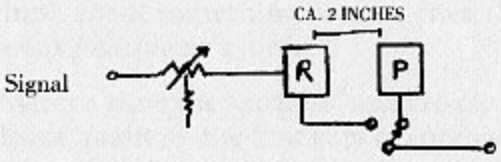
Tape Delay Techniques for Electronic Music Composers

The following technical article on tape delay techniques was requested by composer David Cope for *The Composer*, a magazine which he initiated and edited. The article was included in Volume I, No. 3, December 1969.

Whether in the studio or in concert, the tape recorder has uses beyond its ordinary recording function and can become part of the modifying ensemble in electronic music performance and composition. A common instance of this is tape head reverberation.

In order to utilize tape head reverberation, the recorder must have separate record and playback heads with access to both circuits. Comparison of the incoming signal to the record head with the recorded signal from the playback head is usually accomplished by a switch (Figure 1a).

(Figure 1a)

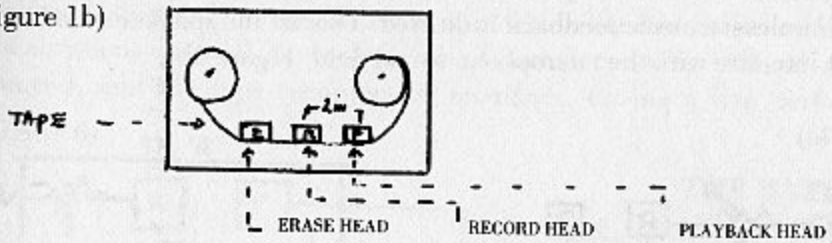


The distance between heads varies with manufacturer.
Figures below are for Ampex 350.

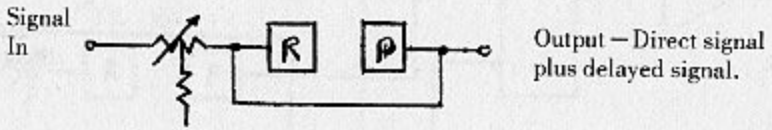
Output delay
266 milliseconds at 7½ ips
133 milliseconds at 15 ips

Signals to the record head are simultaneous with the source. Signals from the playback head are delayed with respect to the record head by the distance the tape must travel between the two heads (Figure 1b). Addition of the playback signal by means of a feedback loop to the record head will cause reverberation (Figures 2 and 3). The amplitude of reverberation is determined by the level of the feedback signal.

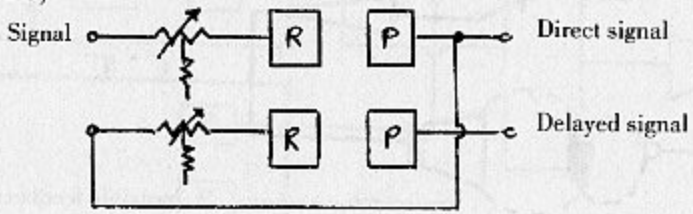
(Figure 1b)



(Figure 2)



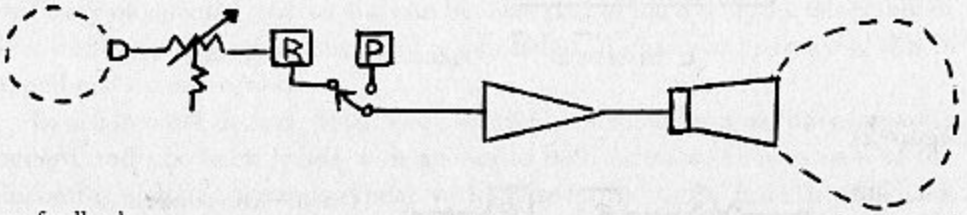
(Figure 3)



Many home tape recorders now have switches which automatically direct the signal from channel 1 playback head to channel 2 record head, and vice versa.

If the tape recorder is fed by a microphone, and the output to the record head is fed into the recording space or concert hall, the circuit acts as a P.A. (public address) system (Figure 4a). If the output from the playback head is fed back, then reverberation occurs (Figure 5). Microphone placement for both circuits is critical unless acoustic feedback is desired. That is, the speaker sound field must not interfere with the microphone sound field (Figure 4b).

