Stylus in Wonderland

An Excursion into the Realms of "High-Fidelity" Disc Recording

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THE Irishism has it that "all improvements are for the worse," a sentiment not without philosophical undertones. Progress in the art of sound recording has certainly made improvements to recordings, but these "improvements" may often make matters worse in other directions. The price of progress often seems to consist in the creation of fresh problems.

Part of these new problems have been created by the striving for the utmost in so-called "high-fidelity" recordings. While it is easy to equate wide frequency range with "high-fidelity," this is only part of the story. Transient response appears to be the most important factor in the recognition of instruments. The characteristic sound of an instrument, it would appear,[1] is determined by its "keying characteristic," that is the attack or build-up of a note under the impact of a step impulse from the executant. The exact relative amplitudes of the various harmonics is obviously less important in the recognition of instruments. This would seem to follow from the fact that various instruments can be identified even when reproduced in indifferent equipment. Certainly the majority of popular priced receivers and radio-gramophones make very limited approaches to the professed ideals of the high-fidelity purists. In this connection it must also be acknowledged that there is considerable evidence for the contention that a genuine binaural or a stereophonic sound system of limited frequency response is more pleasing and satisfactory than a single wide-range monaural system.[2]

The goal of a wide frequency response has very definitely been tackled by the record manufacturers. The pre-war recording limit of some 8,000 c/s has been extended to 15,000 or even 20,000 c/s. The provision of recording extending into the supersonic region may assist in the correct rendition of transients. However, as the atmosopheric absorption at these frequencies may vary by several db depending on climatic conditions, either an air-conditioned listening room or a top corrector geared to a barometer seems a necessary part of the reproducing system.

The seeker after "high" fidelity, or even "medium" fidelity reproduction is now faced with a bewildering variety of recording curves. It was always necessary to monkey with the recording characteristic even in the earliest days of electrical recording. A constant-velocity characteristic in the bass region is impracticable, as the large excursions in the groove modulation would necessitate wide groove spacings in order to prevent grooves cutting into one another. Wide groove spacing would result in a very short playing time; a 12-inch, 78-r.p.m. record would have a possible playing time of less than a minute with an unattenuated bass characteristic. Accordingly, the recording characteristic of Fig. 1 was all the pre-war "hi-fi" addict had to worry over. The bass attenuation could be corrected by a single RC coupling network based upon the turnover frequency f_0.

Such a recording characteristic presented no difficulties at all, especially as high-pressure espionage methods were not needed to discover the characteristic actually employed. In fact the E.M.I. group of companies still employs such a recording curve for 78 r.p.m. discs. Despite this, no serious difficulty in the reproduction of frequencies up to 20,000 c/s from E.M.I. recordings is evident.[3]

The "improvers" have been engaged in a jolly game of recording characteristics. Originally a mild degree of top boost had obvious advantages. Thus by boosting the recorded top level, and reproducing with an equal amount of top cut, the reproduced level would be flat. In the process, needle scratch would be reduced by the reproducing top-cut circuit. Result an improvement in signal-to-noise ratio by an amount roughly equal to half the total top boost. An idea probably inspired by the use of top boost in f.m. broadcasting techniques. The use of a mild degree of top boost gives an overall recording curve somewhat

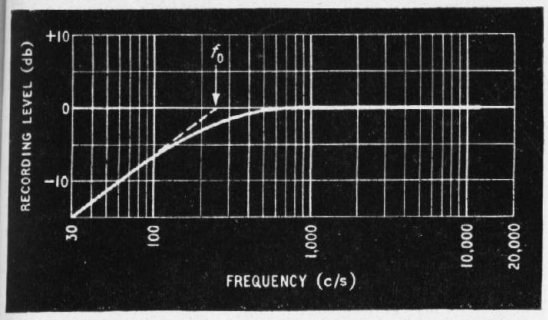

Fig. 1. Recording characteristic representative of pre-war practice. Bass amplitude is restricted to permit of reasonable groove spacing.

