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Description

This invention relates to loudspeakers and in particular to compound loudspeaker drive units in which separate diaphragms are provided for reproduction of the low and high audio frequencies.

In some known loudspeaker systems, separate loudspeaker drive units are provided for reproduction of bands of audio frequencies, for example a woofer unit for reproduction of sounds in a low frequency band and a tweeter unit for reproduction of sounds in a high frequency band. The voice coils of the loudspeaker drive units are connected to the output of a power amplifier, or other source, through a suitable cross-over filter network which ensures that only electrical signals representing sounds in the appropriate bands are applied to the individual loudspeaker voice coils. The characteristic of the cross-over filter is arranged so that in a mid frequency cross-over band intermediate the low and high frequency bands the outputs of the two loudspeaker drive units tail off; the output of the low frequency loudspeaker drive unit reduces with increase of frequency while the output of the high frequency loudspeaker drive unit reduces with decrease in frequency. At a so-called crossover frequency the low and high frequency loudspeaker drive units have outputs which are equal but reduced in comparison with their outputs within their respective frequency bands. The electrical energisations of the respective voice coils are adjusted so that the sound outputs of the loudspeaker drive units are relatively matched and together provide a substantially uniform output over the total frequency range of the combination of the two loudspeaker drive units. The sound radiated from each of the drive units may be said to emanate from the apparent sound source or acoustic centre of that unit; the position of the acoustic centre is a function of the design of the particular unit and may be determined by acoustic measurement.

When separate loudspeaker drive units are provided, the apparent sound sources are physically offset from one another. The loudspeaker drive units are usually mounted on a common baffle such that they lie in a common plane and are offset in a vertical direction in the plane of the baffle. For a listener positioned approximately in line with the axes of the loudspeaker drive units and approximately equidistant from the acoustic centres of both drive units, a desired balance of output from the two drive units can be obtained. However if the position of the listener is moved from the equidistant position, the distances between the listener and the acoustic centres of the two loudspeaker drive units will be different and hence sounds in the mid frequency band produced by both loudspeakers will be received by the listener from the two drive units with a difference in time. This time difference between sounds received from the

two drive units results in a change in phase relationship of the sounds received at the listening position from the two drive units. The sounds from the two drive units no longer add together as intended in the cross-over band. Consequently the resultant received sound levels will vary with frequency and the overall sound output of the loudspeaker combination will appear to the listener to be non-uniform. The resulting raggedness in sound output colours the sound and, with stereo sound systems, there is a loss of clarity in the apparent location of instruments in the sound stage. This is particularly apparent in respect of sound frequencies in the upper mid-range, for example in the region of 3kHz, at which the offset of the drive units relative to one another is comparable to the wavelength of the sound. At a frequency of 3kHz the wavelength is approximately 4 inches or 100 cm.

In an attempt to overcome the undesirable effects on sounds received at positions which are not equidistant from the two loudspeaker drive units, it is known to combine the low and high frequency loudspeaker drive units in a single compound co-axial construction. The compound co-axial loudspeaker drive unit consists of a generally conical low frequency diaphragm driven by a voice coil interacting with a magnetic structure having a central pole extending through the voice coil. A high frequency diaphragm is positioned to the rear of the structure and sound output from this diaphragm is directed to the front of the loudspeaker drive unit by means of a horn structure extending co-axially through the centre pole of the magnetic structure which interacts with the low frequency diaphragm. Thus both the low frequency and high frequency sounds are directed in a generally forward direction from the compound loudspeaker drive unit. In this co-axial form of loudspeaker construction there is no vertical or horizontal offset of the apparent sound sources for low and high frequencies. However the low frequency diaphragm is positioned at the front of the loudspeaker unit whereas the high frequency diaphragm is positioned at the rear of the loudspeaker unit and this results in relative displacement of the apparent sound sources in the direction of the axis of the drive unit and an undesirable time difference in the arrival, at the listener, of sounds from the high and low frequency diaphragms.

