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KLIPSCHORN LOUDSPEAKER

Photograph: Robert Lewis

Manufacturer's Specifications

System Type: Three-way horn-loaded, for corner placement.
Drivers: 15-inch woofer, 2-inch midrange, and 1-inch tweeter.
Frequency Range: 35 Hz to 17 kHz, ±5 dB.
Sensitivity: 104 dB SPL at 1 meter for 1 watt input.
Crossover Frequencies: 400 Hz and 6 kHz.
Impedance: 8 ohms nominal, 4 ohms minimum.
Recommended Amplifier Power: 20 watts minimum.
Dimensions: 52 in. H x 31 in. W x 29 in. D (132 cm x 79 cm x 74 cm).
Weight: 165 lbs. (74.9 kg).
Price: $1,499 each.
Company Address: Klipsch, P.O. Box 688, Hope, Ark. 71801.
For literature, circle No. 90

A legitimate Golden Oldie, now well into its fourth decade, the Klipschorn, along with its designer, Paul Klipsch, are true legends in the field of high-fidelity sound. Nothing I could write would do complete justice to its description, so let me quote the words of a dear friend, long past, Howard Tremaine, who many years ago described the Klipschorn in his *Audio Cyclopedia* (Howard W. Sams & Co., 1959) as follows: "The enclosure is a low-frequency horn so folded that it may be placed in a room corner to utilize reflections from the floor and walls to improve the impedance match at the mouth of the horn and thus increase the response at low frequencies." Continuing Tremaine's description: "One advantage of using a horn at the low frequencies, compared to the use of a direct radiator mounted in a flat baffle, is that the horn efficiency is 10 to 50 times greater; and because of the acoustic loading, a given acoustic power may be generated with considerably less excursion of the loudspeaker diaphragm, thus reducing harmonic and intermodulation distortion."

The low-frequency horn is substantially exponential in its expansion rate and thus would have an acoustic path length of about 8 feet if unfolded. This horn is intended to cover the lower four octaves of the audible range, from about 32 Hz to 400 Hz, where the folded horn is crossed over to a midrange "squawker" that carries the range up to 6 kHz, where the response passes to a tweeter. Midrange and tweeter are also horn loudspeakers, and both are mounted behind a grille assembly placed on top of the folded bass horn.

The system is heavy. Oh, my, it is heavy. And it is big. But there is a reason for its size, and the reason is acoustic efficiency. Ten watts of music into this speaker will part your hair if you stand too close. One is soon reminded of the old horsepower adage: There's no substitute for cubic inches.

Because the Klipschorn uses the corner and floor of the room as a part of the bass reproduction process, the speakers must be placed in the corners for best reproduction. If the listening room does not have available corners or is very small, then, in my opinion, purchase of a Klipschorn system should not be contemplated. It simply needs room to sing.

Because of its bulk, the Klipschorn comes in two pieces, the bass horn and the midrange/tweeter unit. The instructions are clear, and no difficulty should be experienced in assembly or hookup. There are no controls or switches, and electrical connection is made to two well-marked terminals on the rear of the enclosure.

Because of the extreme efficiency of these speakers, you will not need a large power amplifier; 100 watts is more than adequate, and most listening will probably be done at levels below 5 watts. But the amplifier must be of high quality and have low noise. If it should have any hiss or hum, you will hear it with these speakers.

Measurements

The measured magnitude of impedance which the Klipschorn presents to an amplifier is shown in Fig. 1. The lowest value within the audio range is 4.5 ohms and occurs at 55 Hz, while the highest value is almost 10 times that amount, 42.3 ohms, at 2,155 Hz. The peak lies above the limits of the plot of Fig. 1, which is scaled to show the details of impedance throughout most of the audio range.

From the standpoint of amplifier drive requirements, a worst-case frequency appears to be around 5,200 Hz, where the phase angle lags by 70°, although the magnitude of impedance is 11 ohms. This can be seen in the complex impedance plot of Fig. 2. The many pig-tails in this plot are due to local impedance resonances. With the exception of the major bass resonance at 37 Hz, the majority of pig-tails are probably caused by acoustic reflections which occur in the bass, midrange, and tweeter horns. Figure 3 shows the complex impedance rescaled to show the midrange impedance peak at 2,155 Hz. This peak is not a smooth loop, but itself has several minor deviations in its peak range.

