wedges of soft Fibreglas absorbers which are attached perpendicularly to all the surfaces, forming an absorbing layer about two feet thick. This chamber is an equivalent of a free field in space absorbing almost all the energy from a sound source and thereby preventing echoes, standing waves, and reverberation. It is particularly stressed that only a free-field response of a speaker represents its true characteristics, because the speaker itself is measured and divorced from all other influencing factors. The acoustical energy is measured by a calibrated microphone, and after proper amplification, its signal is recorded by an automatic pen recorder that reco[illegible] the amplitudes of a continuous swee[illegible] frequency from 30 to 20,000 cps.

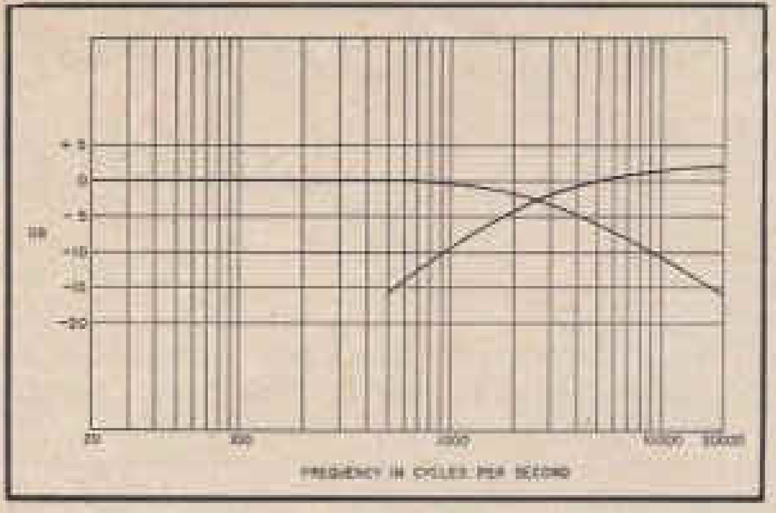

Fig. 6. The measured frequency characteristic of the crossover network.

Design Steps

The approach to a design of a good duplex speaker is, of course, based on known acoustical and electrical facts and good engineering practice. A few of these can be outlined at this time:

(1) First of all, the two components of the speaker, that is, the LF unit and the HF unit, should be independently designed to have as good a frequency response as possible over their working ranges.

(2) The high-frequency and the low-frequency diaphragms should be at substantially the same plane to attain good phasing characteristics in the crossover frequency region.

(3) The two units should be approximately concentrically mounted for proper and constant phasing at the crossover region.

(4) The size of the LF cone should determine the size of the HF horn.

(5) The dimensions of the HF horn should determine the crossover frequency.

(6) The outside surfaces of the HF horn should be so shaped as to have negligible reflections from the LF cone.

(7) The distribution angle of the HF horn should be at least 90 deg. included angle, but not so wide as to cause interference due to reflections from the cone.

(8) The resonance of the LF cone should be at about 50 cps or lower to enhance the extreme low-end response and minimize the low-frequency "hangover."

(9) The efficiency of both units should be as high as normally expected from an efficient single-unit speaker.

(10) The wattage rating of each unit should be so chosen as to assure linearity over its full rated range.

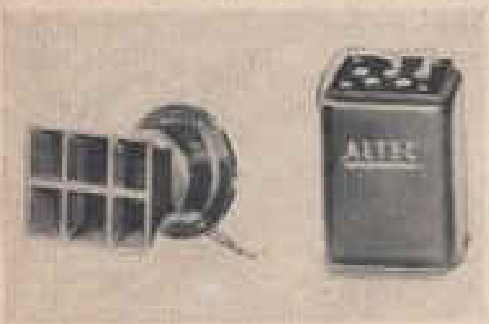

Fig. 4. The high-frequency horn and driver assembly together with its matching crossover network.

