RESEARCH DEPARTMENT

The Robbins–Joseph (R–J) Loudspeaker Enclosure

Report No. L-026

(1955/8)

THE BRITISH BROADCASTING CORPORATION
ENGINEERING DIVISION

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SUMMARY

Tests have been carried out on a small loudspeaker cabinet known as the "R-J enclosure" which has been claimed to give improved bass reproduction. A small increase in efficiency at low frequencies resulting from the particular form of construction adopted is accompanied by some reduction of response in other parts of the frequency range.

1. INTRODUCTION.

A small loudspeaker cabinet of slightly unusual construction and known, presumably from the names of its designers, F. Robbins and W. Joseph, as the "R-J enclosure", has been produced in the U.S.A., where it has been the subject of some publicity. This device is claimed to give, at the cost of a slight reduction in efficiency, a much better performance at low frequencies than is normally obtained with a conventional cabinet of the same cubic capacity. It is manufactured in two sizes, to accomodate respectively 8 in. (20·3 cm) and 12 in. (30·5 cm) diameter cone units. Arrangements were made with Multicore Solders Ltd., agents for R.J. Audio Products Inc., to borrow for a short period a specimen enclosure of the larger size, which had been sent to this country as a sample. This enclosure was tested in conjunction with a standard permanent magnet internal spider R.K. Senior cone unit (I.S.R.K.).

2. DESCRIPTION.

Fig. 1 shows the construction of the R-J enclosure tested. The 12 in. (30·5 cm) chassis diameter cone unit is mounted over a 10½ in. (26·7 cm) diameter hole in a sub-baffle which is spaced away from the front of the enclosure to allow sound to escape by the path shown by arrows. According to the inventors' description[1], the acoustic impedance of the vent channel thus formed contains an appreciable resistive component, the magnitude of which has been adjusted, by varying the spacing between the sub-baffle and the front of the enclosure, to give a damping effect. The external sound outlet takes the form of a slot having an area 40% of that of the sub-baffle opening. The enclosure is lined on all sides except the front with ½ in. (1·3 cm) thick sound absorbent material of the approximate consistency of papier-maché.