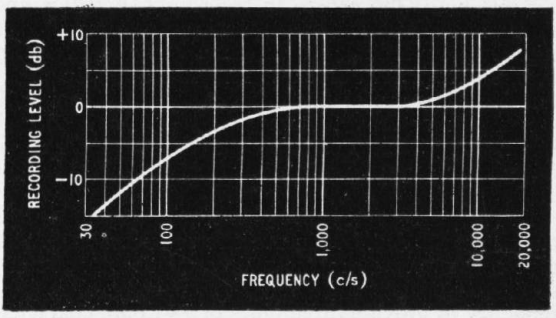

Fig. 2. A moderate degree of top lift in the recording characteristic gives an improvement in the reproduced signal-to-noise ratio.

like Fig. 2, which might be termed the Decca "ffrr" type of recording characteristic.

The extremist technical elements in some quarters were not satisfied with mildness however. First, top boost was accentuated even more, to "improve" signal-to-noise ratio still further. Secondly, bass cut was applied with a much higher cutoff frequency, say 800 c/s instead of 250 c/s, so that bass cutting started much earlier than in the older recordings. The end product is the recording curve of Fig. 3, which has virtually no straightline portion at all. This may be termed typical U.S.A. and l.p. type of characteristic. Such a characteristic is essential for long-playing recordings, as the extreme bass cutting reduces groove modulation to an extent permitting much closer than normal spacing of grooves. Also the use of top boost assists in the reduction of surface noise, despite the 10 db lower overall recording level necessary on l.p. recordings as compared with 78 r.p.m. recordings. Moreover, the standard one-mil (0.001 inch) stylus radius used for l.p. reproduction enables the top frequencies to be successfully traced despite the top boosting.

High-frequency Distortion

Many American firms use virtually the same characteristic for standard 78 r.p.m. records. This with the object of reducing surface noise, and also for the purpose of recording at a higher overall level. The extreme degree of bass cutting does permit of either closer groove spacing, or of a higher overall recording level. Unfortunately this means that the recorded top amplitudes may reach excessive values. Tracing with conventional pickups and styli becomes difficult. Although "harmonic distortion" may be slight, and in fact harmonic distortion of a 10,000-c/s fundamental would be unnoticed, *difference tones* of an unfortunate audibility may easily be produced by a non-linear pickup reproducing two supersonic frequencies. To quote an example "... no large increase in distortion occurs in reproducing the 16-db pre-emphasised continuous spectrum ... yet the addition of a few prominent tones to this spectrum in the region above 2,000 c/s will result in intolerable distortion."[4]

Accordingly a "double think" has occurred on the advisability of a full 16 db of boost at 10 kc/s (N.A.B. recording standard) or even extending to 20 db boost at 15 kc/s ("Orthacoustic" recording standard). Some American firms have reduced the degree of top boost to a modest 12 db at 10 kc/s (Victor). No one at the moment in the U.S.A. appears to use less than this degree of top boost. Accordingly Fig. 4 represents two possible limits for American recordings, both l.p. and 78 r.p.m. A compromise playback curve is capable of effectively reproducing most American recordings to within a couple of db or so. The dotted line in Fig. 4 shows the inverse of this curve, which, together with the circuit of Fig. 5, was proposed by the Audio Engineering Society of America.[5] It will be seen that this gives a very small error in reproducing either type of curve.

In the purist world several more switched playback curves are needed, but in practice the use of a flexible tone control circuit in the main amplifier enables any slight differences to be corrected. In fact there is a tendency to provide three types of 78 r.p.m. characteristic to cover the E.M.I. curve (Fig. 1), and the "ffrr" type of curve (Fig. 2), with an American 78 and and an l.p. position. However, the fashionable equalizing pre-amplifiers are even subdividing l.p. characteristics into various categories. There is clearly a limit to this process, as otherwise the equalizing pre-amplifier will require a minor reference work to accompany it.

