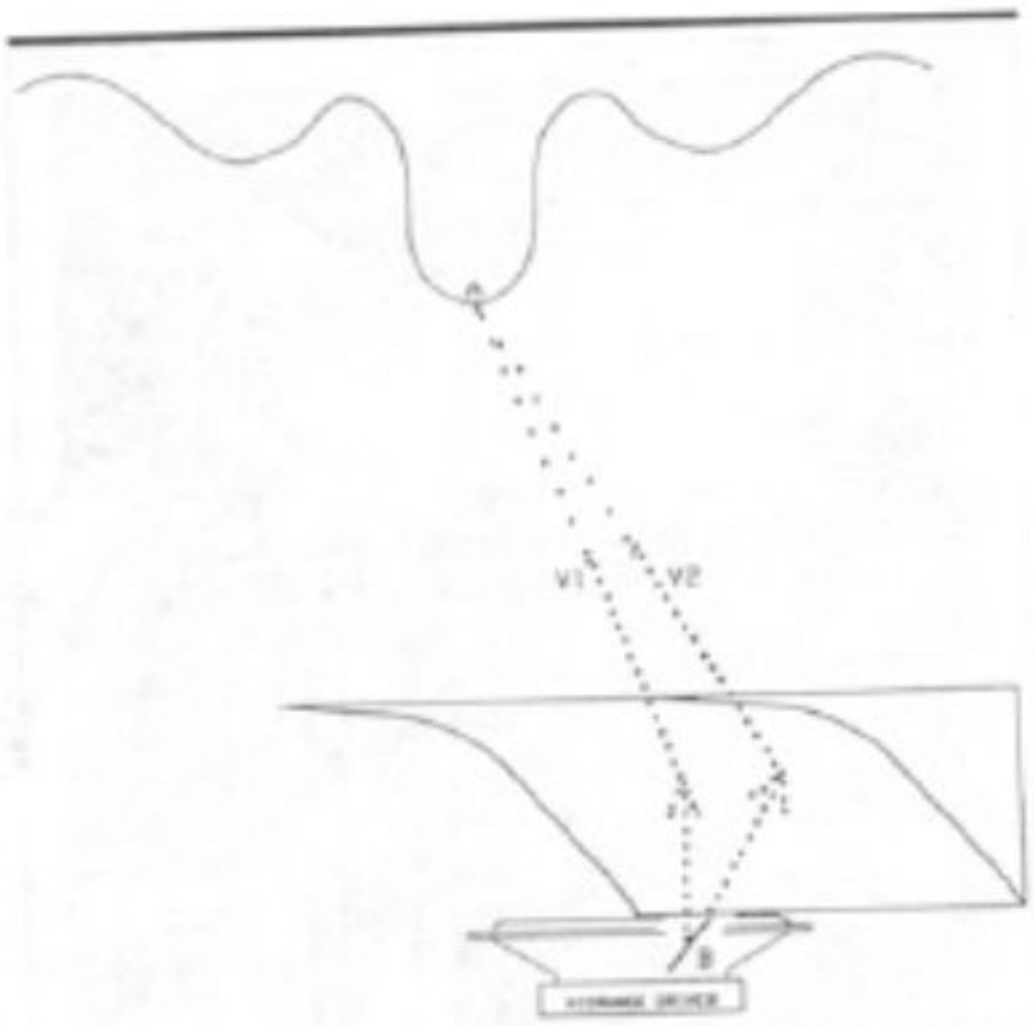

FIGURE 8: A spherical wave is created at point A on the driver.

This is the portion at the top which is necessary to split the driver's output into two equal areas. It was not part of the original design, but the need for it became obvious when I placed the driver over the lens.

Photo 1 shows the heavy, construction paper understructure and *Photo 2* is the final lens. If you view any one of the pieces in *Photo 1* more closely, you will see it is a triangle, except that the hypotenuse is slightly curved, reflecting the shape of the lens slope. This reinforces the concept of a constant slope since the pieces are the same for the hyperconic section as for the conic section.

I filled this understructure with plaster of paris mixed with sawdust to create a dense, nonresonating surface. I later touched up the surface with bondo and glazing putty. After I sanded the unit, I sprayed it with a sandable primer and resanded it until the finish was smooth and even. This created a regular surface that would not color the output (*Photo 2*).

