July 28, 1959 F. J. G. VAN DEN BOSCH 2,897,292

HIGH FIDELITY LOUDSPEAKER

Filed April 19, 1956

Fig.1

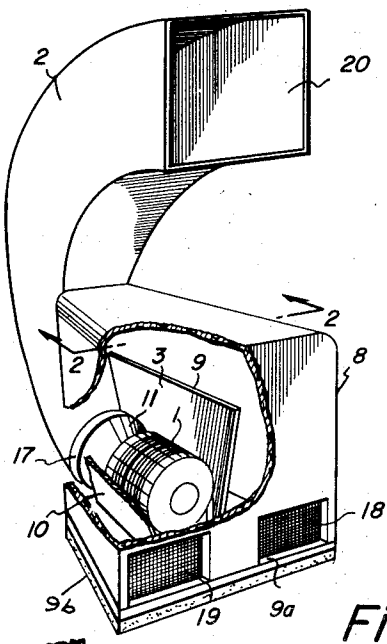



Fig.2

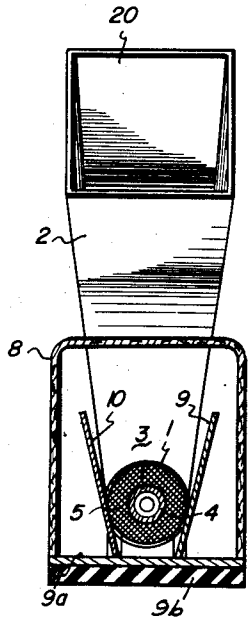
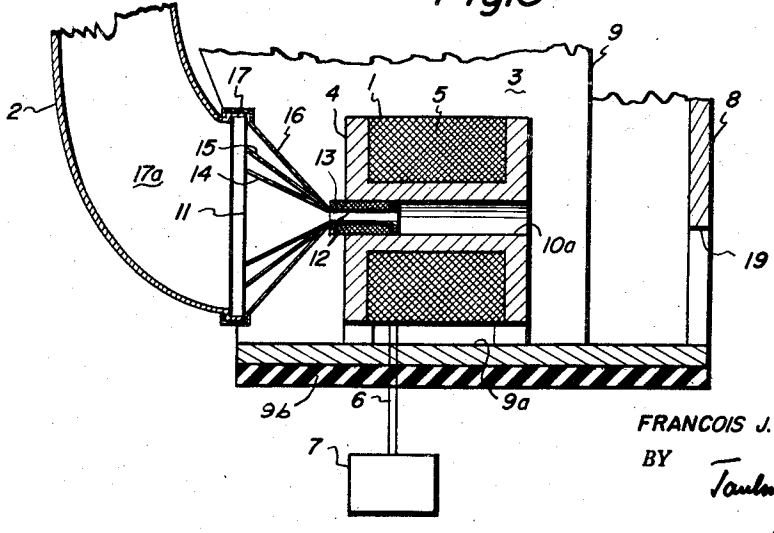



Fig.3




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2,897,292

Patented July 28, 1959



2,897,292

# HIGH FIDELITY LOUDSPEAKER

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Application April 19, 1956, Serial No. 579,354

7 Claims. (Cl. 179—115.5)

This invention relates to a high fidelity loud-speaker. It is an object of the invention to provide a loud-speaker of high fidelity sound reproduction adapted for reproducing with one unit the entire audio frequency range from about 35 to about 18,000 cycles per second.

The ideal reproduction of sound involves the radiation of air waves identical in competition with those originally received within the audible range. This requires an apparatus capable of handling air waves of frequencies between about 25 cycles/sec. and 25,000 cycles/sec. However since listening depends on the faculty of judgement of the human ear, and the ear is a very tolerant judge it is possible to narrow down this range of frequencies.