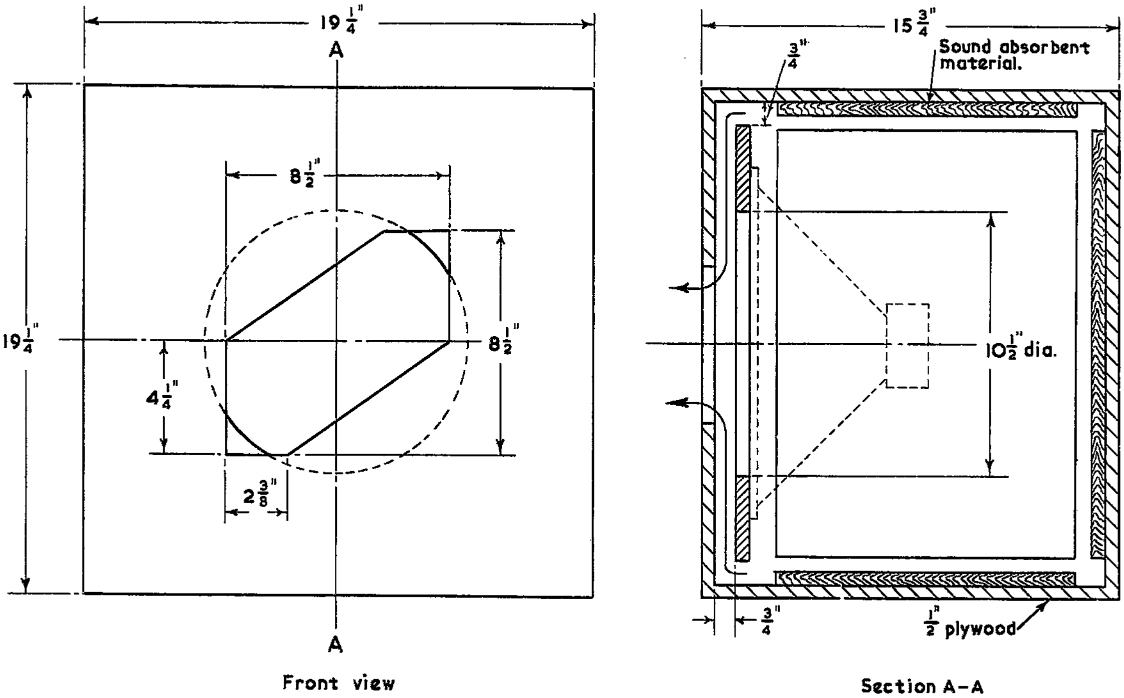

Fig. 1 - R-J enclosure: simplified diagram

The R-J enclosure does not appear to have been the subject of any patent literature and the working principle is not easily defined. The design consists of a combination of two known devices, (a) a reflex vent, which in this case has been designed to give a higher degree of damping than is usually obtained, and (b) the slot outlet, which, while commonly employed for the purpose of broadening the polar characteristics of loudspeakers at high frequencies, also modifies the low-frequency response by increasing the reactive component of the acoustic load presented to the front of the cone. The only essentially novel feature of the arrangement lies in the fact that the sound leaving the vent is combined with that coming from the front of the cone before passing through the slot opening.

3. SUMMARY OF TESTS.

To investigate the effect of the various constructional features and to compare the performance of the R-J enclosure with that of more conventional arrangements, an experimental enclosure was constructed, having the same dimensions but with provision for altering the size, shape and position of the various sound outlets by changing the front panel. The sound absorbent material used in the R-J enclosure was considered inadequate for its purpose and the experimental enclosure was lined with 1¼ in. (3·2 cm) felted slag wool held in position by carpet felt.

The axial frequency response measurements under the various acoustic conditions were taken for (a) constant terminal voltage, i.e. zero source impedance, and (b) source impedance resistive and equal in magnitude to half the nominal impedance of the unit; the latter figure was thought to represent the highest value of output impedance likely to be encountered with a high-quality loudspeaker amplifier. All measurements were made in the Kingswood Warren sound measurement room with the measuring microphone 39 in. (1 m) from the front of the enclosure. At this distance, the errors due to reflection, estimated by observing the pressure/distance relationship for sound emanating from a small source, were ± 1 dB, but as the loudspeaker under test was always placed in the same position in the room, changes in response of less than 1 dB could be observed without ambiguity.

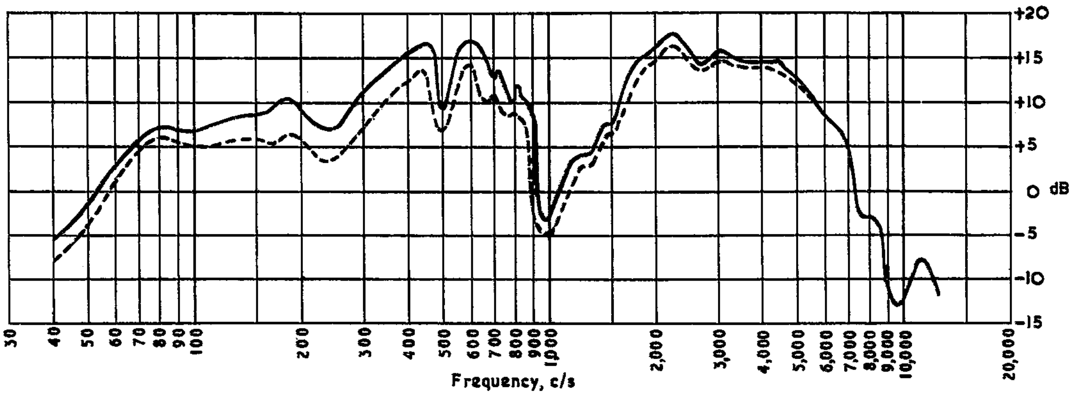

Fig. 2 - R-J enclosure with I.S.R.K. cone unit
Axial frequency characteristics at 1 metre

——— Source impedance: zero
- - - - Source impedance: 6 ohms

Zero output level: 1 dyne/cm^2 for 1 volt source. Nominal speech coil impedance: 12 ohms

Fig. 2 shows the axial response of the test unit mounted in the R-J enclosure, and Fig. 3(a), (b), (c) and (d) the corresponding curves measured with the same unit mounted in the experimental enclosure. For the curve of Fig. 3(a), the arrangement of the sound outlets was the same as in the R-J design. Below 130 c/s and above 1600 c/s, this characteristic is in good agreement with that of Fig. 2; between these two frequencies the response curve of the unit in the experimental box was smoother, a result which may be attributed to the greater thickness of the absorbent lining. In this connection, it may be noted that at frequencies of 1000 c/s and 500 c/s, at which sharp dips appear in the curve of Fig. 2, the wavelength of sound is respectively equal to and twice, the internal front-to-back dimension of the enclosure; in the absence of adequate damping of the enclosure, the impedance presented to the rear of the cone at these frequencies may be expected to rise to a high value.