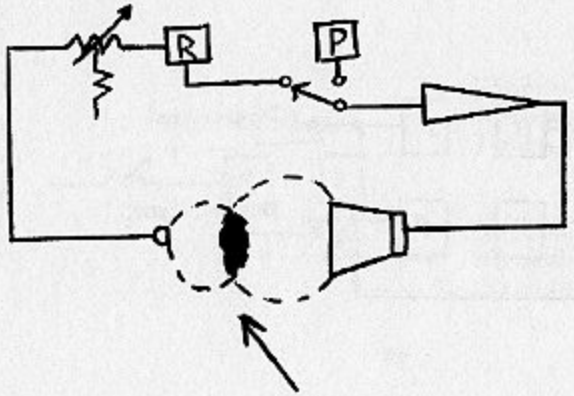
(Figure 4a)



no feedback

direct signal

(Figure 4b)



possible feedback area

(Figure 5)

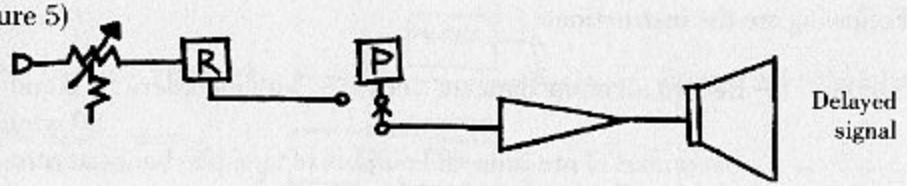
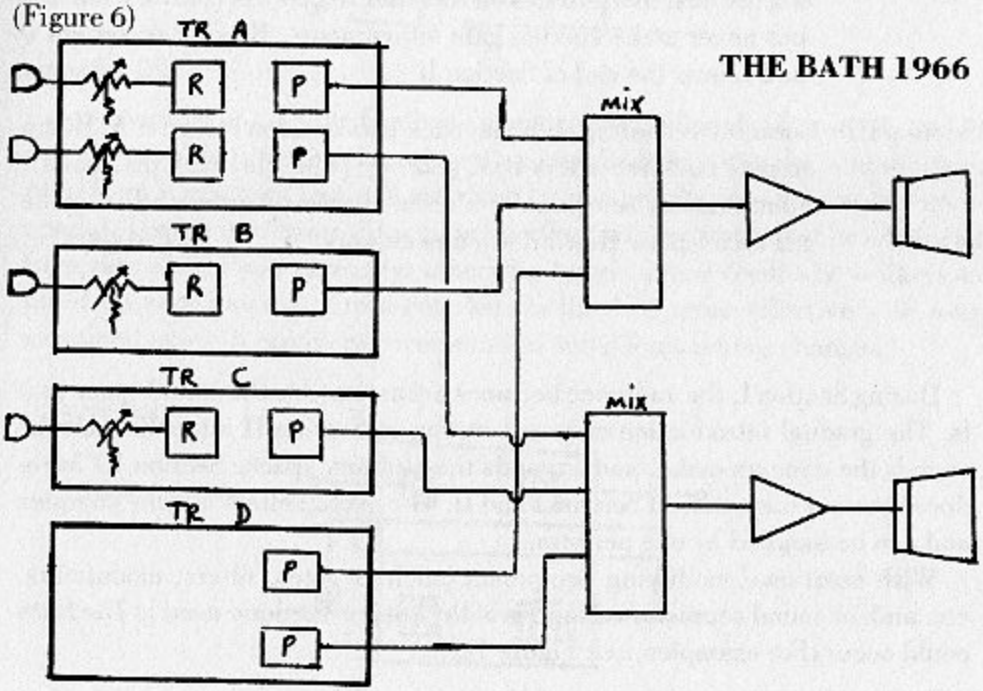


Figure 6 shows the equipment circuit for the *The Bath,* 1966, a composition for Ann Halprin's Dancers' Workshop, in which the dancers' movements and vocalizations as well as environmental ambience were utilized as sound sources, and the tape recorders as modifiers, during a live performance.