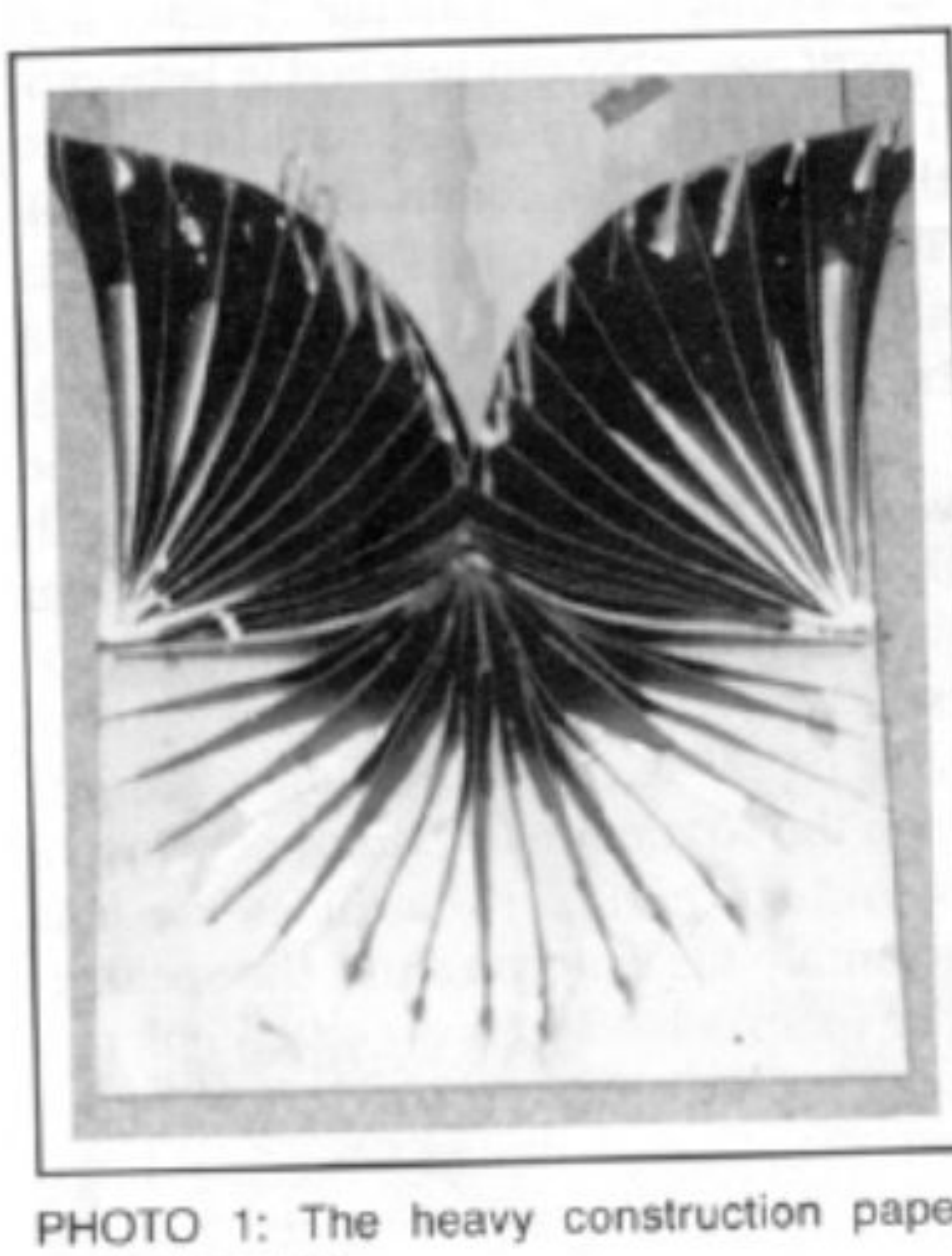

PHOTO 1: The heavy construction paper understructure.

THE SPEAKER SYSTEM. Before I could design a speaker system around the lens, however, I needed a lens for each tweeter. Since the high-frequency lens was considerably smaller, I simply carved it out of wood. The tweeter's lens was also cleaned with bondo, glazing putty, and sandable primer until a smooth, polished surface resulted.

When the lenses were finished, I started to design a speaker enclosure that would effectively use them. I discovered that with the midrange and tweeter mounted over their respective lenses, an aperture is formed between the driver and the lens. The width of this aperture was on the order of the wavelength of the frequencies being produced by the respective drivers. The aperture of the midrange is approximately 9cm corresponding to about 3.8kHz, and for the tweeter, 2cm or 17kHz. Not only is the lens directing the output over 100° in the horizontal, the lens and driver unit is causing diffraction in the vertical plane as well!

