PRIVATE AND CONFIDENTIAL

RESEARCH DEPARTMENT

THE PHILIPS MOVING-COIL MICROPHONE TYPE EL.6040

Report No. L-028

(1956/1)

THE BRITISH BROADCASTING CORPORATION
ENGINEERING DIVISION

RESEARCH DEPARTMENT

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SUMMARY.

Laboratory tests have been carried out on two specimens of the Philips microphone type EL.6040. Measurements of frequency response, sensitivity, impedance and interference from magnetic fields have been made. The microphone has also been tested in the parabolic reflector PRB/2.

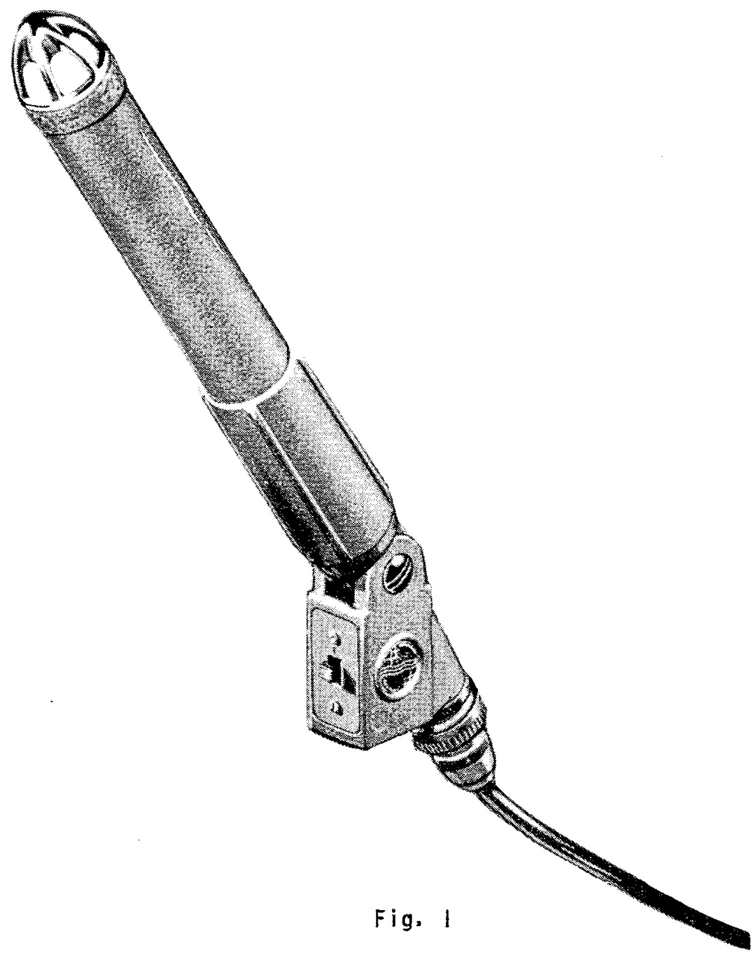

Fig. 1

1. DESCRIPTION OF MICROPHONE.

The Philips moving-coil microphone EL.6040 is a pressure-operated "truncheon" type instrument which, while primarily intended for stand mounting, can conveniently be held in the hand for commentaries and interviews.

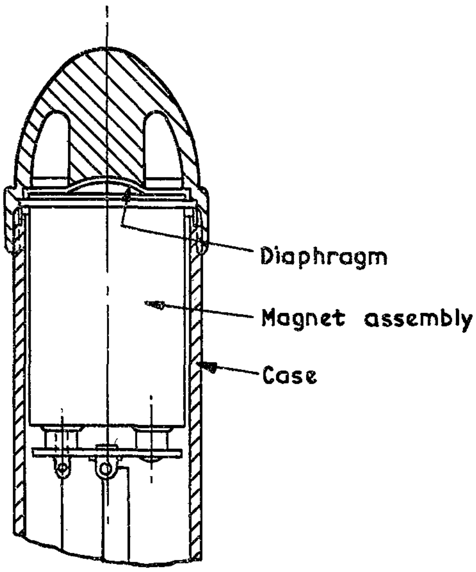

Fig. 2- Diaphragm and magnet system

Fig. 1 shows the general appearance of the microphone. Details of the diaphragm and magnet system are given in Fig. 2. The moving-coil unit is protected by six ribs which also support a cylindrical projection having a concave end almost touching the domed centre of the diaphragm. This projection is presumably intended to modify the directional properties of the microphone at high frequencies; moreover, since the air gap in front of the diaphragm dome is narrow, acoustic damping is probably introduced. The diaphragm is protected from dust by a screen of closely woven cloth, visible in Fig. 1.

