RESEARCH DEPARTMENT

THE SELECTION OF A WIDE-RANGE LOUDSPEAKER FOR MONITORING PURPOSES (SECOND REPORT)

Report No. M.008/2
Serial No. 1949/3

PRIVATE & CONFIDENTIAL.

Research Department | January, 1949.

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Figs. Nos. M.008/2.1 to M.008/2.4

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1. SUMMARY

This report covers the continuation of the work described in Research Report M.008, up to October 1948. During this period improved versions of both Parmeko and Tannoy loudspeakers were tested and the Parmeko was preferred. Difficulties arose in repeating, in production models of the Parmeko loudspeaker, the performance achieved with the sample on which the selection tests had been carried out, and the present report indicates the extent of the compromise which must be accepted if these loudspeakers are adopted in their present form.

2. INTRODUCTION

The position indicated at the end of Report M.008 was that there was some reason to hope that improved models of both Parmeko and Tannoy coaxial loudspeakers would give an acceptable performance, and that, in the meantime, experiments on two-unit loudspeakers were being made by Research Department.

In view of the urgency of the situation it was decided that the latter investigation could not yield the required results in time and the work was temporarily shelved in order to concentrate on the immediate task of selecting a commercial product.

Improved models of both Parmeko and Tannoy coaxial loudspeakers were received and tested both subjectively and objectively. The nature of the improvements and results of the tests will now be discussed.

3. PARMEKO LOUDSPEAKERS

3.1 General

The principal defects of the original Parmeko loudspeaker were considered to be :-

(a) lack of response at extreme high frequencies.
(b) generally "toppy" quality owing to excessive and peaky response at medium high frequencies.
(c) bass resonance at 80 c/s.
(d) lower middle frequency resonance.

3.2 Modifications to Unit

In an attempt to remedy defects (a) and (b), the manufacturers introduced some changes in the high frequency unit and, in addition, supplied a number of alternative high frequency diaphragms, some of metal and others of bakelised fabric. It was thought that the performance could be further improved by modification of the electrical network through which the high and low frequency units are fed. The choice of the characteristics of this network and the selection of the best type of high frequency diaphragm from the samples submitted were carried out by Research Department by objective and subjective tests.

3.3 Modifications to Cabinet

In the meantime, Research Department investigated defect (c). It was decided to extend the volume of the existing Parmeko cabinets by the addition of a plinth, 24" x 31" x 20" high, in which provision was made for mounting an MPA/1 amplifier so that the resulting assembly would replace a complete LB/3 unit. A window was cut in the bottom of the Parmeko cabinet, and the top of the plinth was provided with a corresponding opening. The original vent in the Parmeko cabinet was closed and replaced by vents of considerably greater inertance provided in the plinth. The overall height of the enclosed space was now 47" and there was evidence of some top-to-bottom air resonance. It was therefore necessary to introduce damping and this was effected by covering the window in the bottom of the cabinet by several layers of felt. By the above modifications, the low frequency response of the system was extended to about 45 c/s, and the 80 c/s resonance (defect (c)) was eliminated.

A group of resonances in the lower middle frequency range was also investigated and the most serious of these was found to be an air resonance in the cabinet at 420 c/s. The only acoustic treatment in the original Parmeko cabinet is a layer of thin felt tacked over corrugated cardboard, which gives insufficient damping at this frequency. However, the extension of the cabinet by the addition of the plinth, together with the introduction of the felt **mentioned** earlier, was found to suppress the 420 c/s resonance. It was then observed that the colouration in the lower middle frequency range (defect (d)) had been reduced to tolerable proportions.

3.4 Performance of Modified Version

For the purpose of the balance and final selection tests referred to later, the latest model of Parmeko loudspeaker was used with the modified cabinet and plinth as described, together with a bakelised fabric high frequency diaphragm and electrical network selected by **Research Department**.

