

Fig. 4. Effect of acoustic lens on horizontal distribution.

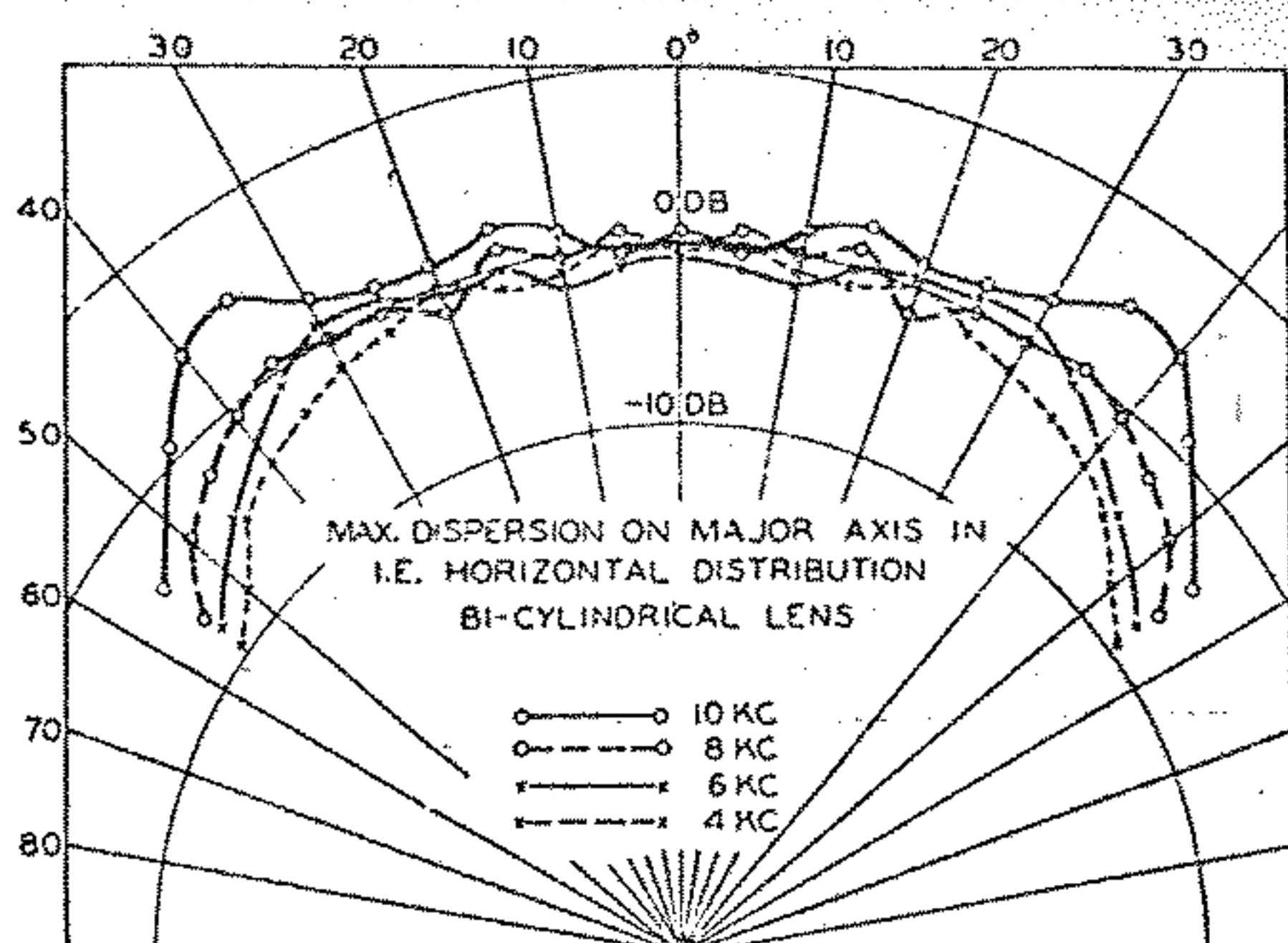


Fig. 5. Horizontal distribution of slant-plate acoustic lens assembly — open-air measuring conditions.