The microphone is attached by a swivel joint to an assembly incorporating an output socket, a short-circuiting switch and a $\frac{3}{8}$ in. Whitworth screw thread for stand mounting. The swivel allows the microphone to be tilted approximately 60°. The usual bass compensation tube is provided terminating in an opening approximately 2 mm in diameter located near the swivel.

Included in the main microphone housing is a transformer giving nominal impedances of 50 ohms, 500 ohms or 25 000 ohms. The four leads from the transformer are brought to the output socket, the common lead being connected to the centre pin and the taps taken to three equidistant pins set at 120° intervals. The associated plug has four holes but there are socket connectors in only the central and one other hole; thus the plug can be inserted in three different positions according to the output impedance required.

Dimensions and Weight

Overall length of microphone	27 cm
Maximum diameter	2·7 cm
Approximate length of cable supplied	5 m
Weight without cable	340 gm

2. METHOD OF MEASUREMENT.

The microphone characteristics were measured in the dead room by the method of substitution using a calibrated pressure microphone. The accuracy of comparison with the standard is within ± ½ dB and the calibration of the standard itself is known to the same degree of accuracy.

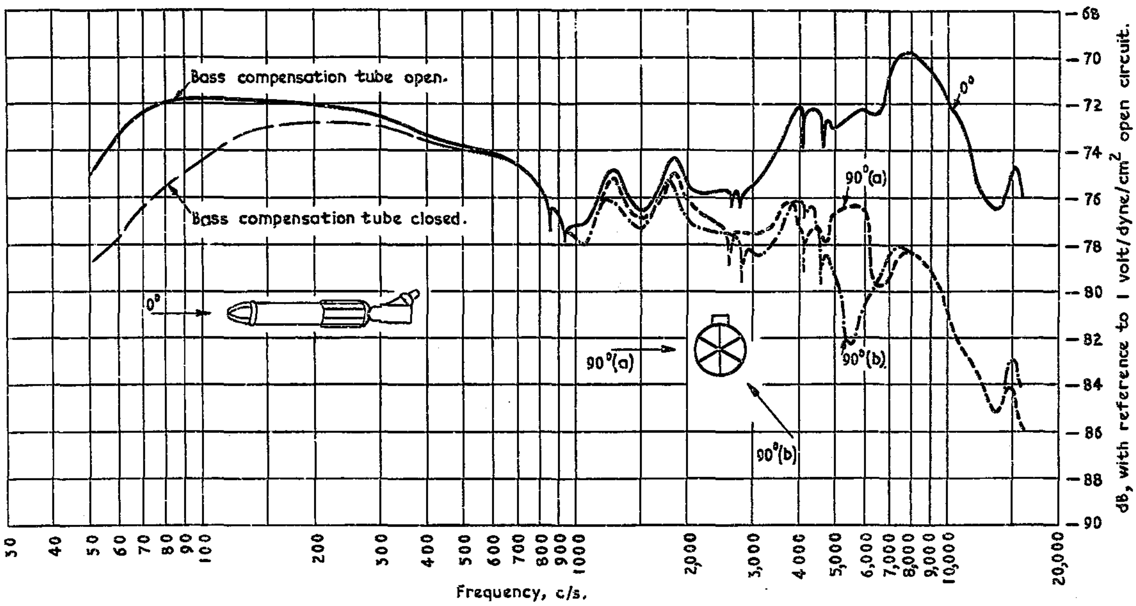

Fig. 3- Open-circuit frequency response characteristics of specimen A measured on 500 ohm output