The best arrangement which could be produced in this way was still defective in extreme high frequency response, but somewhat less offensive than the original in the medium high frequency register. The axial frequency response is shown in Fig. 1, from which it will be seen that the output falls above about 7,000 c/s but is then maintained at a lower level with some irregular fluctuations.

4. TANNOY LOUDSPEAKER

4.1 General

The principal defects of the original Tannoy loudspeaker were considered to be :-

(a) non-linear distortion.
(b) high frequency resonances at a number of frequencies.
(c) resonance at 130 c/s.

4.2 Performance of Modified Version

In the latest model submitted by the makers, defects (a) and (b) had been largely eliminated. Condition (c) was associated with the particular cabinet supplied and in this respect the performance was found to be greatly improved by substituting a cabinet and plinth similar to that used for the Parmeko loudspeaker. All the tests that followed were therefore carried out with a Research Department type cabinet and plinth. The axial frequency response of the assembly is shown in Fig. 2.

5. BALANCE TESTS

Three loudspeakers, the Altec-Lansing, the Parmeko and the Tannoy were set up at Maida Vale in the waiting room adjoining Studio 1, and supplied with programme from that studio. During an orchestral rehearsal, several programme engineers were asked (a) to adjust the positions of the microphone in the studio so as to give the best possible reproduction on each of these loudspeakers in turn and (b) to comment on the standard of reproduction thus obtainable with each.

The results of the above test were :- (a) the optimum microphone position was the same for each loudspeaker, and (b) the order of preference was, Altec-Lansing, Parmeko, Tannoy. Detailed criticisms indicated that the Parmeko and Tannoy loudspeakers, although inferior to the Altec-Lansing in every other respect, had a better bass response, while the extreme high frequency register of the Tannoy was too directional. The latter point was later verified by measurement; the results were communicated to Messrs. Tannoy who put forward for the final selection test another loudspeaker of the same type, modified by the addition of a diffuser consisting of a series of short concentric horns fitted into the centre of the cone. Subsequent objective tests on this arrangement showed that, although the sound distribution had been improved, the horns had introduced a number of resonances.

6. FINAL SELECTION TESTS

The three loudspeakers referred to above were set up in the waiting room at Maida Vale and supplied with choral and orchestral programme from Studio 1. The loudspeaker units were concealed from the audience by a light scrim curtain, with the addition of appropriate lighting arrangements. Nineteen members of the staff listened to the loudspeakers under these conditions and the order of preference was ascertained by secret ballot. Analysis of the results showed a clear preference for the Parmeko as compared with the Tannoy, and a less clearly defined preference for the Altec-Lansing as compared with the Parmeko, the latter judgment having been appreciably affected by the superior bass response contributed by the plinth mounting. As has already been pointed out in Report M.008, the Altec-Lansing loudspeaker is not available to the Corporation as a monitoring loudspeaker and is only included in these tests for information. It was therefore concluded that the Parmeko loudspeaker should be recommended for monitoring purposes, provided that the performance achieved with the sample could be maintained in production.

7. PARMEKO PRODUCTION MODELS

Five further Parmeko loudspeaker units, nominally identical with that used for the final selection test, were obtained from the manufacturers and the overall variation in performance investigated both subjectively and objectively. Considerable differences existed between the units. These differences were mostly associated with the high frequency diaphragms and took the form of variations in the response in the cross-over region of 1,000 - 2,000 c/s, and in the region above 7,000 c/s. In the 1,000 - 2,000 c/s region, partial cancellation between the outputs of the low and high frequency units was taking place, with the result that small variations in the response of the individual units produced a large variation in the combined sound output in this band. The more serious effect, however, was the variation in the performance above 7,000 c/s. In most of the additional specimens submitted, the frequency response curve in this region was more peaky in form than that of the prototype and the reproduction aurally objectionable.

The results of the above tests were communicated to Messrs. Parmeko who then submitted six samples of an alternative type of diaphragm, this time of a light alloy. With the exception of one specimen out of the six, these gave much more consistent performance than those of bakelised fabric. Unfortunately, however, the response of the remaining five diaphragms showed only a small output above 7,500 c/s, except for a single sharp peak at about 11 kc/s which was found to give a very unpleasant effect on many programmes.

