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# Beyer microphone type M160

TECHNOLOGICAL REPORT No. L-061

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THE BRITISH BROADCASTING CORPORATION
ENGINEERING DIVISION

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Technological Report No. L-061

(1965/32)

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## SUMMARY

The Beyer microphone type M160 is of the ribbon type and has a directivity pattern which is nominally a cardioid. Two specimens have been tested and the results of measurements of frequency characteristics, sensitivity, impedance and susceptibility to magnetic fields are given.

One specimen was retested after extensive operational use and its performance found to be substantially unchanged.


## 1. INTRODUCTION

The M160 microphone is made in Germany by the firm of Beyer.

A specimen was first obtained in 1961. After objective testing it was passed to Operations and Maintenance Department for field trial. The performance was found to be very suitable for certain applications and a further five specimens were purchased by Operations and Maintenance Department for use in the Sound Service. Tests have also been carried out by Research Department on one microphone from this batch in order to gain some information about the spread of performance in production. The M160 microphone was approved by D.C.C. in April 1964.

The price of the microphone to the BBC is £35.

## 2. DESCRIPTION

Fig. 1 shows the general appearance and dimensions of the microphone. The ribbon and magnet assembly is contained within the gauze housing and is so arranged that the axis of the microphone is in line with the stem, i.e. the microphone is of the 'end-fire' type.

The M160 microphone has two ribbons closely spaced, one behind the other; according to the manufacturer, this arrangement is adopted to minimise the effect of air leakage between ribbons and pole pieces. Sound is admitted to the rear of the ribbon through a phase-shifting network of which the shunt element is an acoustic resistance provided by a damped labyrinth.