Fortunately, from the standpoint of amplifier drive requirements, none of these deviations can cause any problems whatsoever, as long as the power amplifier can drive 4 ohms at modest power. Because of this, and the fact that up to 25 average watts there is absolutely no change of admittance with drive level, I chose to omit the admittance plot for the Klipschorn. In this case, we do not need it.

Doing a complete set of acoustic performance measurements on the Klipschorn is a tour de force for any reviewer. This is a corner horn loudspeaker system; hence it requires a corner. How does one make free-field response measurements when there are corners? Paul Klipsch solved the problem by building an anechoic chamber with insertable corners. The Klipschorn is also intended to be listened to at ranges greater than 3 meters. The substantial size of this speaker and its geometry require that measurements be performed at such distance, and I have chosen 3½ meters, since this is the distance at which I listened to these units. Even assuming I could lift it, I could not haul the Klipschorn out of doors for lower frequency measurements since it needs corners to reproduce low notes. I puzzled over this problem for quite some time (more time than my incredibly patient editor should ever be forced to wait for a review) and then decided to resort to computer software and physics.

Figure 4 shows the measured free-field amplitude of sound pressure as a function of frequency for a constant drive voltage corresponding to 1 average watt into 4 ohms. The plot is corrected for an equivalent distance of 1 meter on axis relative to the front of the enclosure, although the actual measuring distance is 3½ meters.

Figure 5, the free-field phase response, is plotted in two sections. The midrange phase plot is corrected for a time delay of 11,980 μS, and the tweeter phase plot is corrected for a time delay of 10,308 μS. The 1.672-mS time difference is caused by the physical offset between the tweeter and midrange.

The free-field sound is reasonably uniform from a lower cutoff of around 38 Hz to an upper cutoff of around 18 kHz. The irregularities both above and below the acoustic crossover at 6 kHz are caused by internal acoustic reflections from the drivers, horns, and grille assembly. The system is incredibly sensitive, producing well over 98 dB per watt at 1 meter. It is easy to see why the suggested amplifier rating is only 20 watts per channel. This system really will give the rated 104 dB SPL at a distance of 4 feet into a room. One watt into a Klipschorn will produce the sound level that 30 watts produces with many smaller loudspeakers. If one were to use the full 100 watts of drive for which the Klipsch is rated, the sound level would soar to migraine limits. Dropping a stylus on a record might break a lease, as well as some crockery.

The low-frequency response has some interesting surprises. A measured low-frequency roll-off below 38 Hz does not seem impressive; there are many smaller enclosures which measure as well. But something happens when this low frequency comes as a large-area wavefront whose boundaries are the walls of the room, rather than as a wavefront expanding spherically from a position in front of a wall. For one thing, the first impression one has is that the low end is deficient, because the low-frequency rumbling and grumbling of most systems, which many people associate with low-end reproduction, just isn't there. However, as one begins to really listen to the music and sound, one

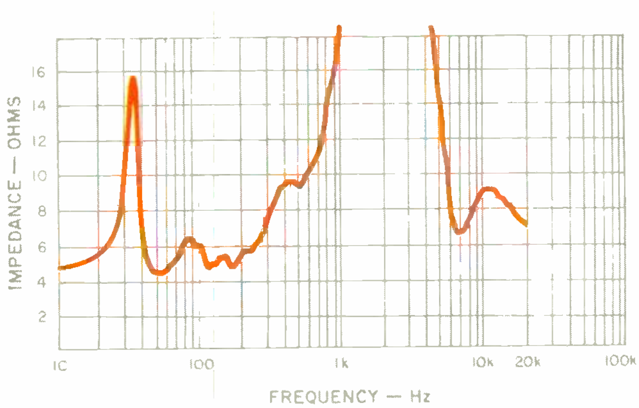

Fig. 1—Magnitude of impedance.

The Klipschorn is heavy! And big! But there is a reason—acoustic efficiency. Just 10 watts will part your hair at close range.

