when a zero-level (read "full-level") test tone is applied to the front channels only. Both machines read correctly at -3 dB, the half-power level. But with the test signal, in-phase, applied at zero level to all four channels, the Sansui machine registers zero-zero, but the SQ machine reacts totally differently, reading +2 on the left and -8 on the right. This happens to be correct and is characteristic of the basic SQ encoder; a later model is able to overcome this difficulty, but it is not a serious one, inasmuch as we normally do not expect to find an in-phase, monophonic signal of equal amplitude applied to all four channels simultaneously.

A happy feature of the CBS SQ encoder is that it enables you to make recordings in either matrixed four-channel sound or in conventional two-channel stereo without the need to rewire the whole setup. As those who are mathematically inclined may see from the CBS SQ encoding equations:

$L_T = L_F - j\ 0.707 L_B + 0.707\ R_B$.

$R_T = R_F + j\ 0.707 R_B - 0.707\ L_B$.

So, when $L_R = R_R = 0$ (i.e., when no rear signals are applied), $L_F = L_T$ and $R_F = R_T$. In plain English, this means that if you feed a two-channel stereo signal into the front inputs of a CBS SQ encoder and nothing into the rear inputs, the outputs will be the same two-channel stereo signal. This convenience permits us—when we are working in two-channel stereo—to use the SQ recorder as an additional two-channel recorder with the encoder in-circuit.

As time goes by, the performance of the two principal competing matrix systems, Sansui QS and CBS SQ, has been improved remarkably. Fig. 5 shows the Sansui QSE-1 encoder with an internal test signal applied at zero level in the left-front channel. Note that this results in -3 dB levels in right-front and left-rear, and practically no signal at all in right-rear. In the decoding process this performance can be improved, and Sansui is now claiming 20-dB separation between adjacent channels around the square. In a recent demonstration at CBS Laboratories using a test record, with the advantage of steady tones but with the disadvantage of the limitations of stereo pickup cartridge performance, I was able to observe separations of over 25 dB from left to right in both front and back, and nearly 20 dB along either side. I also observed that these relations seem to hold up under dynamic conditions—with music from different instruments playing simultaneously, the signals were clearly heard coming from different directions.

Returning to Symphony Hall and turning to the opposite end of the radio booth, we find the mixing and monitoring equipment. Fig. 6 shows the mixing console, which was custom-built for WGBH by General Electric specifically for our needs in Symphony Hall—unfortunately almost ten years ago—before anyone thought of quadraphonics. It is a three-channel, dual-output device, with six mixing channels. Quality is very high with regard to S/N ratio and distortion, but flexibility is quite limited. The meter indications are for the four-channel test signal seen in previous figures. Notice that in order to get the four channels out, five channels are programmed with the test signal. The signal from the channel read by the middle VU meter on the left side of the console is taken from the corresponding output into a Y-connector and fed back, in-phase, to the L and R high-level inputs of the console, which are then in turn fed into the channels monitored by the first and third right-hand VU meters.

Fig. 7 shows the monitoring rack. From top to bottom we have: rear amplifier selector switch; SQ decoder; rear-channels amplifier; tuner for WCRB; tuner for WGBH; front amplifier selector switch; waste space; useless patch-panel; mono amplifier —no longer in use; front-channels amplifier; and more waste space. Outputs for live broadcasting via telephone-company circuits go through the complex array of terminal blocks and patch-panels of Fig. 8.

You might wonder why such a complex setup is necessary to produce a radio broadcast. A few years ago Erich Leinsdorf conducted a performance of Mozart's *The Magic Flute* at the Music Shed in Tanglewood, the Boston Symphony Orchestra's 5,000-seat summer auditorium. This was a semi-stage performance without scenery but with the singers making their entrances and exits on cue, with various stage movements as called for in the libretto, and with lighting effects. Even though this performance took place before the advent of four-channel sound, it strained the capacities of our equipment. Consider that we now have to face the possibility of a similar production, but with four channels instead of two, always bearing in mind that what we produce must be "compatible" entertainment in one, two, and four channels simultaneously. It's not easy but we are into it. In the coming months radio listeners will be able to judge for themselves how successful our efforts prove to be in delivering that "concert-hall realism" into home listening rooms.