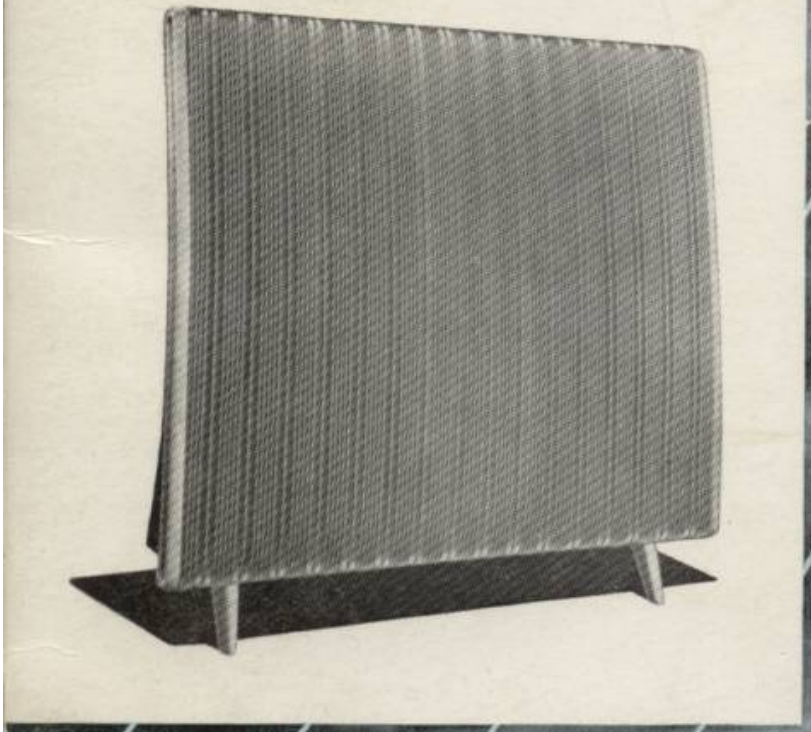
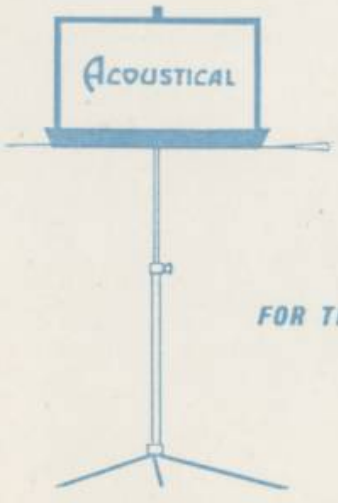
THE QUAD ELECTROSTATIC LOUDSPEAKER



ACOUSTICAL



FOR THE CLOSEST APPROACH TO THE ORIGINAL SOUND

ACOUSTICAL

THE QUAD ELECTROSTATIC LOUDSPEAKER

ACOUSTICAL MANUFACTURING COMPANY LIMITED
HUNTINGDON . HUNTS

Telephone : Huntingdon 361

For the past 30 years virtually all loudspeakers have used the moving coil principle as their fundamental mode of operation.

Acoustical have now developed a radically different type of loudspeaker and the reader may well ask three questions. Why abandon the well tried moving coil drive? Why chose an electrostatic principle? What advantages and disadvantages does this offer the listener?

This booklet attempts first to answer these questions and secondly to present details of the first full range distortionless loudspeaker.

The reader interested in a technical analysis of the subject is referred to a series of articles in "The Wireless World," May, June & August, 1955, copies of which can be supplied by:—

THE ACOUSTICAL MANUFACTURING CO. LTD.

A CHOICE OF PRINCIPLE

Changing from one principle of operation to another merely discards one set of limitations and difficulties and replaces them by an entirely different set. The choice will depend upon which set, with skilful design, is the least limiting in the attainment of the design objective.