FR A-1 001 734 discloses a compound loudspeaker drive unit comprising a low frequency conical diaphragm flaring outwardly from a neck of the diaphragm with a voice coil secured to the neck of the diaphragm and a high frequency domed diaphragm located in the neck of the low frequency diaphragm. The drive unit includes a common magnetic structure having two concentric air gaps in which the voice coils of the low and high frequency diaphragms respectively extend. The whole of the magnetic flux for the air gap in which the voice coil of the high frequency diaphragm moves also passes through the air gap for the

low frequency voice coil.

The use of a common magnetic structure makes it difficult to independently control the magnitude of flux interacting with each of the voice coils and it requires that the loudspeaker drive unit be manufactured as a single complex unit instead of being capable of being manufactured as two independent separate relatively simple units which subsequently are assembled together.

GB A-2 153 628 discloses a construction of compound loudspeaker drive unit including a low frequency diaphragm and a domed high frequency diaphragm located in a central opening in the low frequency diaphragm. The low frequency diaphragm is flat or of conical or domed form extending rearwardly from the central opening thereof to avoid diffraction or tunnel effects upon the high frequency diaphragm so that the high frequency diaphragm is permitted to operate as a direct radiator. An air gap for a voice coil secured to the low frequency diaphragm is formed between an outer pole piece and a central pole piece. A magnet is located in an aperture in the end of the central pole piece and a plate on the magnet forms, with the end of the central pole piece, an air gap for a voice coil secured to the domed high frequency diaphragm.

According to the invention a compound loudspeaker drive unit including a low frequency conical first diaphragm flaring outwardly and forwardly from a neck of said diaphragm to generate sounds in a low frequency range; a first voice coil secured to said neck of said conical diaphragm;

a high frequency second diaphragm of domed form to generate sounds in a high frequency range; a second voice coil secured to a peripheral edge of said high frequency diaphragm; said high frequency diaphragm being located in or adjacent to the neck of the conical diaphragm;

and magnetic means including first and second air gaps in which said first and second voice coils respectively extend, said magnetic means producing a first magnetic flux in said first air gap interacting with said first voice coil and a second magnetic flux in said second air gap interacting with said second voice coil; the magnetic means including a first magnetic structure and a first permanent magnet producing the first magnetic flux in a first magnetic flux path in said first magnetic structure and in the first air gap;

is characterised in that

said low frequency diaphragm and said high frequency diaphragm are adapted to generate said low and high frequency ranges of sound overlapping in a cross-over region and both said diaphragms are adapted to make significant contributions to sound output in said cross-over region;

in that the magnetic means further includes a second magnetic structure and a second permanent magnet producing the second magnetic flux in a second magnetic flux path in said second magnetic structure and

in said second air gap, said second magnetic flux path being separate from said first magnetic flux path;

and in that said second permanent magnet is formed of a material having magnetic properties similar or superior to those of a neodymium iron boron compound so that for a required magnitude of magnetic flux in the second air gap the second magnetic structure is of the same size as or smaller size than a magnetic structure having a neodymium iron boron magnet and the second magnetic structure is of sufficiently small size to be accommodated within the first voice coil adjacent the neck of the first diaphragm in such a position that effective acoustic centres of the first and second diaphragms are coincident and that in the cross-over region the flaring of the conical first diaphragm imposes a directivity upon the radiation of sound from the second diaphragm to cause the directivities of the first and second diaphragms to be matched over frequencies in the cross-over region where both diaphragms make significant contributions to the sound output of the drive unit.

An embodiment of the invention will now be described by way of example with reference to the drawing which shows a cross section through the axis of a moving coil compound loudspeaker drive unit.

Referring to the drawing, a compound loudspeaker drive unit with low frequency and high frequency transducers having co-axial low and high frequency voice coils comprises a chassis 10 in the form of a conical basket having a front annular rim 11 connected to a rear annular member 12 by means of a number of ribs 13. The rear annular member 12 has an annular flange 14 and an annular seat 15. Secured to the flange 14 is a first magnetic structure 16 for the low frequency loudspeaker drive unit. The magnetic structure 16 comprises a magnet ring 17, which may for example be formed of barium ferrite, a front annular plate 18 which forms an outer pole and a member 19 which forms a backplate and inner pole 20. The plate 18, magnet ring 17 and member 19 are held together to provide a magnetic path interrupted by a non-magnetic air gap between the outer pole 18 and the inner pole 20. The poles are circular and form therebetween an annular air gap. The low frequency transducer or loudspeaker drive unit comprises a diaphragm 21 of generally frusto-conical form supported along the front outer edge thereof by a flexible surround 22 secured to the front rim 11 of the chassis 10. A tubular coil former 23 is secured to the rear edge of the diaphragm 21 and is arranged to extend co-axially of the air gap in the magnetic structure 16. The coil former carries a voice coil 24 positioned on the former such that the coil extends through the air gap. The coil is of sufficient axial length as to ensure that for normal excursions of the voice coil, the poles always lie within the length of the voice coil. A suspension member 25, in the form of a spider consisting of inner and outer