Another factor affecting the output of the driver/lens combination is something I discovered when I first designed the lens. Although the phase vector is aligned parallel to the horizontal, the wave vector (the path down which the phase front travels) is at an angle to the horizontal. This means the driver/lens must be located high or turned upside down and placed low so the output will travel to ear level.

With everything previously mentioned in mind, it was not difficult to design a speaker. To make it simple and keep the variables to a minimum, I tried to secure the same drivers and crossover I had used in a previous set of great-sounding speakers. I couldn't find them, but I wasn't concerned about how the drivers sounded. At this point in the project, I simply wished to test the redirecting effect of the lens. All the components I employed are used because of cost and availability. You can substitute different drivers if they meet the constraints mentioned, or you may construct custom lenses.

The DOALS speaker centers around

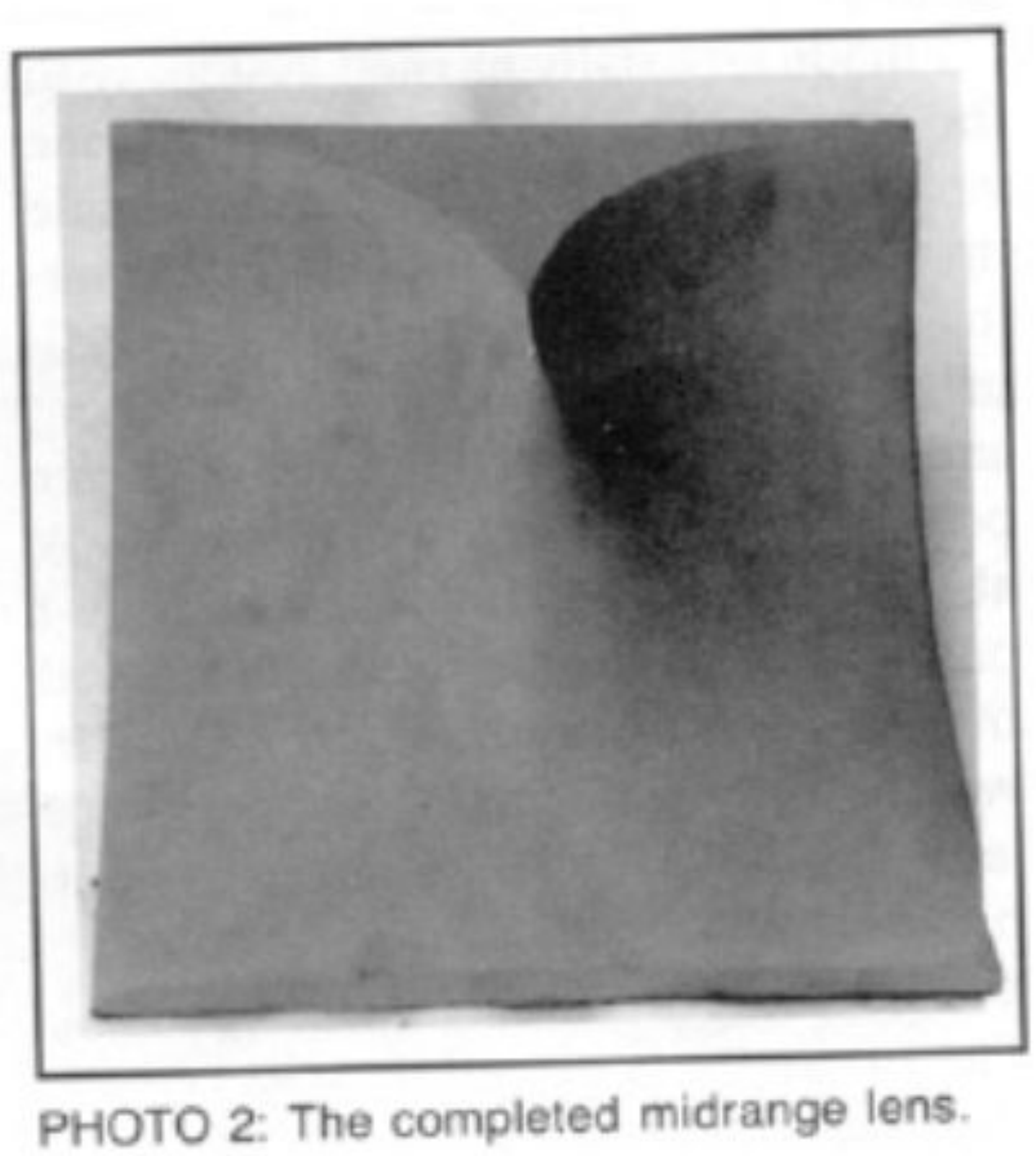

PHOTO 2: The completed midrange lens.

