Sound Reinforcement

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● In last month's discussion of the large auditorium sound system, in among the many faults of the system were some good factors. One was the professional approach used in designing a conventional low-impedance mixer, such as we use in broadcasting and recording. The great majority, of "p.a." systems are assembled from packaged mixers which at best afford several microphone inputs and a line or a power amplifier output. Some of these packaged mixers include a "tone control", a feature with large potential danger from the standpoint of feedback or muffled speech articulation, where hi-end roll-off is used in an attempt to alleviate feedback.

However, when a conventional 600-ohm type mixer is used in the system design, then valuable tools such as sharp cut-off filters and graphic equalizers may be easily inserted. These tools have existed for many years and are in widespread use in studios and other professional systems. Unfortunately, they do not adapt to hi-Z mixers and have been largely neglected by price-conscious sound system installers, who operate in a competitive field.

Most large public spaces have several points in their acoustic characteristics capable of triggering feedback, and because of their large size and thermo-acoustic effects, they will be naturally bass-heavy, thus needing some assist in improving speech articulation. Generally, compensation can be made by either sharp attenuation of system bass response below about 100 hertz with a filter, or the more widespread but gentler roll-off with an equalizer. Judicious equalization with a graphic type device may be sufficient to both alleviate feedback and improve articulation, since perhaps a half dozen or more small sections of the audio spectrum may be either boosted or attenuated simultaneously. More difficult situations, demonstrating sharp acoustic peaks, must be handled with either a tunable dip filter or one or more fixed dip filters. Reference to the **Journal of the Audio Engineering Society** for the past couple of years will provide good reading on this subject.

It will also point up the fact that architects rarely call upon a qualified acoustic consultant when designing large public areas of the enclosed type. The acoustic and/or sound system expert is called in on these jobs only *after* the damage has been done.

In addition to auditoriums, there are notably airport and railroad terminals which seem to suffer universally from acoustic and sound-system problems. In defense of the problems of the architect, I must point out that his client may frequently insist upon the preservation of visual features, to the detriment of acoustical details. It is typical of airport and railroad terminals to claim that acoustic compensation has been attended to by the expedient of cementing acoustic tile to the ceiling areas, or at best by means of a hung tile ceiling, while walls and floors remain hard, reflective surfaces. Low-frequency absorption is negligible and echoes are only a part of the remaining problem with which any sound system must then cope.

In any attempt to solve the potential problems of the sound-system designer, as related to a host of typical architectural restrictions, we must be concerned with microphone and loudspeaker characteristics – particularly polar patterns, mixing facilities and associated filters and equalizers, and audio power distribution with proper impedance matching. In order to avoid oversimplification of this thumbnail list, let's look into each area separately, starting with a professional mixer approach.

FIGURE 1 illustrates a somewhat abbreviated system diagram for a mono system made up of typical professional components. A typical physical layout of the mixer portion is pictured in FIGURE 2. Although small, this system has excellent versatility and operating convenience. Its integral little jackfield affords access to the appropriate points in the system for insertion of filters and equalizers. These devices may be patched in during initial set-up testing, and either left on a patchable basis or wired in permanently later.

Levels as shown are typical for the system, and include provision for the insertion loss of a passive graphic equalizer, plus a nominal gain reduction of at least 10 dB through the use of a compact LDR-type compressor. If a lossless equalizer is to be used, it is possible to eliminate the booster amplifier, assuming slightly higher gains than those shown for the preamplifiers and the program amplifier. Several mic inputs, a hi-level input and a transcription input are typically indicated. Each input has an associated vertical attenuator, and all impedances excepting the 150-ohm microphone inputs, are 600 ohms. Amplifiers are plug-in transistor units with both input and output transformers to avoid common grounding problems.

The mixer shown in FIGURE 2 terminates in a line output of plus 4 dBm and, depending upon the particular need, a number of medium (or even low) power amplifiers are bridged across this line. In turn, the 600-ohm power output (or more typically, 70-volt output for higher power amplifiers) is fed to groups of speakers, which are bridged across a common speaker line with a line-to-voice coil transformer at each speaker.

Note that whenever compression is used in a sound-reinforcement system, the degree of gain reduction must be such that gain recovery during speech or music pauses, will not put the system into feedback.

The various types of filters which we find most useful in sound systems have no insertion loss from a system gain standpoint, and may be purchased in both fixed or variable hi-pass or lo-pass types, and as notch filters. Notch depth is about 14 dB with a quite sharp notch width. Attenuation rate for the hi- and lo-pass units is nominally 18-dB per octave, but may be specially ordered at a 30-dB rate. These filters may be inserted in individual input channels; in individual power amplifier channels; or more logically, in the over-all program channel.