rings interconnected by flexible legs or consisting of a corrugated sheet having annular corrugations, is secured between the coil former 23 and the annular seat 15 of the chassis 10 in order to ensure that the coil former, and voice coil carried thereby, are maintained concentric with the poles of the magnetic structure and out of physical contact with the poles during sound producing excursions of the diaphragm 21. The backplate and inner pole member 19 has a bore 26 extending co-axially thereof for the purpose of mounting a high frequency drive unit 27.

The high frequency transducer or drive unit 27 comprises a second magnetic structure consisting of a pot 28, a disc shaped magnet 29 and a disc shaped inner pole 30. The pot 28 has a cylindrical outer surface so dimensioned as to fit within the interior of the coil former 23 without making physical contact therewith. The pot is formed with a circular recess 31 to receive the magnet 29 and an annular lip 32 to form an outer pole. One circular pole face of the magnet 29 is held in engagement with the bottom wall of the recess 31 and the disc shaped inner pole 30 is held in engagement with the other circular pole face of the magnet such that the circular outer periphery of the inner pole 30 lies co-axially with and within the lip 32 forming the outer pole. A non-magnetic air gap extends between the inner and outer poles. A spacer ring 33 is secured to the front face of the pot 28. Preferably the magnet 29 is formed of neodymium iron boron which allows a very substantially enhanced magnetic field strength as compared with other available magnetic materials to be attained in the air gap between the poles. As a result, the overall size of the high frequency magnetic structure, for a required flux in the air gap, can be smaller than hitherto thereby allowing the high frequency drive unit to be positioned within the coil former of the low frequency drive unit immediately adjacent to the apex of the low frequency diaphragm 21. However it will be appreciated that the magnet 29 may be formed of other materials having magnetic properties substantially similar or superior to that of neodymium iron boron. A high frequency domed diaphragm 34 has an annular support 35 of annular corrugated form and this support is secured at its outer periphery to the spacer ring 33. Secured to the domed diaphragm 34 is a cylindrical coil former carrying a high frequency voice coil 36 such that the voice coil extends through the air gap between the poles 30, 32 of the magnetic structure.

In order to centralise the high frequency unit relative to the low frequency unit, and in particular to ensure that the high frequency unit is coaxial with and does not interfere with motion of the low frequency voice coil a rod 37, preferably of non-magnetic material, is secured centrally to the rear face of the pot 28 and extends through the bore 26 of the low frequency magnetic structure. The high frequency drive unit tends to be held in engagement with the pole 20 of the

magnetic structure 16 by magnetic attraction therebetween but is secured to the structure 16 by a threaded end portion 38 of the rod 37 extending through an aperture in a plate 39 positioned at the rear of the backplate 19 and a nut 40 threaded onto the end portion 38.

Connections to the low frequency voice coil 24 are provided by means of flexible leadout conductors 41 extending from the voice coil 24 to external connectors 42. Connections to the high frequency voice coil 36 are provided by flexible conductors 43 which extend along a recess in the outer wall of the pot 30, between the pot 30 and the inner pole 20 and thence through the bore 26 to external connectors (not shown). In order to allow the conductors to extend through the bore 26, the rod 37 has a diameter smaller than that of the bore 26 so as to leave an annular space through which the conductors 43 extend. Means, not shown, are provided between the pole piece 20 and the pot 28 to ensure that the rod lies co-axially with the bore 26. This means may be a disc secured to the pole piece 20 and having a central aperture of a diameter to receive the rod 37 in a sliding fit. The disc may be grooved to provide a passageway for the conductors 43 between the pole piece 20 and the pot 28. The rod 37 may be of circular, hexagonal or other section and the disc would be provided with a central aperture of matching shape.