For the curve of Fig. 3(b), the R-J internal type of vent was used, but the opening in front of the cone was circular with a diameter of 10½ in., the normal size of aperture for a 12 in. unit; for the curve of Fig. 3(c), the opening was identical in dimensions with that of Fig. 1. For both Fig. 3(c) and 3(d), external vents, in the form of a number of holes in the front panel, were employed in place of the internal vent of Fig. 1. In each case, the total area of the holes was adjusted to give the same vent resonance frequency, 48 c/s, as in the original model. Had time permitted, it is possible that the low-frequency response might have been improved by adopting a slightly different working condition; to this extent, therefore, any

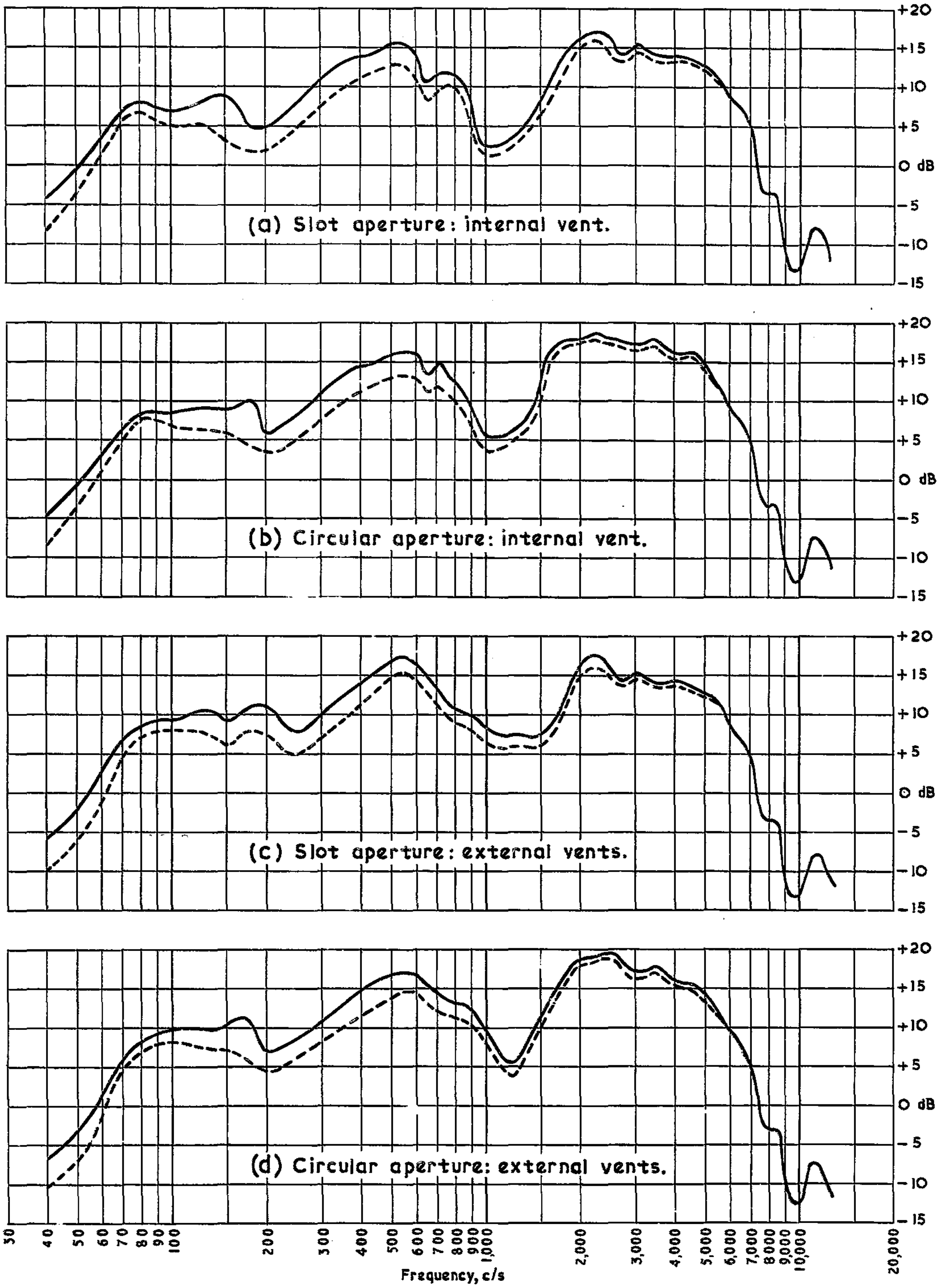

Fig. 3 - Experimental enclosure with I.S.R.K. cone unit
Axial frequency characteristics at 1 metre

——————— Source impedance: zero
- - - - - - - - - Source impedance: 6 ohms

Zero output level: 1 dyne/cm^2 for 1 volt source. Nominal speech coil impedance: 12 ohms comparisons with Fig. 3(a) are weighted in favour of the R-J design. For Fig. 3(d), the 10½ in. diameter aperture was used.