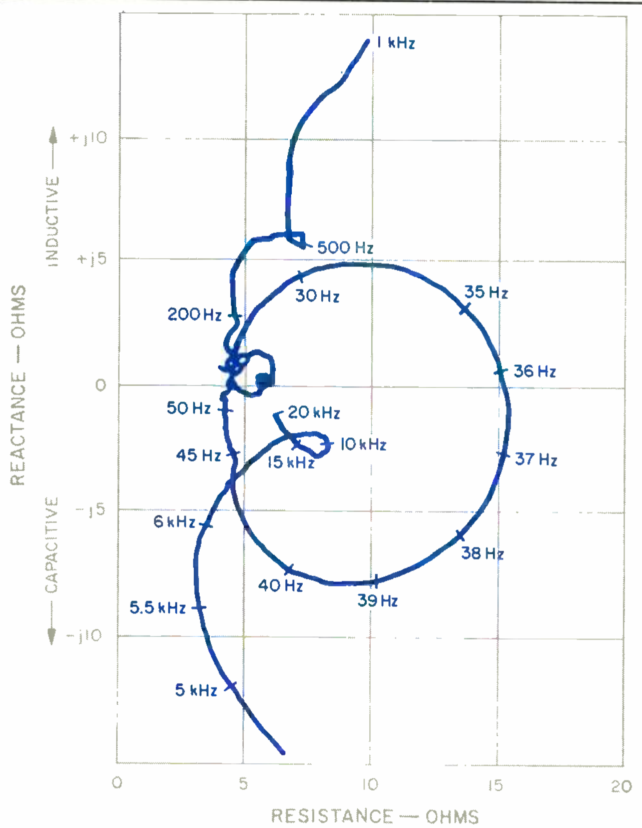

Fig. 2—Complex impedance; see also Fig. 3 for the range from 1 to 5 kHz.

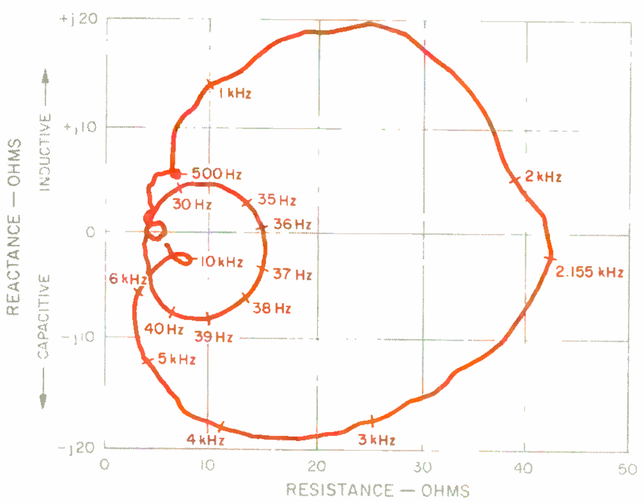

Fig. 3—Complex impedance. Note the rescaling from Fig. 2.

realizes that the deep bass is actually there and that it sounds natural, not overemphasized. Real low-end ambience in a room doesn't rumble; it's simply there as a pervasive ambience. So with the Klipschorn. To be sure, the horn unloads very rapidly as one progresses below 35 Hz and the woofer can be made to rattle with excessive drive at 10 Hz with no great amount of low-frequency musical content in the room, but above 35 Hz it is darn good.

The free-field frequency response measurement of Figs. 4 and 5 required some computer processing. Figure 6 is the 20 Hz to 20 kHz energy-time curve (ETC) of the Klipschorn, measured in the listening room at a distance of 3½ meters. The floor, ceiling, walls, and furniture reflections are present in this measurement. Figure 7 is a processed ETC in which everything has been removed except the direct sound from the Klipschorn. The frequency response measurements of Figs. 4 and 5 correspond to the ETC of Fig. 7. The expanded ETC of the free-field response of Fig. 7 is shown as Fig. 8. This departs from our conventional review format, which puts this expanded ETC at the end of the review.

It is instructive to compare the ETCs of Figs. 6 and 7 since they explain some of the audible midrange problems with this system. Consider Fig. 7. The first response, at 10.3 mS, is the sound from the tweeter, which is mounted up front on the grille. The second response, at 12 mS, is the sound from the midrange horn, whose compression driver lies back near the rear of the enclosure. Believe it or not, the small broad peak at 17.7 mS is the sound from the bass driver, which carries the frequencies below 300 Hz. Now consider Fig. 6. This is the complete sound, room and all. The multiple peaks at 12.5 and 13 mS are due to the tweeter sound which reflects off the side walls and the ceiling. At the listening location, we first hear the tweeter, then the midrange, then a staccato hit from the tweeter reflecting off the floor and ceiling, then a weak tweeter reflection from the side wall, and then the midrange reflecting off the floor and ceiling, with the rest of the room furnishings coming in several milliseconcs later. Fortunately, the left and right channels are symmetric in this sound, since it is caused by the geometry of walls, ceiling and floor. In my earlier listening test, I felt that there was a problem with upper-midrange instrumental clarity, and I believe it is due to this effect. I infer from these actual room ETCs that the Klipschorn will sound best in a very large room with a high ceiling and a heavily carpeted floor.