Twenty more sample diaphragms were submitted by the manufacturers. All but one or two of these were found to possess the objectionable characteristics described above. A change in the manufacturing technique having been made, six further samples of high frequency diaphragm were submitted by Messrs. Parmeko, but the general performance of five out of the six still exhibited the defects already mentioned.

At this stage, the possibility was considered of electrically filtering out the range above 10 kc/s to enable production diaphragms to be used. Since a filter cutting sharply between 7,500 c/s and 10 kc/s would in any case have to include a tuned rejector circuit, it was decided to take advantage of the constancy of the frequency of the peak which it was desired to eliminate and to use a rejector circuit alone, this resulting in a considerable simplification of the loudspeaker circuit.

Attention was now given to the 1,000 c/s - 2,000 c/s region, to which some reference has already been made. It was not possible to reproduce the characteristics of the prototype in this band, and it is thought that these were the result of a fortuitous combination of circumstances. It was, however, found by experiment and verified by subjective test that the best results were obtained from production models by reversing the relative phase of low and high frequency units and by further modifying the electrical circuit associated with the latter.

Fig. 3(a) shows the axial frequency response obtained with the above arrangement. The quality obtained from the production models is still appreciably inferior to that of the specimen used for the selection tests, both in the deficiency in response above 7,000 c/s, and in a certain lack of definition, the cause of which is not at the moment clear, but may be associated with the known difference in response in the 1,000 - 2,000 c/s region. In spite of these drawbacks, the reproduction in general represents a considerable improvement on that obtained with the internal spider Rice Kellog (ISRK) unit in an LB/3 baffle, an axial frequency characteristic of which is shown for comparison in Fig. 4(a). To appreciate fully the difference between the Parmeko and ISRK loudspeakers, the frequency characteristic at oblique angles must be taken into account, since these help to determine the frequency response of the total sound output. As an example, the frequency response of the two loudspeakers concerned is given in Figs. 3(b) and 4(b) for angles of 30° to the axis in the horizontal plane. From these curves it will be seen that the Parmeko loudspeaker gives a much greater total output above 2,500 c/s than does the RK loudspeaker, while the variation in frequency response with angle is much less pronounced. In addition, the new cabinet and plinth mounting gives considerably better bass reproduction than is possible with the original LB/3 cabinet. It should be noted that curve 4(a) is not directly comparable with Fig. 1(a) in Report M.008. The ISRK unit used in obtaining Fig. 4(a) was a different specimen, and the microphone distance was greater, so that the effects of interference between sound from the front and back of the cabinet were altered. This change in microphone distance is one of a number of small modifications introduced into the test routine for loudspeakers as a result of experience. In order that frequency response measurements taken at various angles should be consistent with polar response measurements taken at various frequencies, a standard distance (30") has now been adopted for both. Transient response measurements are, however, still made at close range.

The relative efficiency of the Parmeko and RK loudspeakers has been assessed subjectively. Owing to the wide difference in frequency characteristic, the figure obtained varies considerably according to the programme material, but on the average, the Parmeko loudspeaker requires above 4 db more input for the same general loudness than the RK, which has its maximum response in the frequency band over which the ear is most sensitive. However, in all the listening tests, which included the reproduction of orchestral music in a room 20' x 17' x 12' at Maida Vale, the maximum undistorted output of an MPA/1 was found to give a sound level considerably in excess of normal requirements.

The minimum impedance of the Parmeko loudspeaker in the audio frequency range is approximately 4 ohms. If a matching transformer is not available, the output transformer of the MPA/1 may be connected as for 3 ohms load.

8. <u>CONCLUSIONS</u>

The search for a commercially available wide-range loudspeaker to replace the existing LB/3 assembly has progressed to the point where one type of unit, the Parmeko, mounted in a cabinet system designed for it by Research Department, can be recommended for immediate use. The performance of the production models of this loudspeaker is somewhat inferior to that of the prototype but is of a sufficiently high standard to make a change from the older reproducers worth while.