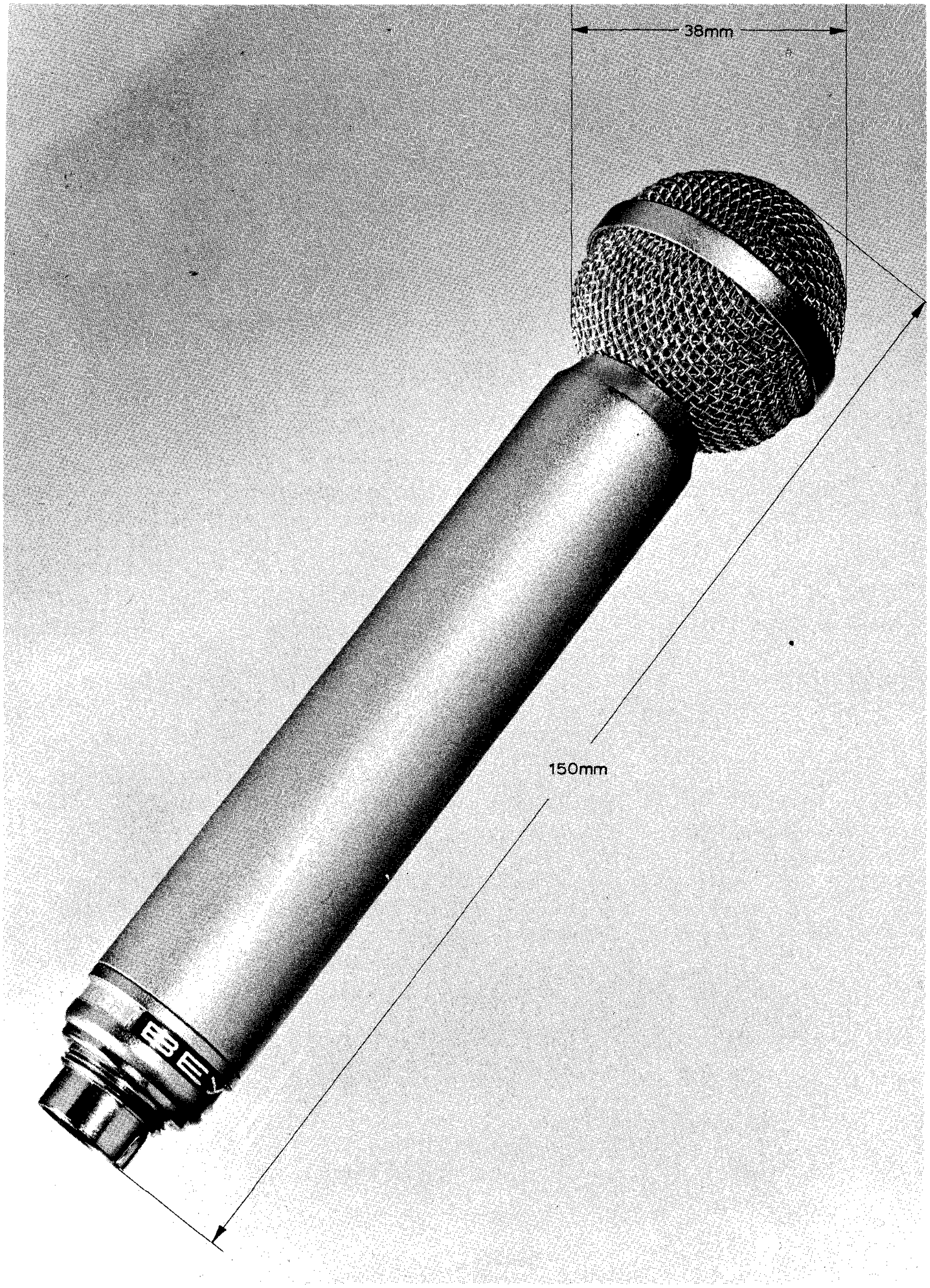


*Fig. 1 - Beyer microphone type M160*

As the microphone housing is symmetrical the manufacturers have engraved two dots, filled in red, 180° apart on a ring round the spherical housing to indicate the direction of the major axis of the ribbons.

A ribbon-to-line transformer is incorporated to give an output impedance of 200 ohms nominal and the output is brought to a three pin connector at the end of the stem.

The microphone weighs 155 g.

## 3. PERFORMANCE

### 3.1. Method of Measurement

The amplitude/frequency characteristics were measured by comparison with a pressure standard; tests below 200 c/s were carried out in a travelling-wave duct and tests above 200 c/s in a free-field room. The characteristics of the standard microphone are known within ± ½ dB; the accuracy of comparison with the standard is within ± ½ dB for angles of sound incidence up to 90° and ± 1 dB for greater angles.

### 3.2. Frequency Characteristics

It should be noted that for convenience the terms 'vertical plane' and 'horizontal plane' have been used in describing the conditions of acoustical tests, the microphone being assumed to be mounted with the ribbon vertical.

Fig. 2 shows for Specimen A the open-circuit frequency characteristics for sound incident at various angles in the horizontal plane. Fig. 3 shows, again for Specimen A, frequency characteristics for sound incident at various angles in the vertical plane; the characteristics of Specimen B with the same conditions of test are given in Figs. 4 and 5 respectively. Measurements for sound incident at 45° to the microphone axis were made on Specimen B but not on Specimen A.

Considering first the performance of Specimen A (Figs. 2 and 3), it will be seen that the axial frequency characteristic is smooth and uniform from 200 c/s to 5 kc/s but that it falls away outside this band. The measured response curves for sound incident at 90° are uneven with pronounced peaks, and, over much of the frequency range, lie below the curve for sound incident at 180°.

The frequency characteristics of Specimen B, unlike those of Specimen A, show undulations throughout the whole working frequency range, and the maximum around 5 kc/s is more pronounced, (Figs. 4 and 5). In this specimen again the output falls below 200 c/s and above 5 kc/s; the rate of cut-off at the low-frequency end is, however, much greater than for Specimen A. The curves for sound incident at 45° are substantially parallel to the curve for axial incidence.