(Figure 6)



Following are the instructions:

Section I—Record all of the dancers' activities with recorders A, B and C *20 minutes*.
Set output of pre-amp and outputs of tape playbacks at zero.

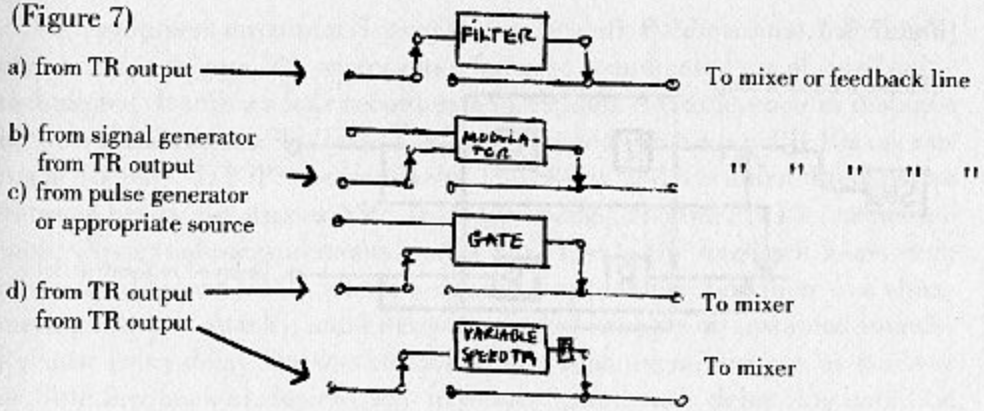
Section II—Rewind and transfer tape from recorder A to recorder D. Continue recording with B and C. Open the pre-amp pot to maximum acceptable output for the space. Put a new tape on recorder A and continue recording. Open the playback pots gradually during the next five minutes on recorder A. Always control feedback but never make sudden gain adjustments. Rewind recorders B and C near the end of Section II *20 minutes*.

Section III—Continue recording with playback pots open on recorder A. Begin to play back recorders B, C and D—(with playback pots open). Continuously select material from all four recorders utilizing the six mixer pots. Rewind when necessary. *20 minutes +*.

During Section I, the audience becomes accustomed to the sound space as it is. The gradual introduction of reverberation in Section II intensifies all the sounds the dancers make, and expands the auditory space. Section III introduces various memories of Section I and II. The overall effect is quite complex and can be handled by one performer.

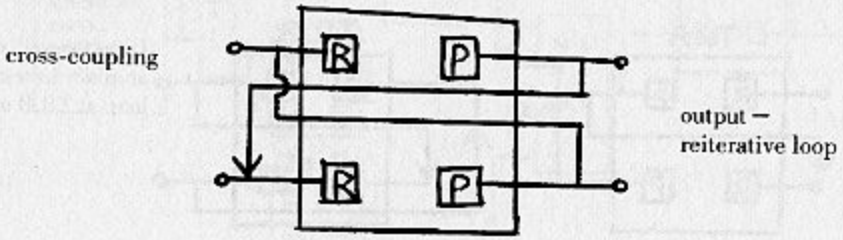
With additional modifying equipment (such as gates, filters, modulators, etc. and/or sound sources), variations of the basic technique used in *The Bath* could occur (For examples, see Figure 7).