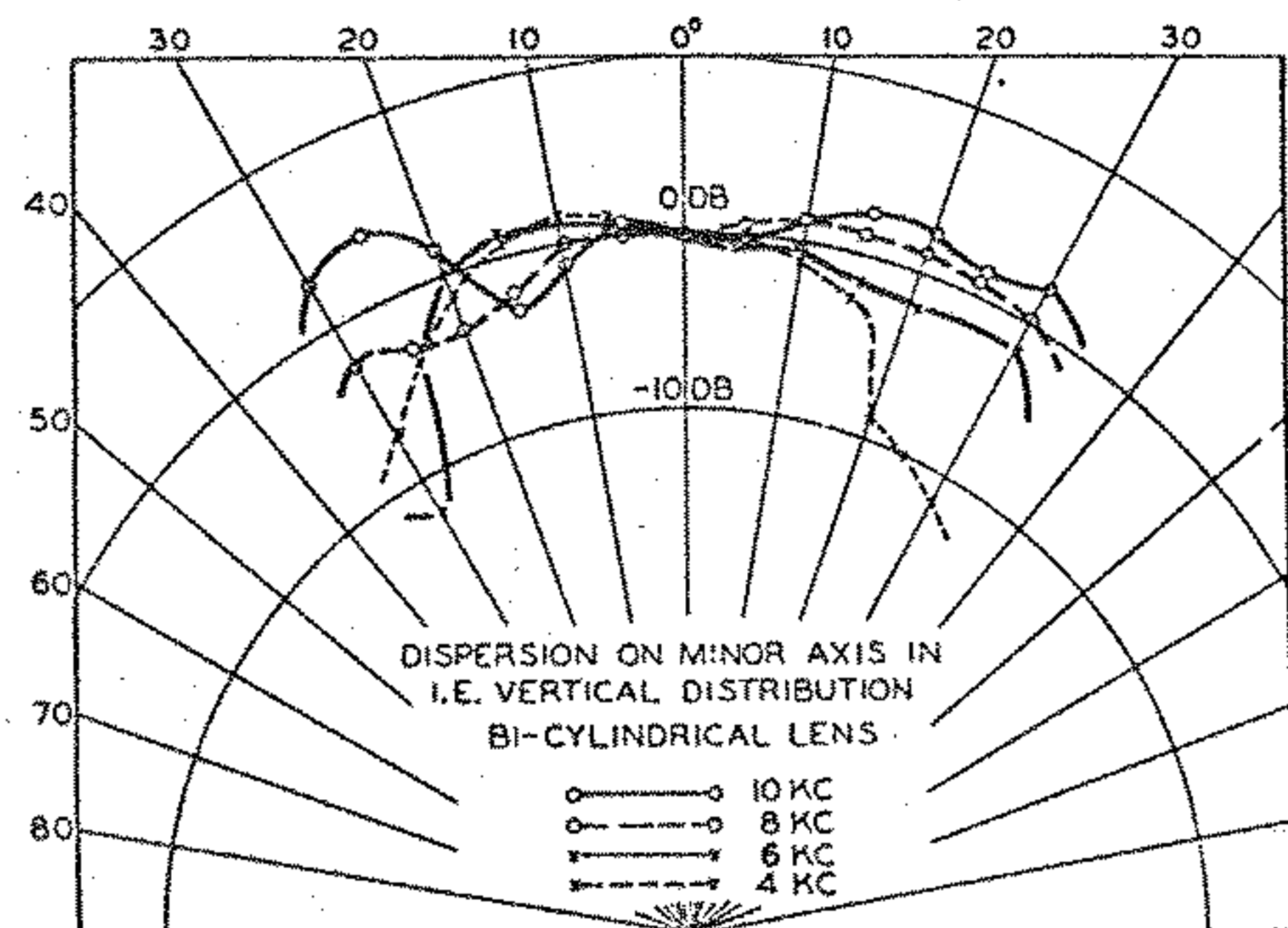


Fig. 6. Vertical distribution of slant-plate acoustic lens assembly — open-air measuring conditions.