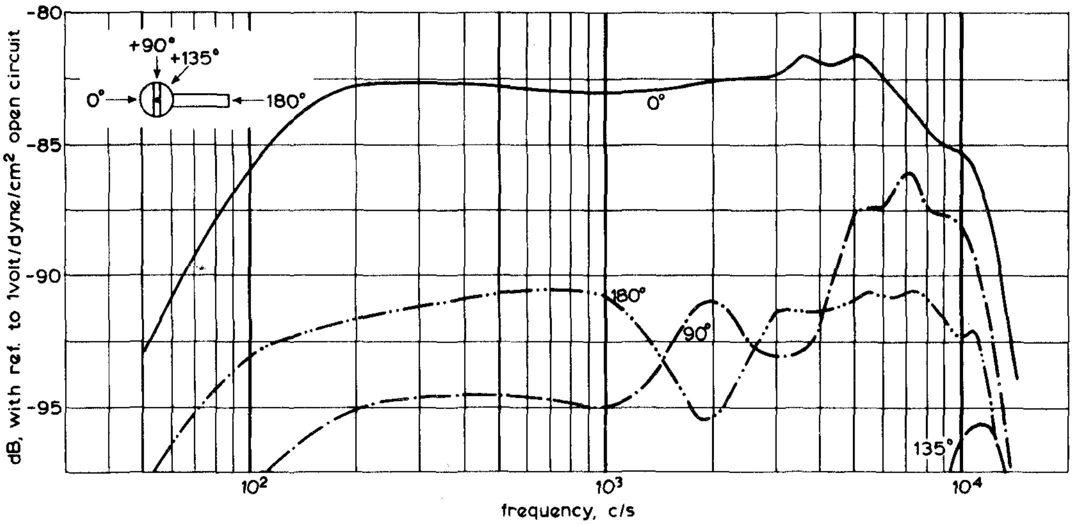


*Fig. 2 - Open-circuit frequency characteristics for sound incident at various angles in the horizontal plane*

Specimen A, No. 1988

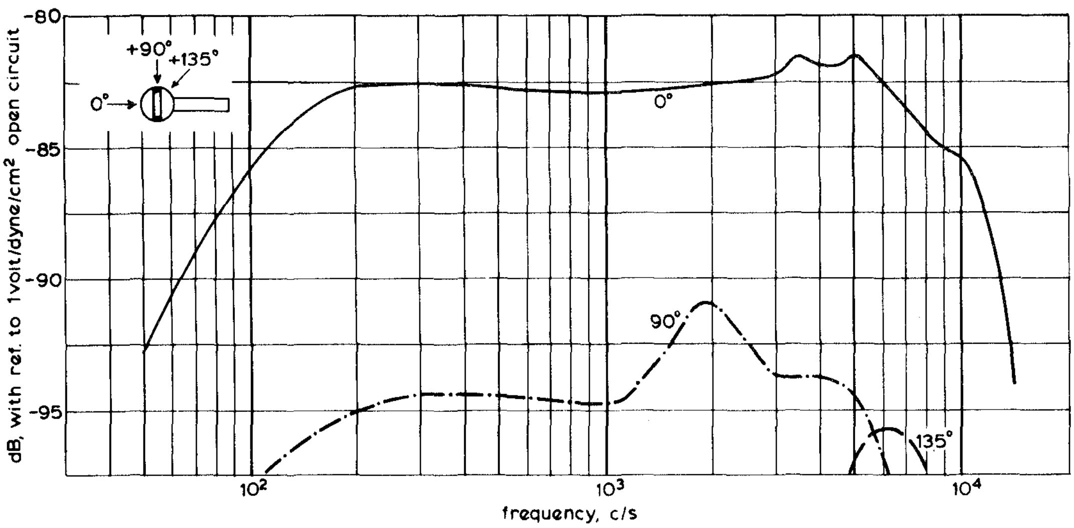


*Fig. 3 - Open-circuit frequency characteristics for sound incident at various angles in the vertical plane*