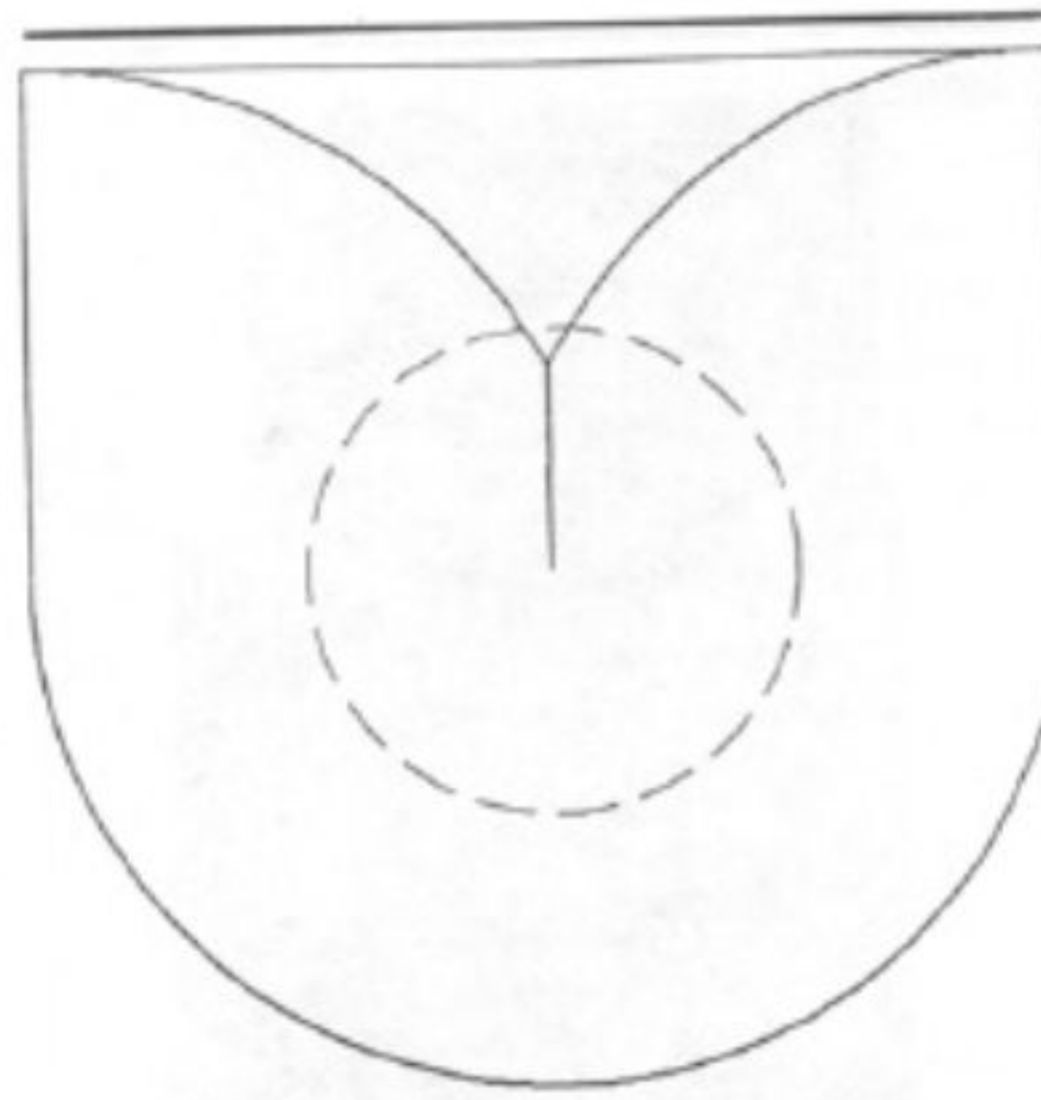

FIGURE 9: The rear portion of the lens redirects the waves created at the driver's edge (the dashed line). The blade portion of the lens (at the top) splits the driver's output into two equal parts.