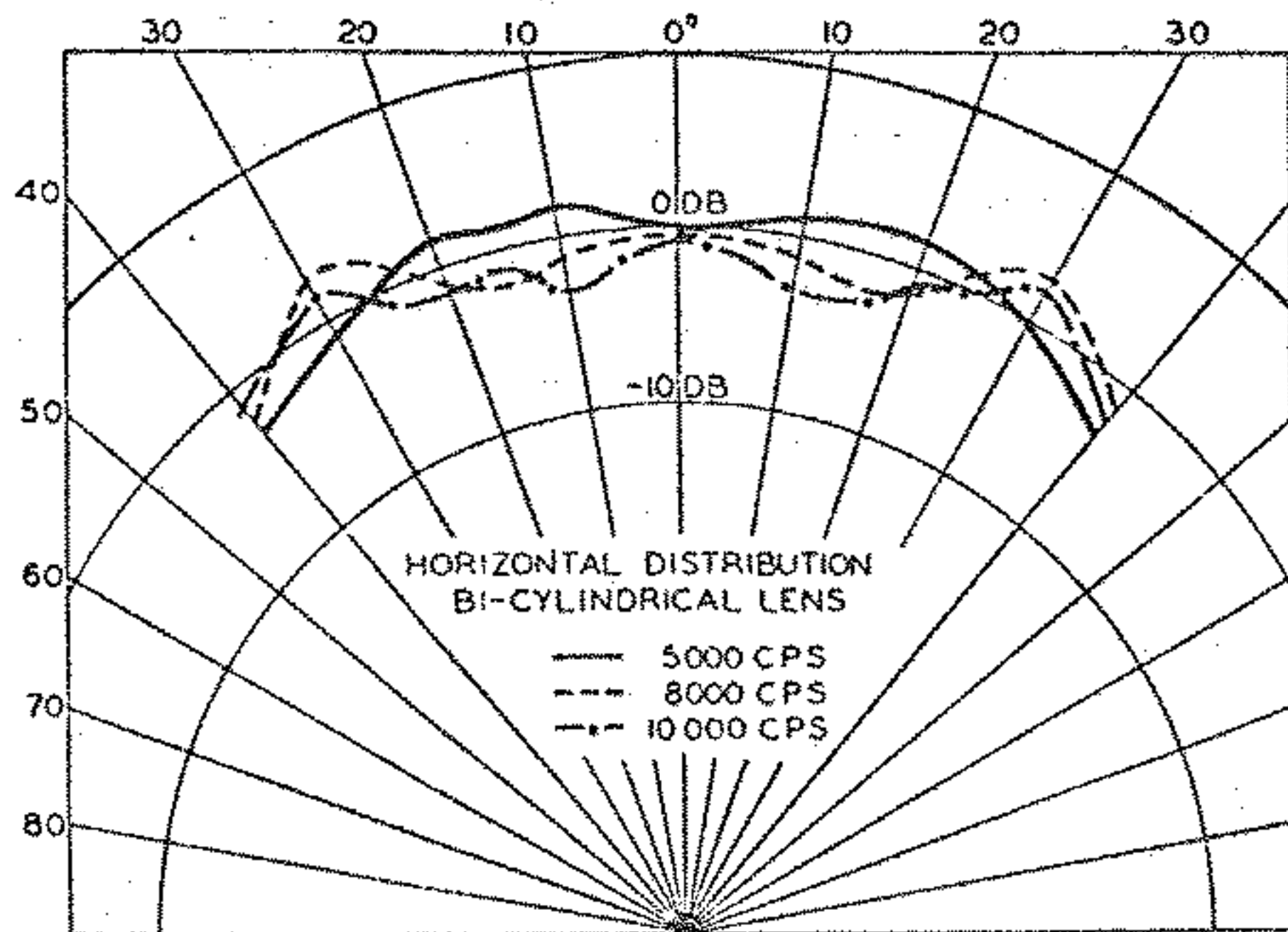


Fig. 7. Horizontal distribution of slant-plate acoustic lens assembly — measured on sound stage.