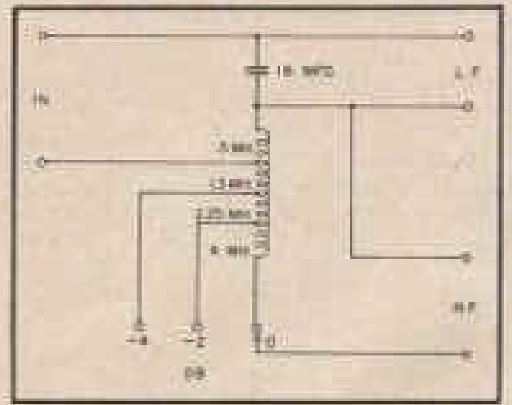

Fig. 5. Schematic of the N-3000A crossover network.

(11) The crossover network should be simple, economical to manufacture, and should be tailored to the acoustical properties of the units with which it is to be used.

(12) Mechanically, the speaker should be engineered for easy assembly and protection of the air gap and voice coil against dust and magnetic particles.

All the above factors are essential, but the degree of success in any one or all of these points will determine the quality of the product.

Two speakers were designed: one, a 12-in. duplex which is now known as the 601A, and the other, a 15-in. duplex, now called the 602A. Since both speakers are similar, the 12-in. duplex will be described here in detail.

Our low-frequency unit was designed for one specific job: to reproduce efficiently all frequencies from 30 to 3,000 cps in a properly designed enclosure. This range is most important because it contains the fundamental frequencies of the majority of sounds. This range, therefore, has to be smooth in response—without peaks or dips that exceed a total of ±3 db in amplitude variation. The cone designed for this job is a straight-sided 12-in. cone having an included angle of 110 deg. At the rim is a two-step compliance cemented to a frame assembly and painted on each side with two coats of a viscous damping liquid. This preparation, when dried, is a viscous plastic layer which acts as a mechanical damping material for the absorption of mechanical energy generated by the voice coil and transmitted by the cone. The wave motion, as it travels from the center of the cone out to the rim, is substantially absorbed by the mechanical resistance of the damping layer and prevented from reflecting back. This action greatly reduces the standing waves in the cone which would appear as serious irregularities in the response of the cone. The compliance portion of the cone is considerably thinner than the cone proper to reduce stiffness, which together with the total cone assembly mass will resonate at about 50 cps. The apex of the cone is supported and centered by an impregnated-cloth spider, which is made very flexible so as not to contribute materially to the total stiffness of the system.

The complete moving system—a damped cone and its supports—is driven by a 3-in. diameter voice coil designed to transform electrical energy to mechanical motion efficiently. The voice coil is wound of aluminum ribbon .004 in. thick and .023 in. wide on a thin stiff paper form. The coil is wound edgewise, insulated and cemented by a var-

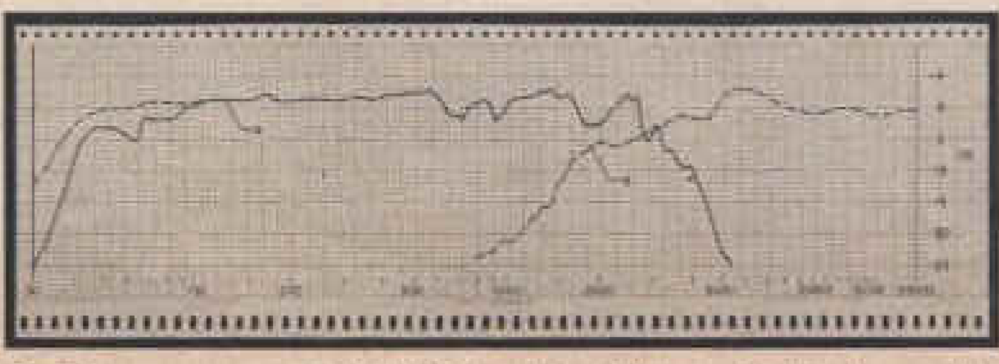

Fig. 7. Frequency response of individual LF (curve A) and HF (curve B) units when assembled and enclosed in the 606A corner cabinet.