Instead of utilising a rod 37 of diameter smaller than that of the bore 26, if the rod is of hexagonal section its diameter may be of a size such that the rod is a sliding fit in the bore 26 to locate the high frequency drive unit co-axially of the pole piece 20 of the low frequency drive unit. Spaces between the faces of the hexagonal section rod and the wall of the bore 26 provide passageways for the conductors 43. Instead of using a plate 39 to secure the high frequency drive unit, a moulding may be used. The moulding would be located by means of a boss on the moulding entering the bore 26. The moulding may be so formed as to provide a mounting for other components such as the electronic components of a cross-over filter and terminals for electrical drive signals for the compound loudspeaker drive unit. As an alternative to the end 38 of the rod 37 being externally threaded, the end of the rod may be bored and threaded internally to receive a screw.

The construction described hereinbefore is particularly convenient in manufacture of the compound loudspeaker drive unit in that the high frequency drive unit is centralised relative to the low frequency drive unit prior to the high frequency drive unit reaching its final rest position on the pole piece 20. As a result the high frequency unit is prevented from engaging the low frequency voice coil during assembly of the compound loudspeaker drive unit. Furthermore this construction facilitates dis-assembly of the high frequency drive unit from the low frequency drive unit if and

when any servicing of the units is necessitated without any need to demagnetise either of the magnetic assemblies.

If desired, an annular baffle 44 having a frusto-conical front surface is secured to the front of the high frequency drive unit to provide a continuation of the surface of the low frequency diaphragm 21 towards the domed high frequency diaphragm.

It will be appreciated that with the high frequency drive unit positioned at or adjacent to the neck of the diaphragm of the low frequency drive unit, as in the above described construction of compound loudspeaker drive unit, the apparent sound source or acoustic centre of the high frequency drive unit is substantially co-incident with the apparent sound source or acoustic centre of the low frequency drive unit. The radiation pattern or directivity of the low frequency drive unit is determined *inter alia* by the form of the low frequency diaphragm. With the high frequency drive unit positioned adjacent to the neck of the low frequency diaphragm, the form of the low frequency diaphragm imposes its directivity upon the radiation pattern or directivity of the high frequency unit. Consequently at frequencies at which both drive units contribute significant sound output, both drive units have substantially similar patterns of radiation or directivity. As a result the relative sound contributions from the two drive units as perceived by a listener are substantially unaffected by the listener being positioned at off axis positions.

The low frequency conical diaphragm is shown in the drawing as being of conical form having an angle of flare which increases from the neck of the diaphragm toward the outer periphery of the diaphragm. However it will be appreciated that the diaphragm may be of conical form having a uniform angle of flare. Also, the low frequency conical diaphragm may be of circular, elliptical or other section as desired.

The high frequency diaphragm is shown in the drawing as being of domed form. Such a diaphragm is suitable because its acoustic centre may readily be located in close coincidence with that of the low frequency diaphragm, and because, in the frequency range where both drive units contribute significant sound output, its small size relative to wavelength gives it, by itself, essentially non-directional sound radiation, allowing the effective directivity to be determined by the low frequency diaphragm. It will be appreciated that the high frequency diaphragm may alternatively be of any other form that provides these characteristics.

Claims

1. A compound loudspeaker drive unit including a low frequency conical first diaphragm (21) flaring outwardly and forwardly from a neck of said dia-

phragm to generate sounds in a low frequency range; a first voice coil (24) secured to said neck of said conical diaphragm;

a high frequency second diaphragm (34) of domed form to generate sounds in a high frequency range; a second voice coil (36) secured to a peripheral edge of said high frequency diaphragm; said high frequency diaphragm being located in or adjacent to the neck of the conical diaphragm (21);

and magnetic means (17, 18, 19, 20, 28, 29, 30, 32) including first and second air gaps in which said first and second voice coils respectively extend, said magnetic means producing a first magnetic flux in said first air gap interacting with said first voice coil and a second magnetic flux in said second air gap interacting with said second voice coil;

the magnetic means including a first magnetic structure (17, 18, 19, 20) and a first permanent magnet (17) producing the first magnetic flux in a first magnetic flux path in said first magnetic structure and in the first air gap; characterised in that