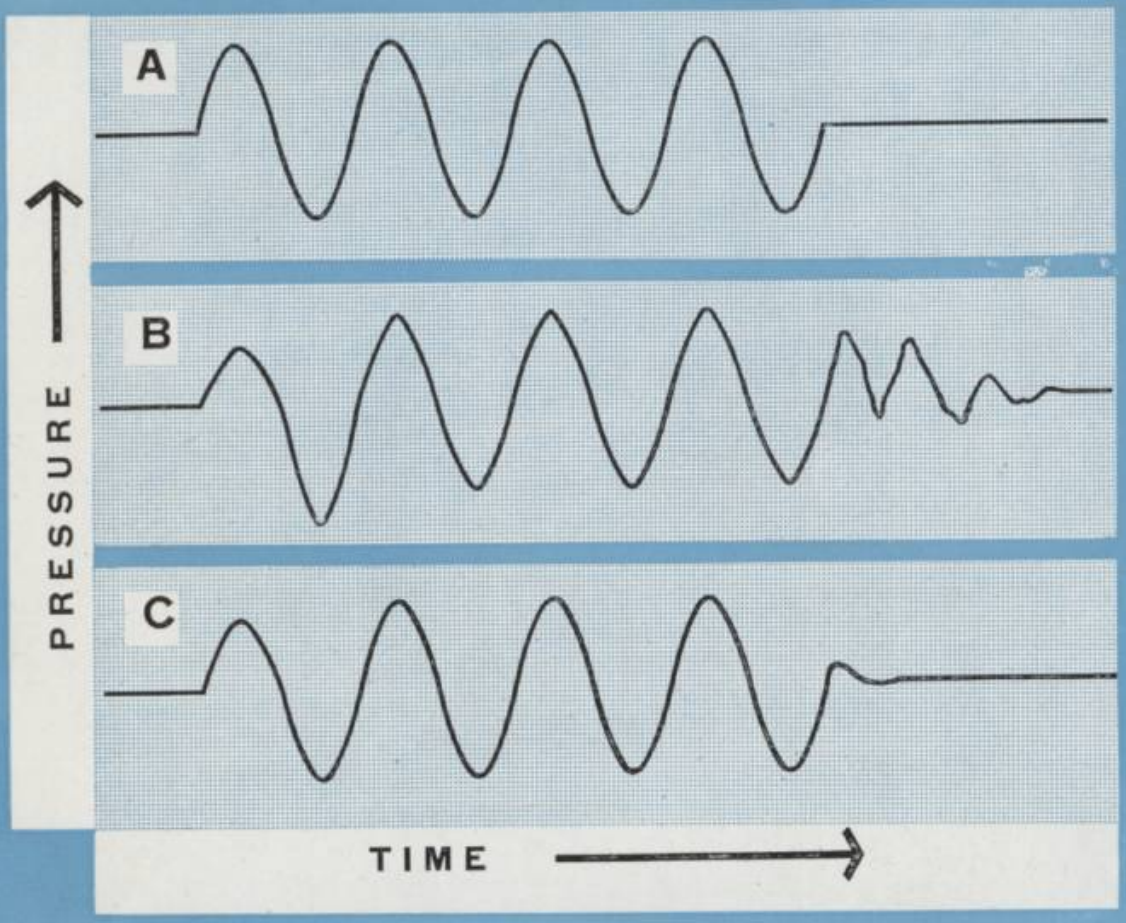
Of course, a principle is merely a tool of the designer and is no guarantee whatsoever of final performance. Nevertheless, a principle will usually show itself as trends in design and some understanding of such trends is perhaps the best way by which the reader can gain some assessment of the final results when mere words are the only vehicle available to describe such an ethereal quality as sound.

SMOOTHNESS

With few exceptions the transfer of electrical energy to sound energy is achieved by first converting the electrical energy into a mechanical form by causing mechanical vibration to occur in a diaphragm or cone. Such a system has many resonances, thousands of which can be significant in the reproduced sound. Each resonance accepts electrical energy in an amount depending upon its structure, stores it and then radiates it as sound. Each resonance differs from its neighbour in a manner virtually impossible to predict and equally impossible to control. The "art" in moving coil design consists in endeavouring to even out these resonances so that they are least objectionable.

By using an electrostatic drive, the diaphragm can be energised in such a way that the majority of these resonances are not energised. Further, since the diaphragm can be some hundred times lighter than a conventional cone, the energy in storage, and hence the effect on those resonances which are excited, can be and is virtually eliminated.

The result of removing the stored energy is to make a much more intimate contact between the electrical forces and the air into which sound is radiated. The effect is termed "smoothness."



B. shows the effect of stored energy in a well-designed cone when reproducing a pulse sound A.
C. is the same pulse reproduced by an electrostatic system.

