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A NOISE REDUCTION SYSTEM FOR CONSUMER TAPE RECORDING

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A Noise Reduction System for Consumer Tape Recording

The B-Type noise reduction system is designed for the reduction of hiss in consumer tape products. Employing techniques similar to those used in the wideband A-Type professional noise reduction system, the B-Type system retains the advantages of inaudible action, good record-playback matching, and low distortion. (See Journal of the Audio Engineering Society, October 1967, and Audio, June/July 1968, for a discussion of system principles.)

In sound recording systems the high audio frequencies are often pre-emphasized during recording and de-emphasized during reproduction in order to improve the signal-to-noise ratio. However, the equalization characteristic must be chosen such that even with high-level, high frequency signals there are no detrimental effects. Therefore the allowable boost with fixed equalization is not as great as it might be for optimum utilization of the recording medium. For example, recording an instrument such as a piano or violin does not usefully load the tape over the whole audio spectrum, and thus high frequency noises are noticeable during reproduction.

It is clear that the situation could be improved with a more flexible equalization method. The B-Type noise reduction system provides a characteristic, controlled by the incoming signal, which achieves a much more efficient utilization of the tape recording medium under all signal conditions. During playback a complementary characteristic is applied which restores all signal components to their correct amplitudes and phases and in the process attenuates any noise introduced during recording.

In the professional A-Type system the signal and noise frequency spectrum is split into four bands. In consumer tape applications, however, the main noise problem, tape hiss, can be handled inexpensively but adequately by the use of a single high frequency noise reduction band. The B-Type system uses such a method and is effective from approximately 1kHz upwards; the noise reduction provided is 3dB at 600 Hz, 6dB at 1.2kHz, 8dB at 2.4kHz, and 10dB at 5kHz.

In the B-Type system the width of the noise reduction band is variable, being responsive to the amplitude and frequency distribution of the signal. In this way it is possible with relatively simple circuitry to obtain significant amounts of noise reduction down to quite low frequencies without causing audible modulation of the noise by the signal.

The B-Type system utilizes the same differential method of signal processing as in the A-Type system. Since the high-level signals are treated separately from the low levels, there are no high-level signal handling problems, the low-level signals being the only ones which undergo any kind of variable action.

A block diagram of the B-Type noise reduction system is shown in the first figure. At the bottom of the figure the symmetrical nature of the system can be seen. On the playback side a network is provided which passes only low-level, high frequency signals. These signals are allowed to return to the subtractor and partially cancel low-level noise components coming from the tape. High-level signals are not allowed to pass through the network and do not cancel; the high-level signals therefore pass through essentially unchanged.

In partially cancelling the low-level noise components from the tape, the playback half of the system also unfortunately partially cancels any legitimate low-level components of the signal itself. Therefore, the reason for the existence of the record half of the system is to pre-compensate for the low-level signal cancellation which takes place in the playback portion of the system. If, in the configuration shown, a network having identical characteristics to that used in playback is used on the record side, the system output signal will be identical to that at the system input. There will be no alterations of frequency response, phase response, or transient response. In other words, the system will be a truly complementary one which preserves the integrity of the signal.

From the point of view of maintaining signal integrity it is almost immaterial what type of network is used, provided only that the two networks are identical. But from a noise reduction point of view, the characteristics of the network are crucial. If the frequency response or signal limiting characteristics of the network are incorrect then there may be either insufficient noise reduction or, even worse, an apparently changing amount of noise reduction, depending on the signal.

In order to maximize the amount of noise reduction obtained under signal conditions the high-level blocking circuit mentioned previously is a variable high-pass filter. Under given signal conditions the cutoff frequency is caused to shift upwards sufficiently to attenuate any high-level signal components but not so far that low-level signals at higher frequencies cannot pass through. It is important that all low-level high frequency components should be able to pass through, since in the playback mode these return to the subtractor and produce the noise reduction. Thus, the desired action of attenuating high-level signal components, so that there is no danger of tape overload, is achieved without impairing the noise reduction action at frequencies higher than that of the high-level signal. The cutoff frequency of the filter automatically conforms itself to the amplitude and frequency distribution of the incoming signal. This technique yields sufficient noise reduction even under high-level signal conditions to avoid noise modulation effects (breathing).

