AMPEX
CORPORATION
professional products division

SERVICE BULLETIN

934 CHARTER ST. · REDWOOD CITY, CALIF. · EMERSON 9-1481 · TWX REDWOOD CITY, CAL 41 · CABLE ADDRESS: AMPEX, REDWOOD CITY

AMPEX MASTER EQUALIZATION (AME)

Tape noise, or "hiss" is perhaps the greatest limiting factor in the quality of present-day tape recordings. Record and pre-recorded tape making has become so quiet that, in many examples, noise heard on a production record or tape is very little more than that of the master tape.

The tape manufacturers are presently engaged in an all-out effort to reduce noise on the tape itself, while we at Ampex have undertaken a series of studies with an aim to improving noise problems with the tape presently available.

The great majority of master recordings are made at a tape speed of 15 ips. From a noise standpoint, this is the worst speed possible: a 7-1/2 ips or 30 ips original tape should be quieter, but has, of course, the usual limitations of frequency response on the one hand and playing time on the other.

This "noise" referred to is subjective noise -- the noise heard rather than the noise measured on a volt meter. To give some objective basis to the study, however, we were concerned largely with the noise generated in the frequency band from 2000 to 6000 cycles per second -- that band to which the ear is most sensitive as indicated by the Fletcher-Munson study of ear sensitivity.

The noise generated by the tape cannot actually be reduced by any means outside of improving the tape itself. However, an increase in the signal-to-noise ratio can be obtained by increasing the signal level. Dangers in high-level recording at the higher frequencies lie not so much in ordinary harmonic distortion but in compression and self-erasure.

As the input signal amplitude increases to a high level, the amount of signal actually recorded on the tape reaches a limit called saturation. At this point, the signal on the tape is much less than the input signal, or is compressed to about one-half the amplitude or less of the input signal. Since this saturation level varies with frequency, a very uneven response is obtained when recording at too high a level. If the high-frequency input level is increased still more beyond the saturation point, the signal on the tape decreases. This phenomenon is known as self-erasure: A high-level, high frequency signal not only erases itself as it is being recorded, but partially erases any other tone which is also being recorded. This phenomenon is particularly evident when recording at 7-1/2 ips or 3-3/4 ips at a high level. The audio effect is exemplified by the cymbal crash which so often sounds as if two loaves of bread were being slammed together.

Our aim, then, in developing a new equalization curve was to attempt to increase the signal to the tape in the band from 2000 cycles to 6000 cycles, while simultaneously decreasing the playback level (thus, the noise) in that band, yet still escape the problems of compression and self-erasure when making high-level 15 ips recordings as normally done in the recording of master tapes in a recording studio.

At any given audio frequency recorded on tape, there exists a certain dynamic range -- this range limited at one end by the noise generated by the tape and at the other end by the maximum signal amplitude that can be recorded on the tape. It was our discovery that this total dynamic range afforded by the tape was not being fully utilized at 15 ips tape speed with the present NAB equalization curves.

Studies were made in the Ampex Research Department of the frequency spectrum of recorded sound. The results of these studies indicated that a greater signal amplitude could be recorded on the tape in the region of 2000-6000 cycles than is presently allowed by NAB equalization -- without significant increase in overall distortion. Extensive listening tests confirmed the calculated results; the tests utilizing a special 2-channel Model 350 which enabled the listener to simultaneously hear original recordings recorded by both the NAB and the AME equalization curves. In addition, and in cooperation with the RCA Victor Division, master recordings were made at their studios in New York using an equalization curve identical to the proposed AME curve. They experienced no objectionable distortion or compression problems even in the most severe recording condition -- a Perez Prado rock 'n' roll number.

The final AME curve affords an approximate 8 db increase in signal-to-noise ratio, on the weighted scale discussed previously, on master recordings.

In the production of commercial tapes, the AME curve should be used for any recording from the original master down to the master used on the duplicator.

The playback curve (Fig. 1) differs from the NAB curve by a depression of the response by about 8 db in the region from 2000 to 6000 cycles. The AME record curve (Fig. 2) incorporates an increase in response in this same area, such that the overall response of the recording system is flat from record input to playback output.

The Ampex Master Equalization Curve is to be offered in addition to the standard NAB equalization in all forthcoming multi-channel Model 300 recorders. The 351M electronics, to be used in multi-channel Model 300 recorders, as well as the electronics used in the Model 3300 four track duplicator, will have equalization switch selection to accommodate AME. Circuit changes are necessary to convert existing Model 350 electronics from 15 ips NAB to AME equalization.