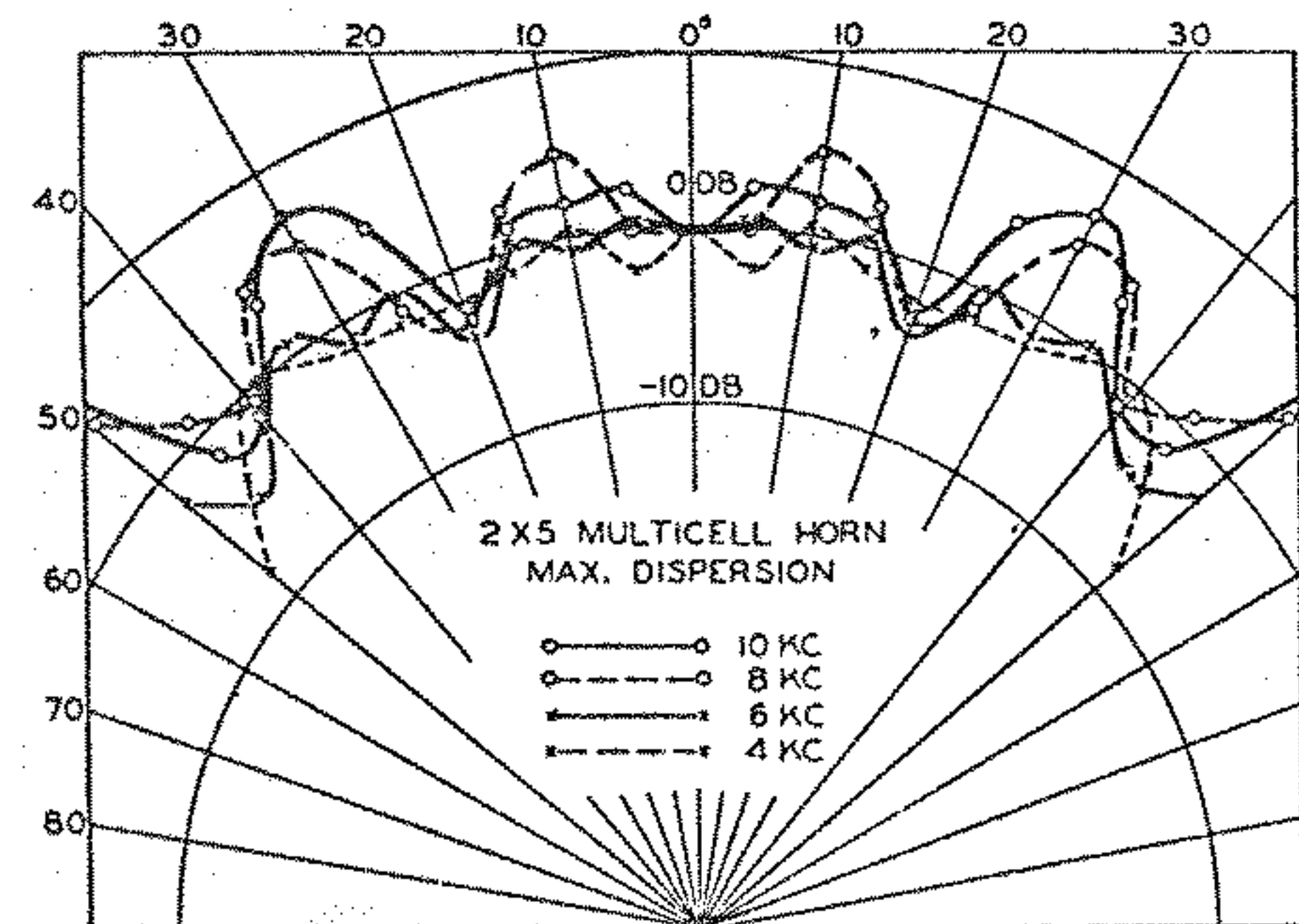


Fig. 8. Horizontal response of typical 2 x 5 multicell theater horn — open-air measuring conditions.

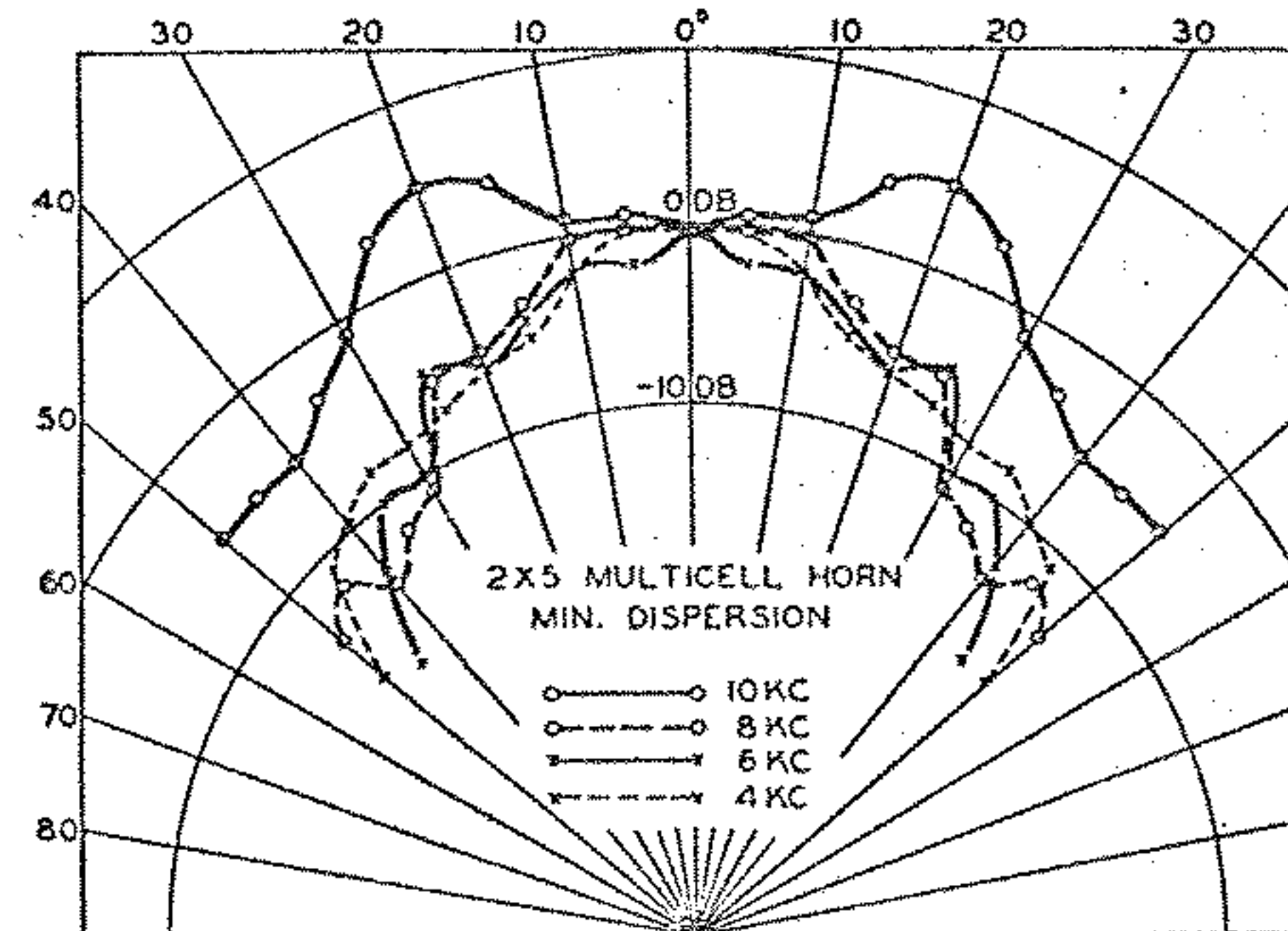


Fig. 9. Vertical response of typical 2 x 5 multicell theater horn — open-air measuring conditions.