There is another obvious item related to geometry, but due this time to the geometry of mounting the tweeter and midrange horns on the front of the enclosure. The ETC of Fig. 8 illustrates this situation. In Fig. 8, I have corrected the time scale to correspond to a microphone position which is 1 meter in front of the grille. The tweeter sound arrives at 3.7 mS but has an internal reverberation whose period is about 167 μS with a decay rate of about 9 dB per period. This causes the irregularities in free-field sound around 6 kHz, which is evident in Fig. 4. Since this frequency coincides with the acoustic crossover range, the reverberation may possibly be associated with the crossover process. The midrange sound first appears at 5.38 mS and shows a mild reverberation characteristic which pulls the energy out for a half-millisecond or so before it drops. Subsequent enclo-

Measured "free-field" using computer software, the K-horn is reasonably uniform from around 38 Hz to upper cutoff at 18 kHz.

sure reflections occur after about 6 mS. The first sound from the woofer is not on this measurement since it arrives about 8.4 mS after the sound from the tweeter.

What does it mean? A loss of clarity for those sounds which contain significant energy around 6 kHz, such as higher register female vocals and piano, but clean transient sound for both mid-register and extreme upper-register instruments such as some horns and triangle.

The 3-meter room response (which, for this speaker only, was actually measured at 3½ meters) is shown in Fig. 9. I measured only the on-axis response, not only since this is the recommended listening position, but also because a 30° off-axis response does not make much sense for a corner horn. This is the frequency spectrum of the first 13 mS of sound at the listening position and includes all the signals shown in the ETC of Fig. 6. The effect of early reflections is clearly evident in the plot of Fig. 9. Of particular interest is the fall-off of energy below 350 Hz. The reason is simple: The woofer sound doesn't begin to arrive until more than 8 mS after the sound from the tweeter, and is rejected by the time gate of the TDS measuring instrument. If I were to tune to the sound from the woofer, then the midrange and tweeter would be substantially reduced. In general, the 3-meter response is quite similar in character to the free-field response (which was taken at precisely the same physical location). The timbral balance of high, mid, and low portions of the spectrum is quite good. Only the time of arrival of those sounds will detract from sonic accuracy.

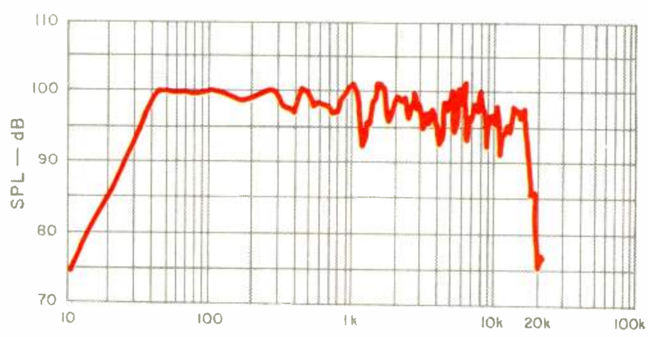

Fig. 4—Free-field sound pressure level for a constant voltage drive corresponding to 1 average watt into 4 ohms.

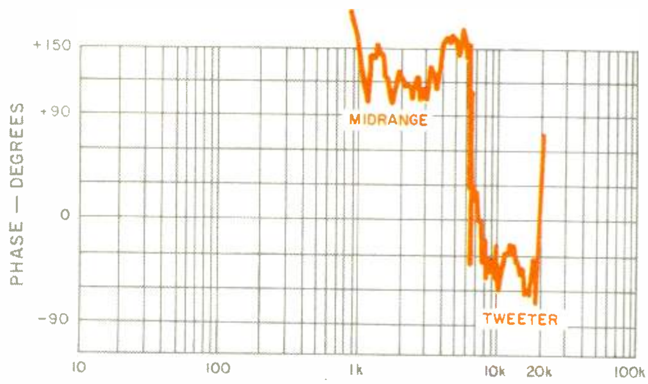

Fig. 5—Free-field phase response at 3½ meters. The midrange response is corrected for 11,980-μS time delay, while the tweeter response is corrected for 10,308-μS time delay.