As a matter of interest, this same sort of study was carried out for 7-1/2 ips operation. The findings indicated that the present 7-1/2 ips NAB curve is satisfactory when using existing tape, so no recommendation is made to change the 7-1/2 ips equalization at this time.

The record circuit changes to Model 350 equipment is shown in (Fig. 3). A three position switch is used in place of the present two position equalization switch. This allows the new equalization to be added without losing the present NAB equalization. Obviously, the two position switch might be rewired if one were to sacrifice flexibility. Control C. should be adjusted to yield the response curve shown in (Fig. 2).

A companion change should be made in the playback circuit to yield the response shown in (Fig. 1). However, this change is complex. In the interests of simplicity, we have developed an external "black box" which is to be inserted in the output line immediately following the playback amplifier output. This is shown in (Fig. 4). Note that this circuit does not provide flat overall response when monitoring the input signal (Meter and Output Switch in the RECORD LEVEL position), and that the meter will read an equalized, rather than true, response on the playback of an AME-recorded tape. The equalized meter response does provide, however, a true indication of the signal actually recorded on the tape. The insertion loss of the network shown in (Fig. 4), using the specified inductors is 1/2 db. Use of other inductors may result in more or less insertion loss.

To align the equipment to the new AME curves, it is desirable to use a standard alignment tape. The Ampex Standard Alignment Tape, Cat. No. 4494 or Cat. No. 50483, will play back through the passive output network (Fig. 4) with the characteristic shown in the special response curve of (Fig. 5).

At a later date, Ampex intends to make available to its customers kits containing all parts, escutcheons, etc., necessary for the correct internal modifications to the Models 300 and 350 for the new AME curve modification. A letter addressed to the Service Department, Ampex Corp., Redwood City, will bring this information as soon as it becomes available.

In the meantime, it is hoped that the information contained herein will be of benefit to Ampex users.

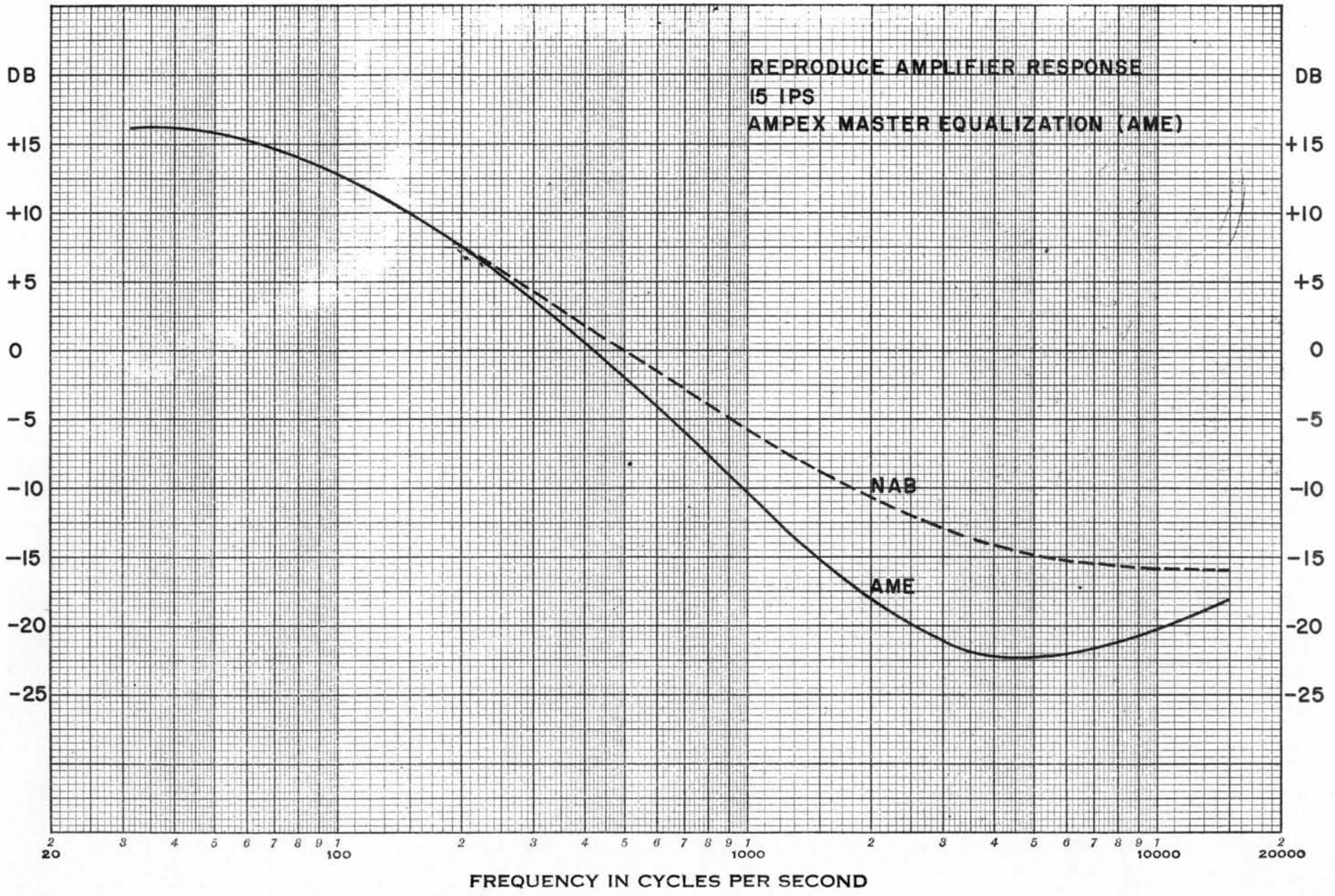
REPRODUCE AMPLIFIER RESPONSE
15 IPS
AMPEX MASTER EQUALIZATION (AME)
DB
+15
+10
+5
0
-5
-10
-15
-20
-25
NAB
AME
20
100
1000
10000
20000
FREQUENCY IN CYCLES PER SECOND