A view of a 100-w loudspeaker system consisting of a low-frequency horn equipped with four driver units and two 80° acoustic lens assemblies is shown in Fig. 12. The response characteristic of a 50-w loudspeaker system, using two low-frequency driver units and one 80° acoustic lens system, is shown in Fig. 13. This curve represents a smoothed average

of warble-tone measurements taken on the horn axis on a studio sound stage. Corrections have been applied for the characteristic of the measuring microphone and the scale is substantially similar to that used on the charts of the usual types of sound-measuring equipment.

Listening tests using program material

have been very gratifying. No low-frequency resonances were observed and the high-frequency tones were exceptionally clean. The horizontal distribution was observed to be in conformance with the curves previously shown. When compared with a conventional theater loudspeaker system under A-B test conditions, the new system brought the

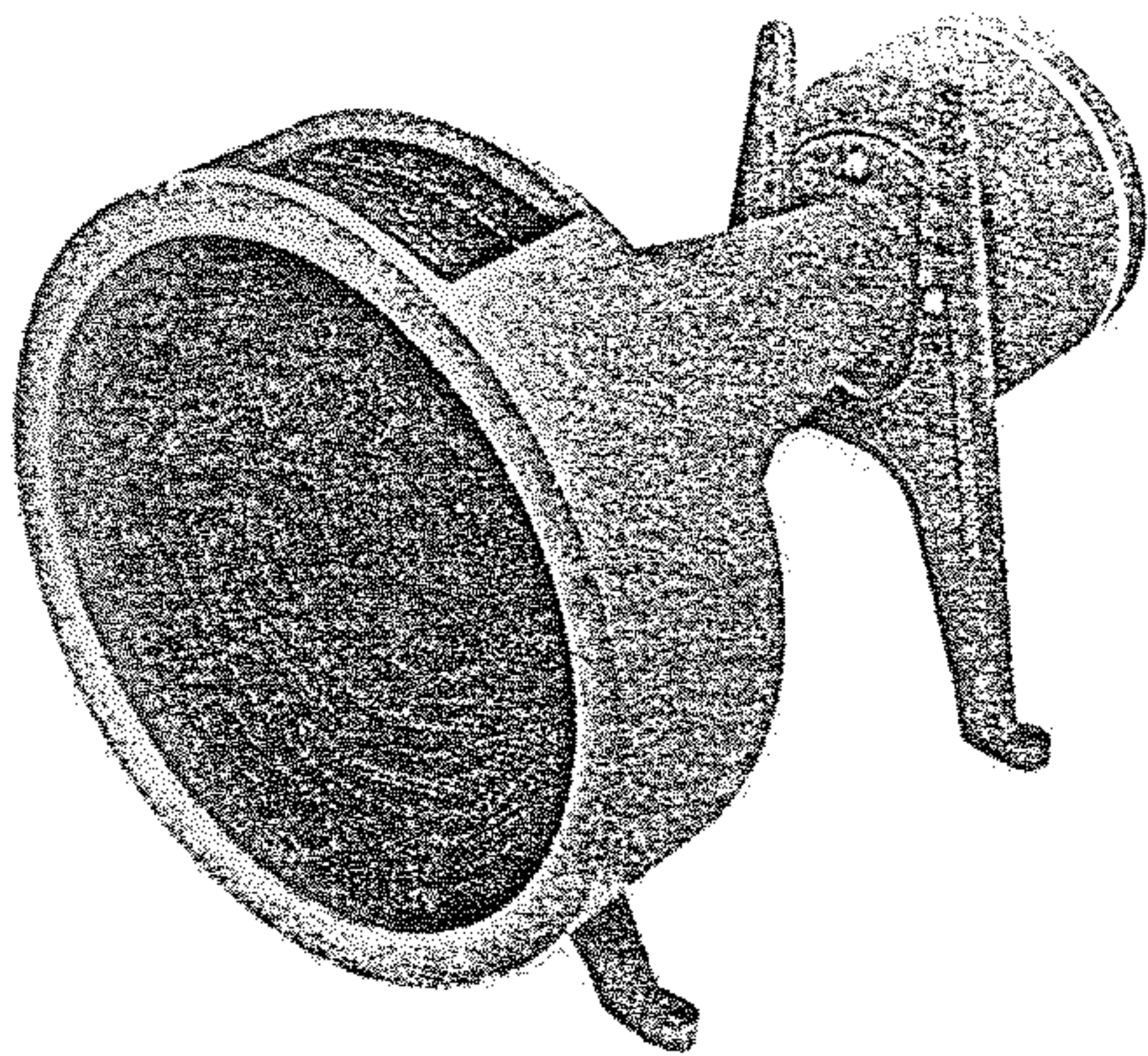


Fig. 10. Front view of T550A acoustic lens assembly.