" Smoothness " must not be confused with an even frequency response or with balance. These relate to the ability of the loudspeaker to treat all parts of the frequency spectrum equally. Thus shrill, brilliant, woolley, hollow, disjointed and similar comments usually indicate an uneven frequency response and are distinct from smoothness. An even frequency response is, of course, an equally important requirement and is a matter of skill in design regardless of operating principle. In other words, changing from moving coil to electrostatic principles neither helps nor hinders in this respect.

What then is the aural effect of smoothness ? It is clearly related to the degree of musicalness of the loudspeaker. Thus if a loudspeaker which is smooth and yet has an unbalanced frequency response reproduces a violin, the sound will be that of a real and *natural* violin, the effect of unbalance being that of playing under peculiar conditions. If the loudspeaker is not smooth, then the violin will never

be natural, no matter how " level " the frequency response. The best that can then be achieved is an imitation sometimes even boarding on caricature.

Absence of smoothness quickly causes fatigue to the musical ear, a state of affairs which can well worsen the wider the frequency range. Lack of smoothness is largely responsible for the disillusionment experienced by many a proud owner of " Hi-Fi " when demonstrating to his musical friends.

SENSITIVITY—& A CONCEALED COST

The sensitivity of a loudspeaker is important in that it determines the power output of the amplifier needed to produce the required volume of sound in the listening room.

Theoretically, the sensitivity of an electrostatic design can be increased as desired, but if this is to be done without degrading other features then the difficulties and cost increase rapidly. Economically then, it is obvious that the pursuit of sensitivity should cease when the cost of further increase is more than the cost of a similar increase in amplifier power. This may well occur at a lower sensitivity than that attained with most moving coil loudspeakers. This does not affect acoustic performance although it may represent a concealed cost in that the amplifier power requirements may be increased.