The situation also is not helped by the appearance of a number of new companies which often specialize in American and foreign recordings generally. In my innocence I had assumed that these records were processed here from tapes. Apparently this is seldom the case, and the pressings are generally made from masters sent from the country concerned. Although in some cases records of English artists are also made here and processed from the tapes. Thus one company, it would seem, may issue recordings with a range of characteristics depending on circumstances. One company frankly admitted that it did not know what characteristic was in use for its U.S.A. pressings, although British recordings were of the Fig. 2 type of curve.

In other cases dark rumours circulate the "hi-fi" bazaars that the actual recording curve is vastly different from the published curve. Indeed, one obtains the impression that sometimes the characteristic is regarded as a top-secret commercial possession, and that publication would be detrimental to the company.

The existence of heavily "top-boosted" recordings which have also an extreme degree of bass cutting is hardly an academic issue. Reproduced on average equipment without equalization the result is most shrill and unnatural. A considerable number of "playing desks" for 3-speed reproduction are available. These desks are in many cases fitted with pickups capable of a quite high standard of reproduction, which only accentuates the lack of bass and the preponderance of top. One looks in vain for any equalizing control. By adding approximately 2s 6d worth of R and C to the output of a popular playing desk, I was able to prove to the amazed owner that something approaching "high fidelity" was possible, and that the irritating "thinness" of the l.p. discs and U.S.A. type 78 r.p.m. discs could be transformed into a well-balanced reproduction with adequate bass and unobstrusive treble. Considering that these playing desks are not cheap, and that l.p. discs cost some 30s or so, the additional cost of some form of simple equalizing circuit is small. Certainly the public at large can notice the difference, even when playing into a cheap broadcast receiver, for

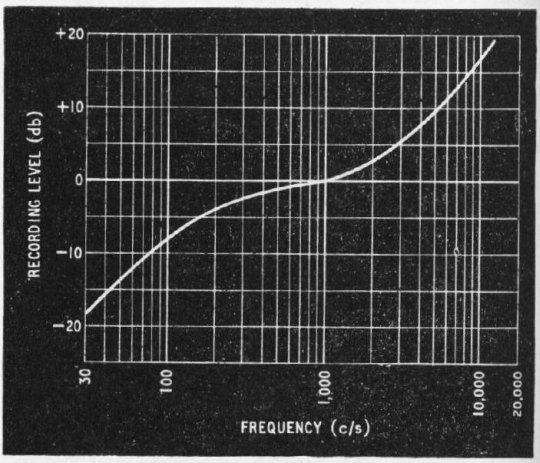

Fig. 3. Frequency distortion when carried to extreme limits introduces some unexpected problems.

additional 20 db of unbalance between top and ble cannot be eradicated even with a very indifferent producer.

It is quite possible that designers feel quite unable cater for all the recording characteristics now unished on the public. However, for the general market me attempt at equalizing seems desirable, if only to oduce a noise that can be listened to in reasonable mfort. The "hi-fi" addict is in a less happy position. seems that in many cases he can not be certain *hich* characteristic is employed even by a single mpany. Moreover, even where a single characteris- is nominally in use, it now appears that this is not infallible guide. Electronic designers in their in- cence may label the equalizer switch position for specific recording. This may in fact be an undue nfidence in the stability of a recording curve. It ould appear in many cases that the recording gineer has a considerable latitude in this respect. hus the exact bass turnover frequency may be justed "to suit the music," which I gather means at when playing time and groove modulation con- ct, the bass turnover is adjusted to suit. Moreover e question of amplitude limiting and volume com- ression is a singularly difficult one to track down. We e assured that this is standard practice in recording, t the only definite evidence I have is a statement m one company that in their case limiting or com- ression is never used.

ape "Masters"

The universal use of tape recording methods has ised many new objections. This mainly from high- ow reviewers who object to classical recordings ing bisected at precisely the worst possible point . . . tistically speaking. It would also appear that record- g level, noise level and even recording characteristics ay abruptly change due to a "tape join." The otting of "tape joins" is an essential accomplish- ent of the first-class record reviewer. In this connec- on also, a peculiar situation has arisen in connection ith l.p. records which contain dubbings from early 8 r.p.m. records. Almost always the reviewer is at ains to emphasize the superior quality of the l.p. dub- ing as compared with the 78-r.p.m. originals. While is is certainly a possibility in cases where both cords were made from an original tape master, it is fficult to see how this can happen in the cases where 78 r.p.m. pressing was used to make the l.p. version.

