United States Patent [19]

Dahlquist

[11] **3,824,343**

[45] **July 16, 1974**

[54] **MULTIPLE DRIVER DYNAMIC LOUD SPEAKER**

[76] Inventor: **Joh G. Dahlquist,** 500 E. 85th St., New York, N.Y. 10028

[22] Filed: **Nov. 29, 1972**

[21] Appl. No.: **310,535**

[52] **U.S. Cl.** ..... **179/1 E,** 181/31 B
[51] **Int. Cl.** **G10k 11/00**
[58] **Field of Search** ..... 179/1 E, 1 D; 181/31 B

[56] **References Cited**

UNITED STATES PATENTS

2,217,279	10/1940	Karns	181/31 B
3,105,569	10/1963	Evans	181/31 B
3,385,929	5/1968	Magyar et al.	181/31 B
3,666,041	5/1972	Engelhardt	181/31 B

FOREIGN PATENTS OR APPLICATIONS

1,216,851	5/1963	France	181/31 B
1,339,664	9/1963	France	181/31 B
1,042,024	6/1956	Germany	179/1 E

Primary Examiner—Kathleen H. Claffy
Assistant Examiner—Douglas W. Olms
Attorney, Agent, or Firm—Mark T. Basseches; Paula T. Basseches

[57] **ABSTRACT**

A loud speaker assembly capable of producing coherent sound with multiple driver, dynamic loud speakers is provided, which assembly is characterized by sonic frequencies of the mid-range and treble frequency bands being generated by wide dispersion, dynamic transducers which are free-air mounted within an acoustically transparent enclosure. The mounting of all of the transducers in the assembly is preferably coordinated as a function of the rise time characteristics of the transducers by positioning the transducers forwardly and rearwardly in the assembly along their radiating axes with respect to a listening area, in such manner that the sound waves generated by electrical signals simultaneously impressed upon the transducers will be simultaneously impinged upon a point in the listening area equidistant from the radiating axes of the transducers.