The variable filter, shown in the first figure, follows a 1.5kHz fixed high-pass filter, which defines the lower effective limit of the noise reduction action and further reduces noise modulation effects. The variable high-pass filter is controlled by an amplified, rectified, and smoothed signal taken from the output of the filter.

The frequency responses of the record and play units at very low levels are given in the second figure. The complementary nature of the characteristics can be seen.

The record characteristics under single signal conditions at various levels are shown in the third figure. When the level of the signal increases, the amount of high frequency boosting is progressively reduced. At 0 VU the boosting is negligible, and the record output signal is substantially equal to the input signal.

The noise reduction system as described produces an effective noise reduction of 9dB when measuring cassette noise according to the DIN 45405 noise weighting characteristic.

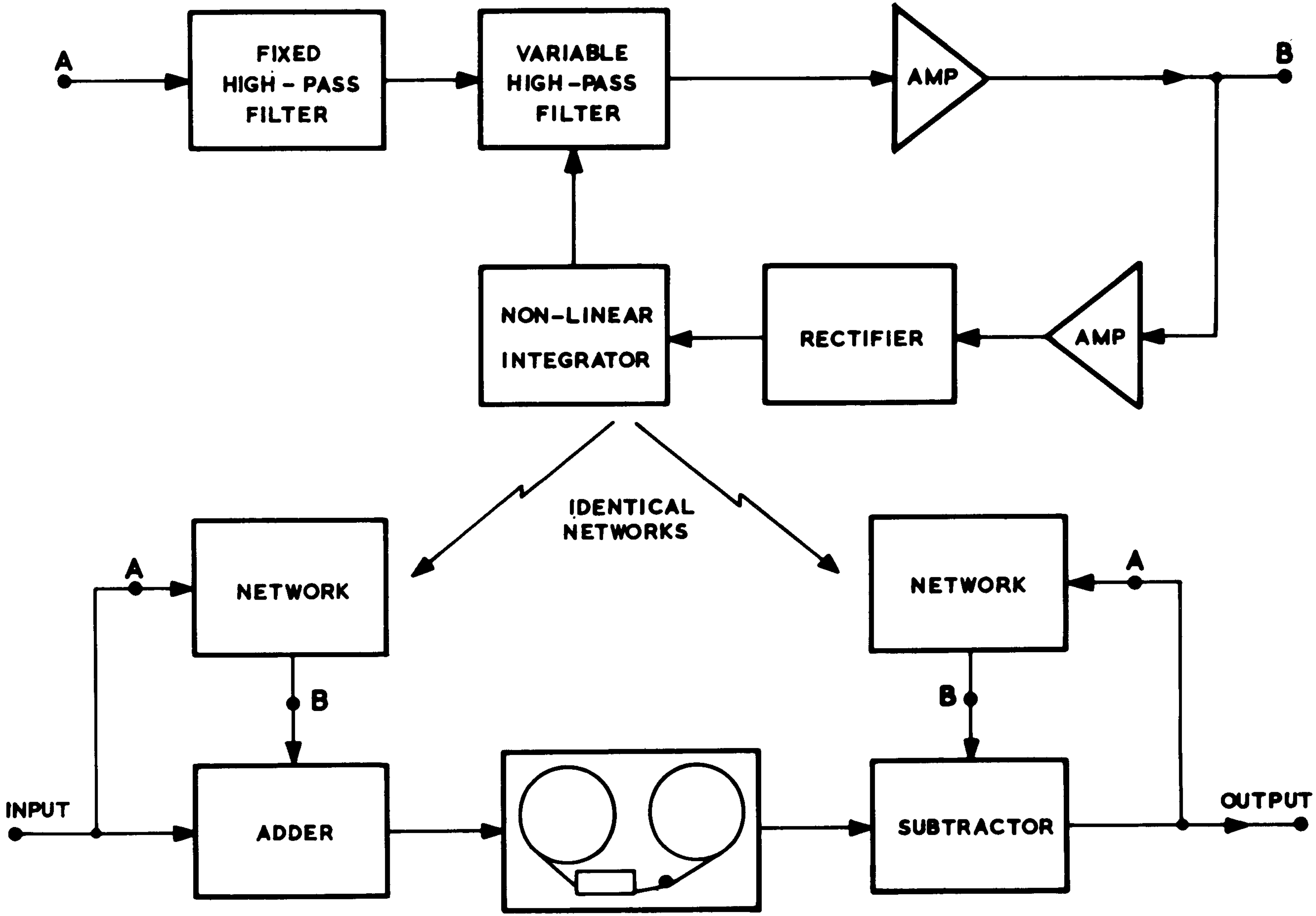
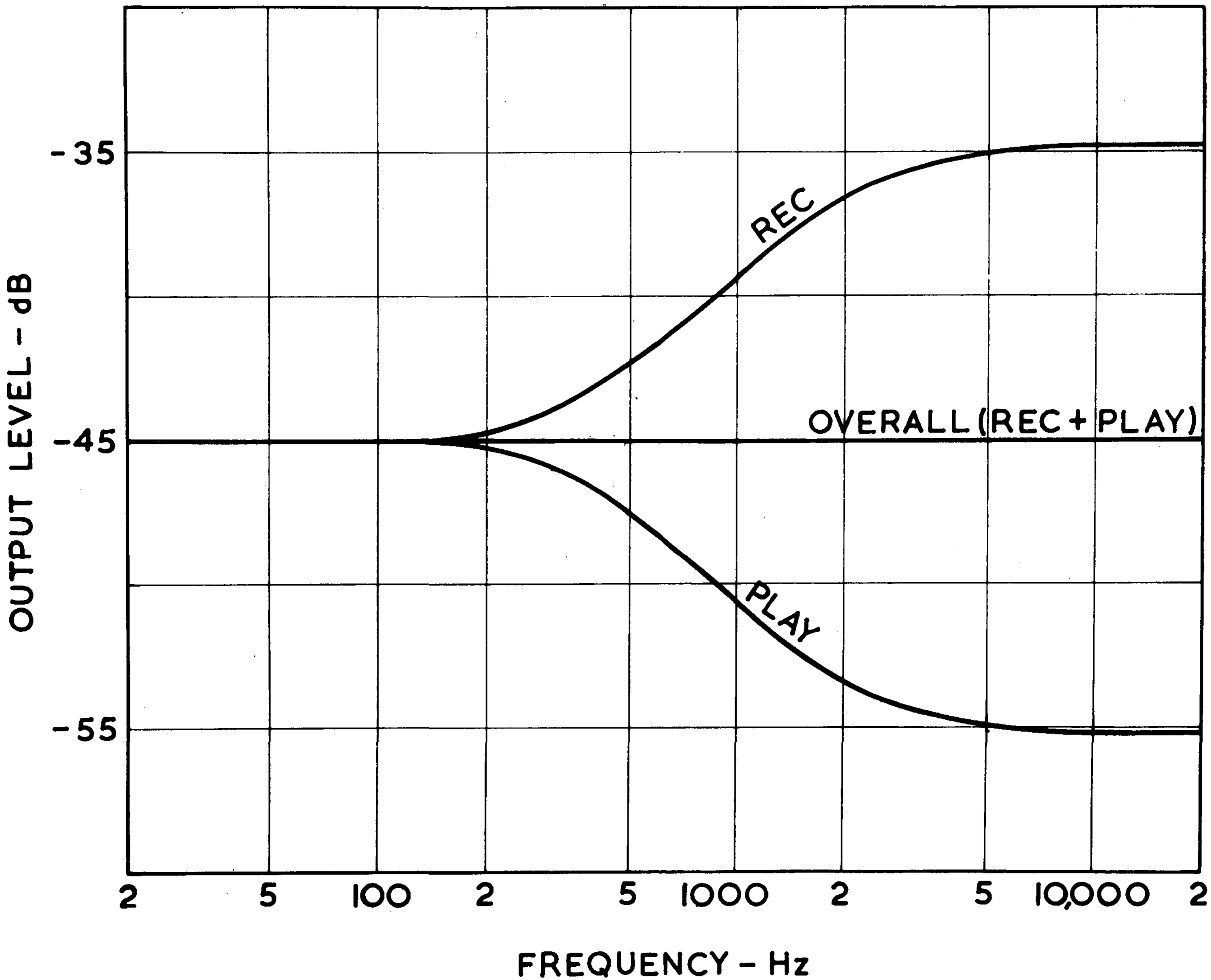