(Figure 7)

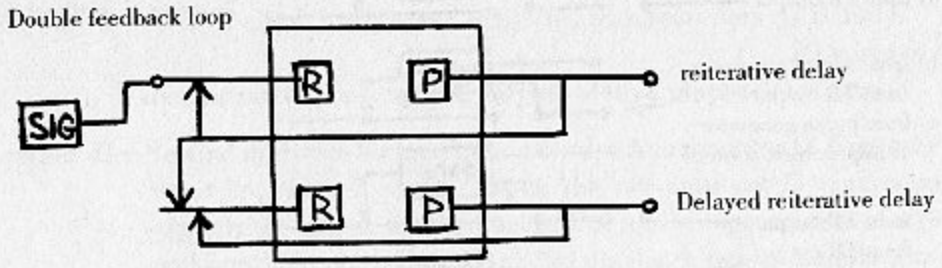


Cross-coupling or a double feedback loop between channels (Figures 8a and b) can produce continuous reiteration of an attack until: it decays, a new attack occurs, or a resonant mode is activated (which results in a continuous crescendo). These circuits are difficult to handle. Gain controls must be advanced from zero slowly and carefully; otherwise large volume feedback is likely to build up very quickly. Cross-coupled feedback is quite effective with long sustained tones; it produces reverberation and effects timbre changes.

(Figure 8a)

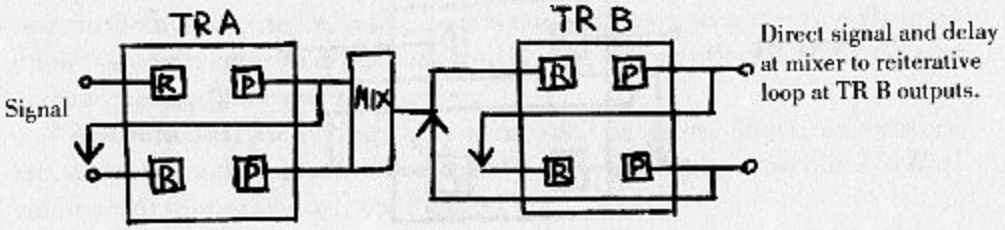


(Figure 8b)



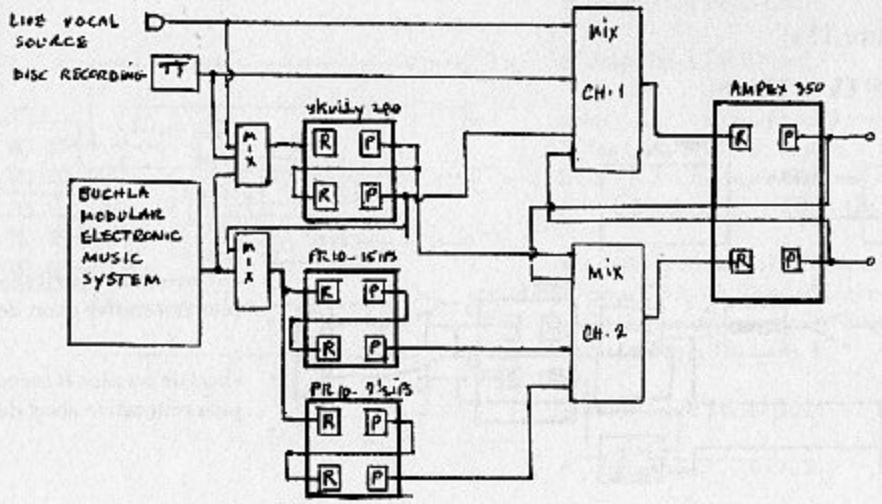
In order to get very fast repetition of attacks, the circuit shown in Figure 9 was used for part of the tape portion of *Light Piece for David Tudor,* 1965. (Four channel tape, amplified piano and light projections.)

(Figure 9)



The equipment circuit for *Beautiful Soop,* (Smith Publications), 1967, two-channel tape (Figure 10), represents a far more complicated use of small delay techniques. It utilizes four recorders and exploits the difference in distance between heads in the Skully 280, Ampex 350 and two Ampex PR 10s operating at 15 and 7 1/2 IPS, respectively. The Skully 280 has about three inches between heads; the Ampex 350, about two inches; and the PR 10s, about one inch. (No actual measurements were made. Use of the feedback loops were determined by ear.) With all the feedback loops in operation there is a shimmering effect on attacks, and interesting timbre changes on sustained sounds. Because every delay line was controlled by a separate mixing pot, as much or as little feedback as desired was introduced, and each delay line could be treated as a separate source. By sending delay lines to various modifying devices, a large number of variations could occur.