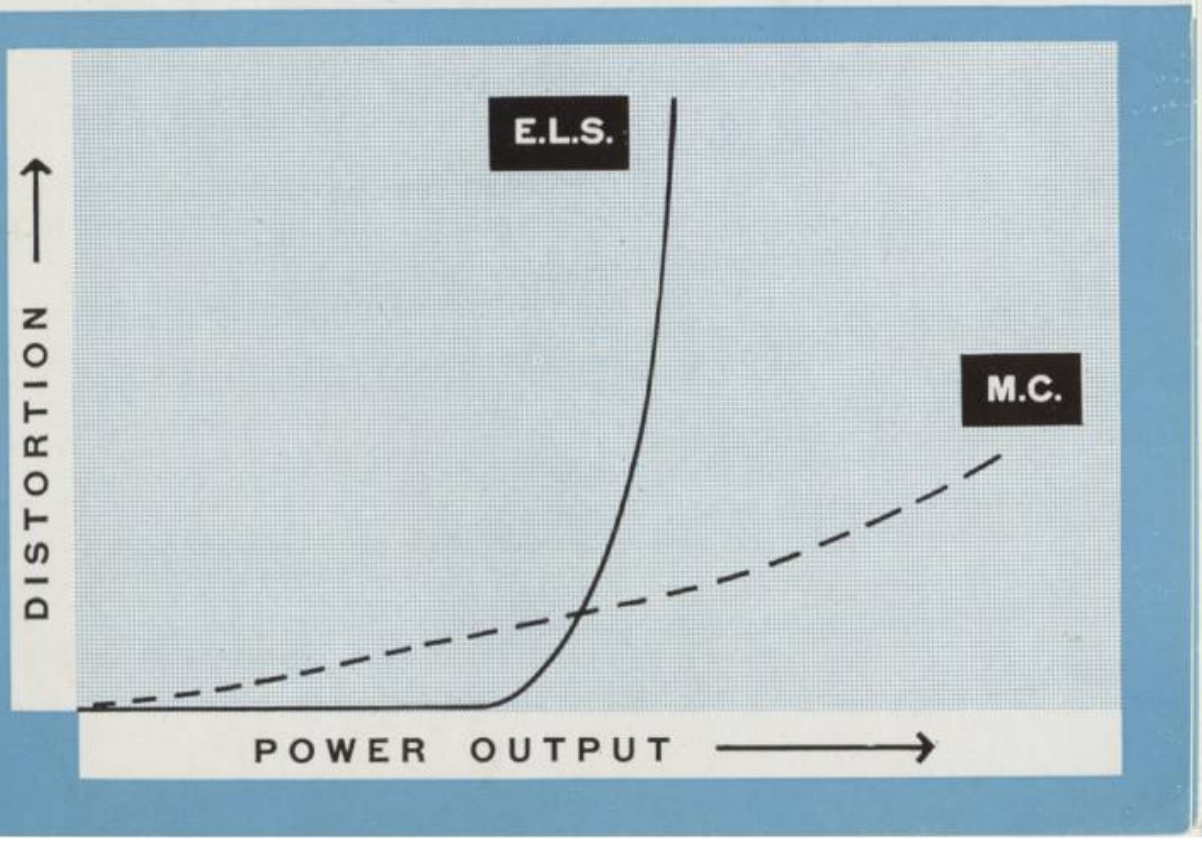
DISTORTION & POWER

An electrostatic loudspeaker may be constructed in such a way that non-linearity and therefore distortion is effectively non-existent.* This will hold good up to a certain fixed maximum power output per unit area of diaphragm. Beyond this power level, distortion will occur. With a moving coil system, distortion is small at low levels and increases more or less as the power increases, there being no clearly defined point of abrupt change.

Having designed an electrostatic loudspeaker for a given maximum power, the distortion at any level up to that maximum power will be lower than that of an equivalent moving coil loudspeaker. If, however, the maximum designed power is exceeded then distortion will be severe and an equivalent moving coil system, similarly overloaded, would be very much more acceptable.

Clearly, therefore, an electrostatic design can be and in fact must be closely related to its environment. A design for the highest grade domestic listening would be entirely unsuitable in a large public room. Similarly an electrostatic design for a public hall would also be unsuitable for domestic use, since quite apart from any consideration of size and cost, the larger speaker would be less intimate in the home.

** Patent applied for.*

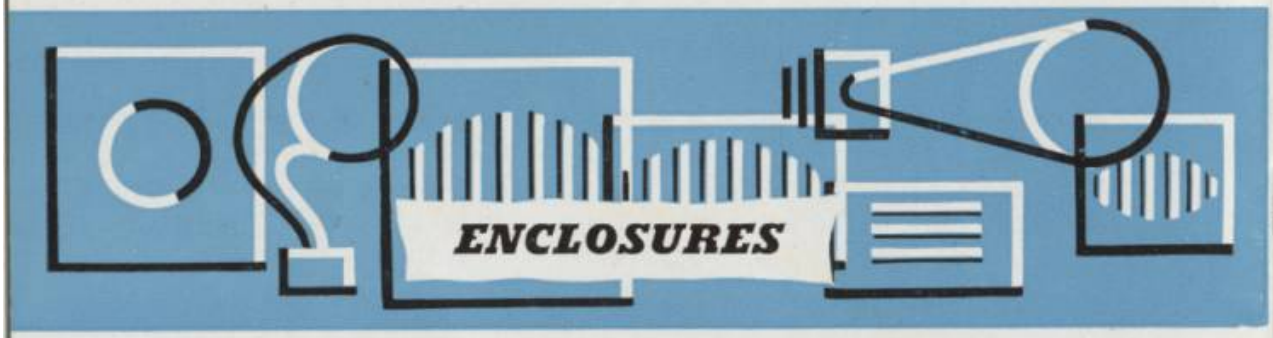


LOUDNESS

For serious listening to a reproduced sound the stimulus at the ear should be similar to that obtained in natural listening. In terms of loudness therefore (and always provided that domestic conditions permit) the sound pressure at the ear should be of similar intensity to that experienced in a favourable seat in the concert hall.

An electrostatic loudspeaker of quite modest size can produce this intensity under normal home listening conditions.

This " favourable seat " intensity level provides ample margin of distortionless power for all types of serious listening at home.



