SOUND TALK
FROM THE MAKERS OF "SCOTCH" BRAND MAGNETIC TAPE

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THE EFFECT OF COATING THICKNESS ON THE FREQUENCY RESPONSE OF MAGNETIC TAPE

The field near the air gap of a magnetic recording head diminishes rapidly with distance from the pole tips, giving rise to some interesting magnetic recording phenomena. This effect is illustrated in Figure 1 which shows the flux configuration around an idealized recording slit of zero length. The curve at the bottom shows the relative field intensity as a function of the distance in any direction from the slit.

It is well recognized that the rapid decrease in field intensity in the longitudinal direction of tape motion plays an important part in recording of high frequency signals which occupy very short wavelengths along the tape. Successive recorded portions of the tape must pass rapidly out of the effective recording field before the high frequency signal changes polarity if excessive demagnetization is to be avoided.

However, the fact that the recording field diminishes rapidly in the direction of the tape thickness is also of importance in determining the depth to which the tape coating is recorded. At some small distance from the head surface, the field intensity is no longer sufficient to magnetize the coating. It becomes apparent, then, that at long wavelengths the depth to which the tape coating is magnetized can be increased by increasing the total strength of the recording field. This may be accomplished by increasing the audio and supersonic bias currents energizing the head.

The usual method of determining "optimum" recording conditions for a given system is by recording a low level, low frequency signal on the tape, and adjusting the amplitude of the supersonic bias to obtain the maximum reproduced signal. The audio recording amplitude is then adjusted for the maximum tolerable distortion level in the reproduced signal.

Increasing the bias current decreases the low frequency response, but this loss may be restored by proportionately increasing the audio record level. Moreover, it will be found that, so long as the audio and bias amplitudes are maintained in the desired ratio, they may be varied over a wide range (from perhaps one half to five times the usual "optimum" value) without materially affecting the distortion level.

Decreasing the audio and bias results in reduced output because of the restricted depth of recording, whereas increasing them does not alter the reproduced low frequency signal. It does, however, cause the recording process to be less sensitive to separation between the recording head and the tape, which may be desirable in certain applications.

Unfortunately, these same relationships do not hold true when recording high frequency signals of a wavelength approaching the thickness of the tape coating. Under these conditions, an increase in the bias current of perhaps 50% beyond the "optimum" value results in loss of sensitivity and output which cannot be recovered by increasing the audio recording current in the head.

At high recording bias levels, the field intensity directly over the pole tips is sufficient to saturate the tape coating, and the principal region of recording then advances to the broad fringing field some distance away. The attendant loss of resolution accounts for the pronounced (and irrecoverable) loss of high frequency response when high recording intensities are used.

An interesting series of experiments involving tapes of various coating thicknesses will serve to illustrate these principles.

Three different tapes having "high output" coatings 0.25, 0.5 and 1.0 mils thick were prepared and tested using high, low and "optimum" amounts of bias signal. The resulting frequency response curves are shown in Figures 2, 3, and 4 respectively.

Also, it was found that the maximum usable signal (obtained by increasing the audio record current), was in all cases proportional to the sensitivity values indicated in the response curves, so that the curves represent the true differences in performance among the tapes and bias settings.

From the curves of Figure 2, it is apparent that, using a high value of bias, the low frequency responses of these tapes are almost directly proportional to the coating thickness. This would be expected from the fact that the depth of the recording field should be sufficient to magnetize the full thickness of the coatings.

The high frequency responses, however, tend toward a common value, and indicate that the short wavelength magnetization is confined to a very thin layer on the surface of the tape. Self demagnetization of the deeper layers probably accounts, in large measure, for this effect.

It is interesting to note in Figure 3, that recording with a low value of bias signal virtually eliminates differences in the output of these tapes. The limited recording intensity restricts the depth of magnetization to approximately that of the thinnest tape, and the additional coating material in the thicker tapes is ineffective.

The curves of Figure 4 showing the frequency responses of these tapes when each is recorded using "optimum" bias, illustrate the large differences which might be encountered in practical applications. Increasing the coating thickness demands increased bias for most efficient recording, which simultaneously improves the low frequency response and reduces the highs.

From these studies, it is possible to generalize regarding the effect of coating thickness and bias on tape performance.

1. The low frequency output of a magnetic tape varies approximately as the coating thickness provided a sufficient recording bias is used to magnetize the full depth of coating.

2. The response of a thin tape coating is the same as that of a thick coating, provided the latter is recorded with a value of bias current just sufficient to magnetize the thin coating.