5 Claims, 6 Drawing Figures

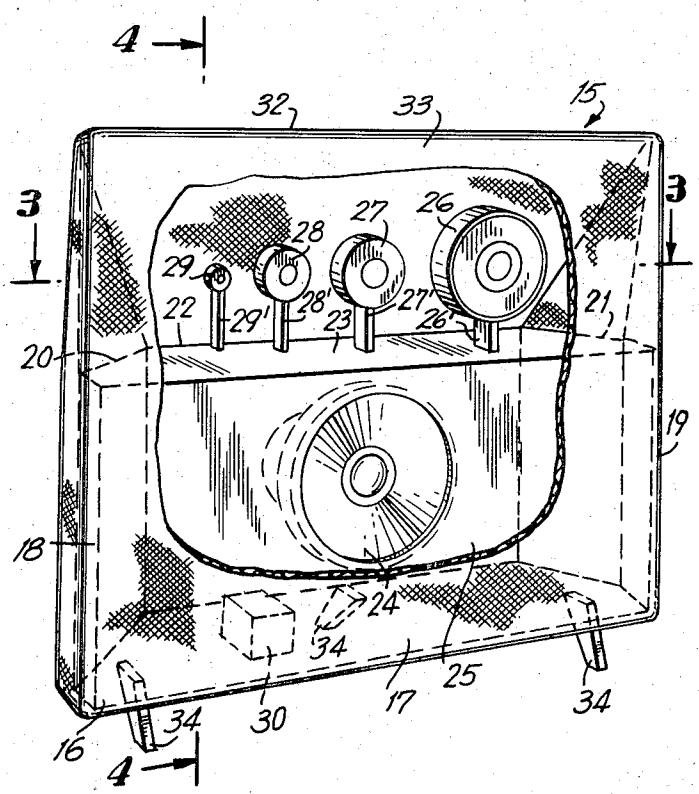


FIG. 1
PRIOR ART

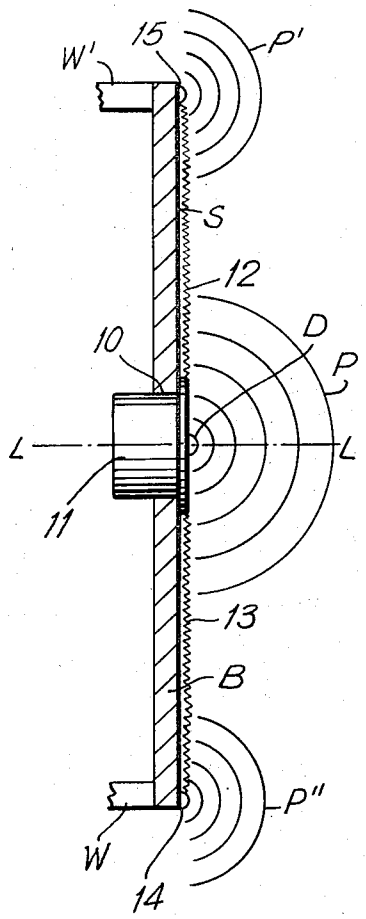


FIG. 2

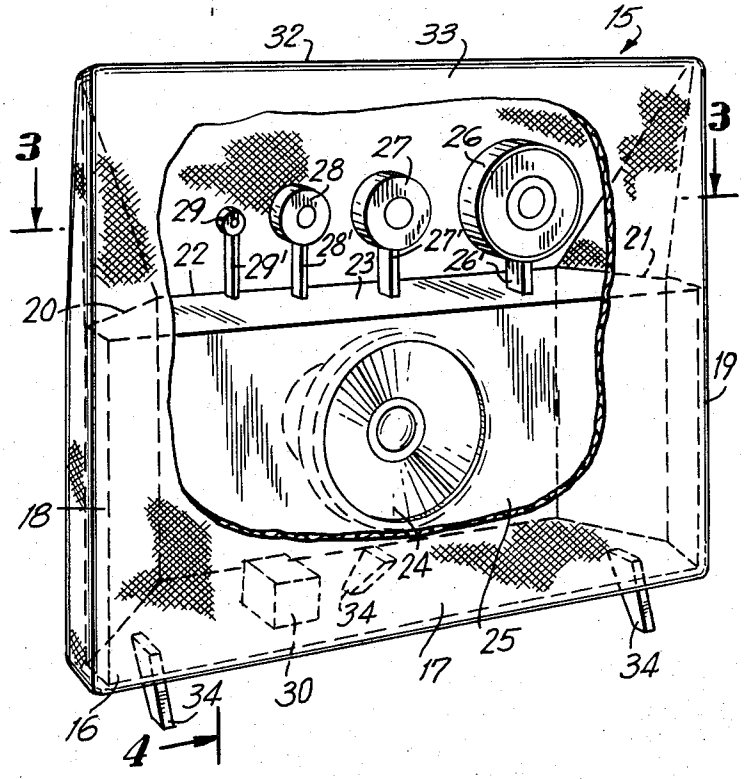


FIG. 3

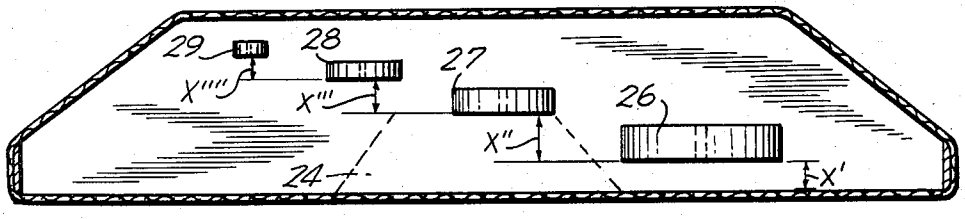


FIG. 4

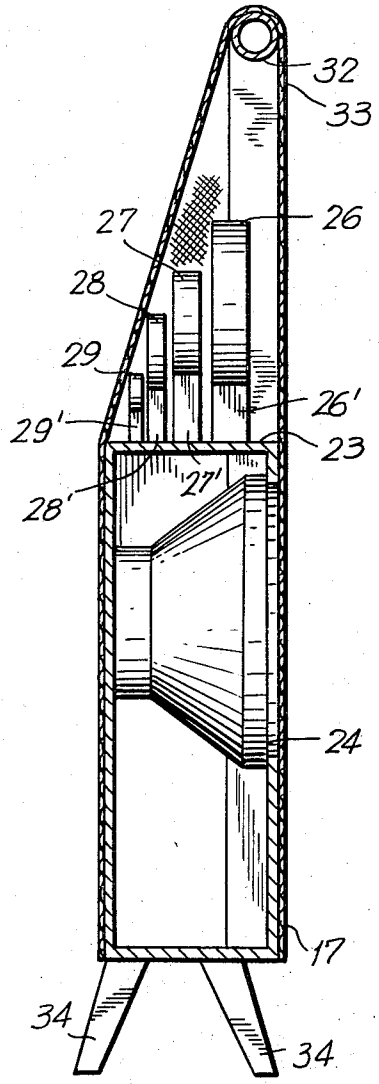
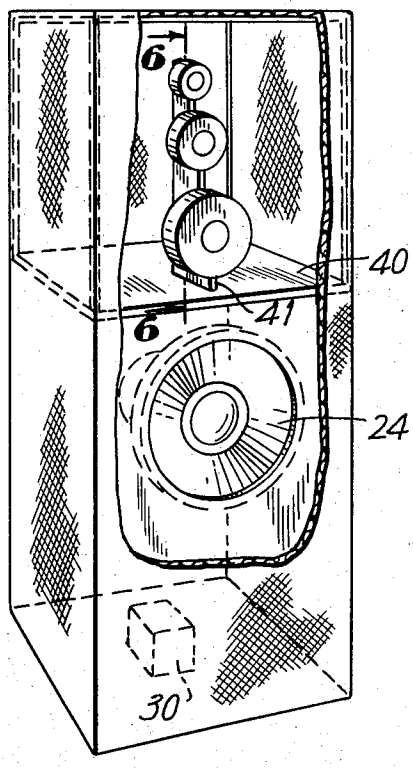


FIG. 5



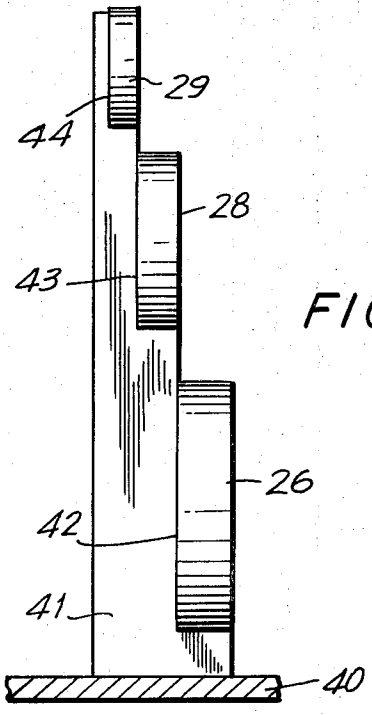


FIG. 6

MULTIPLE DRIVER DYNAMIC LOUD SPEAKER

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention is in the field of high fidelity sound reproduction and relates more particularly to a high fidelity loud speaker assembly of the multiple driver, wide dispersion dynamic type.

2. The Prior Art

It is known to provide as a means for reproducing sound an assembly comprising two or more transducers of the so-called dynamic or permanent magnet type, each of which transducers is connected to a frequency dividing network or crossover which functions to divide the frequencies of the output of an audio amplifier into frequency bands, and to apply the bands thus obtained to the respective transducers especially constructed or adapted to reproduce such bands.

Typically, speaker assemblies of such known types incorporate an enclosure or chamber with or without venting means, the front face of the enclosure being defined by a baffle or board to which the transducers are mechanically connected, the baffle being provided with apertures through which sound may be radiated.

As conducive to an understanding of the present invention, it should be explained that the typical multiple transducer loud speaker assembly employing wide dispersion transducers, i.e., cone or dome type speakers (but not horn type speakers) wherein the diaphragms are directly coupled to the air load, incorporate a direct connection between the drivers and the front board, wall or baffle of the box, enclosure or chamber.

Typically the transducers include a perimetal ring or rim provided with mounting holes bolted to the inner or outer face of the baffle. The woofer or bass reproducer may be housed within a separate enclosure, the front wall of which is defined by the front baffle, or separate sub-enclosures may be formed, each of which sub-enclosures nonetheless employs a front baffle member.

Substantial activity has been undertaken in the field of improving speaker systems of the type described, all of which systems suffer, in greater or lesser degree, from a lack of coherence, as hereinafter defined. The avenues of investigation heretofore attempted have included the utilization of various porting devices, air coupling schemes, means for damping or controlling spurious vibrations of the diaphragms and enclosures, etc. Notwithstanding the improvements in enclosure design and in transducer design, units heretofore known have all suffered from a common "boxiness" or constriction of sound, readily identified by expert listeners.