For reasons that may be obvious, I was not able to make a far-field turntable measurement of the horizontal and vertical polar energy response. Even if I had the services of King Kong to move the speaker, I would still need to rotate the whole room, walls and all. However, I was able to verify, by selected close-up microphone measurements, that the horizontal and vertical polar energy response was essentially smooth within ±15° of the normal listening position. This agreed with my earlier listening impressions; I was able to walk around the room, over a significant range, without change in the level or tonal balance of the sound.

Measured harmonic distortion for the frequencies of 41.2 Hz, 110 Hz, and 262 Hz is shown in Fig. 10. These frequencies correspond to the musical tones of E_1, A_2, and middle C, respectively. I chose middle C rather than A_4 (440 Hz) because the actual acoustic crossover from woofer to midrange is slightly above 250 Hz, and I wanted to measure the distortion for the same driver at all frequencies. Low bass (E_1) harmonic distortion progresses smoothly from a few tenths of a percent at 100 mW drive upward to near 10% at 60 average watts, with second harmonic slightly above third harmonic throughout the whole range. Mid-bass harmonic distortion at 110 Hz does not look at all like the low-bass distortion. Mid-bass harmonic level stays essentially uniform and of low level throughout the entire drive range, as the woofer really likes the acoustic load in this important frequency range and pumps out acoustic power with little distortion. Up near the crossover at middle C, the harmonic distortion again rises uniformly with drive level, although its total level is very low even at a thundering 100+ dB SPL at normal listening distance. If you like it loud and you like it clean, this is the speaker.

Intermodulation of middle C by E_1 (41.2 Hz), when both are mixed in equal proportions, is shown in Fig. 11. The magnitude of IM is impressively low when we look at the sound pressure levels which are involved. Music played at a 10-watt average level into the Klipschorn is reproduced at sound pressure levels which many other fine loudspeaker systems simply cannot reproduce, yet the IM remains below 4%. The nature of this IM is principally amplitude modulation of middle C by the lower tone up to about 50 average watts. At 100 average watts (ear-protection levels), the IM mea-

Because the listening room is part of the low-bass reproducing system, the K-horn requires at least four feet of side walls in the listening room.

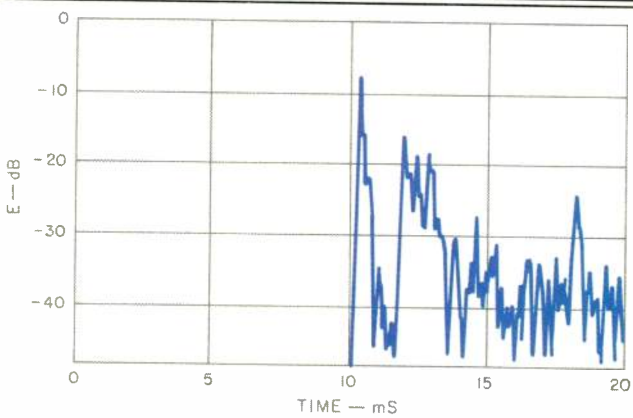

Fig. 6—ETC of the Klipschorn including early reflections from the room.

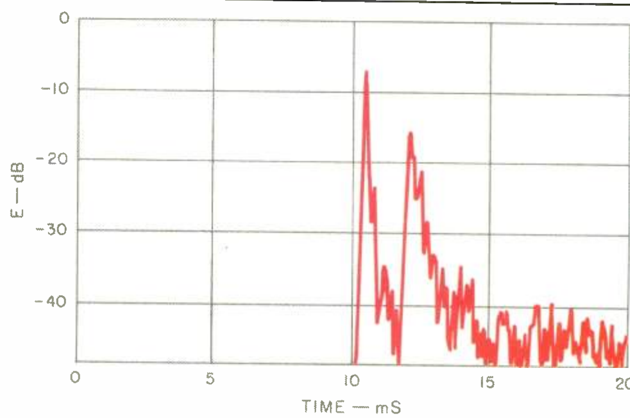

Fig. 7—ETC of Fig. 6 minus the room reflections.