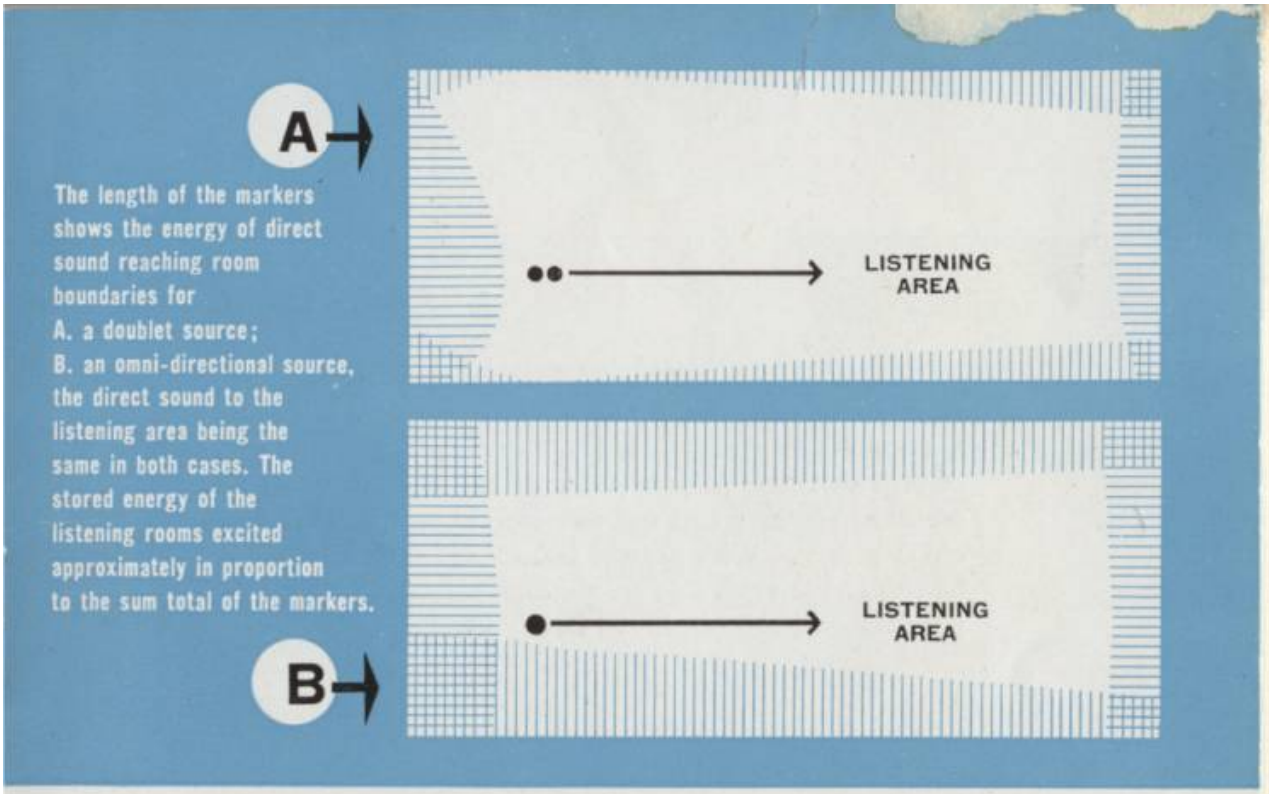
ENCLOSURES

Enclosures are boxes, cabinets, baffles, horns and other structures which, apart from producing a pleasing housing for the loudspeaker, form part of the operation of the loudspeaker and must be designed with the loudspeaker as a single entity.

Enclosures may be used to useful effect in electrostatic loudspeaker design as with any other type of drive. Due to electrical characteristics peculiar to an electrostatic system however, it is possible to construct an electrostatic loudspeaker in a form known technically as a doublet without the heavy losses incurred when this is attempted with a moving coil drive.

A doublet offers both advantages and disadvantages over a cabinet system, and these may be briefly summarised:—

(*a*) Sound radiation is confined to one plane instead of three, reducing modification of the sound by the listening room characteristic by the same degree:



The length of the markers shows the energy of direct sound reaching room boundaries for
A. a doublet source;
B. an omni-directional source, the direct sound to the listening area being the same in both cases. The stored energy of the listening rooms excited approximately in proportion to the sum total of the markers.

(*b*) A doublet does not utilise an enclosure so that problems of unwanted enclosure resonances do not arise:
(*c*) The price to be paid for these advantages is a reduction in power output and/or restriction in frequency range.

The effects of rooms and cabinet enclosures are largely confined to the low and middle registers and a doublet assists at these frequencies in producing smoothness, the aural effect of which has already been discussed.

THE DIRECTIONAL CHARACTERISTIC

The effect of directional characteristics on reproduced sound is extremely complex and is much more subtle than the obvious requirement of an even response throughout the listening area.