FIG. 1

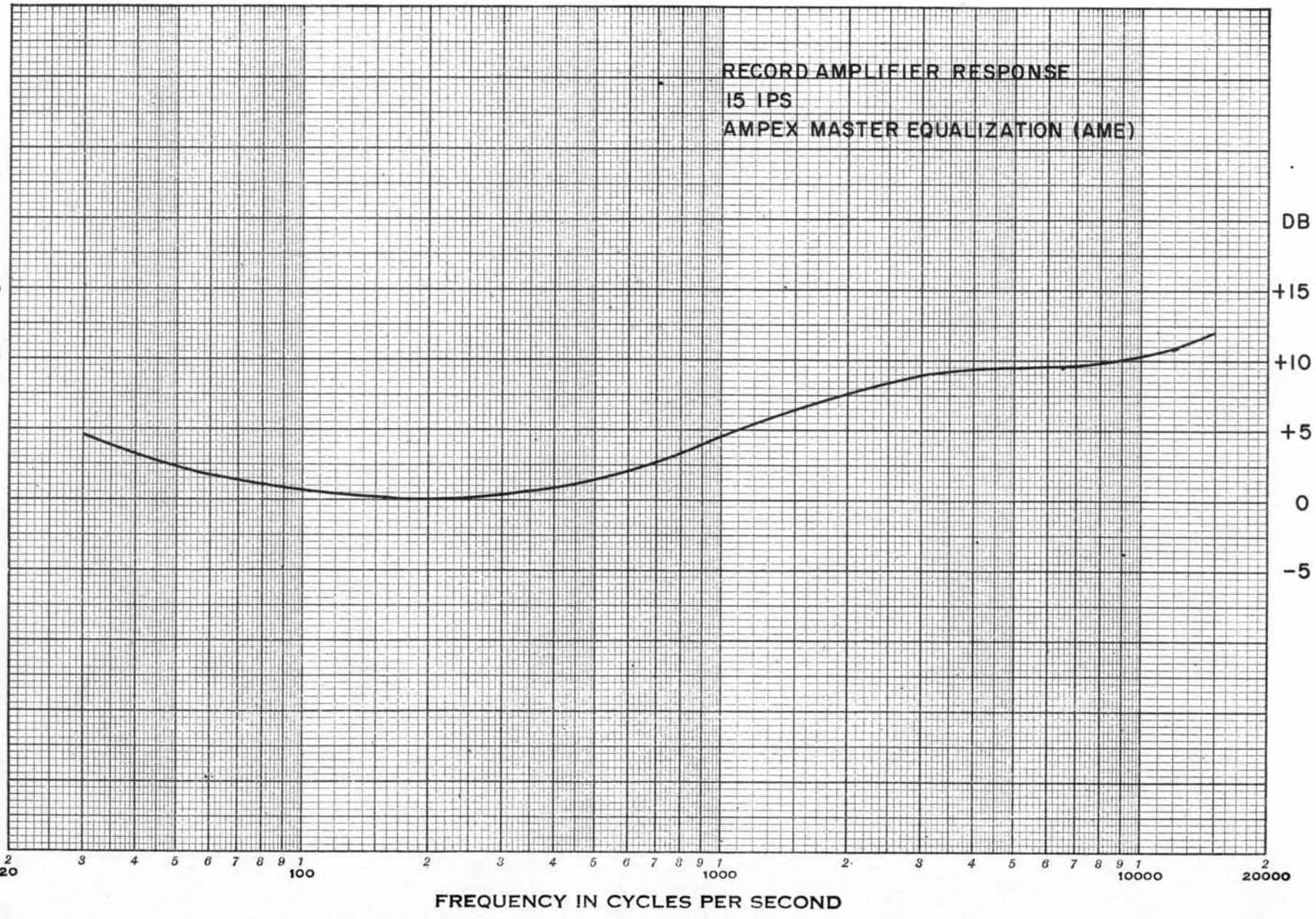
RECORD AMPLIFIER RESPONSE
15 IPS
AMPEX MASTER EQUALIZATION (AME)
DB
+15
+10
+5
0
-5
DB
+15
+10
+5
0
-5
20
100
1000
10000
20000
FREQUENCY IN CYCLES PER SECOND