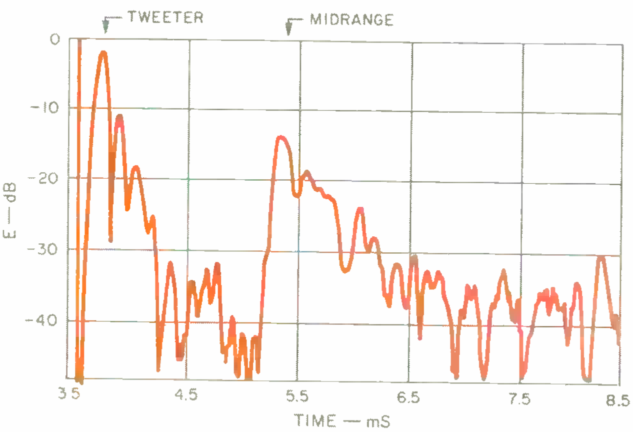

Fig. 8—ETC of Fig. 7 with an expanded time scale and corrected for a 1-meter measurement position.

sures 12.88% and has picked up a phase modulation of 6° peak-to-peak on middle C, in addition to about 8% peak-to-peak amplitude modulation.

The result of the crescendo test is also impressively good. In this test, the ratio of sound pressure level to drive power is measured for selected musical tones. Perfection occurs when the SPL precisely tracks the drive power. In the case of the Klipsch, the tone of E_1 (41.2 Hz) slowly drops in relative SPL with drive power such that a 63-watt test level is 0.5 dB below the level which represents perfection, relative to a starting power level of 100 mW. The tone of A_2 (110 Hz) drops in a similar manner by 1.2 dB from a starting reference of 100 mW to a 63-watt maximum test level, while middle C slowly drops by 0.7 dB over the same range. The net effect will be an extremely mild softening of instrumental timbre as the sound pressure rises to high levels. This measurement also indicates that no discernible lateral shift of stereo image should occur with changes in drive level.

The same exemplary performance is maintained when a second musical tone is added to an existing tone. This means that stereo imaging should remain steady, with no instrumental wander caused by changes in musical dynamics throughout the useful intensity range of the Klipsch reproducer. In short, the Klipsch stays together regardless of what happens in the music.

Use and Listening Tests

A stereo Klipschorn reproducing system requires a room with two good corners. Period! If your listening room does not have left-channel and right-channel walls which come out in an uninterrupted fashion for at least 1½ meters from their respective corners, then forget it.

I am fortunate in that I have two such corners in my listening room. The geometry of the room also reasonably matches Klipsch's recommendations of a ratio of 1.00 to 0.618 for distance between speakers to distance from front wall to rear wall. The reason for all this fussiness becomes evident when you begin to listen to the system: The listening room is part of the low-bass reproducing system.

As mentioned above, the first impression one has is that the Klipschorn is deficient in low bass. This impression is visually reinforced by the massive presence of the system itself: "Anything that big should go right on downstairs in bass." But as one settles down for listening, it becomes apparent that the low end really is there. Not obtrusive, not rumbly, but there.

Many years ago, when listening to a similar pair of Klipschorns, I decided to find out how accurate the low end was. So I placed two high-quality condenser microphones outside my house, in a location where I could listen to the sound they picked up while viewing the same microphone location through a picture window that stretched between the two Klipschorns. It was only a matter of walking outside

Overall, the Klipschorn demands a great deal of respect as an accurate reproducer, surviving modern recording and electronic technology well.

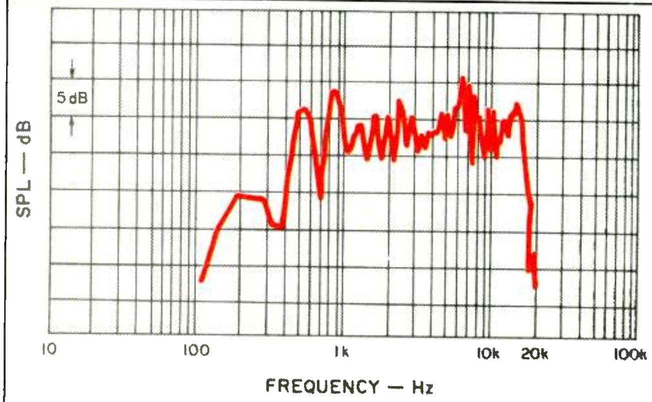

Fig. 9—Three-meter room response; see text.