When a diaphragm is set in motion in free space the air in front of it is given a certain velocity and a pressure is set up which reacts on the diaphragm. This pressure is proportional to the air particle-velocity, and must obviously be small compared with the forces due to the inertia and stiffness of the diaphragm itself. The diaphragm therefore works with a very small load and so its motion is almost entirely determined by its own stiffness and mass. Its own natural frequencies will be pronounced and the useful work done by the diaphragm on the air will in general be small.

Any known loud-speaker is a compromise. Hence the various types developed in the art. Amongst these the moving coil loud-speaker has found a preponderant use.

Many types of cabinets to improve frequency response have been proposed, and a certain trend has been noticeable recently to employ several loud-speakers intended to cover the required frequency range.

Amongst the various known types the horn loud-speaker has been rather neglected.

The first function of the horn is to load the diaphragm. If the horn is removed the sound energy is at once reduced and the diaphragm will increase its amplitude so that it clatters. A receiver element without a horn is like a motor without a load. The horn is so to speak the antenna of the loud-speaker. Any horn must be designed to meet the following requirements:

(1) A given applied force acting on the diaphragm must cause air at the throat of the horn to have nearly a uniform velocity over the whole range of audio frequencies.

(2) The area of the mouth must be such that little sound energy is reflected.

Finally the law of increase of cross sectional area with the length of the horn and the rate of that increase must secure the maximum transmission of sound energy and a constant ratio of pressure and air velocity at the throat over the whole range of audio-frequency range.

For a high fidelity sound reproduction a single horn however presents a serious drawback since it has to be excessively long, if it is to cover the whole audio frequency range and it is largely because of this drawback that horn type loud-speakers have not hitherto been successfully used.

The object of my invention has been achieved and the



aforesaid drawback is overcome by using according to my invention a moving coil loud-speaker a main feature of which is that the cone means is composed of several cones of varying diameter mounted on the same "speech coil" and rigidly connected with each other. Furthermore the speech coil and cones are freely suspended in the apparatus so that no mechanical hindrance exists to their movement along the axis of the field magnet. This driving unit is mounted between two horns, one in front and one at the back of the unit. The front horn has the special function to reproduce the higher frequencies, while the rear horn reproduces the lower frequencies. To achieve this end I prefer to make the front horn of a pure exponential design, while the rear horn has been given the form of a folded horn. To achieve optimum results I provide the throat of the exponential horn with the same aperture as the diameter of the largest of the piston cones. The cones should be made of hard paper or light cardboard and covered with a hard varnish similar to a high grade furniture varnish. Cone centering is achieved with a light chamois leather. Furthermore my electric field means provide a field power which is at least four times the maximum audio power delivered to the speech coil.

With regard to the horns they are made of non-resonating wood such as for example heavy plywood (twelve ply as a minimum). The primary portion of the folded horn is provided with an inclination of approximately 75° relative to the bottom of the horn.

One special advantage of using two horns driven by the same loud-speaker is that sound attains a certain amount of relief impossible to achieve by any other acoustical loud-speaker device except by going to extreme complications such as multi-horn speakers. Since the unit covers the whole frequency range no distortion is suffered through cross-over networks or unbalanced speakers.

The loud-speaker and cabinet unit to be efficient must stand on rubber and may not be attached to any wall or other piece of furniture.

The nature of my invention will be still better understood by the description thereof in connection with the accompanying drawings in which:

Figure 1 shows a sectional side view of a preferred embodiment of the loud-speaker according to my invention.

Figure 2 is a cross sectional view of the folded horn along line **11—11** in Figure 1.

Figure 3 is a cross sectional view of the driving unit of the loud-speaker in greater detail.

In Figure 1 the loud-speaker consists of the driving unit **1**, the exponential horn **2** and the folded horn **3**. The driving unit comprises an electro magnet iron core **4** and windings **5**. Current is supplied to the windings **5** of the electro magnet through leads **6** which are connected to the audio circuit **7** of a conventional radio receiving set or television set. The apparatus consists of a horn casing **8** and two baffles **9** and **10** disposed at an angle of about 75° relative to the bottom plate **9***a* of the loud-speaker. A rubber pad **9***b* is added to the bottom of the bottom plate **9***a*.