While there are in existence electrostatic loud speakers which are capable of producing more or less coherent sound, free from the unpleasant distortions above set forth, electrostatic speakers of necessity incorporate certain drawbacks which detract from their widespread use, i.e., high initial expense, large overall size, fragility, the necessity for providing a well regulated high voltage DC power supply, required proximity to an electrical outlet, etc.

I have discovered that many of the deficiencies in prior art speaker systems are not due to deficiencies in the transducers themselves but, rather, are due to the manner in which the speakers have been mounted. I

have discovered that lack of coherence of sound in such systems is, in large measure, attributable to what will be termed "baffle propagation effects."

By way of explanation of the term "baffle propagation effects," if a moving coil loud speaker or wide dispersion transducer were held in free air, e.g., a 1 inch dome driver radiating a 1000 Hz tone, it will be noted that the tone is audible whether or not the dome or diaphragm driver is facing a listener. The driver may be said to have an omni-directional radiation characteristic at such frequency. If, however, the same driver is now mounted on a baffle or surface which is relatively rigid and substantially larger than the speaker diaphragm itself (the baffling system universally used at the present time), the radiation which was free to propagate behind the transducer is now constrained to the frontal hemisphere over the larger area defined by the baffle.

I have discovered that the thus baffled transducer results in the production of a high intensity sound field which propagates outwardly in all directions along the surface of the baffle until it encounters a discontinuity, such as a raised portion or an edge or a terminus of the baffle.

I have further determined that a diffraction occurs at such discontinuity, edge or terminus, which diffraction results in the production of secondary virtual sound sources at the discontinuity, edge or terminus, which secondary sources inescapably introduce into the audible signal time delay distortion products. Obviously, the sound directly radiated by the diaphragm and that radiated by secondary sources, by reason of the displacement of the secondary sources from the diaphragm, will inherently be carried to the ear of the listener at displaced time intervals, a factor which, in large measure, accounts for the lack of coherence in the conventional baffle mounted speaker system.

The so-called baffle propagation effects induce additional distortion products in the audible signal, which reduce the naturalness of the reproduced sound. Specifically, the secondary radiating sources have been found to be "frequency dependent," i.e. the secondary radiating sources may emphasize one frequency over another. Thus, if a baffle mounted transducer is emitting a blend of frequencies of, for example, 4000 Hz and 6000 Hz, of equal intensity, the propagating characteristics of the baffle board and secondary sources may be such as to disseminate the 4000 Hz tone with greater efficiency than the 6000, with the result that the musical balance will be altered.

Still another difficulty inhering in baffle board propagation is the fact that the high intensity energy propagated by one transducer along the baffle surface is impinged upon the cone and voice coil structure of all of the other transducers mounted on the same baffle, resulting in the production of intermodulation distortion products and microphonics, since vibrations applied to the diaphragm must also affect the movement of the voice coil.

I have discovered that by eliminating the baffle of the speakers, particularly the speakers other than the bass reproducer, namely, those reproducing above about 400 to 500 Hz or higher, the sound reproduction characteristics of the multi-speaker, wide dispersion assembly is dramatically improved.

I have further discovered that the elimination of time delay distortion effects introduced by baffle mounting

of the mid and high frequency reproducers, particularly when coupled or combined with compensation for differences in the rise time characteristics of the speakers, whereby still a further cause of time delay distortion is eliminated or minimized, results in the production of a combined loud speaker assembly having sound reproducing characteristics rivaling those of the finest electrostatic speakers, with increased reliability, wider dispersion, and substantially decreased cost as contrasted with such electrostatic speakers.

SUMMARY OF THE INVENTION

The present invention may be summarized as relating to a coherent sound source incorporating multiple wide dispersion drivers of the dynamic type, the drivers being of the wide dispersion type (as opposed to incorporating a horn type, air coupling system). The assembly includes a more or less conventional woofer or bass transducer, which is preferably mounted within a separate enclosure forming a part of the assembly. Positioned within the assembly, but externally of the enclosure, is at least one additional wide dispersion, dynamic transducer.

It is a characterizing feature of the present invention that said at least one additional transducer be substantially completely surrounded by free space. Preferably the radiating diaphragm components of the bass radiator and free space mounted transducer are, in addition, offset one from the other in the direction of the listening axis in such manner that, notwithstanding any differences in rise time between the transducers, an electrical signal impressed simultaneously on both transducers will result in the production of a sound impulse which will simultaneously reach the ear of the listener.