FIG. 2

MODEL 350
RECORDING AMPLIFIER MODIFICATION
(FOR AME CURVE)

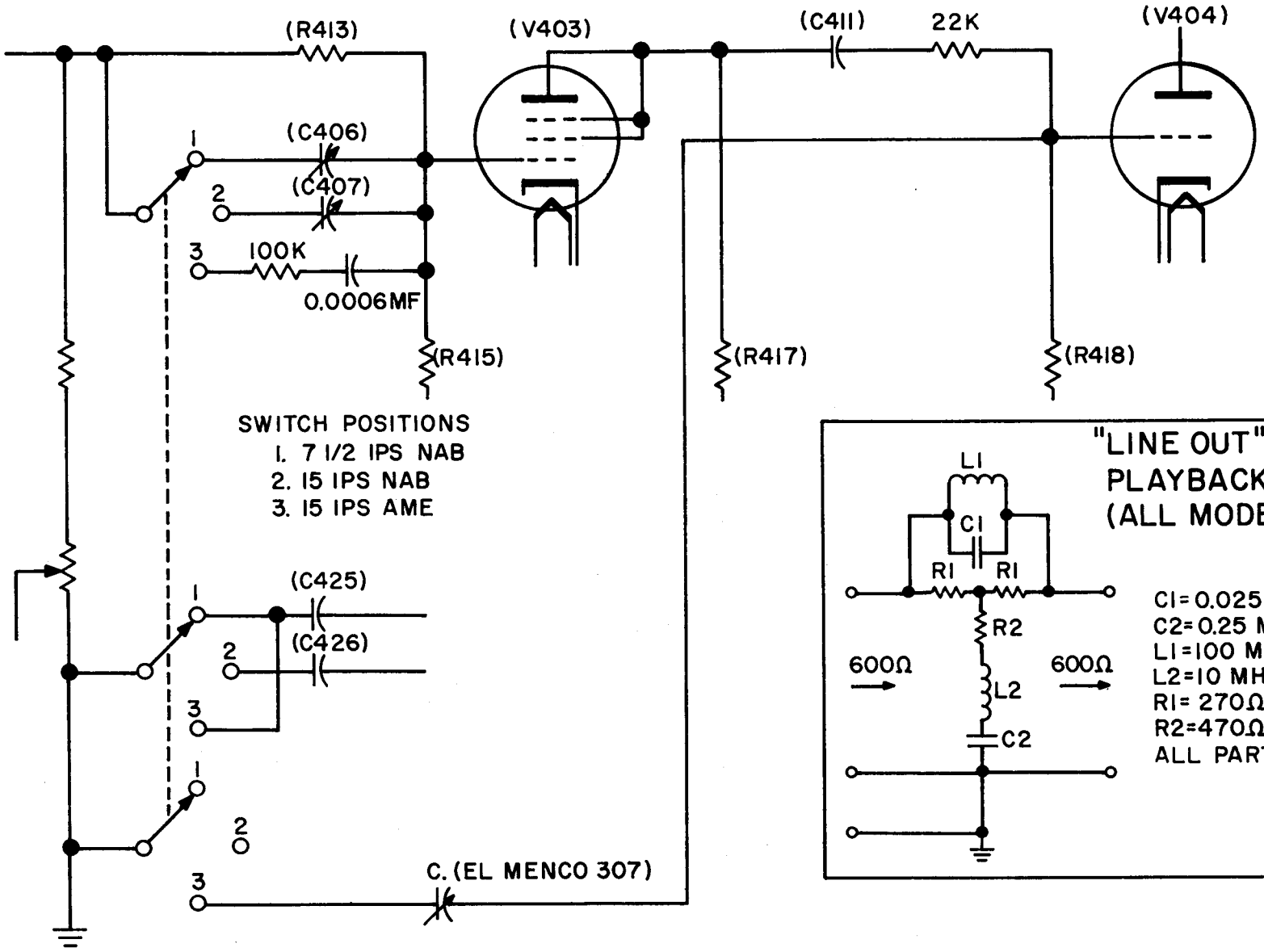

FIG. 3

FIG. 4

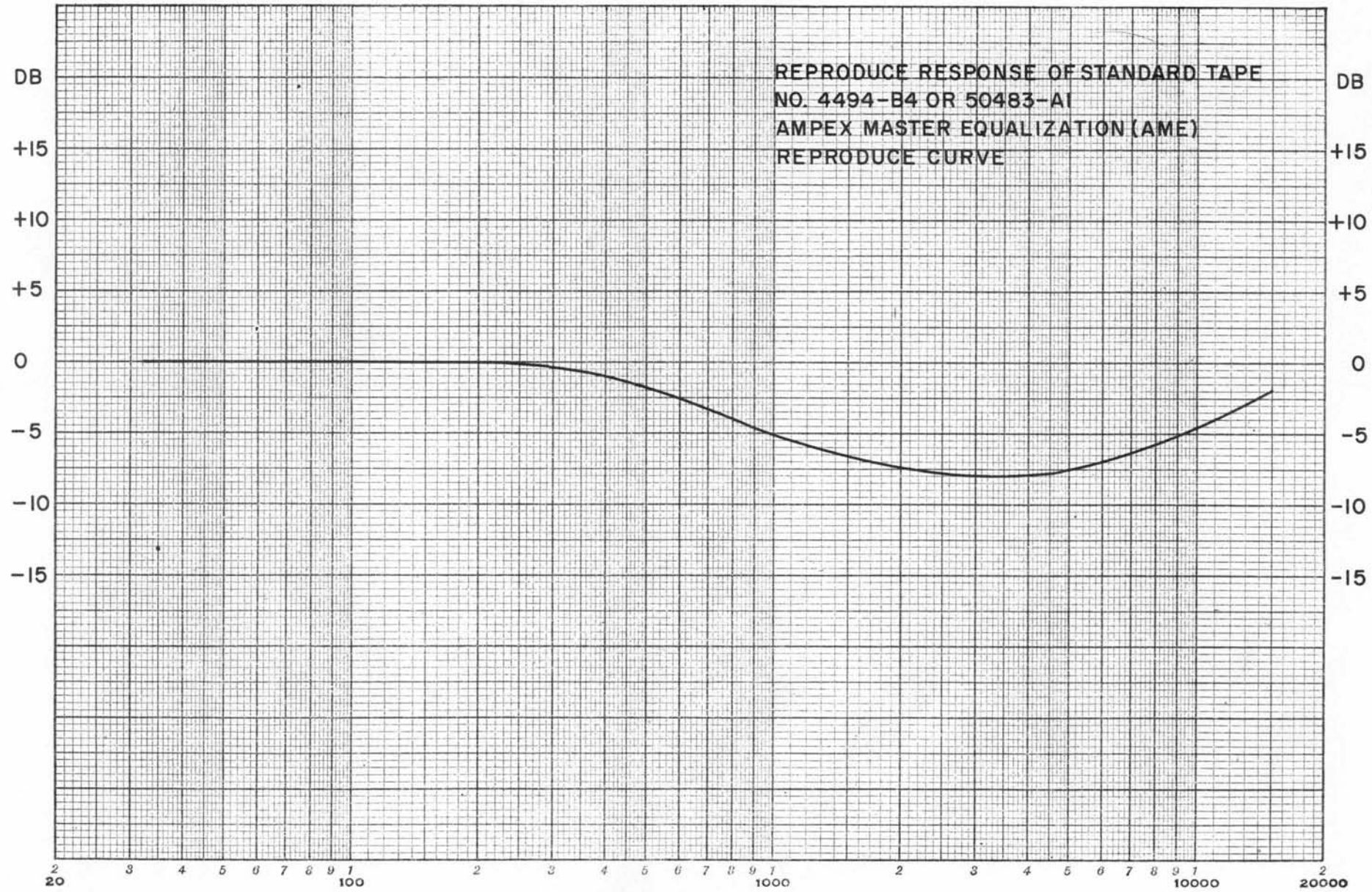
REPRODUCE RESPONSE OF STANDARD TAPE
NO. 4494-B4 OR 50483-A1
AMPEX MASTER EQUALIZATION (AME)
REPRODUCE CURVE
DB
+15
+10
+5
0
-5
-10
-15
20
100
1000
10000
20000
FREQUENCY IN CYCLES PER SECOND

FIG. 5