Between baffles **9** and **10** the electro magnet **4** is placed near the bottom **9***a*. In the central bore **10***a* of the iron core **4** of the electro magnet there is suspended the cone member **11** which comprises a cylindrical coil bearing portion **12** with the speech coil **13** mounted thereon, and a plurality of frusto-conical elements **14**, **15**, **16** whose smaller end surface area is the same and which cone elements are all connected with this smaller end to the hollow cylindrical portion **12**. The latter extends into the interior of the bore **10***a*. Instead of the three frusto-conical elements of the multi cone member **11** the latter may also consist of two, four or more cone elements. The

rim of the frusto conical member having the larger opening of maximum diameter is connected by means of a chamois leather **17** to the throat **18** of the exponential horn **2**, the throat **18** being of substantially the same diameter as the wider open end surface of the largest frusto conical element **3**. The chamois leather **17** serves for centering the multi cone and speech coil freely floating in the central bore of the electro magnet. Sound is emitted to the air outside the loud-speaker through openings **18** and **19** in the casing **8** of the folded horn **3** and through the mouth **20** of the exponential horn.

In order to achieve optimum results of sound reproduction it is preferred to build the exponential horn of a height of between 100 cm. and 150 cm. for the bottom **9** of the loud speaker to the top of the horn. The radio of height of the folded horn to the exponential horn is approximately 1:2 to 2:3.

What I claim is:

1. In an electro-acoustic device, the combination of a moving coil loudspeaker comprising a magnet having a central bore, a speech coil freely floatingly disposed in said bore in one end of said magnet, an element having a plurality of frusto-conical parts, each part having a small end opening and a large end opening, the end of said element having the small end openings being rigidly attached to said speech coil, said combination further comprising an exponential horn having a narrow and a wide opening, flexible connecting means attached to the end of said exponential horn having the narrow opening, on the one hand, and to the end of said element having the large end openings, on the other hand, said flexible connecting means maintaining said element and said speech coil freely floating, and a folded horn connected to the other end of said magnet.

2. The arrangement of an electro-acoustic device, comprising, in combination, a cabinet, a moving coil loudspeaker in said cabinet and comprising a magnet having a central bore, a speech coil freely floatingly disposed in said bore in one end of said magnet, an element having a plurality of frusto-conical parts, each part having a small end opening and a large end opening, the end of said element having the small end openings being rigidly attached to said speech coil, said combination further comprising an exponential horn having a narrow and a wide opening, flexible connecting means attached to the end of said exponential horn having the narrow opening, on the one hand, and to the end of said element having the large end opening, on the other hand, said flexible connecting means maintaining said element and said speech coil freely floating, a folded horn in said cabinet and connected to the other end of said magnet, and rubber means on said cabinet for supporting said device free from contact with any wall or piece of furniture.

3. The combination as described in claim 1, wherein said multi-frusto-conical element comprises at least two frusto-conical members of different conical slope, the narrower of which members is inserted in the widest member, all of said members having a common smaller end opening, along the periphery of which end opening they are joined to each other, and to said speech coil, and said members having wide end openings of different diameters, said narrow opening of said exponential horn being connected by means of said flexible connecting means to the wide end opening having the largest diameter.

4. The combination as described in claim 1, wherein said flexible connecting means is an annular chamois leather.

5. The combination as described in claim 1, wherein said magnet is of a size sufficient to provide a field power which is at least four times the maximum audio power delivered to the speech coil.

6. The combination as described in claim 1, wherein said folded horn comprises a primary portion and a bottom member, said primary portion being inclined at approximately 75° relative to said bottom member.

7. The combination as described in claim 1, wherein the ratio of the height of the folded horn to the height of the exponential horn is approximately from 1:2 to 2:3.

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