Accordingly, it is an object of the present invention to provide an improved multiple transducer dynamic speaker assembly.

It is a further object of the present invention to provide a speaker assembly of the type described which is capable of providing a coherent sound source.

Still a further object of the present invention is the provision of a multiple transducer loud speaker assembly of the type described, employing wide dispersion transducer components and capable of recreating sound with a fidelity, clarity and freedom from aberrations superior to dynamic speaker assemblies heretofore known.

It is still a further object of the invention to provide an improved speaker assembly of the type described which is susceptible of producing a more precise imaging effect than speakers of conventional design.

Still a further object of the invention is the provision of a speaker assembly of the type described which is capable of producing audible signals which are essentially free from factors reducing the coherence of the sound, namely, time delay distortions, intermodulation distortions, diffraction products and the like.

It is still a further object of the present invention to provide a loud speaker assembly of the type described wherein the mid-range frequencies and treble frequencies are produced by wide dispersion dynamic transducers which are free-space mounted within acoustically transparent portions of the assembly.

To attain these objects and such further objects as may appear herein or be hereinafter pointed out, reference is made to the accompanying drawings, forming a part hereof, in which:

FIG. 1 is a schematic view of the sound radiation pattern of a conventional baffle mounted, permanent magnet speaker of the dome type;

FIG. 2 is a perspective view of a loud speaker assembly in accordance with the invention, with parts of the grille broken away to show details of construction;

FIG. 3 is a horizontal section taken on line 3—3 of FIG. 2;

FIG. 4 is a vertical section taken along the staggered line 4—4 of FIG. 2;

FIG. 5 is a perspective view of a further embodiment of the invention, with parts broken away to show details of construction;

FIG. 6 is a magnified detail comprising a vertical section taken on the line 6—6 of FIG. 5.

For purposes of clarity, it is considered helpful to include the following definitions:

"Transducer" or "direct radiating dynamic transducer" within the context of the instant application is intended to refer to a diaphragm, cone or dome type permanent magnet speaker, as distinguished from an electrostatic speaker or a horn loaded driver.

"Coherent sound" refers to an audible signal containing complex information bits, wherein the information bits falling upon the ear of the listener arrive in the same temporal relation as the electrical energy inputs to the loud speaker assembly, i.e., are largely free of distortion products and particularly of time delay distortion products.

"Time delay distortion" in a loud speaker refers to the distortion of a complex, (i.e., non-sinusoidal) wave form resulting from lack of synchronism among the energy outputs of the various drivers in a frequency divided speaker system. While the total energy output in a time delay distorted signal may be identical with that of an undistorted signal, the wave forms generated in the distorted signal will differ from those of the original signal. While some time delay distortion inheres in the energy output of even a single, unbaffled transducer, such distortion products are relatively small at the center of the band covered by the speaker but increase toward the upper and lower limits of the band.

"Rise time" as used herein should be understood to relate to the time lag inherent in all transducers between the impressing of a voltage on the transducer and the diaphragm of that transducer responding to the voltage.

Referring now to the drawings, in FIG. 1 there is shown a baffle board B having mounted in a suitable aperture 10 a conventional transducer 11, in this instance a dome type reproducer. It will be appreciated that, as is typical, the Board B may form the front face of a loud speaker enclosure, the side walls W′ and W″ of which are shown.

As is the case with all of the transducers hereinafter referred to, and as is well known, the radiating diaphragm, dome or cone D of the transducer 11 is mechanically connected to a voice coil comprising one or more turns of a conductor mounted within a high intensity magnetic field. The diaphragm and coil are supported for reciprocal movement in a direction generally paralleling the listening axis L—L. When an audio signal is impressed upon the voice coil, the diaphragm will be caused to move, generating sonic energy radiated in pattern P.

I have discovered that by baffling the transducer **11** in the manner noted, substantial amounts of sonic energy, viz. the energy generated at the front of the speaker which would, in the absence of baffling, be radiated rearwardly, are propagated along the surface S of the baffle B, in patterns of propagation schematically represented by the wave fronts **12** and **13.** When the high concentration of sonic energy reaches the edges **14** and **15** of the baffle or at any discontinuity or abutment on the baffle face, there are created secondary radiating sources, such as P′ and P″, which radiating sources will provide secondary propagation points or areas radiating sound waves.