3. Increased recording bias, as demanded by thicker coatings, results in reduced high frequency output.

A practical example of the effect of

coating thickness is a comparison of the operating requirements and performance of "Scotch" brand No. 120 "High Output" tape and No. 190 "Extra Play" tape. (Note: The magnetic properties of "Weather Balanced" No. 150 tape are identical with those of No. 190 tape.) Each of these tapes employs a similar type "high output" coating (1100 gauss remanence), the principal difference being the coating thickness (0.65 mil in the case of No. 120 tape and 0.35 for No. 190 tape).

The No. 120 tape requires the standard bias intensity and is capable of much increased output at low frequencies. The No. 190 tape requires about 20% less bias and, when recorded under these conditions, has outstanding high frequency performance.

When No. 190 tape is recorded with standard bias, its response is almost identical with standard No. 111 tape as would be expected. By proper selection of the recording tape, and further, by adjustment of the recording conditions in accordance with the principles discussed above, the performance characteristics of a recording system can be optimized for any recording application.

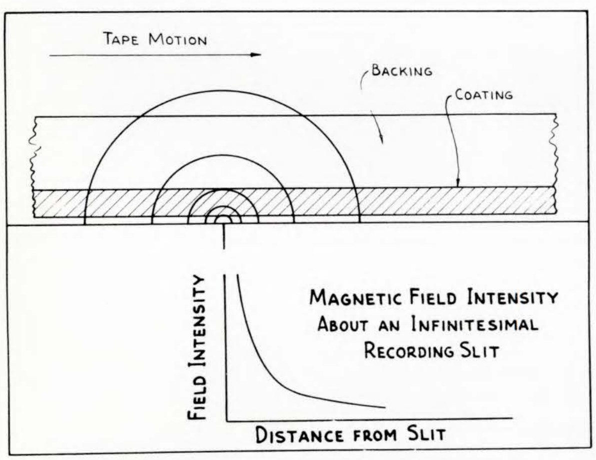

Fig. 1

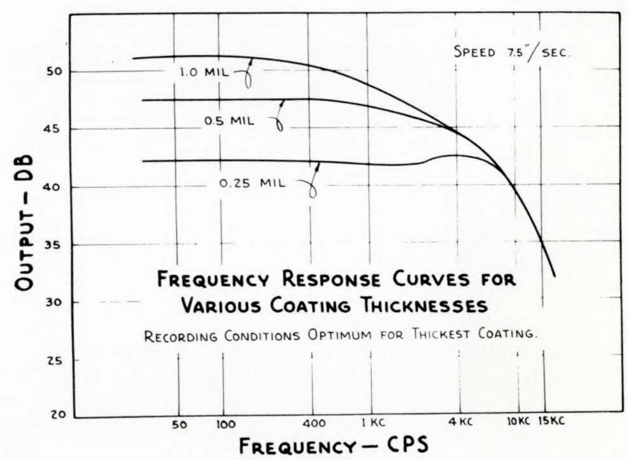

Fig. 2

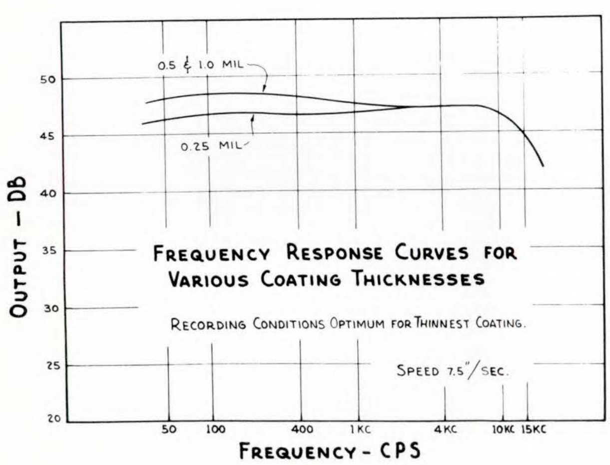

Fig. 3

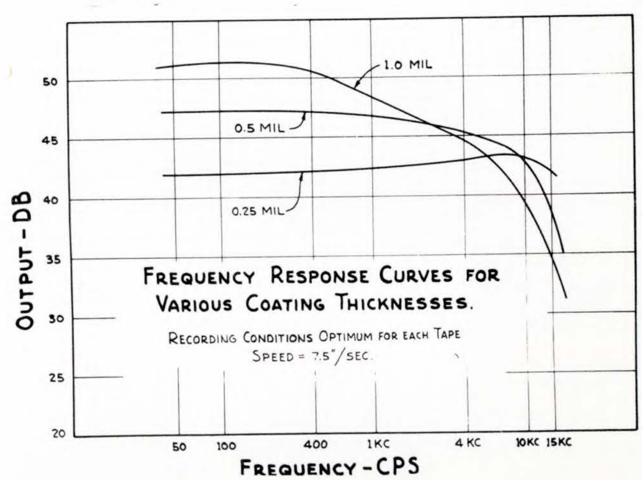

Fig. 4