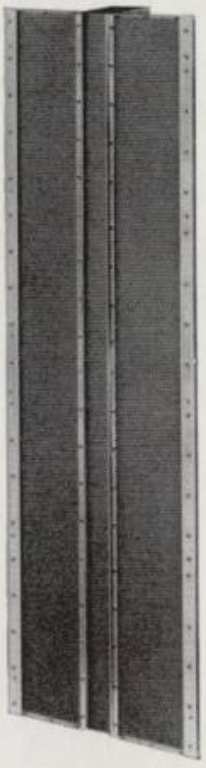
In view of the larger radiating area it is more difficult, and hence more expensive, to obtain what is usually considered a desirable characteristic with an electrostatic system than with a moving coil system.

However, there are a number of methods by which this disadvantage can be mitigated in order to obtain a musical balance throughout a reasonable listening area without recourse to the more elaborately shaped constructions and without introducing the lack of homogeneity usually difficult to avoid with such constructions.

RELIABILITY

In terms of reliability a number of problems are inherent and unique to electrostatic loudspeaker design:—the effect of high voltages; plastics under stress; dust; moisture and moisture vapour; and temperature changes are the more obvious ones. With present technology these hazards can be reduced to negligible proportions provided care is taken not to exceed any maximum ratings specified.

● **THE WORLD'S FIRST FULL RANGE ELECTROSTATIC LOUDSPEAKER**



Developed by Acoustical Manufacturing Company Limited and demonstrated to an invited audience of the country's leading audio engineers on May 21st, 1955.

THE OBJECTIVE

Listeners interested in sound reproduction in the home can broadly be divided into two groups.

The individual interested in music can rarely attend all the live concerts of his choice. He therefore, installs a loudspeaker in his home so that he can enjoy music having removed the problems of time and place.

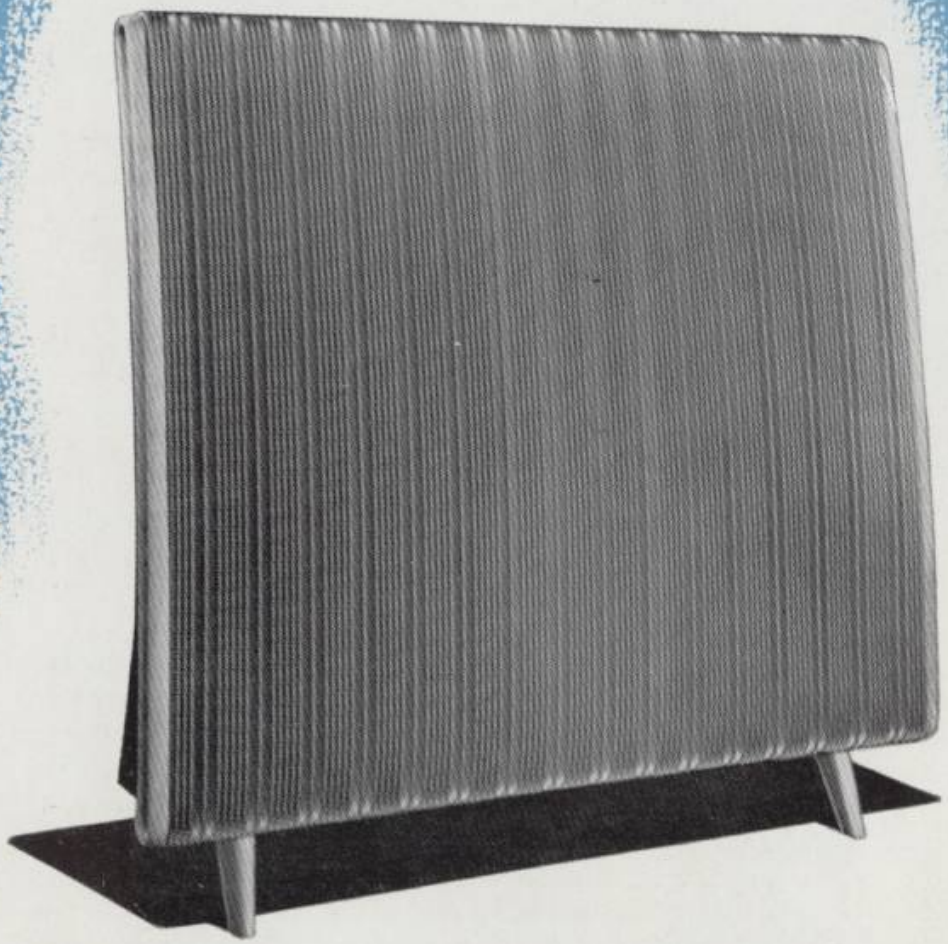
In recent years a second group has arisen which, though previously little interested in music, nevertheless obtains considerable emotional satisfaction from the sensation of sound, particularly reproduced sound under their own control.