Specimen A, No. 1988

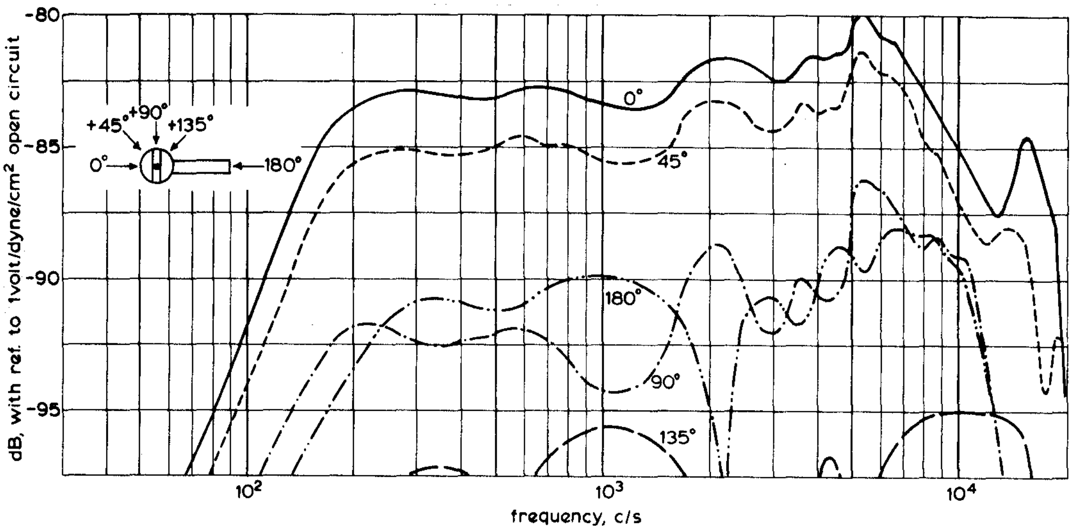


*Fig. 4 - Open-circuit frequency characteristics for sound incident at various angles in the horizontal plane*

Specimen B, No. 3071

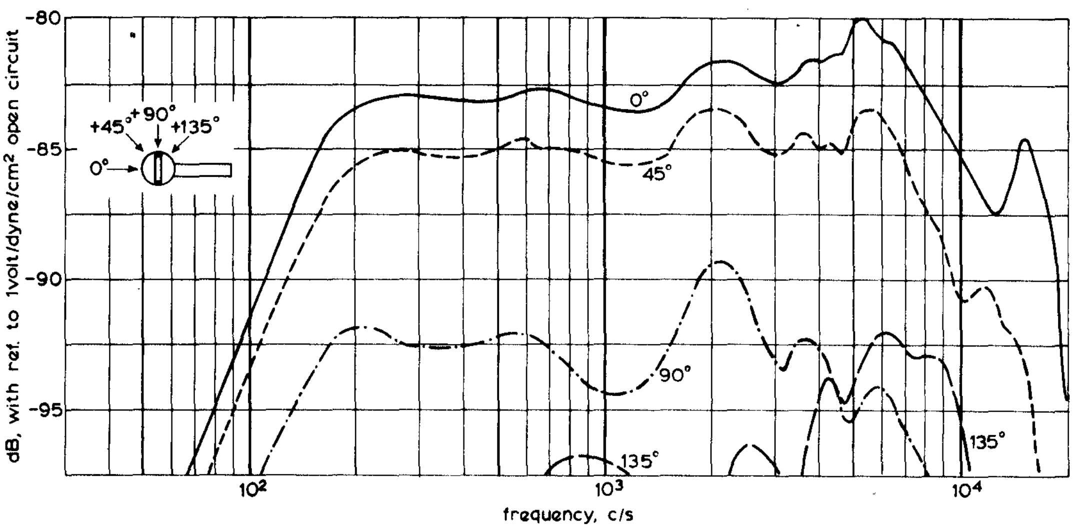


*Fig. 5 - Open-circuit frequency characteristics for sound incident at various angles in the vertical plane*