All this progress, therefore, has brought us to the ge where top boost is employed to improve record ignal-to-noise ratio. This, however, at the risk of acing difficulties, and unpleasant distortion effects, hich may be avoided by refraining from excessive oost. Despite this English recordings (including the E.M.I. group with no top boost) are quoted as having me 5 db lower noise level than U.S.A. recordings, hen reproduced with a flat frequency response.[5] The urchaser of a record, even if aware that equalizing is ecessary, cannot be certain in many cases what qualizing is needed. To complicate the issue, more han one time constant may be needed in both bass nd treble to correct for the actual characteristic used. lso, a record player made by one firm may give alanced reproduction of its rivals records, while iving a screechy, unbalanced reproduction of its anufacturer's own records.

While the need for some regularization of this situa- ion has been long apparent, agreement over recording

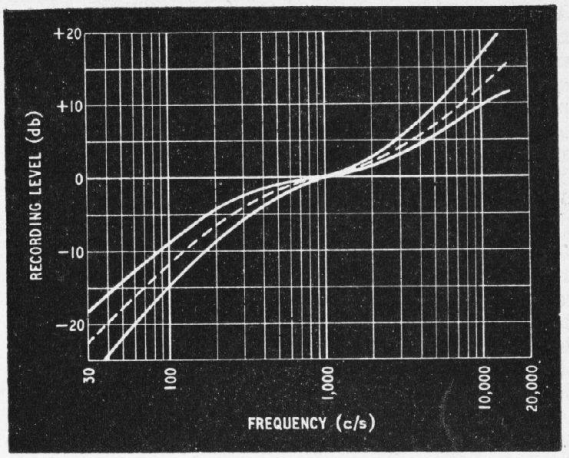

Fig. 4. The two full-line curves represent the variation found in current American practice. Good compensation within these limits is given by the circuit of Fig. 5. The compensation would be exact for the dotted characteristic.

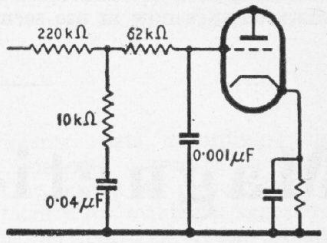

Fig. 5. Correction circuit (see reference 5) that will cope with most American recordings both 78 r.p.m. and l.p.

standards seems as elusive as international political agreement. Recent American attempts to define a single standard American recording specification have only been able to reduce recording characteristics to a total of four. Including, say, E.M.I. and Decca "ffrr" characteristics, it seems that a minimum of six equalizing curves, and possible eight to cater for l.p. idiosyncrasies, should be available at the control board of a modern "hi-fi" radiogram. Armed also with flexible bass and treble tone controls together with rumble attenuators, dynamic scratch filters, steep-cutting surface noise eliminators, and fast-gating "pop" noise slicers, the musically inclined listener has every chance of extracting entertainment from a record. That is if he can stop worrying about stylus wear and whether the makers have automatically corrected for the inner groove tracing loss, or whether the servo-tracking top booster should be cut in. Recent press comments to the effect that "the record is nearly over before concert room balance is achieved" have more than a trace of truth.[6] Moreover, critics' comments on orchestral balance, "thinness" of string reproduction and such-like matters, have been in some cases merely due to the use of incorrect equalizing. While the august pages of *The Gramophone* seem free from this error, it is difficult to see how it can be avoided when several characteristics may be employed on differing records from the same maker.

