July 17, 1962 C. E. WATTS 3,044,570

LOUDSPEAKERS

Filed April 2, 1958 2 Sheets-Sheet 1

Fig. 1.

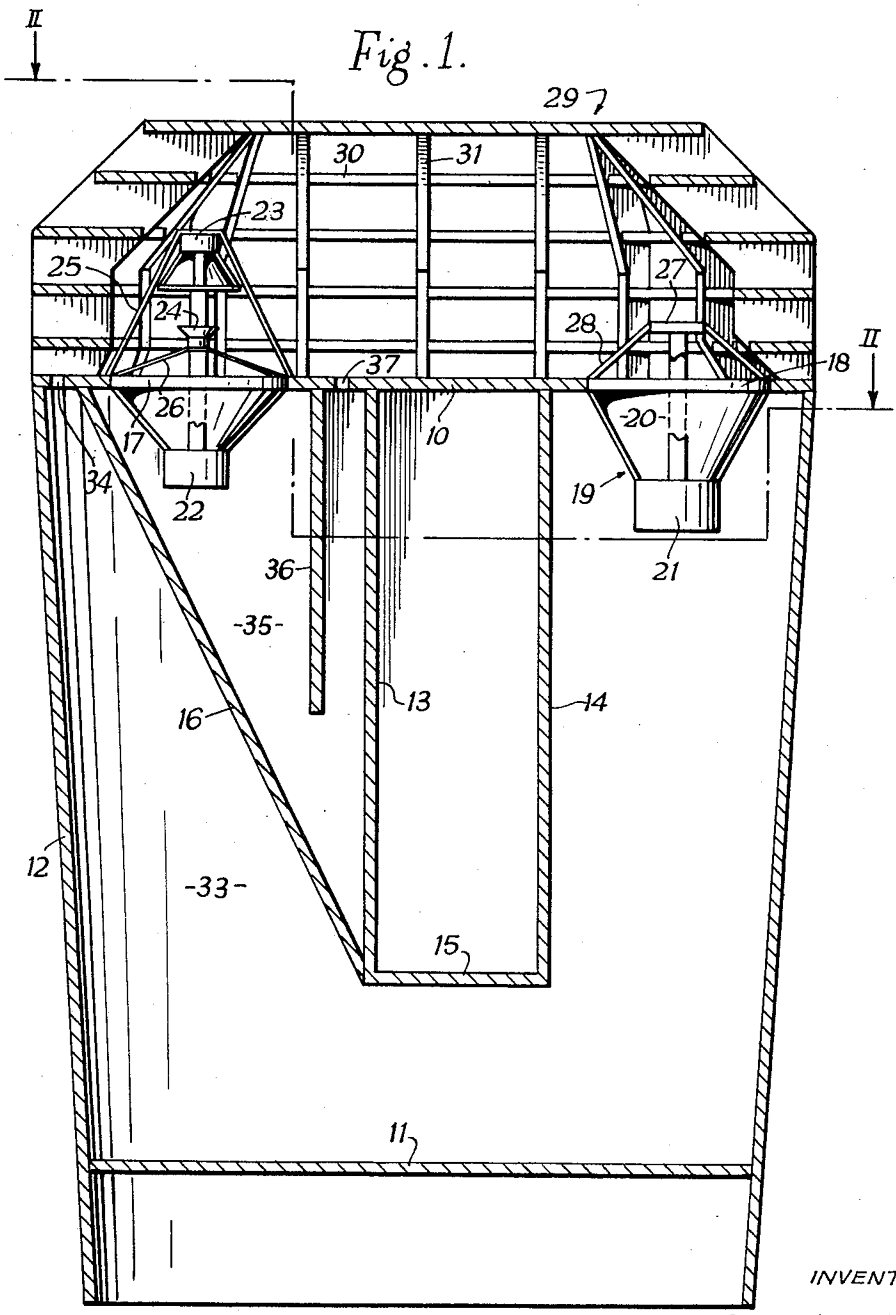

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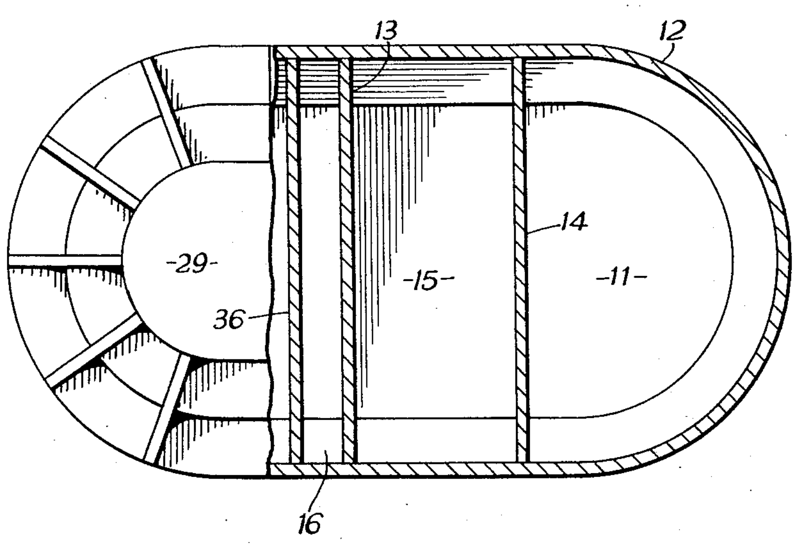
Fig. 2.



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United States Patent Office

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LOUDSPEAKERS

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The present invention relates to loudspeakers.

In the specification of my British Patent No. 769,204 there is described a loudspeaker of novel construction and that specification is concerned with reproduction of intermediate and low frequencies.

One of the difficulties met with in reproducing the highest frequencies, and to a lesser extent also the intermediate frequencies, arises from the focusing effect of the diaphragm which radiates the sound. It is known that when the dimensions of the diaphragm, or that part thereof which is effective at any frequency, are comparable with the wavelength corresponding to that frequency, interference effects produce a concentration of sound intensity around the axis of the diaphragm.

The original source of all signals which have to be reproduced by a loudspeaker is a microphone. The waveform generated by a microphone contains not only a representation of the sound waves reaching it directly from a source, such as a musical instrument, but also representations of reflections of the sounds from the source from the boundaries of the space in which the source is located. For satisfactory sound reproduction it is, therefore, necessary to convert the signal waveform into sound waves all the frequency components of which are radiated in all directions, or at least over a wide angle.

The present invention has for its principal object to apply these considerations to improving sound reproduction, and, as one important step in such improvement, to reduce the directional effects at the higher frequencies.

According to the present invention there is provided a loudspeaker comprising two or more separately driven diaphragms arranged to reproduce different parts of the acoustic frequency range, these diaphragms being disposed at least approximately in axial alignment.