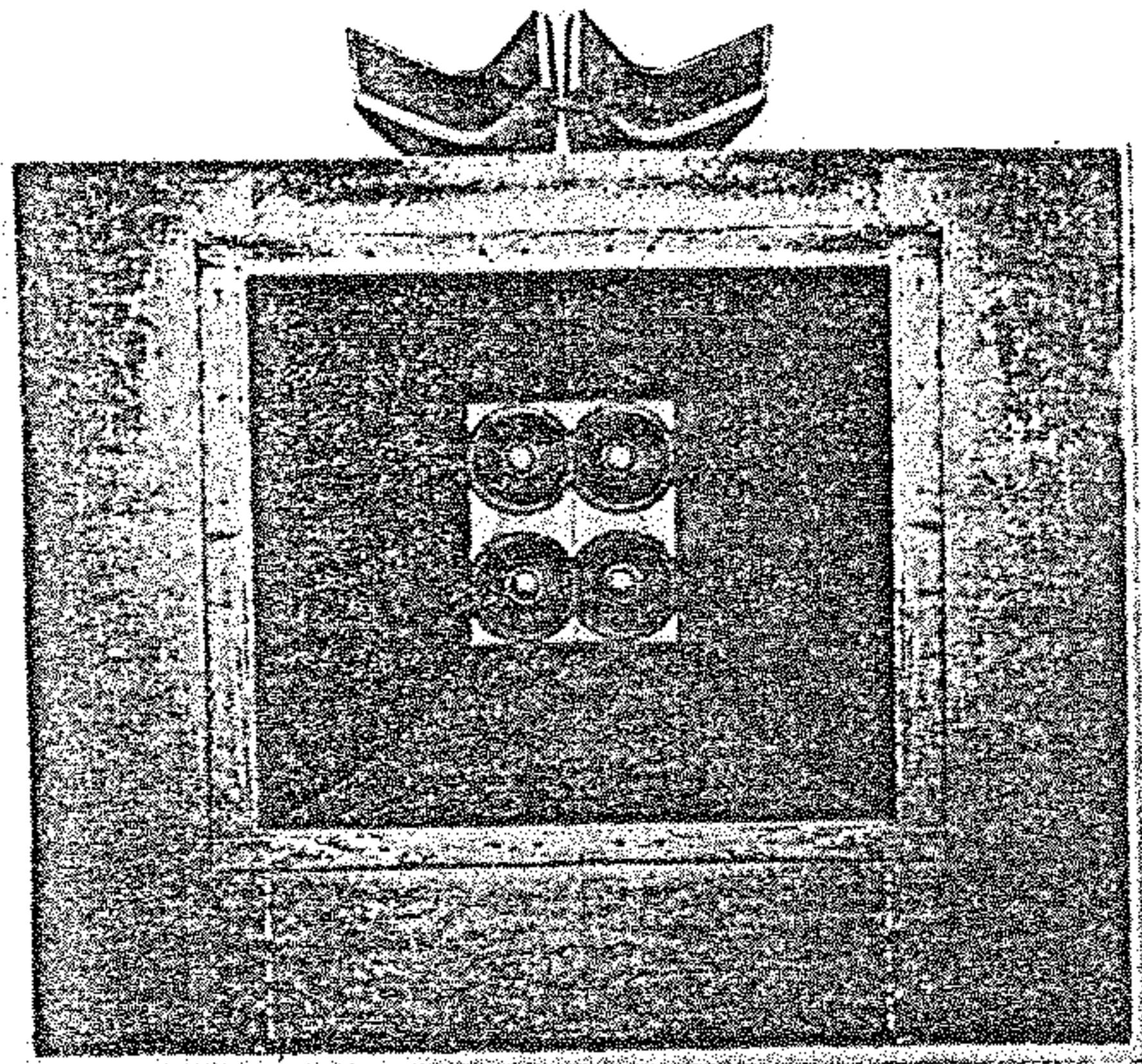


Fig. 12. View of T502B loudspeaker system.

Fig. 11. Theoretical response of four-driver low-frequency horn assembly.