It seems evident that prejudice in British circles against U.S.A. recordings is largely due to the need for more extreme equalizing on U.S.A. recordings. Conversely, much favourable American comment on British recordings in the immediate post-war period is explained. The ordinary listener was unable to

keep abreast of the complexity of recording characteristics. Thus, reproduced with little or no equalizing, British recordings would sound full and balanced, compared with the U.S.A. records on which top boosting had been applied with enthusiasm. This compares with the situation here, where some record players make little or no provision for equalizing, so that those records employing a Fig. 3 characteristic sound thin and devoid of real bass.

Despite the fact that the public are unlikely to demand equalizing networks on their record players, there can be little doubt that they will strongly prefer correct equalizing. They can hardly be expected to demand something they do not know exists. The first disc player manufacturer who backs up the provision of equalizing with adequate press publicity will no doubt reap some adequate return for his enterprise.

Some of these facts are somewhat surprising, and, indeed, alarming, to those simple souls who require to reproduce a gramophone record with reasonable fidelity. Some half-dozen equalizer networks is the minimum requirement, assuming that minor discrepancies may be accommodated by use of a wide-range tone control unit. However, some measure of standardization to reduce the many varied recording characteristics now in use seems long overdue. Perhaps when this is finally achieved, the gramophone industry could consider a few more "improvements." One suggested improvement is the issue of standard 78-r.p.m. pressings optionally in noiseless plastic. A further suggestion is the issue of "extended play" 45-r.p.m. records, pressed on 10-inch discs. This would obviate the very real risk of high intermodulation components on the inner grooves of the present 7-inch 45-r.p.m. "extended play" records. It would seem too much to ask, of course, that the recording characteristic be indicated on the record label itself.

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Magnetic Recording

For Purposes Other Than Entertainment

By H. G. M. SPRATT, B.Sc., M.I.E.E.

THE main advantages of magnetic recording are sufficiently well known to require no more than enumeration: (1) wide frequency band, (2) high dynamic range, (3) low noise level and (4) capability of re-use after erasure. These good qualities were early appreciated and exploited for the purposes of entertainment. There are, however, a number of other less obvious advantages which can be classed together under the heading "mechanical adaptability," and these have extended the use of magnetic recording into fields which other recording processes cannot readily enter. Because the significance of these secondary features is not immediately obvious, a brief survey of them would seem a logical introduction to a study of the various applications they have made possible.

In the first place, it is quite easy to effect multiple-track recording on standard $\frac{1}{4}$in-wide tape and the width can, if desired, be extended up to several inches. It is easy to provide reels of tape in lengths up to 5,000ft—longer if the machine is designed to take them—and it is easy to run lengths of 1,200ft or more continuously as closed loops. As an alternative, the recording material can be supplied and used in the form of rectangular sheets instead of tape. Furthermore, if the standard base is insufficiently robust, a thicker material such as 0.005in cellulose tri-actetate can be substituted. This is standard cine-film base which can be slit to 16mm or 35mm, with or without the normal perforations added, and either fully or stripe coated. Finally, if all these varieties of base fail to satisfy, the magnetic coating can be applied to solid metal in the form of a drum or disc, by dipping or spraying. This last technique ensures full dimensional stability at the highest practicable running speeds, and this in turn permits the use of non-contact heads since a constant separation between head and coating surface is guaranteed while the high speed ensures a reasonable playback voltage. The use of rotating drums or discs also facilitates synchronizing.

Turning to consider some of the applications, we will start with the more obvious, and those least removed from conventional operation. Under this heading comes the "talking book for the blind,"[1] an equipment using a few hundred feet of $\frac{1}{2}$in-wide tape on which 24 tracks are recorded. A cassette houses the loaded and unloaded spools and when this is placed in position in the machine, the tape is wound from one spool to the other. At the end of each run the cassette is turned over and the head shifted to register with the next track. Thus one reel of tape, running at a speed