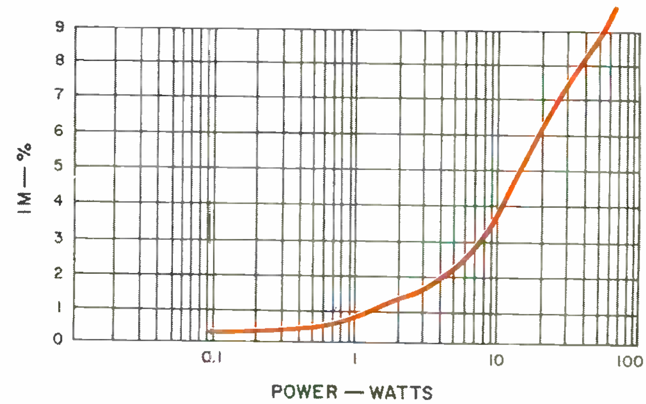

Fig. 11—IM of middle C (262 Hz) caused by mixing with E_1 (41.2 Hz) at equal levels.

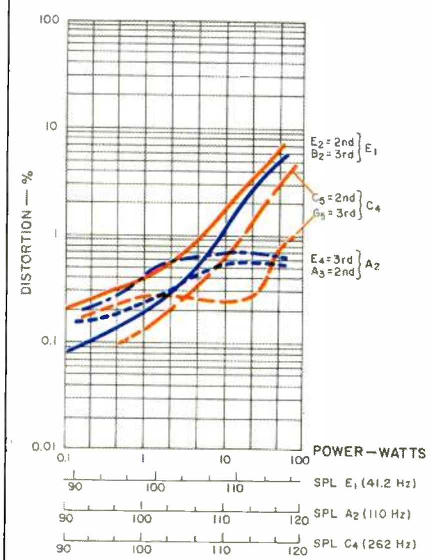

Fig. 10—Harmonic distortion for the test tones of E_1 or 41.2 Hz, A_2 or 110 Hz, and C_4 (middle C) or 262 Hz.

and listening, then walking inside and listening to compare the reproduced sound with reality. I could also switch between the K-horns and a pair of excellent speakers whose bass could shake the house on pipe organ; they made the K-horns sound thin by comparison. Then a funny thing happened. The sound of a slammed car door sounded like a slammed car door on the K-horns, but sounded like muffled "whumps" on the "wider range" system. The same with helicopter fly-overs (quite frequent where I used to live) and with the sound of distant traffic. I never forgot that experiment nor its ear-opening ramifications with regard to sonic accuracy versus measurement. Quite true, I have listened to many excellent subwoofers that could shake the walls at 10 Hz, while the K-horn produced little sound pressure even an octave above that frequency. But in my personal opinion, accurate percussive bass is a specialty which a properly set-up corner horn seems to have to itself.

Orchestral balance is also quite accurate; horns and strings stay put and are accurately placed on the stereo stage. Brass is brilliant and accurate on this system, and these instruments are so well placed that I felt I could point directly at each instrument. On the down side, to my ears, vocals, particularly female ones, seemed strident, and I could not get an accurate sonic illusion of piano, which always seemed larger than life, even at lower sound levels.

The usable listening area extends over much of the listening room, and one can move about freely without losing stereo balance as long as the speakers are at least 3 meters from your listening location. It takes a pretty good-sized room to get a good sound from the Klipsch system; a small room will probably produce sonic disappointment. This is not a speaker system you haul to a dormitory.

The Klipsch system has two additional sonic characteristics which warrant discussion. First, it is one of the few sound-reproducing systems which sound natural when one walks into an adjacent room. This is an interesting subjective illusion, one which I cannot explain. However, we have all had the experience of hearing a live musical instrument being played in an adjacent room; it still sounds natural and we can readily tell that it is not artificially reproduced. The piano recordings with which I had had trouble while in the listening room actually sounded "live in the next room" when I was in a room adjacent to the listening area. While others may disagree, that is the illusion I experience.

The second characteristic is the maintenance of timbral balance even when the sound is reproduced at substantially lower sound levels than would be normal for a given piece of material. Again, this is my personal opinion, and others may disagree.

Overall, the Klipschorn is a Golden Oldie that survives modern recording and electronic technology very well. A bit jagged in the midrange, it still demands a great deal of respect as an accurate reproducer. *Richard C. Heyser*