Specimen B, No. 3071

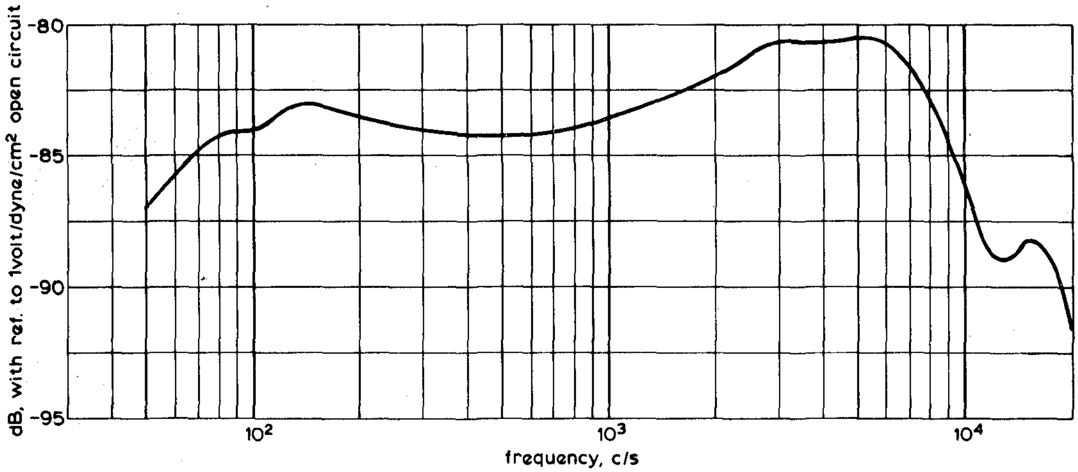


*Fig. 6 - Manufacturer's published frequency characteristic for axial incidence*

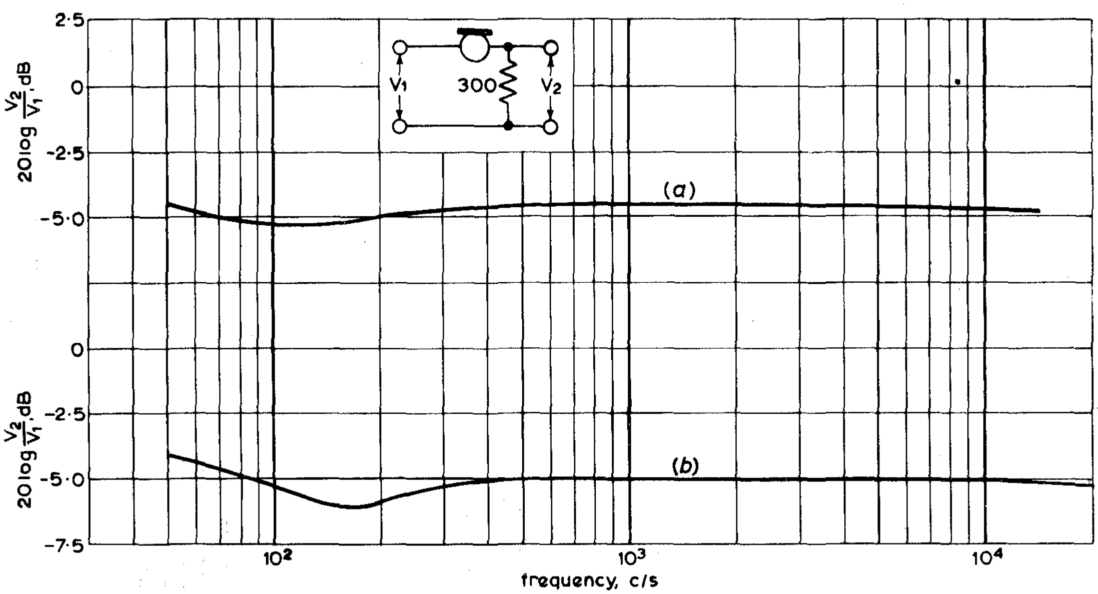


*Fig. 7 - Relationship between open-circuit voltage and voltage developed across 300 ohm load*

(*a*) Specimen A, No. 1988 (*b*) Specimen B, No. 3071

Fig. 6 shows the axial frequency characteristics claimed by the manufacturer. The general trend in the frequency range above 200 c/s is in reasonably good agreement with the measured performance, but the extended bass response indicated by the manufacturer is not obtained with the specimens tested.