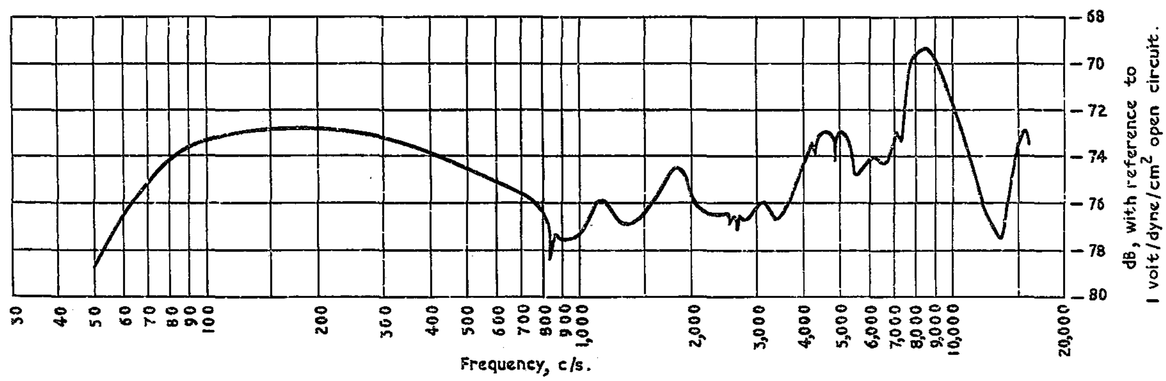

Fig. 4- Open-circuit axial frequency response characteristic of specimen B measured on 500 ohm output

3. FREQUENCY RESPONSE.

Figs. 3 to 8 show the results of measurements made on two specimens of EL.6040 microphones.

Fig. 3 shows the open-circuit response curve of specimen A with the transformer connected for 500 ohms impedance; response curves are given for axial and 90° sound incidence. The figure also shows the change in low frequency response which would result if in gripping the microphone in the hand, the aperture of the bass compensation tube were accidentally obstructed. Fig. 4 shows the axial frequency response of specimen B.

The open-circuit response curves with the output tap set for 50 ohms are identical in form with those of Fig. 3 but the voltage sensitivity is 10 dB lower.

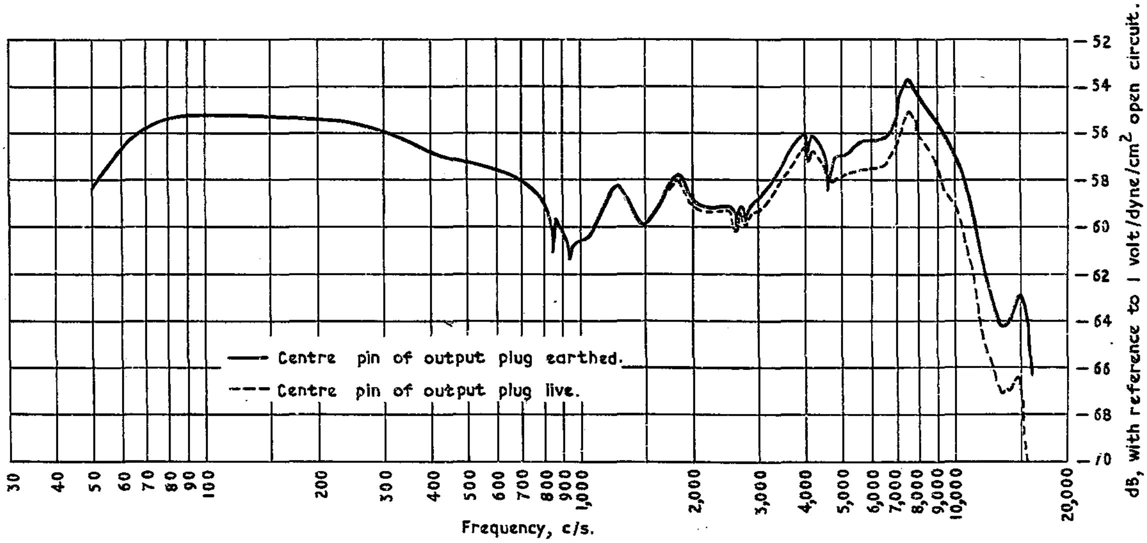

Fig. 5- Open-circuit axial frequency response characteristics of specimen A measured on 25 000 ohm output

Fig. 5 gives the open-circuit response curve of specimen A with the transformer tap set for 25 000 ohms impedance. It should be noted that this measurement includes the effect of the cable capacity. The microphone in this condition is presumably intended to be directly connected to the grid circuit of a valve and will therefore have one leg earthed. With such a high impedance, however, the effect of capacity unbalance in the transformer becomes apparent and the response at high frequencies therefore depends on which of the two output leads is used as the live connection. Curves are given for both conditions.