The axis of a diaphragm is a line from its center in the direction of its vibration and axial alignment of the diaphragms therefore means that their axes are coincident.

The diaphragms should be arranged to be energized in phase, that is to say in such a manner that in response to a unidirectional transient they move in the same direction, that is, the diaphragms are driven in the same direction in space.

According to a subsidiary feature of the invention the loudspeaker comprises a radiator of the low acoustic frequencies of approximately cylindrical, frusto-conical, or flattened cylindrical or frusto-conical shape, so arranged in relation to the aforesaid diaphragms that the axis of the diaphragms passes eccentrically through the said radiator.

The invention will be described by way of example with reference to the accompanying drawing in which

FIGURE 1 is a view in sectional elevation of one embodiment of the invention, FIGURE 2 is a plan view in section on the line II—II of FIGURE 1 to a reduced scale.

In the drawing a cabinet has an upper wall **10**, a lower wall **11** and joining these walls a wall **12** of flattened frusto-conical shape. The upper part of the cabinet is divided by two vertical transverse walls **13** and **14**, a horizontal transverse wall **15** and an inclined wall **16**, all these walls extending from front to back of the wall **12**.

In the upper wall **10** are formed apertures **17** and **18**. In aperture **18** is mounted a first loudspeaker unit **19** having a diaphragm **20** and a driving electromagnet **21**.

Three loudspeaker units **22**, **23** and **24** of the same construction as the unit **19** but of progressively smaller size are mounted in and over the aperture **17**. Thus the unit **22** is mounted in the aperture **17**, the unit **23** is supported by brackets **25** above and in axial alignment with the unit **22**, and the unit **24** is supported by brackets **26** between and in axial alignment with the units **22** and **23**. The diaphragms of units **19**, **22** and **24** face upward and that of the unit **23** faces downward.