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ISSUE
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2-2-49

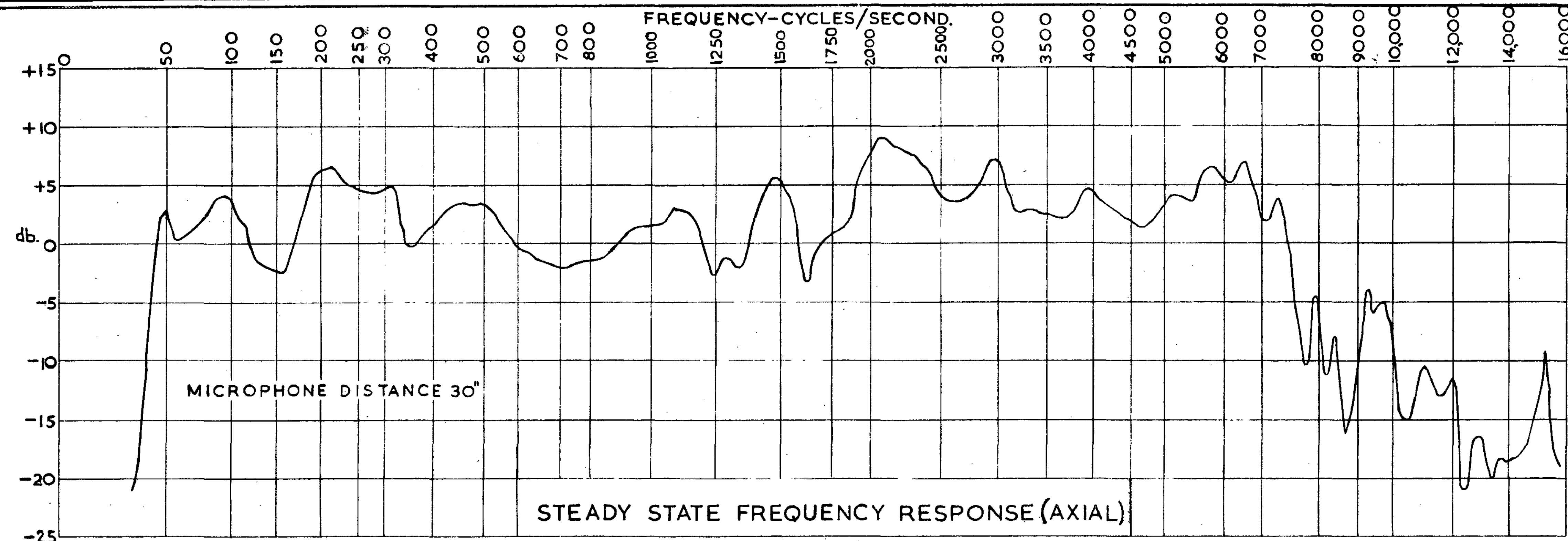

FIG. 1.
PARMEKO 3/47 PROTOTYPE.