Fig. 6 shows the relationship between the open-circuit voltage of the microphone and the voltage produced across a resistive load equal in magnitude to the nominal impedance. The curves relate only to the 50 ohms and 500 ohms output impedance. The 25 000 ohm output of the microphone would normally be operated into a substantially open circuit; in this case therefore the effect of loading was not considered. With present Corporation equipment, the microphone when set for 50 ohms or 500 ohms impedance, will normally be loaded with 30 ohms or 300 ohms respectively; the change in frequency response resulting from this mismatch is however negligible.

Apart from the swivel, the shape of the microphone appears to be symmetrical; nevertheless at certain high frequencies the response to sound at 90° incidence varies in a somewhat unexpected way when the instrument is rotated about its axis. Fig. 7, for example, shows the directivity pattern of specimen A taken in this way at 5·5 kc/s. It will be seen that while there is no regular feature which could be attributed to the protective ribs there is an overall variation of 6 dB in response. The same effect is apparent from the two 90° curves in Fig. 3. Similar results were obtained

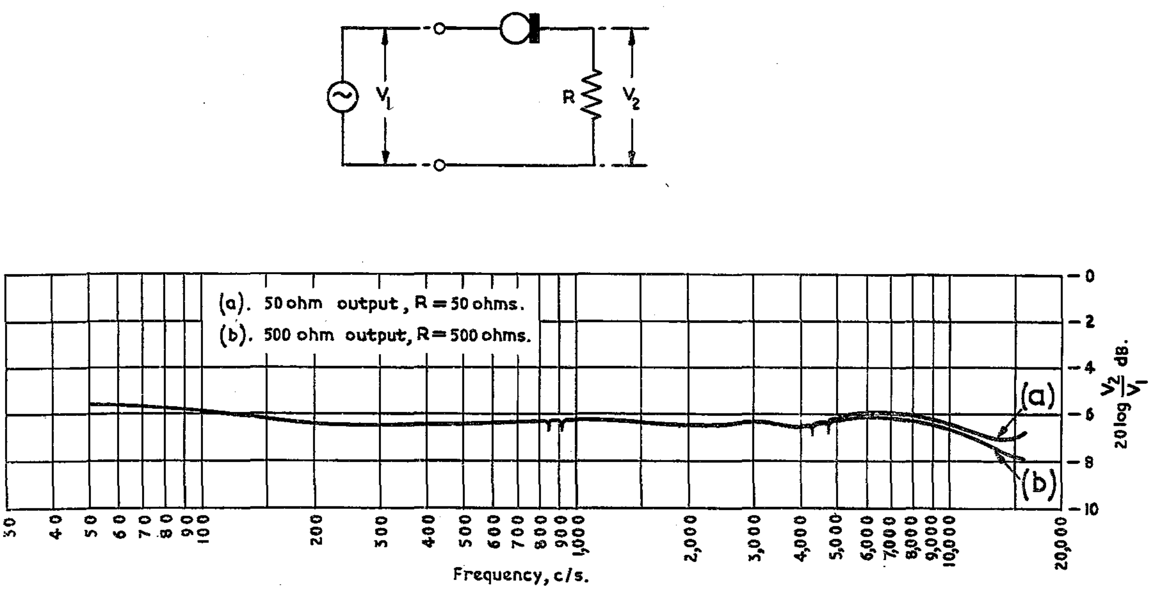

Fig. 6- Relation between open-circuit voltage and voltage across load resistance R. Specimen A

