too great a distance for editing successfully. For example, in editing on sound there will be  $9\frac{1}{4}$  unwanted inches of picture. Is there any likelihood of moving the audio closer to the video head?

*Mr. Roizen:* This is a problem that everybody who comes to the plant asks about. Most network people have pointed it out in the past, and here again some of the parameters of the operation of the tape come into play. Nine and a quarter inches may seem like a long way, but it's actually only  $\frac{1}{2}$  sec of tape time. Only under very stringent picture and sound conditions would there be a problem. For example, a gunshot, which must occur at a specific time, has a very short sound in relation to the picture. The cut must be at the end of the gunshot as far as the sound goes. There

are problems but probably no worse than present film problems when the sound is ahead of the picture and film. There is an advantage in the video-tape recorder in that it is possible to erase the sound and redub it easily by shutting the tape through the machine. In the case of the gunshot, it would be no trouble at all to move it back, just a bit, and have the picture come out right. I think this is a problem of technique. The man twirling the reels back and forth and listening for the right point will usually find enough picture material and enough sound to cut where it will work out right. We've discussed this frequently and have not yet arrived at a completely satisfactory answer.

*Mr. Lewin:* The difference seems chiefly that in motion-picture production you do not edit single-system film, which has the sound displaced forward, as you have in this medium; you edit double-system, which means you can cut picture and track any place you like. Once you've done that, then you make a composite print.

*Mr. Bach:* In editing film magnetics on a combination of picture and soundtracks, we have developed a means of sliding the soundtrack forward and back without the use of any storage devices and without introducing any motion troubles. These techniques could just as well be used on this other problem. You could slide the sound adjacent to the picture and then edit straight across and, after putting the picture together, you could slide the sound back to be in advance of the picture, wherever you wanted it to be.

*Mr. Lovell:* That technique is a very interesting one. With the appropriate lineup of a magnetic record head, erase head and playback head, plus the addition of some simple audio switching, it is possible to move the sound back so that it is opposite the picture, then edit it as has been indicated—in the dead sync condition—to use film terminology, then move the sound ahead again to its original position. I don't know of anyone who is doing this but it is an interesting possibility.

*Mr. Dodds:* If this displaced system can possibly be changed so that we can simultaneously record picture and sound in the same spot, it should certainly be looked into.

*Mr. Seille:* Concerning the female guide and the adjustment that controls the distance of tape in relation to the head assembly, for the rotating head assembly, in the case of color I can now understand that this may be a necessary operational adjustment, but could not this be made fixed for monochrome? In other words, the distance of the female guide assembly cannot be changed. Its radius can be changed on the prototypes. I've seen also many tapes being chewed up by a misadjustment of that and it could possibly be fixed as the tapes are uniform.

*Mr. Ginsburg:* The key to keeping the total required adjustment range of the female guide as small as possible lies in getting into the field properly designed alignment tapes so that the operators can correctly position the guide with respect to the head. Once this is done, the actual adjustment range needed for the guide is quite small, even under fairly wide variations of temperature and humidity. The adjustment needed to compensate for tip wear is very small since there is a self-compensating

change in the amount of tape stretching. The amount of guide movement required to compensate for two mils of tip wear would only amount to 0.2 mil.

*Mr. Lovell:* When will it be possible, or why isn't it possible, to have a monitor head arrangement following the record head, so that the signal could be seen as it plays off the tape a fraction of a second after it's been recorded? This is a common practice in audio recorders and it would be very helpful to the broadcasting people if such a monitoring head were available. It would seem that putting another similar 2-in. head on the same shaft, perhaps  $\frac{1}{2}$  in. away, would do the trick.

*Mr. Leslie:* It is certainly possible to solve the problem, but it would be uneconomical from both the manufacturer's and the customer's standpoint. The monitor head assembly would have to be located a considerable distance from the recording head assembly in order to avoid electro-mechanical interferences of a type that would be particularly distressing when the recordings are to be used interchangeably. The added cost for such provisions would

not prove very attractive to prospective purchasers, especially in light of the proven reliability of the machines as they are now.

*Mr. Grever:* I would like to add that we will reduce the tape life by a factor of 2 if we do this, because every time you record you will go over it twice and every time you play back you will go over it twice so that for record and playback function you will have gone over the same area four times. It would be a serious reduction in tape life and this is a big problem.

*Mr. Anderson:* Without being facetious, I can note that sitting through a number of shows each costing about \$100,000 and up per hour and wondering if there is anything on the tape makes the problem of having the second head seem less serious.

*Mr. Horsley:* What is the prospect for being able to record and re-record from tape to tape as is customarily done with magnetic tapes in audio practice?