With both groups the appeal is to the emotions via the ear, but it is clear that the character of the stimulus giving the satisfaction is entirely different.

In a loudspeaker designed for the first group, the essentials are that the loudspeaker itself should be as unobstrusive as possible, it must be non-fatiguing and have the minimum of those distortions musically unacceptable. The loudspeaker forms no part of the artistic chain.

In the second group the loudspeaker does become part of the artistic chain and it is required to produce maximum emotional effect having chosen suitable music and other sounds to assist it.

A loudspeaker designed for the second group will never be suitable for the first group. The reverse, however, is possible, since distortion effects can be added electronically. This approach is, in fact, similar to that commonly used in recording, i.e. multi-microphones, echo chambers, frequency distortion, etc. Such a procedure can only be artistic if applied with the utmost discretion and taste.



THE QUAD ELECTROSTATIC LOUDSPEAKER

is a design of modest size intended for the highest grade of music listening under domestic conditions. It is suitable in rooms from 1,000 to 5,000 cubic feet, and is capable of providing distortionless reproduction under such conditions up to a volume level similar to that experienced in the concert hall.

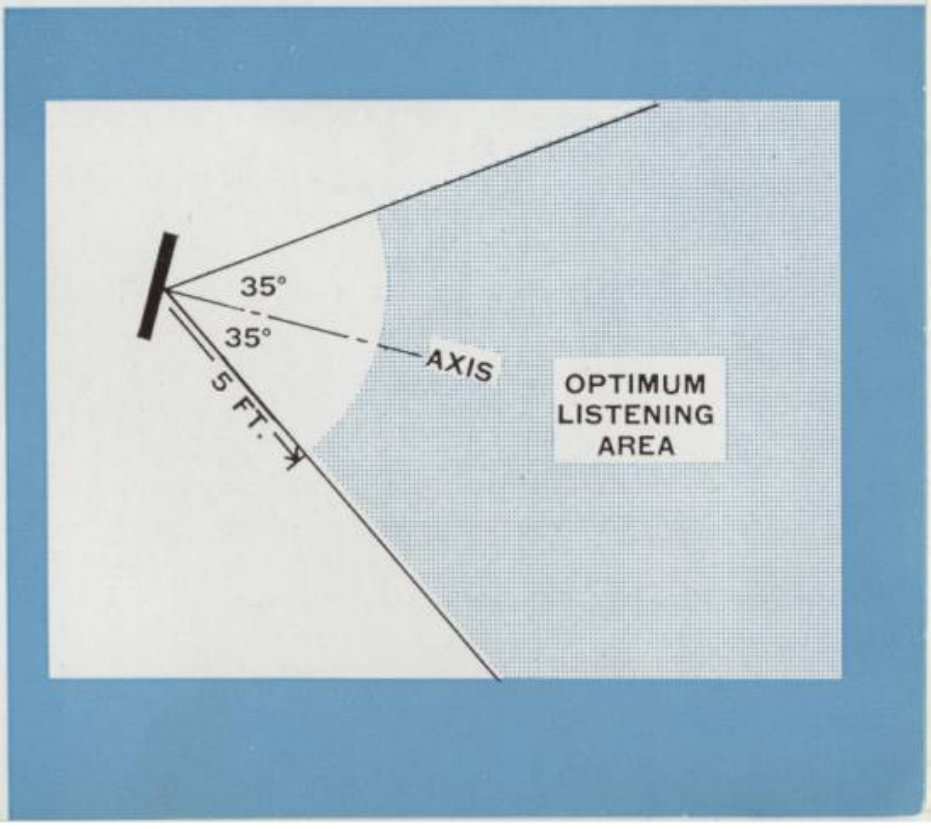
It is designed with every emphasis towards the natural, non-fatiguing and unobtrusive quality desirable for serious listening to music of all types.

There is no doubt that the very unobtrusiveness of the speaker will seem an anticlimax to many people because of the complete absence of " spectacular Hi-Fi." For the rest, there will be a degree of naturalness which has given rise to such expressions as " Freshness," " Relaxed," " Transparent," " Window on the Orchestra."