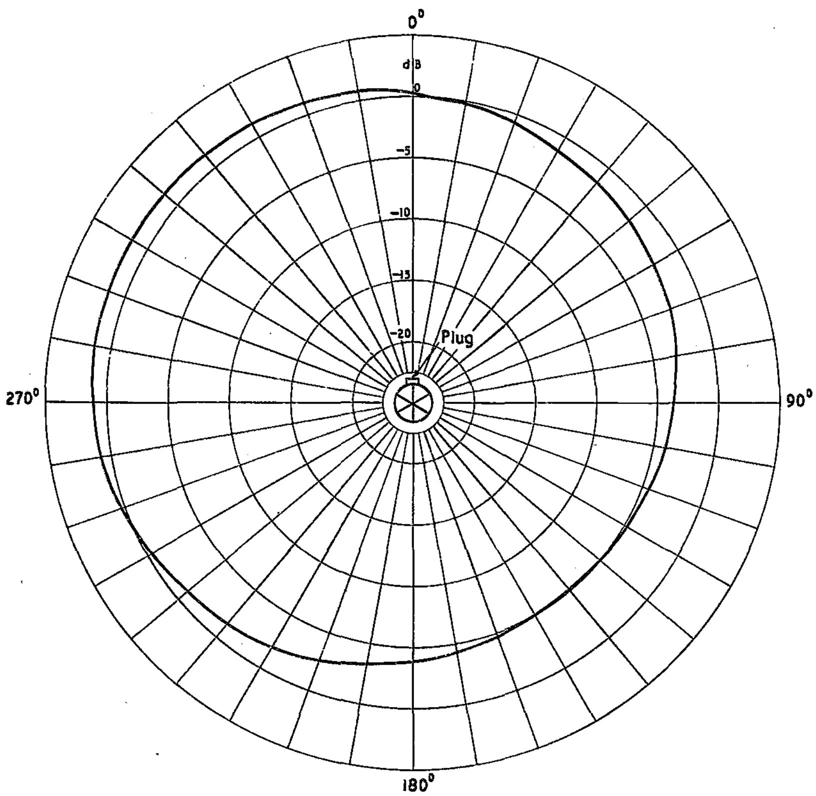

Fig. 7- Directional pattern of specimen A at 5500 c/s in plane perpendicular to microphone axis

with specimen B, though at a different frequency. It was not possible without dismantling the microphone to discover the cause of the variation.

4. TRANSIENT RESPONSE.

Specimen B was tested for transient response by the method described in Research Report No. M.002. Low damped resonances were detected at 850 c/s, 2·7 kc/s, 3·4 kc/s, 4·45 kc/s, 4·6 kc/s, 6·4 kc/s, 7·6 kc/s and 7·9 kc/s. Some of these will be seen to correspond with the small irregularities in frequency response in Fig. 4.

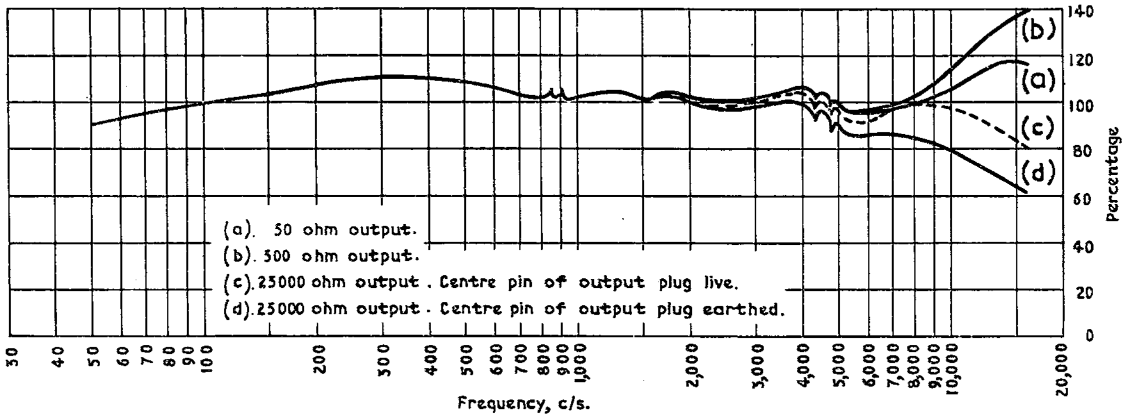

Fig. 8- Modulus of microphone impedance expressed as percentage of nominal value. Specimen A

5. IMPEDANCE.

Fig. 8 shows the change of impedance of the microphone with frequency. The small irregularities on the curves are due to the resonances appearing in Fig. 3. In the case of the 25 000 ohm impedance, the effect of unbalanced capacity is apparent at high frequencies.

6. SENSITIVITY.

At 1 kc/s, the open-circuit axial sensitivity of the microphone, set for 500 ohms impedance, is −77 dB with reference to 1 volt/dyne/cm²; however, there is a dip in the frequency response curve at this point and the average, taken over the mid-band region of 300 c/s to 3000 c/s, is approximately −75 dB. The corresponding figure given by the manufacturers for 1 kc/s is −73 dB.

The mid-band open-circuit sensitivities of the microphone with the transformer tap set for 50 ohms and 25 000 ohms are respectively −85 dB and −58 dB with reference to 1 volt/dyne/cm².