said low frequency diaphragm (21) and said high frequency diaphragm (34) are adapted to generate said low and high frequency ranges of sound overlapping in a cross-over region and both said diaphragms are adapted to make significant contributions to sound output in said cross-over region;

in that the magnetic means further includes a second magnetic structure (28, 29, 30, 32) and a second permanent magnet (29) producing the second magnetic flux in a second magnetic flux path in said second magnetic structure and in said second air gap, said second magnetic flux path being separate from said first magnetic flux path;

and in that said second permanent magnet (29) is formed of a material having magnetic properties similar or superior to those of a neodymium iron boron compound so that for a required magnitude of magnetic flux in the second air gap the second magnetic structure is of the same size as or smaller size than a magnetic structure having a neodymium iron boron magnet and the second magnetic structure is of sufficiently small size to be accommodated within the first voice coil (24) adjacent the neck of the first diaphragm (21) in such a position that effective acoustic centres of the first and second diaphragms are coincident and that in the cross-over region the flaring of the conical first diaphragm (21) imposes a directivity upon the radiation of sound from the second diaphragm (34) to cause the directivities of the first and second diaphragms to be matched over frequencies in the cross-over region where both dia-

phragms make significant contributions to the sound output of the drive unit.

2. A compound loudspeaker drive unit as claimed in claim 1 further characterised in that the second permanent magnet (29) is formed of neodymium iron boron. 5
3. A compound loudspeaker drive unit as claimed in claim 1 or 2 further characterised in that the first diaphragm (21) flares outwardly with a progressively increasing angle of flare from the neck to a front peripheral edge of the diaphragm. 10
4. A compound loudspeaker drive unit as claimed in any preceding claim further characterised in that the low frequency voice coil (24) is carried by a coil former (23) secured to the neck of the low frequency conical diaphragm (21), that the low frequency voice coil (24) is spaced rearwardly from the neck of the low frequency conical diaphragm (21) and that the second magnetic structure (28, 29, 30, 32) is disposed within the coil former (23) intermediate the neck and the low frequency voice coil. 15
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5. A compound loudspeaker drive unit as claimed in any preceding claim further characterised in that the first magnetic structure (17, 18, 19, 20) and the first diaphragm (21) form a first manufactured unit; in that the second magnetic structure (28, 29, 30, 32) and the second diaphragm (27) form a second manufactured unit separate from said first manufactured unit; in that the first magnetic structure includes a central pole piece (20) with a central bore (26) extending axially therethrough and that said second magnetic structure (28, 29, 30, 32) includes a rod (37) of non-magnetic material extending rearwardly to enter said bore (26) and thereby locate said second magnetic structure relative to said first magnetic structure. 30
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6. A compound loudspeaker drive unit as claimed in claim 5 further characterised in that the second magnetic structure (28, 29, 30, 32) is secured to a front end face of the central pole piece (20) of the first unit. 45
7. A compound loudspeaker drive unit as claimed in claim 5 or 6 further characterised in that conductors (43) providing electrical connections to the second voice coil (36) extend through the central bore between a wall of the central bore (26) and the rod (37). 50
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Patentansprüche