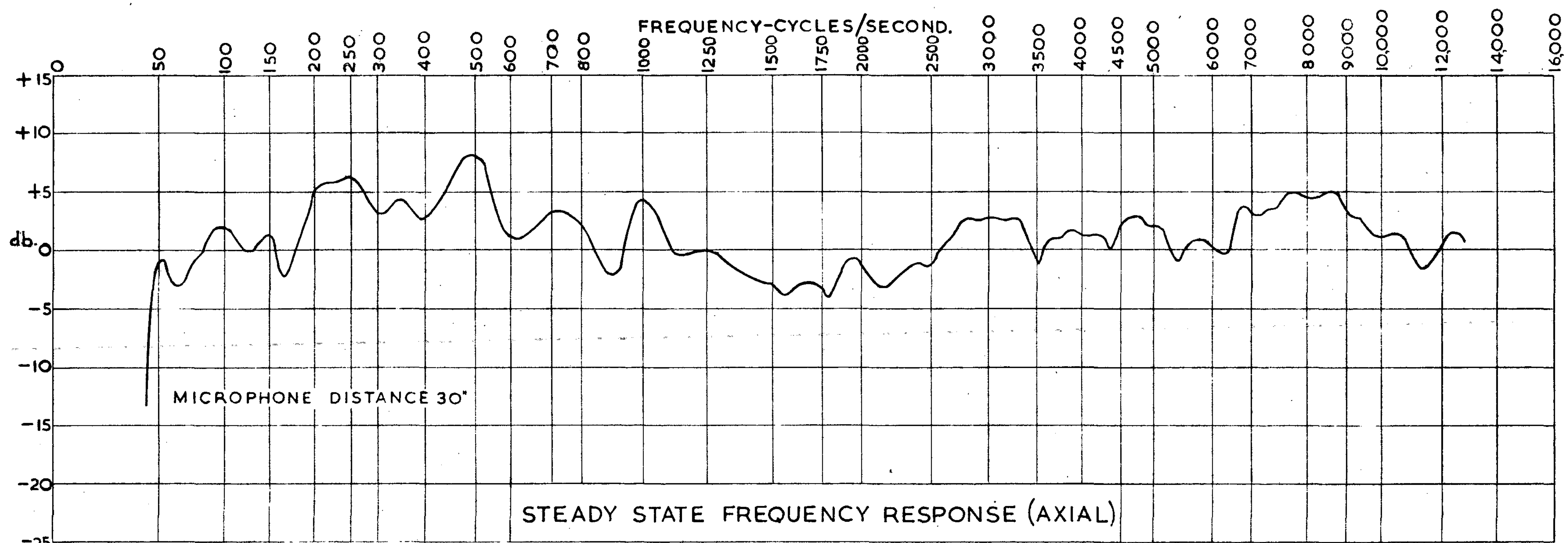

FIG. 2.
TANNOY 4/47

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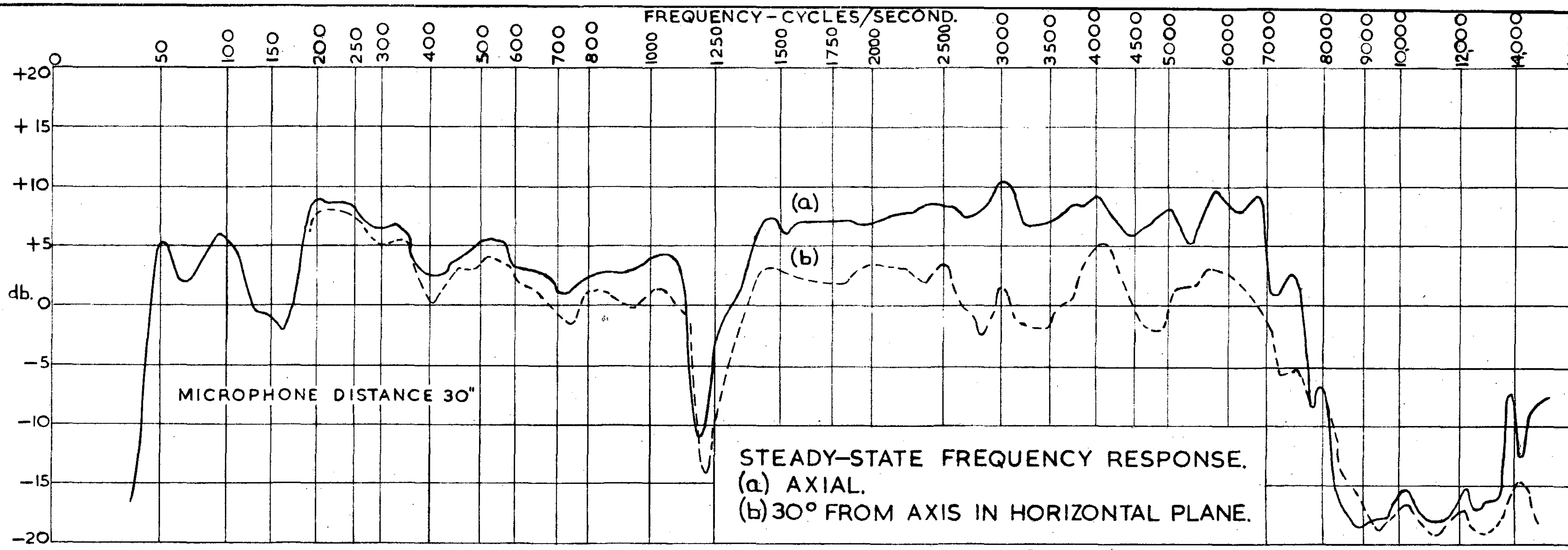