Specimen A was retested after prolonged field trial and, in spite of some rough handling (the gauze sphere was severely dented), the changes in performance noted were so small as to be within the limits of experimental error.

Figs. 7(*a*) and 7(*b*) show for Specimen A and Specimen B respectively the correction to be applied to the open-circuit response curves for operation into a 300 ohm load. It will be seen that for each of the specimens, the effect of a 300 ohm load on the frequency characteristic is negligible.

## 4. SENSITIVITY

The open-circuit sensitivity of each of the specimens in the mid-band region is about -83 dB with reference to 1 volt/dyne/$cm^2$. This figure agrees with that given by the manufacturer.

## 5. IMPEDANCE

Figs. 8(*a*) and 8(*b*) show the modulus of impedance of Specimen A and Specimen B respectively. The impedance of Specimen A at mid-band frequencies is close to the nominal figure of 200 ohms; that of Specimen B is about 230 ohms. The impedance of each microphone rises at high frequencies and in each case there is a resonance in the 100 c/s to 200 c/s region.

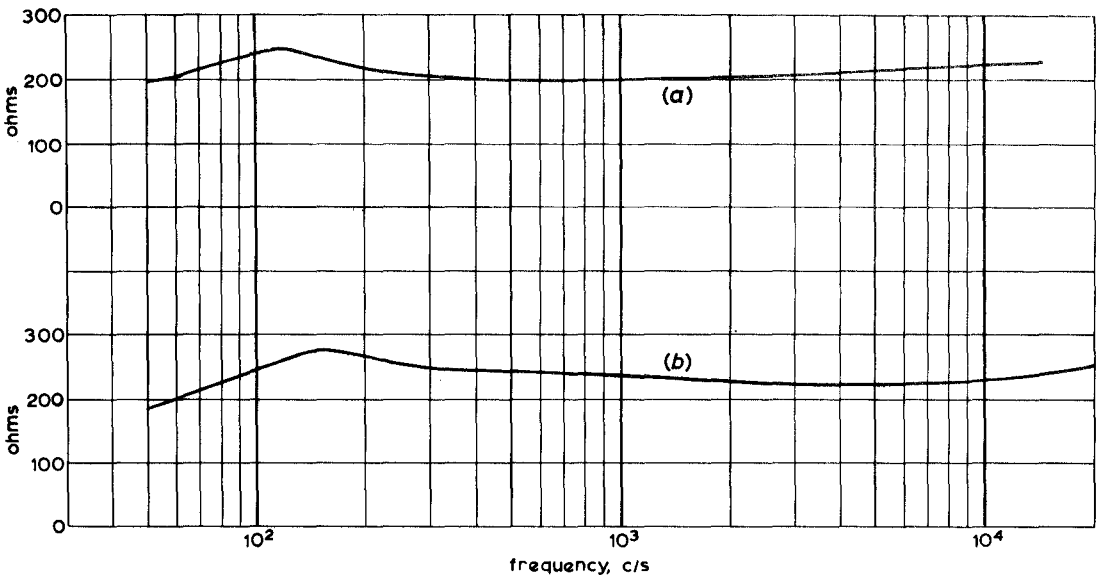


*Fig. 8 - Modulus of impedance*