(Figure 10) **BEAUTIFUL SOOP 1967**



I of IV for two-channel tape, 1966 (CBS Music of Our Time series, ODYSSEY 32-160160) utilized one tape threaded through two recorders (Figure 11a) for an approximate eight second delay plus the shorter cross-coupled delays. Figure 11b shows the circuit for *I of IV*. Inserting a mixer in the feedback line provided control over the amount of feedback.

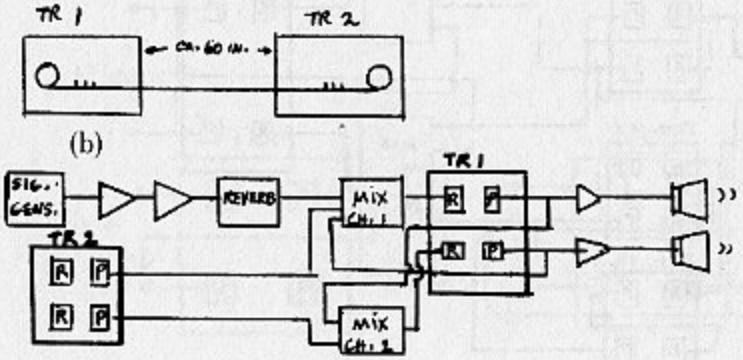
In *C(s) for Once*, 1966 (Berandol Music Inc., Canada), three tape recorders (with one tape threaded through all three) delay live sounds of voices, flutes, trumpets and organ (Figures 12a and b).

The console operator cues the performers and is instructed when to introduce the delay lines during the course of the performance.

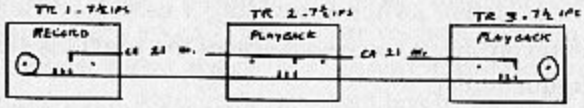
Most of the diagrammed circuits can be set up using home equipment, provided that the tape recorders have separate record and playback heads. Four input-one output mixers for isolating the input signals are available for five dollars from Lafayette Radio (Cat. 99T 4535 mono; the stereo mixer is not recommended). All feedback loops are accomplished by external patching.

(Figure 11a)

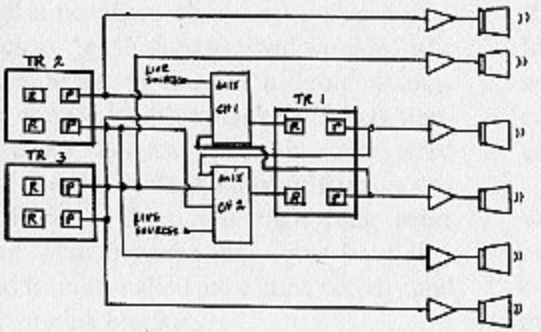
I OF IV – 1966



(Figure 12a)



(b)



3″ delay from TR 2-Ch. 1.

6″ delay from TR 3-Ch. 1.

short delay from playback head plus 3″ lag from TR 2-Ch. 1. and 6″ lag from TR 3-Ch. 2. plus cross-coupled reiteration loop from TR 1, Ch. 2.

short delay from playback head plus 3″ from TR 2-Ch. 2 and 6″ lag from TR 3-Ch. 2 plus cross-coupled reiteration loop from TR 1-Ch. 1.

3″ delay from TR 2-Ch. 2.

6″ delay from TR 3-Ch. 2.

A very flexible and interesting studio and performance tape recorder could be designed with the following considerations:

1. simultaneous access to each head via output jacks which bypass the comparison switch (input/repro).
2. an erase head defeat switch (providing a useful overlay function even though the record head somewhat erases the previous signal, especially the high frequencies).
3. selective synchronization (record head can be switched to playback head).
4. noiseless switching from: record to playback mode, erase or no erase without stopping the tape transport.
5. a playback head before the erase head.
6. extra playback heads with adjustable distance from the normal playback head for fine control of delay times.
7. multiple channels, i.e., 4 to 8.