In one example, the diaphragm of the first unit **19** has a diameter of about 11 inches, that of the second unit **22** a diameter of about 10 inches and an axial height of about 4 inches, the diaphragm of the third unit **23** has a diameter of about 5 inches and an axial height of about 2 inches, and that of the fourth unit **24** a diameter of about 2 inches and an axial height of about 1 inch. The four units are designed to operate over approximately the ranges 30 to 200, 200 to 1000, 1000 to 5000, and 5000 upward respectively, and suitable cross-over networks are provided in order to feed to each unit the appropriate part of the frequency range. The mouths of the diaphragms of the second and third units **22** and **23** are spaced apart by about 5 inches, and the mouths of the diaphragms of the third and fourth units **23** and **24** are spaced apart by about 2½ inches. A circular baffle **27** about 3¾ inches in diameter is supported by brackets **28** about 3¼ inches in front of the mouth of the diaphragm of the first unit **19**. Thus it will be noted that the second and third units and the third and fourth units are spaced apart by a distance less than the diameter of the larger, that is the diameter of the second and third units respectively.

Over the upper wall **10** and enclosing the third and fourth units **23**, **24**, which project above the wall **10**, is a cover **29** having honeycomb walls. These walls may be formed of approximately horizontal and vertical slats **30** and **31**. The openings may be covered with dust-proof fabric (not shown).

The cross-over networks operate to prevent all signals outside a given band from reaching a given units. As is known there is always a slight overlap between the adjacent frequency bands in the outputs of such cross-over networks. Diaphragms reproducing adjacent and overlapping bands of frequencies are driven in such a manner as to be in phase at the frequencies in the overlapping regions, that is, the diaphragms are driven in the same direction in space; the purpose in driving the diaphragms in phase in the overlapping frequency regions is to reduce directional effects by reducing the cancellation of sound waves that occur when diaphragms are driven in opposing phase. The arrangement of the second, third and fourth units **22**, **23** and **24** in axial alignment serves to mask sounds of frequencies above the range proper to each of the second and third units. Moreover, the disposition of these diaphragms results in avoidance of focusing effects.

Although examples of dimensions and spacings for the second, third and fourth units have been given, in practice the spacings are so adjusted that all frequencies within the acoustic range of the loudspeaker are radiated in all directions around, and also through an angle above and below horizontal, at approximately uniform intensity.

The unit **19** is loaded by the chamber **33** between the walls **12** and **14**, **15** and **11** and **12** and **16**, the cross-sectional area of this chamber decreasing in a direction away from the unit **19**. The chamber preferably terminates in an aperture **34**. The unit **22** is loaded by a chamber **35** between the wall **16** and a further transverse wall **36** and between the wall **36** and the wall **13**, this chamber preferably terminating in an aperture **37**.

The side wall **12** of the loudspeaker constitutes the main radiator of the lowest frequencies and it is noted that this wall is of approximately flattened frusto-conical shape and that the aligned axes of the second, third and fourth diaphragm pass eccentrically through this radiator.

A greater number of apertures or vents 34, 37 than shown may be desirable and it has been found that the reproduction of the lowest frequencies can be improved by covering these vents with soft material, such as foam rubber, which may be about ½ inch thick.

I claim:

1. A loudspeaker having three frusto-conical diaphragms for reproducing low, medium, and high frequencies respectively and of large, medium and small diameter respectively, loading means for said large diameter diaphragm comprising a chamber and partitions in said chamber defining a nearly closed passage of cross-section decreasing in a direction away from said large diameter diaphragm, said chamber having boundaries including an apertured end wall and flexible side walls for radiating said low frequencies, said large and medium-diameter diaphragms being mounted in apertures in said end wall, means supporting said small diameter diaphragm from said end wall substantailly coaxial with and spaced from said medium diameter diaphragm with the concave sides of said small and medium diameter diaphragms facing one another, and three independently energizable electromagnetic driving means coupled to said three diaphragms respectively.

2. A loudspeaker according to claim 1 comprising within said chamber further partitions defining a further loading passage extend from the convex side of said medium-diameter diaphragm and having a cross-section decreasing progressively in a direction away from the medium diameter diaphragm.

3. A loudspeaker according to claim 1 comprising a baffle of diameter substantially smaller than that of said large-diameter diaphragm and means for fixedly supporting said baffle spaced from and on the concave side of said large-diameter diaphragm.

References Cited in the file of this patent

UNITED STATES PATENTS

1,877,294	George	Sept. 13, 1932
1,951,692	Evens	Mar. 20, 1934
2,034,882	Scribner	Mar. 24, 1936
2,043,416	Lueg	June 9, 1936
2,049,784	Thomas	Aug. 4, 1936
2,114,680	Goldsmith	Apr. 19, 1938
2,565,069	Engholm	Aug. 21, 1951
2,869,667	Leslie	Jan. 20, 1959
2,969,848	Farwell	Jan. 31, 1961