(*a*) Specimen A, No. 1988 (*b*) Specimen B, No. 3071

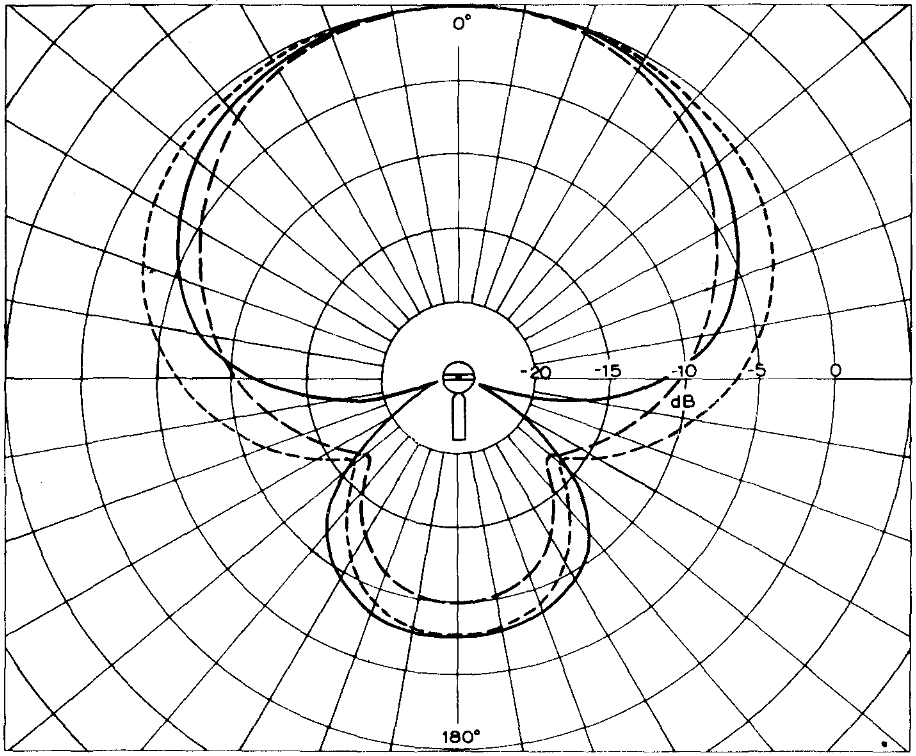


*Fig. 9 - Directivity patterns in horizontal plane measured with half-octave bands of noise centred on frequencies*

— — — 70 c/s ——— 1 kc/s - - - - - 7 kc/s

Specimen B, No. 3071

## 6. DIRECTIVITY PATTERNS

Polar response curves for Specimen B, measured with half-octave bands of noise centred on 70 c/s, 1 kc/s and 7 kc/s are given in Figs. 9 and 10 for sound incident in the horizontal and vertical planes respectively. The directivity patterns are 'cottage loaf' shaped. In the 1 kc/s band the curves have substantially the same shape in the two planes, the front lobe being slightly 'narrower' than a cardioid. In the 70 c/s band, which is outside the working range of the microphone, the directivity pattern is well maintained. The horizontal directivity pattern in the 7 kc/s band exhibits the widening commonly associated with a pressure gradient element at higher frequencies. In the vertical plane this effect is, however, more than offset by the loss which occurs at large angles of incidence when the wavelength of the sound is comparable with the length of the ribbon.