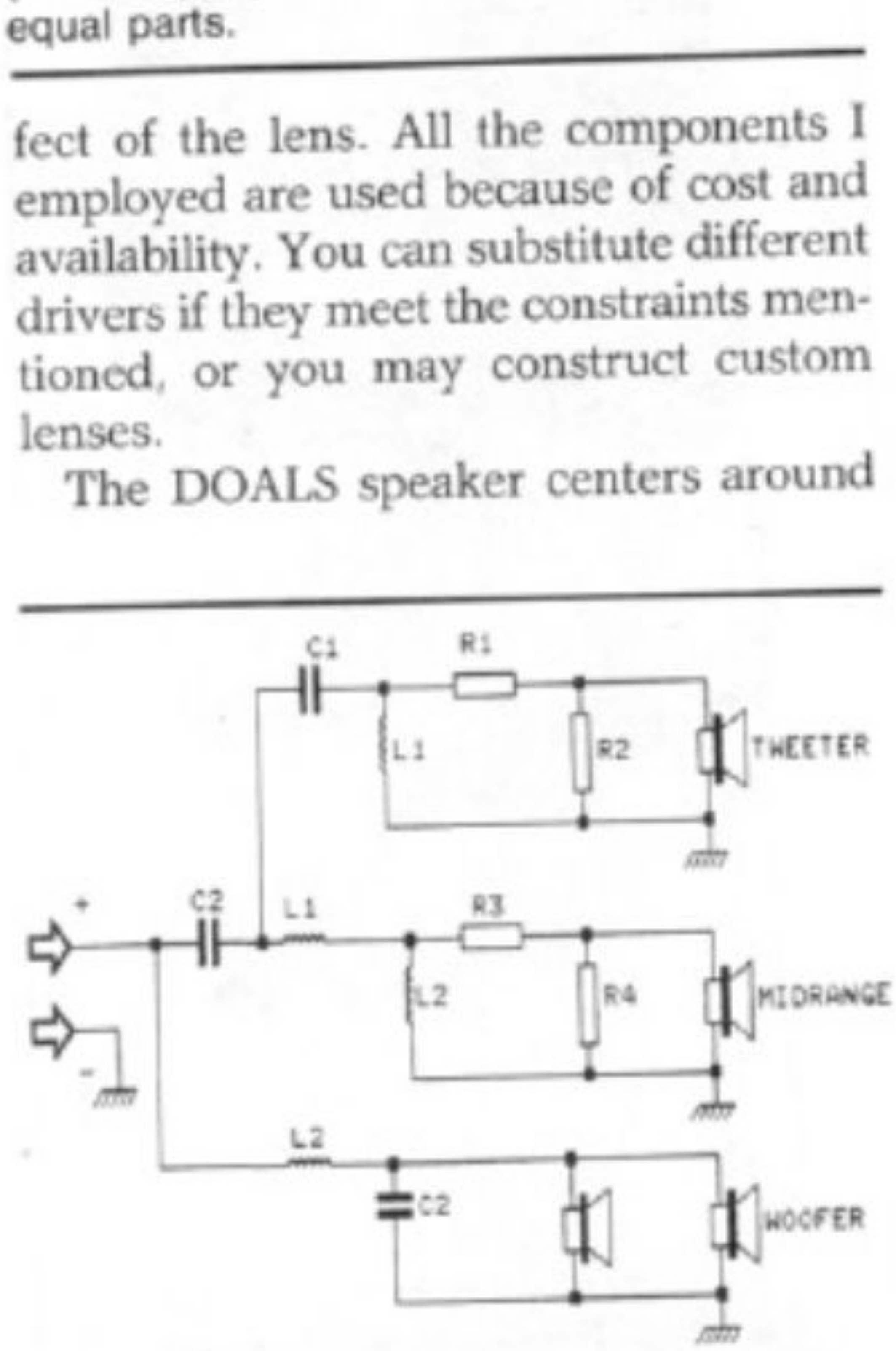

FIGURE 10: The crossover schematic.

TABLE 1

DOALS PARTS LIST

Attenuation resistors (15W)	
R1	0.5Ω tweeter, series
R2	37Ω tweeter, parallel
R3	2Ω midrange, series
R4	12Ω midrange, parallel
Capacitors (nonpolar and 50W+)	
C1	5.6μF tweeter-midrange
C2	33μF midrange-woofer
Inductors (air core and 50W+)	
L1	0.15mH midrange-tweeter
L2	1.25mH woofer-midrange
Drivers	
tweeter	Polydax TW60A, piezo
midrange	Polydax MHD12P25 FSM, paper cone
woofer	6.5" heavy-duty polypropylene in an Isobarik configuration