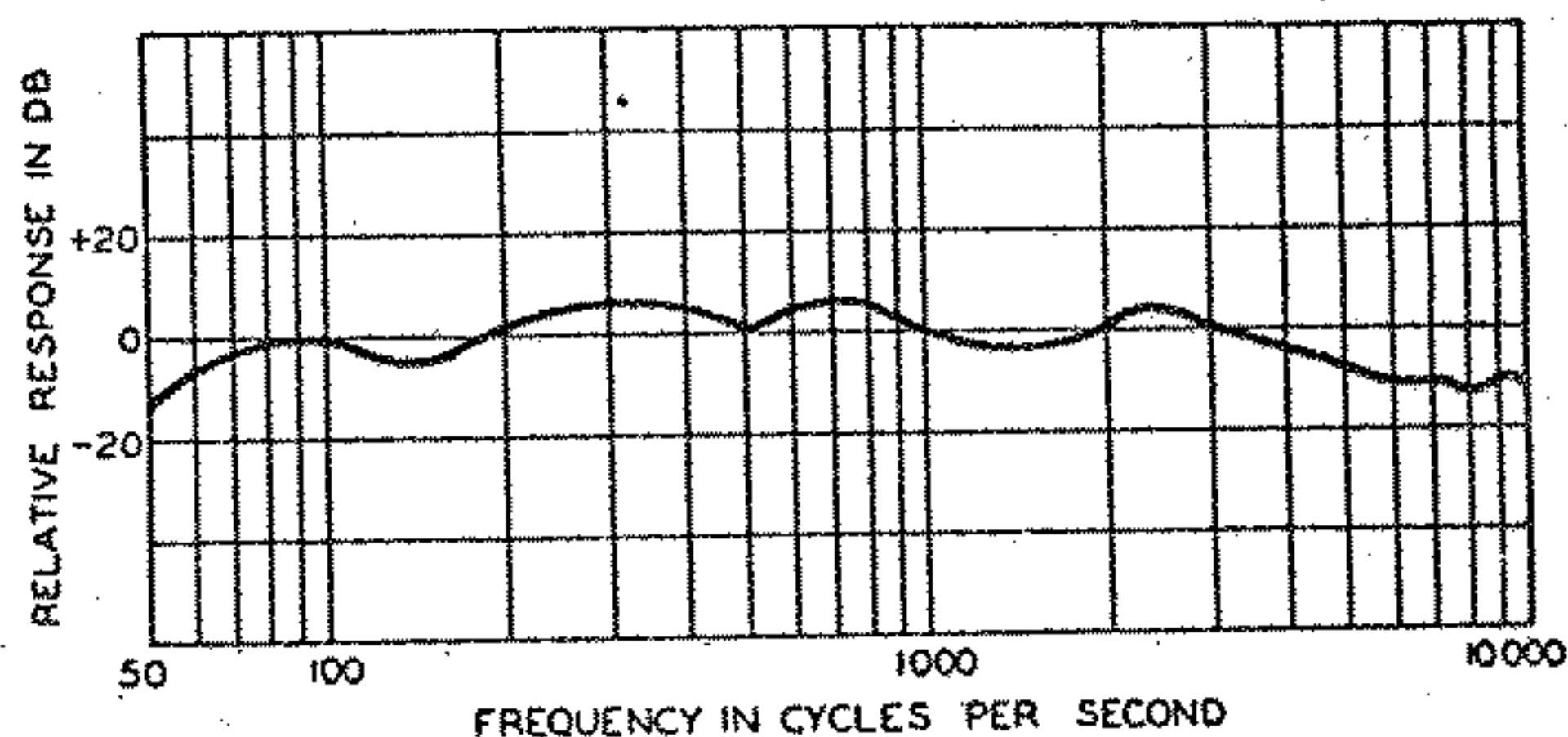
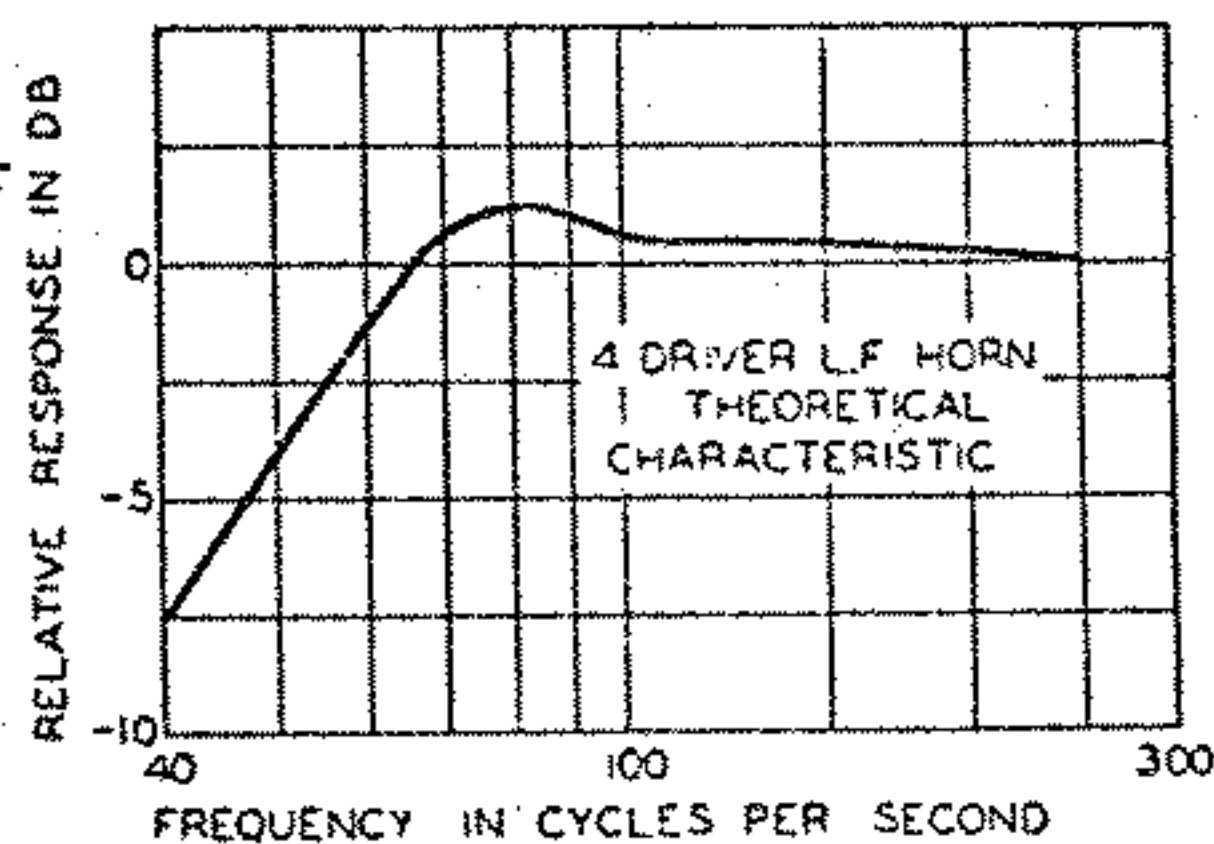