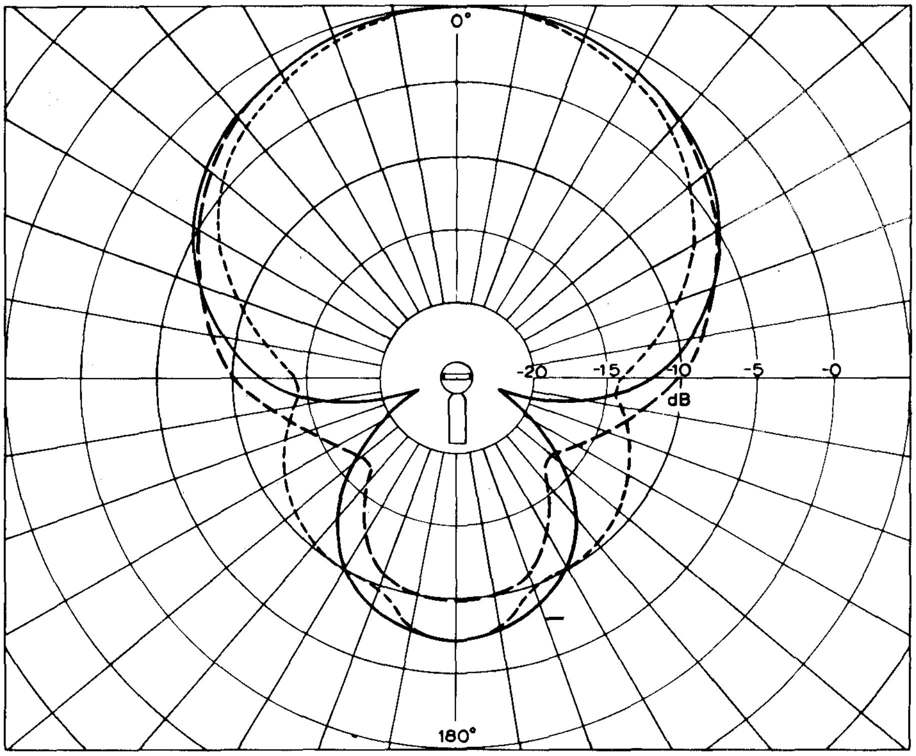


*Fig. 10 - Directivity patterns in vertical plane measured with half-octave bands of noise centred on frequencies*

—·—·— 70 c/s ———— 1 kc/s ------ 7 kc/s

Specimen B, No. 3071

## 7. NOISE

### 7.1. General

In the absence of interference the noise output of the microphone is that due to the resistive component of its impedance; the noise outputs of the two specimens are therefore within about ½ dB of each other. The r.m.s. open-circuit noise voltage in the frequency band up to 10 kc/s is hence about -134 dB with respect to 1 volt unweighted and about -128 dB when weighted by an aural sensitivity network type ASN/3. The sound level required in the mid-band region to produce a microphone output equal to that due to the weighted noise is about +29 dB relative to $2 \times 10^{-4}$ dyne/cm$^2$, a figure which is somewhat high, but is acceptable for many applications.

### 7.2. Interference from Magnetic Fields

The open-circuit outputs of the microphones due to a uniform magnetic field were measured at 50 c/s, 1 kc/s and 10 kc/s. The microphone orientation was chosen at each frequency to give a maximum output. The figures for a field of 1 milligauss are given in Table 1 together with sound level in the mid-band region required to give an equal output voltage.

*TABLE 1*

| | I<br>OPEN-CIRCUIT VOLTAGE OUTPUT DUE TO MAGNETIC PICK-UP IN FIELD OF 1 MILLIGAUSS<br>0 dB = 1 volt | | II<br>SOUND LEVEL IN MID-BAND REGION TO GIVE OUTPUT SHOWN IN I<br>0 dB = 2 × $10^{-4}$ dyne/$cm^2$ | |
|---|---|---|---|---|
| FREQUENCY | SPECIMEN A | SPECIMEN B | SPECIMEN A | SPECIMEN B |
| 50 c/s | -143 | -134 | +14 | +23 |
| 1 kc/s | -108 | -110 | +49 | +47 |
| 10 kc/s | -91 | -89 | +66 | +68 |

The above figures, compared with corresponding data for other microphones in service, indicate that the susceptibility to interference from magnetic fields is not excessive and no difficulties are likely to arise from this cause.

## 8. CONCLUSIONS

In the M160 the makers have produced a small, ribbon type, microphone having directional characteristics between figure-of-eight and cardioid.

There is considerable restriction of bass response rendering the microphone unacceptable for use on orchestral programmes. The microphone has, however, proved very suitable for light entertainment programmes, where with close operating techniques the slightly high noise level is quite acceptable.

One specimen was retested after field trial and little change in performance could be detected; this result suggests that the design is inherently robust.

CHS

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