It should be noted that the broad hump centred on 550 c/s, which appears in all the curves, is not a feature of the I.S.R.K. unit[2] but is characteristic of any square-fronted enclosure of the dimensions shown in Fig. 1[3, 4].

3.1. Effect of Slot.

By comparing Fig. 3(a) with Fig. 3(b) and Fig. 3(c) with Fig. 3(d), it will be seen that the change from circular outlet to slot lowers the average level of axial response by some 2 dB between 100 c/s and 5 kc/s when the original internal vent is used, and between 700 c/s and 5 kc/s with external vents. Off-axis frequency characteristics, not reproduced here, show a slight increase in high-frequency response in the plane perpendicular to the slot; this effect is well known and need not be discussed further. Finally, with the internal vent, the use of the slot has no effect on the response below 100 c/s; with the external vent, the response between 40 c/s and 80 c/s is raised by a barely measurable amount.

3.2. Effect of Internal Vent.

Alternatively, by comparing Fig. 3(a) with Fig. 3(c) and Fig. 3(b) with Fig. 3(d), it will be seen that the change from external to internal vent gives a small increase in response below 60 c/s, together with a slight irregularity in the characteristic at about 650 c/s. In addition, where a slot outlet is used there is a loss of 2 to 3 dB in the 80 c/s to 250 c/s region while the dip at 1200 c/s is accentuated.

3.3. Overall Effect.

It is not easy to assess the advantage of the particular form of construction adopted in the R-J enclosure over the conventional vent arrangement to which Fig. 3(c) refers. A distinction must be drawn between a genuine increase in overall efficiency of the amplifier-loudspeaker system at some part of the frequency range and an increase in relative response at one part of the range brought about by lowering the response at another. Thus, the absolute level of response shown in Fig. 3(a) exceeds that of Fig. 3(c) at 60 c/s by only 0 to 1½ dB and at 40 c/s by 1½ dB to 2 dB, the two figures in each case corresponding respectively to the lower and higher limits of source impedance considered. In Fig. 3(a), on the other hand, the average level of response between 100 c/s and 1500 c/s is some 2 dB lower than in Fig. 3(c), and if this average had been taken as datum, an improvement of 2 to 4 dB in relative low frequency response could have been claimed. In view of the steeply falling response at low frequencies in all cases, it is perhaps more relevant to compare the frequencies at which the response has sunk to a given level. Assessed in this way, the lower limit of the frequency range shown in Fig. 3(a) could be said to extend downward by 5% to 10% compared with that of Fig. 3(c).

4. SUBJECTIVE COMPARISON.

An attempt was made to compare subjectively the performance of the R-J enclosure with the enclosure of Fig. 3(c), in the reproduction of programme in live surroundings using in each case an I.S.R.K. cone unit. The tests were conducted in a room of 1850 cu. ft (52 cu. m) volume, having an average reverberation time of 0·5 sec. As might be expected from curves 2 and 3(c), the quality of reproduction was in neither case high by modern standards. Particular attention was paid to the low-frequency response. There appeared at first to be little correlation in this respect between the difference heard on switching from one loudspeaker to the other and the difference between the curves of Figs. 2 and 3(c). It soon became apparent, however, that the spatial separation between the two enclosures and the residual differences between the two nominally identical cone units were having a greater effect upon the result than the difference between the two enclosures under test. Eventually, the two enclosures were placed close together, a series of tones with a ± 10% warble in the range 40 c/s to 400 c/s was applied to the two cone units alternately and the difference between the electrical inputs required to produce equal loudness for an observer situated midway between the axes of the two units was measured. On interchanging first the position of the enclosures and then the cone units themselves and averaging the results, the differences in response attributable to the enclosures alone were in satisfactory agreement with that predicted from curves 2 and 3(c).

5. CONCLUSION.

In the case of the 12 in. I.S.R.K. unit studied, the particular combination of apertures which is the characteristic feature of the R-J enclosure was found to raise the response of the loudspeaker at low frequencies by amounts up to 2 dB above that obtained with a more conventional arrangement. This slight gain in response is however achieved at the expense of losses in other parts of the frequency range. The performance of a 12 in. unit in an enclosure only 19¼ in. × 19¼ in. × 15¾ in. (49 cm × 49 cm × 40 cm) is not in any case such as to be of much interest to the Corporation but it is possible that the same form of construction might be applicable to a larger volume.

6. REFERENCES.

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