7. NOISE.

In the absence of magnetic induction interference the noise output from the microphone is that arising from thermal agitation. With the transformer tap set for 500 ohms impedance, the r.m.s. open-circuit noise voltage in the band 0 c/s to 10 000 c/s is −131 dB with reference to 1 volt unweighted, and −125 dB when weighted by an aural sensitivity network (type ASN/3). The sound level in the mid-band which would produce an output equal to the weighted noise is therefore +24 dB with reference to 0·0002 dyne/cm^2.

8. INTERFERENCE FROM MAGNETIC FIELDS.

The mid-band sound levels, with reference to 0·0002 dyne/cm^2, required to give an output voltage equal to that induced by a field of 1 milligauss at 50 c/s, 1 kc/s and 10 kc/s are + 46 dB, + 48 dB and + 56 dB respectively.

9. PERFORMANCE IN PARABOLIC REFLECTOR PRB/2.

The variation in high frequency response with angle of incidence is smaller than for most other microphones suitable for outdoor use. This feature, coupled with the extended high frequency range, suggests that the microphone could be used with advantage to replace the S.T. and C. type 4017 in the parabolic reflector PRB/2. The gain/frequency characteristic of a PRB/2 reflector fitted with an EL. 6040 microphone was measured in the open air with the focus adjustment set at "35 ft to ∞". Because of adverse weather conditions, only the frequency range from 500 c/s to 10 kc/s could be covered and the working distance was limited to 40 ft; for the same reason the accuracy of measurement was only about ± 2½ dB. Fig. 9 shows the gain/frequency characteristic together with a similar curve previously obtained with the S.T. and C. microphone type 4017. In the latter case the focus control was likewise set at "35 ft to ∞" but the working distance was 75 ft; at such a long range however the frequency characteristic is nearly independent of distance and it is possible to make a fair comparison between the two curves. With the increasing directivity factor of the type 4017 microphone at high frequencies, the active area, and hence the gain, of the parabola are progressively reduced; with the EL.6040 this effect is much less marked.

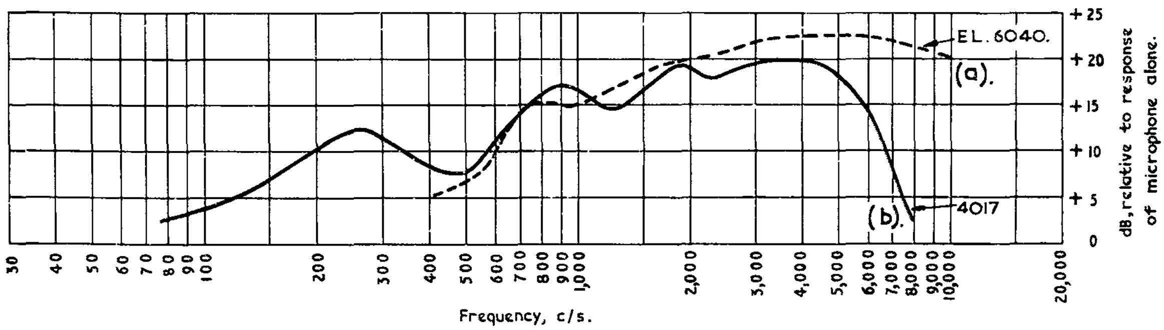

Fig. 9- Gain/frequency characteristics of 36 in. diameter parabolic reflector PRB/2 measured on axis using 4017 and EL.6040 microphones

EL.6040 microphone 40 ft from sound source. Focus adjusted for "35 ft to ∞"
4017 microphone 75 ft from sound source. Focus adjusted for "35 ft to ∞"

10. CONCLUSION.

Unlike most moving coil microphones the Philips EL.6040 has the frequency response well maintained even beyond 10 kc/s. This extended range was very noticeable on a speech test; at the same time the low response in the 300 c/s to 3 kc/s region and the numerous small irregularities in the frequency characteristics were not as objectionable as might have been expected. In addition to its potentialities as a hand microphone for commentaries and interviews, the EL.6040 would be a suitable replacement for the obsolete S.T. and C. microphones type 4017 at present used in the parabolic reflector PRB/2.

The 25 000 ohms output of the microphone could, if desired, be connected to the high impedance input of a midget recorder.

Induction pick up from stray alternating magnetic fields is unlikely to be serious except in the neighbourhood of television monitors or similar equipment.