

## WAR DEPARTMENT

## SIGNAL CORPS LABORATORIES

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OCEANPORT, NEW JERSEY

March 19, 1937

SUBJECT: Magnetically Recorded Signals.

TO: Chief Signal Officer, War Department, Washington, D.C.

1. There is inclosed herewith correspondence between Captain Harrod G. Miller, of your office, and Mr. W. D. Hershberger, of these Laboratories, now on leave attending the University of Pennsylvania, concerning an invention of Captain Miller and Mr. Friedman, of your office. This invention has been reviewed by these Laboratories and reported on by indorsement dated June 5, 1936 and December 28, 1936. Attention is invited to the attached copy of Engineering Report No. 20, dated February 9, 1932, which covers the test of nine types of magnetic material in an endeavor to secure suitable material for magnetic recording purposes. Attention is particularly invited to the high insertion loss reported at the bottom of page 4, and the masking of high frequencies reported upon in subparagraph 3, page 8, and the finding: "In short, the principle of superposition does not hold for the telegraphone as an element in a signal network." and to the final conclusions, paragraph V, page 12.



WM. R. BLAIR  
Lt. Col., Signal Corps  
Director

3 Incls.

- Incl. 1- Lt. Capt. Miller, 3-15-17,  
with 2 photostat incls.
- Incl. 2- Memo. fm. Mr. Hershberger,  
3-17-37.
- Incl. 3- E.R.No. 20, 2-9-32

Memorandum for Capt. Harrod G. Miller, Office of the Chief  
Signal Officer, Washington, D. C.,

Through Director, Signal Corps Laboratories.

Subject: System and Means for enciphering and deciphering  
Magnetically-recorded Signals.

1. In essence the answer to both questions depends on one factor: the lack of linearity in the recording (and reproducing) process. If the magnetic record were a faithful replica of the input signal as regards amplitude, we could superpose signals without limit and these signals would not get mixed up with each other irrevocably. Unfortunately, this is not the case. Large signals will mask small signals previously recorded due to an erasing effect similar to that normally exerted by a large magnet provided for that very purpose. The erasing process consists essentially of introducing a large signal of zero frequency and it would be ineffective for this purpose if the recording were linear.

2. By accident I have recorded signals on a steel wire when the erasing magnet was not energized. The result was a garbled signal in which both old and new recordings could be recognized distinctly, but the last signal recorded was the predominant one. In short, I have found experimentally that we have superposition, but of a non-linear variety. I have very scanty measurements on this effect, and they will be found

in my 1931 and 1932 notebooks. But since we do not have strict linearity, the best thing to do is to attempt to minimize its effects. I would make the following suggestions: (1) use the smallest possible amplitude of input signal, so as to reduce distortion of the non-linear variety, and (2) taper the power in the recording magnets so the first magnet to record carries the greatest amount of power and the last one to record the smallest amount of power. This could be accomplished by using recording magnets with different numbers of turns, or by varying the air-gap in an appropriate manner. These are merely tricks to minimize the deleterious effects arising from the non-linear record which you will have in any case.

3. To sum up; the resultant record is not the algebraic sum of the component records but can be made to approach this sum by low amplitude recording. As to your second question, I do not know how it could be answered other than experimentally.

*W. D. Hershberger*  
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