POSITION

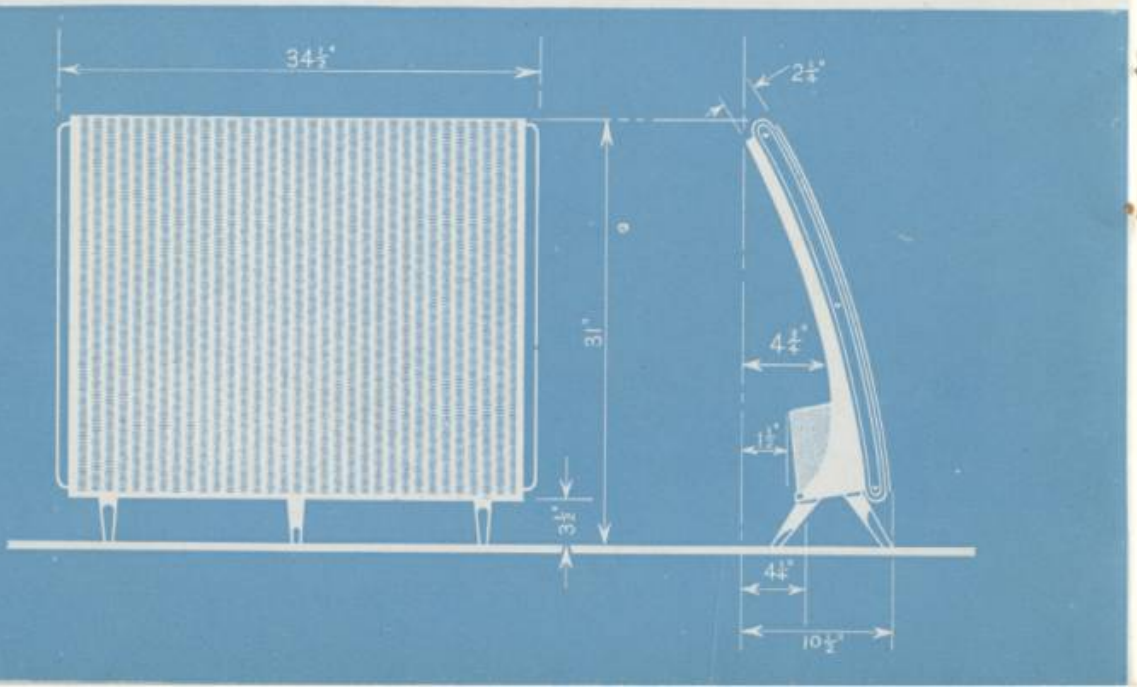
The loudspeaker is free standing and being a doublet it exhibits all the desirable characteristics of such a system already referred to on page 8. It does not require the use of corner positions and is in fact uncritical of position except that it should not be operated closer than 2 feet from any wall or large surface parallel to the plane of the loudspeaker. Both front and back radiation should be as unrestricted as possible.

Good musical balance will be obtained when the listener is seated in the area covered by an angle of nearly 90° symmetrical to the front axis of the loudspeaker.



SPECIFICATION

	6 ft. on axis in free space 93 dB referred to ·0002 dynes/cm² in frequency range 50 c/s.–10 Kc/s.
MAXIMUM OUTPUT	100 dB referred to ·0002 dynes/cm.² in range 70 c/s.–7 Kc/s.
	Total integrated radiation equivalent to 95 phons in enclosures up to 5,000 cubic feet with average reverberation.
BANDWIDTH	45 c/s.–18 Kc/s. Rate of attenuation — asymptotic to 18 dB/8ve.
DISPERSION	Approximately 70° Horizontal 15° Vertical.
IMPEDANCE	30–15 ohm in range 40 c/s–8 Kc/s falling above 8 Kc/s. (see power amplifier requirements).
AC POWER CONSUMPTION	Negligible.
AC VOLTAGE RANGE	100–120, 200–250 volts 50–60 c/s.
DIMENSIONS	See drawing.
WEIGHT	Net 35 lbs. (16 Kilos approx.).



Guarantee

This instrument
is guaranteed against
any defect in material or
workmanship
for a period of twelve months
from the date of purchase.
We undertake
to replace within this period,
free of charge, such parts
as may prove on examination
to be defective
provided that the instrument
has been operated within
the conditions
specified in this booklet
and was purchased at
our full current
retail price.

ACOUSTICAL MANUFACTURING COMPANY LTD.

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