FIG. 3.
PARMEKO 2/48 PRODUCTION MODEL.

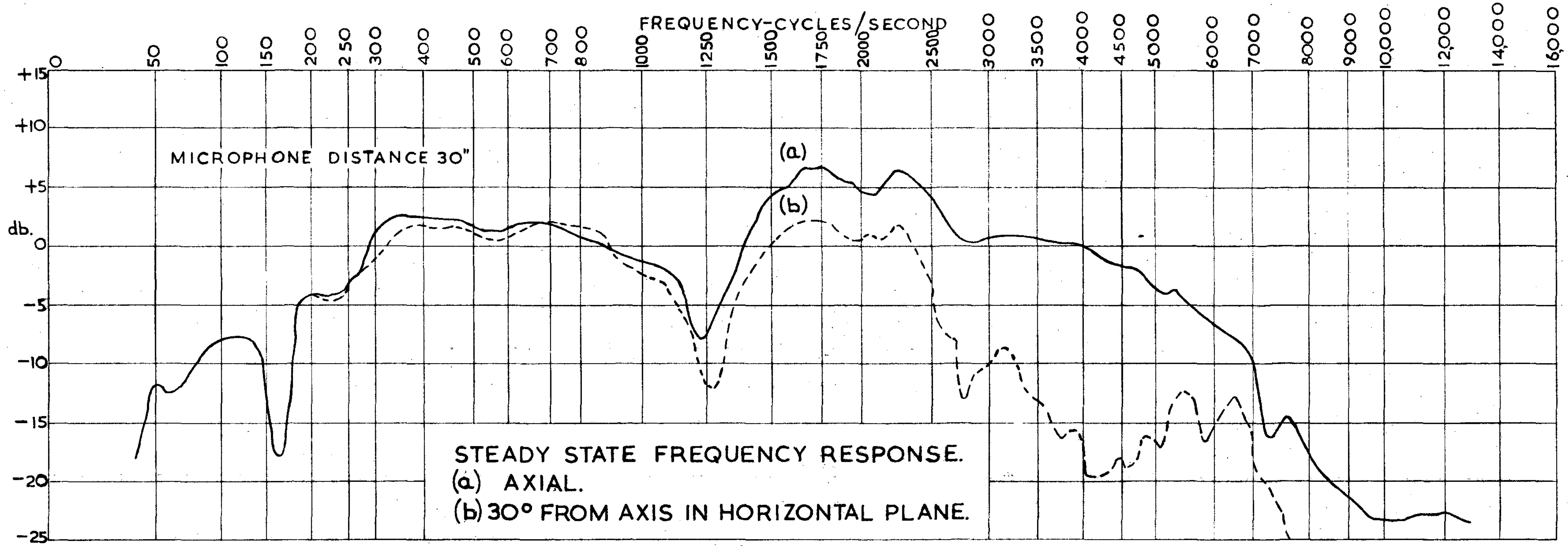

FIG. 4.
I.S., R.K. IN L.B.3 BAFFLE.

BBC

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