As previously noted, the wave fronts produced by the secondary sound sources P′ and P″ are, of necessity, out of timed sequence with the sound produced by the principal source P by a temporal delay factor which a function of the time required for the high energy sound to travel from the transducer **11** to the edges **14** and **15.** While the intensity of the fields P′ and P″ is substantially less than the intensity of the principal radiation pattern P, they will nonetheless introduce substantial time delay distortion products in the audible signal, which distortion products will necessarily detract from the realism of the musical or other sounds generated. Since the secondary sources P′, P″ radiate different frequencies with varying efficiencies, the tonal balance of the radiations from points P′ and P″ may differ significantly from that of the primary source, further degrading the accuracy and acoustical frequency balance of the sound waves. Further, secondary radiating sources have unpredictable polar distribution patterns which are likewise frequency dependent.

The existence of the secondary or virtual radiating points P′ and P″ will necessarily reduce the imaging ability of a stereo or quadrophonic system since spurious information is emanating from positions displaced from the actual sound source. As a result, whereas in an ideal stereo system a listener is able to locate or imagine the virtual location of a given instrument in an overall pattern of sound, and such ability provides a substantial degree of satisfaction and realism, the existence of secondary radiating areas will introduce errors in perspective. Manifestly, the secondary or virtual sound sources will interfere with the imaging characteristics of the speakers, i.e., the ability of the speakers accurately to recreate the proper spacial location of the components of the audible signal.

A further problem inhering in the baffle mounting of speakers is the resultant reduction of the dispersion of the speakers and the introduction of polar lobe patterns.

A further distorting influence in multiple speaker systems employing baffles, the means conventionally employed for mounting the transducers, is the fact that frequently the woofer, mid-range and tweeter reproducers are mounted with their diaphragms in coplanar alignment or, worse, with the diaphragms of the mid-range and tweeter advanced in a plane closer to the listener than the diaphragm of the woofer.

Since the rise time of a permanent magnet speaker unit is a function largely of the mass and area of the diaphragm and voice coil assembly and the strength of the magnetic field, the rise time of a woofer, with its larger and heavier diaphragm, is nearly always greater than that of the mid-range reproducer which, for the same reasons, is typically greater than that of the tweeter or high frequency reproducer. It will be appreciated that coplanar baffle mounting of woofer, mid-range and tweeter introduces additional aberrations into the audible signal in that the transducer capable of responding most rapidly to an electrical audio signal is also disposed most closely to the ear of the listener. As a result, electrical signals in different frequency bands simultaneously impressed on different transducers and which are intended to reach the ear of a listener at a given instant of time, will be received at different instants of time, which different instants will be separated not only by the inherent rise time differences of the transducers but, in addition, by the fact that the tweeter may be mounted forwardly and, hence, more closely to the ear of the listener than the diaphragm of the woofer.

The reproduction of a complex acoustical wave form, such as a pulse, square wave, requires that the low frequency and high frequency signal components be superimposed with specified amplitude in the specified time sequence. Otherwise, in the absence of synchromization, a wave form will be produced which has the same frequency spectrum as the original signal but different wave shape.

There is shown in FIG. **2** a loud speaker assembly **15** in accordance with the invention. The assembly **15** includes a woofer enclosure portion **16** of conventional design, and may be of the bass reflex, infinite baffle, air suspension or, preferably, so-called transmission line type.

The woofer enclosure includes a base or bottom wall **17,** side walls **18, 19,** rearwardly angled back wall portions **20, 21,** a rear wall **22** and a top wall **23.** It will be appreciated that the shape of the woofer enclosure **16** is not critical. A woofer member **24** is mounted in standard fashion to the front wall **25** of the woofer enclosure.

The speaker assembly includes a plurality of additional transducers **26, 27, 28, 29,** respectively for reproducing mid-range, upper mid-range, high frequency and ultra high frequency bands. It will be appreciated that four additional transducers need not be employed, the use of two normally being adequate for full coverage of the audible spectrum.

As is conventional, a frequency divider network **30** is provided, functioning in the usual fashion to divide the input signals into various band widths, the outputs of the frequency divider network **30** being led to the appropriate transducers **24, 26, 27, 28, 29** designed to reproduce such band width.

Critical to the improved operation of the instant system is the free-air mounting of the transducers **26** to **29.** The term "free space mounting" is intended to connote a condition in which the transducers **26** to **29** are structurally supported to the loud speaker assembly with the support means incorporating a minimum of area, and particularly of area facing in the direction of the listener. Obviously, in order to secure the transducers **26** to **29** at a predetermined location within the speaker assembly, some physical support is necessary. Hence the term "free space mounted" describes an ideal but theoretical condition.