Fig. 13. Response characteristic of 50-w system — smoothed average warble-tone measurements.

apparent source of sound considerably closer to the audience, thus indicating a desirable presence factor.

References

1. J. K. Hilliard, "Theater loudspeaker design, performance and measurement," *Jour. SMPE*, 52: 629-640, June 1949.
2. William B. Snow, "Basic principles of stereophonic sound," *Jour. SMPTE*, 61: 567-589, Nov. 1953.
3. Winston E. Kock and F. K. Harvey, "Refracting sound waves," *J. Acoust. Soc. Am.*, 21: 471-481, Sept. 1949.

Discussion

John Hilliard (Altec Lansing Corp., Calif.): In one of the slides you showed a round, diffusing-type horn system. How does that compare with the one of the rectangular type?

Dr. Frayne: The curves are quite similar over their respective design angle of distribution. I'm sorry we don't have a curve on it here. It was designed for 50° distribution. At 25° off the axis the response was falling off.

Mr. Hilliard: By coincidence, I happened to measure two or three of them and found that whenever you take the lens properties out of it, the directional properties increase, that is the frequency response was extended and the drop-off with azimuth was less than it was with the lens assembly on it.

Dr. Frayne: That's not in accordance with measurements shown in Fig. 4.

Mr. Hilliard: This was a general statement that in all cases when the diffuser element was taken off the properties of the two units measured were improved and these were measured in an anechoic chamber with the 640AA microphone as the standard.

Dr. Frayne: I wouldn't want to dispute your word, but I don't think it agrees with our findings.

M. A. Kerr (Bureau of Ships): You said in the beginning of your paper that the spread of sound at the high frequencies was necessary for the spatial illusion and this work that you're showing begins at the high-frequency end and works downward. That would assume that there is a crossover point where the spatial illusion effect is no longer necessary, because I don't see any similar spread in your low-frequency units. Is there any critical frequency point or general area where it is no longer necessary to properly spread the low frequencies?

Dr. Frayne: According to Snow² very poor localization is obtained below 1000 cycles.

John Volkmann (Radio Corp. of America, Camden, N.J.): Your paper did not show any directional characteristics for the low-frequency speaker?

Dr. Frayne: No.

Mr. Volkmann: Does it match the directional pattern of the high-frequency speakers? In particular, how does the directional pattern of the combined systems act in the crossover frequency range?

Dr. Frayne: The 50-cycle distribution is very uniform. The 500-cycle distribution of the low-frequency speaker measures essentially the same as that obtained from the lens. I would say that the performance of the low-frequency system is quite comparable to any 50- or 100-w system today in theaters. The thing we're trying to emphasize here is the lens of the high-frequency units.

Mr. Volkmann: I'd like to point out that there is a fundamental difference in the design of the low-frequency horn relative to the high-frequency horn, namely, if I judge the design correctly, the low-frequency horn is designed on a basis of a plane-wave progression in the horn.

Dr. Frayne: That's right.

Mr. Volkmann: In a straight-axis exponential horn design the plane wave radiation would tend to give a sharpening of the directional pattern with an increase in frequency, whereas the high-frequency horn design, being based on the lens principle, the radiation would tend to give a spherical distribution of the sound within its angular range and there would be, in the crossover region, then, a disparity between the two types of directional patterns.

Dr. Frayne: Well, I've seen curves on both the 50-w and 100-w systems covering the angles we mention here. There were no signs of such disparity.

Mr. Volkmann: My second question is whether or not you really desire a spherical distribution pattern in the vertical angle, where, for example, in an auditorium you want the same level in the front rows of seats as in the back rows? Except where the loudspeakers are up high enough, is it not more desirable to have a sharp directional pattern in the vertical plane in order to balance the level from front to back more uniformly?

I would like to make another point. The low-frequency horn has a very similar likeness to one of the models (straight axis) that RCA tested in connection with the experiments that were conducted by Douglas Shearer back in 1935 or 1936.

Dr. Frayne: I believe the model you were referring to was a folded-type horn while the present unit is a short front-loaded horn.

Richard H. Ranger (Rangertone, Inc.): Isn't your premise that the intensity is the most important factor in initial stereophonic work, directly limited to frequencies from 1000 cycles up, because the human head itself serves as a cross-over point where below 1,000-cycles phase is predominant, and above 1,000-cycles intensity is the dominant factor for spatial emphasis.

Dr. Frayne: Somewhere in that neighborhood.