1. Lautsprecherkombinationseinheit, mit einer konischen ersten Membrane (21) für tiefe Frequenzen, die sich von einem Halsabschnitt der Membrane aus nach aussen und vorn erweitert, zum Erzeugen von Schall in einem tiefen Frequenzbereich; mit einer am Halsabschnitt der konischen Membrane befestigten ersten Schwingspule (24); mit einer kalottenförmigen zweiten Membrane (34) für hohe Frequenzen, zum Erzeugen von Schall in einem hohen Frequenzbereich; mit einer zweiten Schwingspule (36), die an einem Umfangsrand der Membrane für hohe Frequenzen befestigt ist; wobei die Membrane für hohe Frequenzen in oder bei dem Halsabschnitt der konischen Membrane (21) angeordnet ist; und mit Magnetmitteln (17, 18, 19, 20, 28, 29, 30, 32) mit einem ersten und einem zweiten Luftspalt, in welche sich die erste bzw. die zweite Schwingspule erstrecken, welche Magnetmittel im ersten Luftspalt einen ersten, mit der ersten Schwingspule zusammenwirkenden Magnetfluss und im zweiten Luftspalt einen zweiten, mit der zweiten Schwingspule zusammenwirkenden Magnetfluss erzeugen und welche Magnetmittel eine erste Magnetstruktur (17, 18, 19, 20) mit einem ersten Permanentmagnet (17) enthalten, der den ersten Magnetfluss in einem ersten Magnetflussweg durch die erste Magnetstruktur und den ersten Luftspalt erzeugt; dadurch gekennzeichnet, dass die Membrane (21) für tiefe Frequenzen und die Membrane (34) für hohe Frequenzen dazu ausgelegt sind, den tiefen und den hohen Schallfrequenzbereich sich in einem Uebergangsbereich überlappend zu erzeugen, wobei beide Membranen im Uebergangsbereich signifikante Beiträge zum erzeugten Schall liefern; dass die Magnetmittel ferner eine zweite Magnetstruktur (28, 29, 30, 32) mit einem zweiten Permanentmagnet (29) enthalten, der den zweiten Magnetfluss in einem zweiten Magnetflussweg durch die zweite Magnetstruktur und den zweiten Luftspalt erzeugt, wobei der zweite Magnetflussweg vom ersten Magnetflussweg getrennt ist; und dass der zweite Permanentmagnet (29) aus einem Material besteht, dessen magnetische Eigenschaften denjenigen einer Neodym-Eisen-Bor-Verbindung gleichwertig oder überlegen sind, so dass für eine erforderliche Grösse des Magnetflusses im zweiten Luftspalt die zweite Magnetstruktur die gleiche Grösse oder eine kleinere Grösse als eine Magnetstruktur mit einem Neodym-Eisen-Bor-Magnet hat und die zweite Magnetstruktur genügend klein ist, um innerhalb der ersten Schwingspule (24) benachbart zum Halsabschnitt der ersten Membrane (21) in einer solchen Stellung aufgenommen zu

- werden, dass die effektiven akustischen Zentren der ersten und der zweiten Membrane zusammenfallen und dass im Uebergangsbereich die sich erweiternde Form der konischen ersten Membrane (21) auf die Schallabstrahlung von der zweiten Membrane (34) eine Richtwirkung ausübt, wodurch die Richteigenschaften der ersten und der zweiten Membrane bei Frequenzen im Uebergangsbereich, wo beide Membranen signifikante Beiträge zum von der Kombinationseinheit abgegebenen Schall liefern, aneinander angepasst sind.
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- 5, dadurch gekennzeichnet, dass die zweite Magnetstruktur (28, 29, 30, 32) an einer vorderen Stirnfläche des zentralen Polstücks (20) der ersten Magnetstruktur befestigt ist.
7. Lautsprecherkombinationseinheit nach Anspruch 5 oder 6, dadurch gekennzeichnet, dass Leiter (43), welche elektrische Verbindungen mit der zweiten Schwingspule (36) herstellen, sich zwischen einer Wand der zentralen Bohrung (26) und dem Stab (37) durch die zentrale Bohrung erstrecken.
- Revendications**
1. Dispositif d'excitation pour haut-parleur composé comprenant un premier diaphragme conique à basse fréquence (21) s'évasant vers l'extérieur et vers l'avant à partir d'un col du diaphragme pour engendrer des sons dans une gamme de basse fréquence; une première bobine mobile (24) fixée au col du diaphragme conique; un second diaphragme à haute fréquence (34) de forme bombée destiné à engendrer des sons dans une gamme de haute fréquence; une seconde bobine mobile (36) fixée à un bord périphérique du diaphragme à haute fréquence; le diaphragme à haute fréquence étant installé dans le col ou à proximité du col du diaphragme conique (21); et des moyens magnétiques (17, 18, 19, 20, 28, 29, 30, 32) comprenant un premier et un second entrefers dans lesquels la première et la seconde bobines mobiles s'étendent respectivement, les moyens magnétiques produisant un premier flux magnétique dans le premier entrefer interagissant avec la première bobine mobile et un second flux magnétique dans le second entrefer interagissant avec la seconde bobine mobile; les moyens magnétiques comprenant une première structure magnétique (17, 18, 19, 20) et un premier aimant permanent (17) produisant le premier flux magnétique dans un premier trajet de flux magnétique dans la première structure magnétique et dans le premier entrefer; caractérisé en ce que le diaphragme à basse fréquence (21) et le diaphragme à haute fréquence (34) sont à même d'engendrer les gammes sonores de basse et haute fréquences qui se chevauchent dans une région de chevauchement et les deux diaphragmes sont à même d'apporter des contributions significatives à la production sonore dans la région de chevauchement; que les moyens magnétiques comprennent, en outre, une seconde structure magnétique (28, 29, 30, 32) et un second aimant permanent (29) produisant le second flux magnétique dans un second trajet de flux magnétique dans la seconde structure ma-