In the embodiment of FIG. **2,** the transducers **26** to **29** are supported upon struts **26′, 27′, 28′** and **29′,** respectively, which struts present, in the direction of the listening axis, a minimum of surface area.

Optionally and preferably, the side faces of the struts **26′** to **29′** and the outer surface of the top wall **23** of

the woofer enclosure are padded with sound absorptive materials to minimize reflection.

For appearance purposes, the speaker assembly is provided with an acoustically transparent frame **31** extending along the sides **18, 19** of the woofer enclosure and a distance thereabove, the frame including a top stretcher member **32.** An acoustically transparent but optically opaque grille cloth **33** is stretched over the entire front face of the assembly and over at least the rear face portions of the assembly above the woofer enclosure.

The areas within the frame but external of the woofer enclosure are preferably free from sound reflecting surfaces and, accordingly, if the frame components are formed of solid materials, such as wood or the like, the portions of such frame components are preferably covered with sound absorbing materials.

It is desirable that no substantial reflecting surfaces be present within the portions of the assembly within the frame but external of the woofer enclosure.

Optionally, the speaker assembly may be provided with an acoustically semi-transparent blanket to be disposed rearwardly of the transducers in order that backward radiation from the speakers **26** to **29** is somewhat reduced, so that if the speaker assembly is placed adjacent or in proximate relation to a wall in the listening room, rearward radiation will be reduced as compared to forward radiation.

As best appreciated from an inspection of FIGS. **3** and **4,** the positions of the speakers are offset from one another in the direction of the listening axis, with the woofer **24** being disposed forwardly of the mid-range speaker **26,** which is in turn disposed forwardly as respects upper-mid-range driver **27,** which is in turn disposed forwardly of tweeter **28,** which is in turn disposed forwardly of super tweeter **29.**

The condition thus schematically illustrated is intended to show the manner of disposing the transducers in accordance with their rise time characteristics. While the illustrations herein are intended to be schematic only, it should be appreciated that the spacing X′ (FIG. **3**) between the major radiating surface of the mid-range transducer **26** and the woofer **24** is calculated as a function of the rise time characteristics of the respective transducers, such as to "handicap" the woofer, in this instance, with its slower rise time in such manner that a signal simultaneously impressed on the terminals of the woofer **24** and mid-range transducer **26** will reach the ear of a listener essentially simultaneously.

In similar fashion, transducer **27,** having a more rapid rise time than transducer **26,** is displaced rearwardly of the transducer **26** a distance X″; transducer **28** rearwardly of transducer **27** a distance X‴, and transducer **29** rearwardly of transducer **28** a distance X⁗, such that each of the transducers is appropriately "handicapped" in accordance with its rise time characteristics.

It will be understood that the rise time characteristics of the transducers and, accordingly, their forward and rearward positioning within the assembly, may be calculated or experimentally determined in known manner. However, a convenient empirical manner of positioning the transducers involves feeding to a pair of transducers intended to cover adjacent frequency bands, a square wave which spans the frequency bands, and observing the reproduced sound on an oscilloscope. The higher frequency transducer is then adjusted forwardly or rearwardly relative to the top wall portion **23** until the square wave form picked up at a microphone equidistant from the speaker axes and observed on the oscilloscope is as near perfect as possible.

Once the position of the transducers is established, for instance transducer **26** relative to the woofer **24,** the process is repeated, using a square wave covered by transducers **26** and **27,** to establish the proper positioning of the transducer **27.** The process is repeated to establish the correct positioning of the remaining transducers.

Normally, in production, the transducer units will be sufficiently constant in their rise time characteristics to permit the establishment of a selected spacing, without requiring individual testing of each unit, although individual testing is desirable for optimum performance.

In the square wave testing procedures, it is desirable to pass the square wave signal through the frequency dividing network since conventional networks may, to a degree, introduce time lag and phase shift effects.

It is recognized that the forward and rearward placement of transducers within the enclosure is effective principally in on-axis listening and that listening at a position remote from the axes of the transducers may involve the introduction of rise time errors, due to greater proximity to one than to the other of the transducers. No design, however, can completely compensate for rise time changes, it being the intention of the described forward and rearward orientation to optimize on-axis listening.