*Mr. Leslie:* Tape copies are used on the air every day. There is a certain amount of loss in signal-to-noise ratio and in resolution at the present time, but dubs are without question fully acceptable for broadcast use.

Even copies of copies have been used on the air. Since there is always some degradation in the process of duplicating, whether audio or video, the best approach to the improvement of signal-to-noise characteristics in copies lies in improving these characteristics in the basic machine. Duplication is better now than it was some time ago and we expect it to continue to improve.

*Mr. Neuhauser:* We have been told about signal-to-noise ratio improvement but no figures have been given on typical signal-to-noise ratios that are capable of being achieved. What are these values?

*Mr. Leslie:* With the prototype machines that were delivered to the networks, the signal-to-noise ratio varied with the machines depending upon their condition at that time and the tapes that were available. The signal-to-noise ratios varied from 30 to 34 db. The method of measurement was taking peak-to-peak video with respect to rms noise. On the VR-1000 machine that we're putting out now, I believe the minimum signal-to-noise ratio is 34 db.

*Mr. Lovell:* In view of the lateness of the hour we will at this time bring the discussion to a close.

Ed. Note: Plans are to publish within a very few months two or three more video-tape recording papers, chiefly about color recording.

## Improved Television Viewfinder for Motion-Picture Production

By KARL FREUND

A low-cost TV viewfinder using a 1-in. vidicon with 600-line resolution is described. An earlier version of this viewfinder which used a  $\frac{1}{2}$ -in. vidicon with 300-line resolution was presented at the Society's 80th Convention in Los Angeles. The new viewfinder is expected to cut costs of motion-picture production by enabling the director to view a picture on a TV monitor as it is being filmed, thus aiding him in making decisions concerning re-takes.

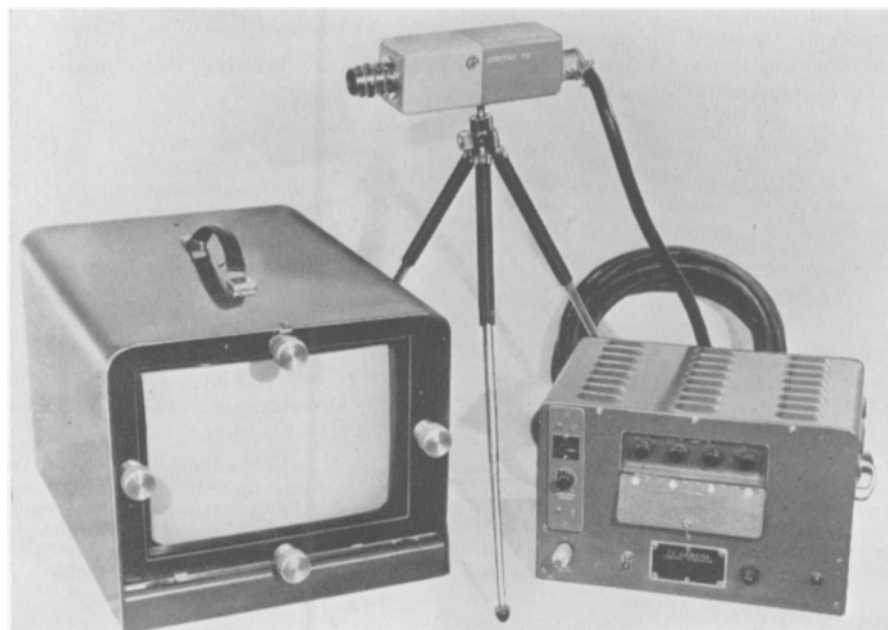


Fig. 1. Miniature camera is  $2\frac{1}{2}$  in. square and  $7\frac{1}{2}$  in. in length.

THE BENEFITS of a device which would permit a motion-picture director to watch a picture on a TV monitor as it was being filmed have been considered by the author since the introduction of live television. At the Society's 80th Convention in Los Angeles, a converted Mitchell Viewfinder with an optical system and  $\frac{1}{2}$ -in. vidicon closed-circuit TV camera, developed by Lockheed Aircraft Co., was introduced. The demonstration was premature in that the optical system incorporated in the viewfinder absorbed too much light and the  $\frac{1}{2}$ -in. vidicon was not sufficiently light sensitive to compensate for the loss.

The viewfinder described in this paper represents a new approach to the problem. It was decided that the desired results would be more likely to be obtained by developing a miniature camera using a 1-in. vidicon with higher resolution than 300 lines and by-passing the optical system. It was recognized that the earlier system had the advantage of zero parallax but rather than modify existing cameras, which would be an expensive procedure,

Presented on April 24, 1958, at the Society's Convention in Los Angeles by Karl Freund, Photo Research Corp., 837 N. Cahuenga Blvd., Hollywood 38.

(This paper was received on August 7, 1958.)