Program-type equalizers are relatively useless in sound-system work, since their curves are based upon a fixed hinge point, and they are so broad in character that they may actually help to cause, rather than eliminate feedback, as with a tone control. Where an equalizer is indicated, the versatile graphic, (FIGURE 3) with multiple adjustable frequencies of a mirror-image type, is most appropriate. Such an equalizer may be used to put a hole in an area of feedback potential, or give

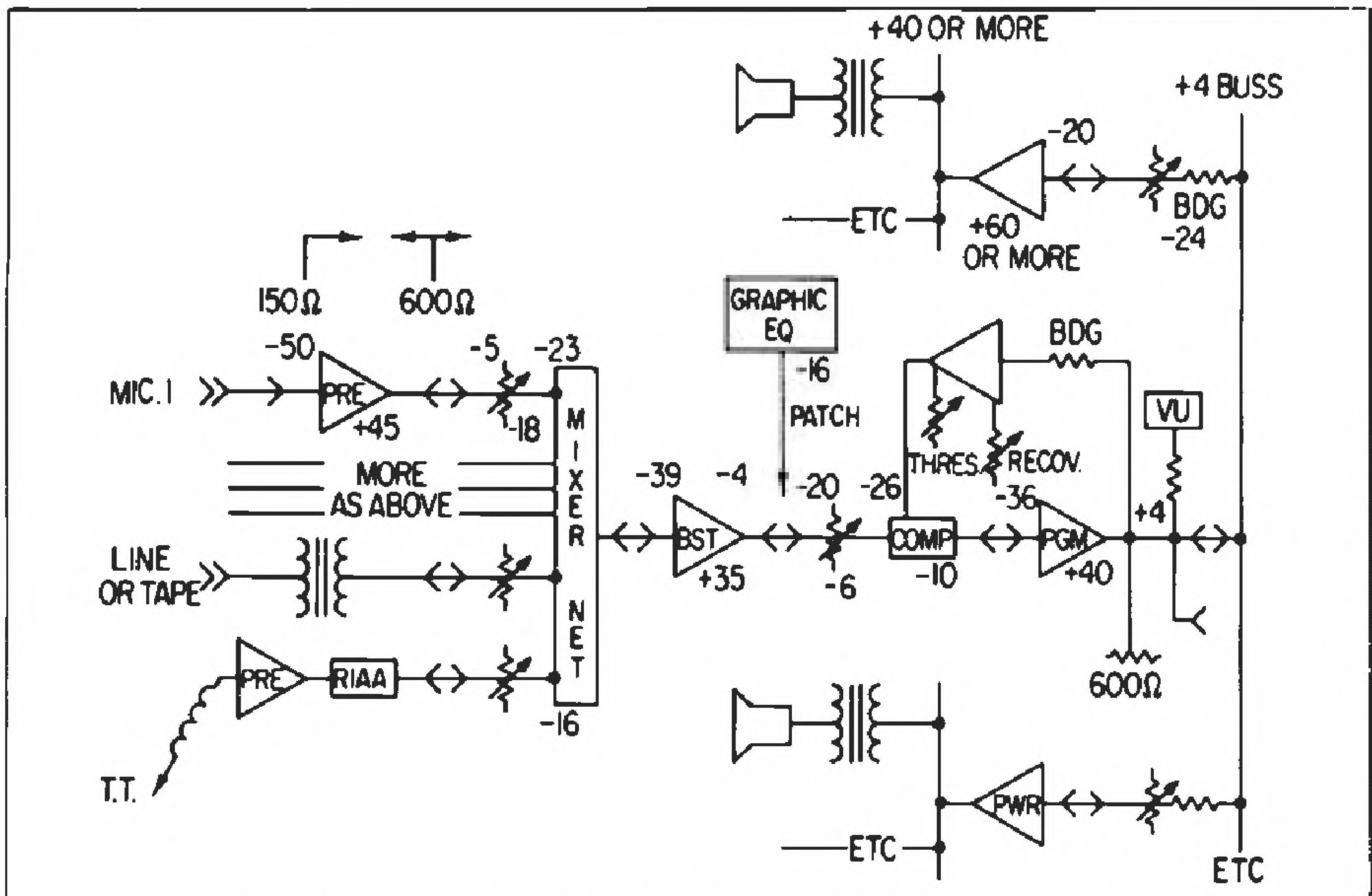

Figure 1. An abbreviated block diagram of a small sound-reinforcement system.

Figure 2. The physical layout of the mixer portion of a small sound-reinforcement system.