Three or more decorative leg members **34** are preferably fixed to the under surface of the speaker assembly **15.**

In the embodiment of FIGS. **5** and **6,** wherein like parts have been given like numbers, it will be observed that the woofer **24** is, in this instance, mounted within a generally rectangular enclosure, to the upper surface **40** of which there has been affixed a tree-like transducer support **41.**

The transducer support **41** is notched to define recessed transducer receiver faces **42, 43** and **44,** for receiving the midrange, tweeter and super tweeter transducers **26, 28** and **29,** respectively.

It will be appreciated that in this embodiment the forward and rearward positioning of the transducers is preset in the fabrication of the tree **41,** in accordance with the rise time characteristics of the transducers.

As with the prior described embodiment, the area **45** designates an acoustically transparent frame, dome or envelope above the woofer enclosure, the acoustical transparency being present in the front, sides, top, and preferably, at least to a limited degree, the rear surfaces of the dome or frame. Additionally, solid surfaces within the dome or frame, such as the upper face of the upper wall **40** of the woofer enclosure and the edges of the strut support **41,** are provided with a covering of acoustically absorbent material.

From the foregoing it will be observed that there is provided in accordance with the present invention, a multiple transducer loud speaker assembly wherein several of the major deficiencies observed in dynamic loud speaker assemblies heretofore known have been eliminated.

It will be understood that the lower frequency limit selected for the free-space mounted transducers pro-

ducing the lowest frequency tones may be set at any frequency sufficiently high to avoid cancellation effects. Normally the frequency reproduced by a free-space mounted transducer should not be below about 400 to 500 Hz.

Listening to the speaker fabricated in accordance with the present invention, and particularly an on-axis listening, is characterized by an unusual and unique clarity and definition in the mid, upper mid and treble ranges particularly, making the speaker reminiscent of the finest electrostatic loud speakers, without the beaming or directivity inherent in such electrostatic speakers in the higher frequency ranges. The loud speaker assembly exhibits a freedom from coloration which is readily apparent when compared to a control speaker assembly consisting of the same transducers and frequency dividing network mounted on a baffle, whether or not the baffle forms a part of an enclosure.

Numerous variations in constructional details may readily suggest themselves to skilled workers in the art in the light of the instant disclosure. Accordingly, the invention is not to be construed as limited to the specific embodiments illustrated and described herein but, rather, should be broadly construed within the scope of the appended claims.

Having thus described the invention and illustrated its use, what is claimed as new and is desired to be secured by Letters Patent is:

1. A multiple transducer dynamic loudspeaker assembly comprising, in combination, a frame including an acoustically transparent front face, an enclosure within said frame, a bass radiator transducer mounted within said enclosure, strut means mounted within said frame and extending externally of said enclosure, said strut means presenting minimal area in the direction of said front face of said frame, at least two additional direct radiator dynamic transducer members positioned within said frame externally of said enclosure, said at least two transducers being supported solely by said strut means and being, with the exception of the connection to said strut means, completely surrounded by free space, the area within said frame and rearward of said at least two transducers being substantially free of sound reflective surfaces facing the front of said speaker, and a frequency dividing network means for dividing the electrical signals fed to said loudspeaker assembly into at least three discrete frequency bands, and applying an appropriate said band to each said transducer.

2. The loudspeaker assembly in accordance with claim 1 wherein portions of said frame external of said enclosure are substantially acoustically transparent.

3. The loudspeaker assembly in accordance with claim 2 wherein said rear face of said external frame portion is of lesser acoustic transparency than said front face.

4. The loudspeaker assembly in accordance with claim 1 wherein the radiating axes of said transducers are substantially parallel and the radiating surfaces of said transducers are displaced one from the other along said axes in accordance with the rise time characteristics of said transducers a distance whereby the sound wave generated by each of said transducers responsive to an electrical signal simultaneously impressed upon said transducers will simultaneously reach a listener in front of and equi-distant from the axes of said transducers.

5. A loudspeaker assembly in accordance with claim 1 wherein the radiating axes of said transducers are disposed in substantial parallel alignment and are directed toward a listening area forwardly of said front face of said assembly, the radiating diaphragms of said transducers being displaced one from another in inverse relation to the relative rise time characteristics of the transducers whereby the transducer having a longer rise time will be disposed closer to said area, with the diaphragm of each transducer having a longer rise time than another transducer closer to a point within said listening area equi-distant from said diaphragms than each other transducer having a shorter rise time.

* * * * *