FIGURE 1. B-TYPE NOISE REDUCTION SYSTEM - BLOCK DIAGRAM



LOW-LEVEL FREQUENCY RESPONSE
FIGURE 2. CHARACTERISTICS OF RECORD AND PLAY PROCESSORS

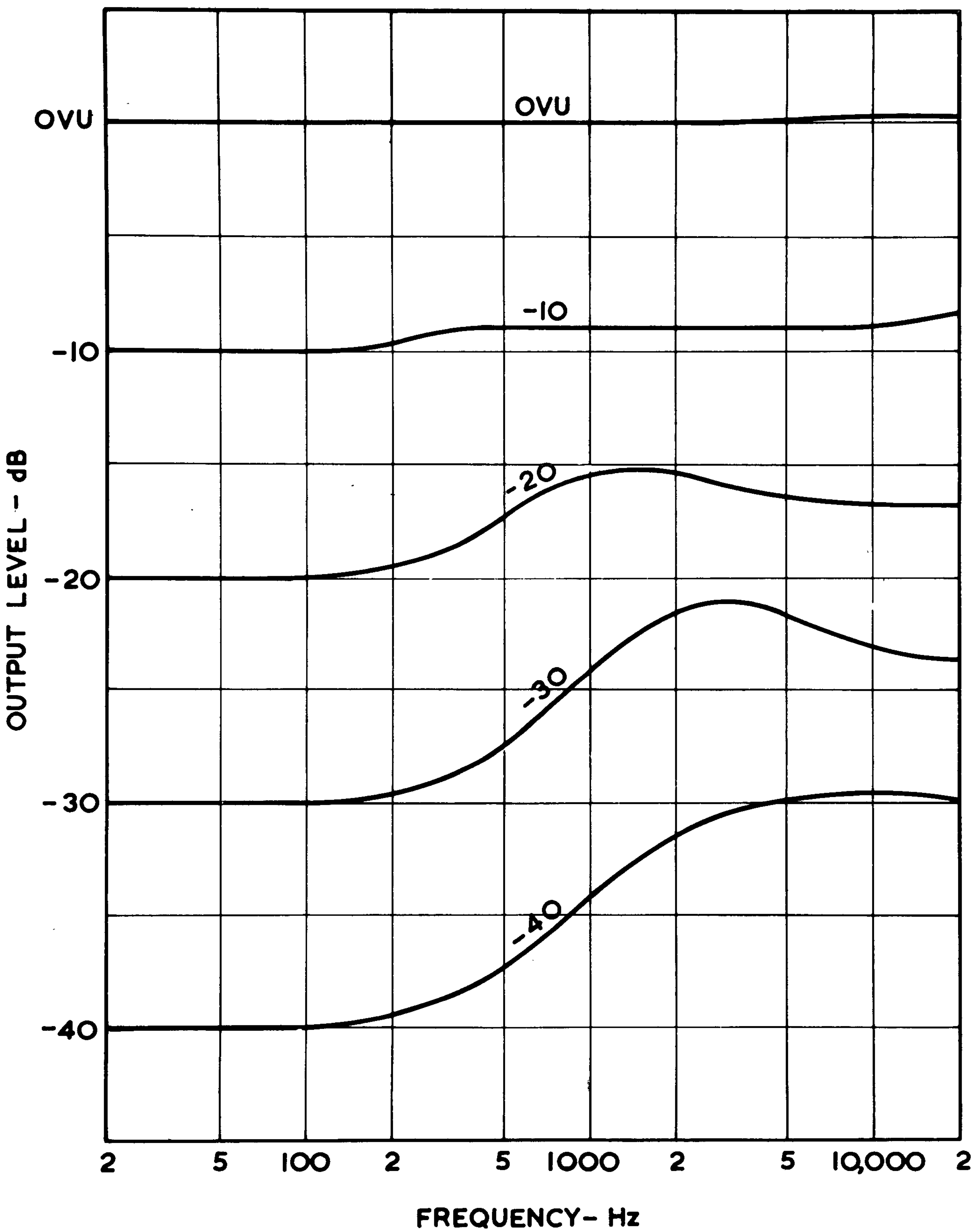


FIGURE 3. RECORD PROCESSOR CHARACTERISTICS