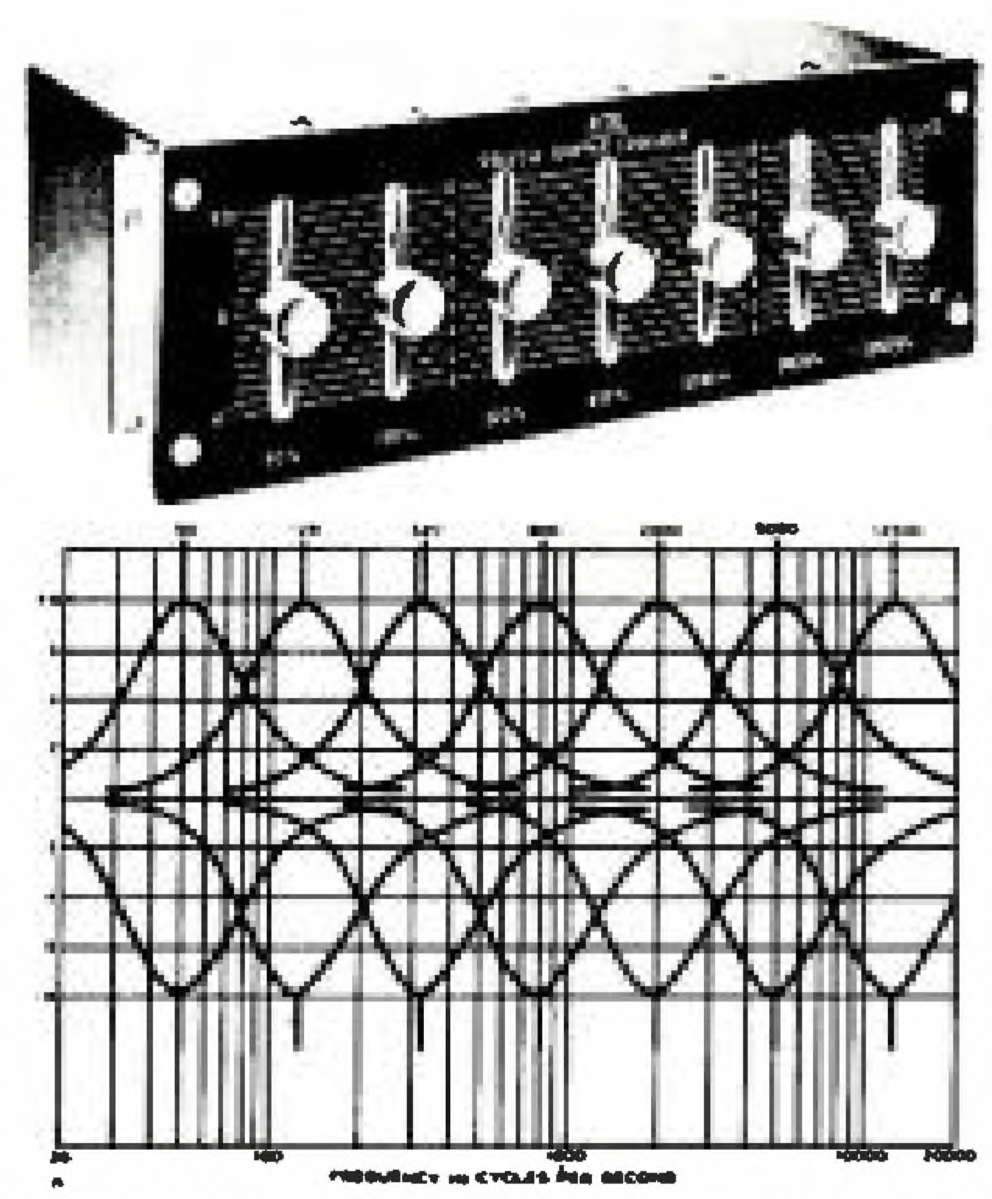

Figure 3. In (A) an Altec graphic equalizer is shown. (B) shows the possible boost or cut attainable with the individually-controlled seven channels.

moderate boost in those regions where speech needs an assist to improve articulation.

These equalizers may be ordered with a specified number of adjustable channels, and at specified frequencies, if desired. They are available in both passive and active configurations. The diagrammed system provides sufficient gain to accommodate a passive type with an insertion loss of 16 dB. It is shown as being inserted between the booster and the master-gain control, and will of course affect all speaker locations.

Filters are logically patched into the program line at any point past the mixer network, again affecting the entire system. If it is desirable to filter an area fed by one group of speakers only, then the filters(s) would be patched into the jacks on the input to the appropriate power amplifier(s).

As you can now see, the conventional professional mixer approach has given us the facility to quickly try out and then permanently utilize whatever tools we may need to correct acoustical problems existing in a given room. In addition, the simple idea of foregoing the usual high-power amplifier, in favor of bridging a number of low- or medium-power amplifiers off the mixer line output, gives us area control of volume levels — the ability to compensate each area through filtering and equalizing — and ease of impedance matching. In the January issue of **db**, J. F. Walthier gave an adequate rundown on proper impedance matching by the constant-impedance or the constant-voltage approach. Either method will eliminate power wasted in heating improperly matched lines, as well as affording a degree of level control for each speaker.