- gnétique et dans le second entrefer, le second trajet de flux magnétique étant séparé du premier trajet de flux magnétique; et que le second aimant permanent (29) est formé d'une matière ayant des propriétés magnétiques semblables ou supérieures à celles d'un composé néodyme fer bore, de sorte qu'en vue d'une amplitude requise de flux magnétique dans le second entrefer, la seconde structure magnétique est d'une taille égale ou inférieure à celle d'une structure magnétique comportant un aimant en néodyme fer bore et la seconde structure magnétique est d'une taille suffisamment petite pour pouvoir être logée dans la première bobine mobile (24) à proximité du col du premier diaphragme (21) dans une position telle que les centres acoustiques efficaces du premier et du second diaphragmes coïncident et que dans la région de chevauchement, l'évasement du premier diaphragme conique (21) impose une directivité sur le rayonnement du son provenant du second diaphragme (34) afin de faire en sorte que les directivités du premier et du second diaphragmes soient concordantes sur des fréquences situées dans la région de chevauchement où les deux diaphragmes apportent des contributions significatives à la production sonore de l'unité d'excitation.
2. Unité d'excitation pour haut-parleur composé suivant la revendication 1, caractérisée, en outre, en ce que le second aimant permanent (29) est en néodyme fer bore.
3. Unité d'excitation pour haut-parleur composé suivant la revendication 1 ou 2, caractérisée, en outre, en ce que le premier diaphragme (21) s'évase vers l'extérieur sous un angle d'évasement progressivement croissant depuis le col jusqu'à un bord périphérique extérieur du diaphragme.
4. Unité d'excitation pour haut-parleur composé suivant l'une quelconque des revendications précédentes, caractérisée, en outre, en ce que la bobine mobile à basse fréquence (24) est supportée par une armature de bobine (23) fixée au col du diaphragme conique à basse fréquence (21), que la bobine mobile à basse fréquence (24) est espacée vers l'arrière du col du diaphragme conique à basse fréquence (21) et que la seconde structure magnétique (28, 29, 30, 32) est disposée dans l'armature de bobine (23) entre le col et la bobine mobile à basse fréquence.
5. Unité d'excitation pour haut-parleur composé suivant l'une quelconque des revendications précédentes, caractérisée, en outre, en ce que la première structure magnétique (17, 18, 19, 20) et le premier diaphragme (21) forment une première unité manufacturée; que la seconde structure magnétique (28, 29, 30, 32) et le second diaphragme (27) forment une seconde unité manufacturée séparée de la première; que la première structure magnétique comprend une pièce polaire centrale (20) présentant un alésage central (26) qui la traverse axialement de part en part et que la seconde structure magnétique (28, 29, 30, 32) comprend une broche (37) en matière non magnétique qui s'étend vers l'arrière dans l'alésage (26) et qui positionne ainsi la seconde structure magnétique par rapport à la première structure magnétique.
6. Unité d'excitation pour haut-parleur composé suivant la revendication 5, caractérisée, en outre, en ce que la seconde structure magnétique (28, 29, 30, 32) est fixée à une face d'extrémité avant de la pièce polaire centrale (20) de la première unité.
7. Unité d'excitation pour haut-parleur composé suivant la revendication 5 ou 6, caractérisée, en outre, en ce que des conducteurs (43) fournissant des connexions électriques à la seconde bobine mobile (36) s'étendent à travers l'alésage central entre une paroi de l'alésage central (26) et la broche (37).

