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(54) SELF-DAMPING SPEAKER MATCHING DEVICE AND METHOD

VERFAHREN UND VORRICHTUNG ZUR SELBSTDÄMPFENDEN LAUTSPRECHERANPASSUNG

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Description

TECHNICAL FIELD

The invention relates to loudspeakers, and in particular to a damping circuit for use in association with loudspeakers and, in particular,' to a self-damping crossover circuit for use in multi-speaker audio systems.

BACKGROUND ART

The problem of sound distortion in loudspeakers is well known. Generally it is detectable especially in the bass regions of sound reproduction as a form of "rumble", which muffles or masks the full purity of the bass tones. The problem also occurs in the mid-range and upper ranges of audio frequency reproduction, but is less noticeable to an untrained ear. This distortion is apparent in coil-driven loudspeaker systems having a single coil-driven loudspeaker, as well as those having a plurality of coil-driven loudspeakers. High fidelity audio loudspeaker systems usually comprise at least two and more often, three or more separate coil-driven speakers. These speakers will include a speaker to cover the high frequency high notes (tweeter) and a speaker to cover the low frequency bass notes (woofer), and in most cases, a speaker to cover the mid-range frequency notes (mid-range). In some cases there may be multiple speakers for each range. It is customary in such multi-speaker systems to provide one or more filter circuits known as "crossovers" in which the signals for the various ranges are separated so that they are reproduced in the appropriate speakers in the system. Such crossovers incorporate one or more crossover coils as part of the filter circuit. The precise causes of the type of distortion described above are not entirely clear, however, it seems reasonable to assume that one source is the collapsing of the magnetic fields created around the crossover coil during the passage of audio signals. As the magnetic fields collapse, they induce, within the coil, a secondary transient signal related to, but not part of, the primary audio signal. Some evidence is available for this theory in the well-known relationship between the strength of the primary signal and the strength of the distortion signal. Various attempts have been made to deal with the problem.

One recent proposal is shown in U.S. Letters Patent No. 4,160,133. In this Patent, the speaker itself is manufactured with an additional damping coil mounted directly on the speaker. The degree of effectiveness of this solution has not been evaluated, but it is certain that the cost of manufacturing speakers incorporating this proposal would be considerably higher than the manufacture of conventional speakers, and the efficiency of the speaker is adversely affected. Thus such a solution would be less than optimal for the consumer. Consequently, this proposal has not achieved wide acceptance.

In general terms, the present invention finds its application both to single speakers and to such crossover circuits so that a damping effect is provided over a part of the frequency ranges or indeed all of the frequency ranges to damp out distortion.

It is believed that a major cause of speaker distortion is in the design of the crossover circuits themselves. Such crossover circuits inherently incorporate some form of coils, of varying inductances, whereby signals may be divided up into groups or bands of selected wavelengths for reproduction in the different speakers. It is, of course, well known that the passing of electrical current wave forms through a coil will result in the development of transient electromagnetic fields around the coil itself. As the current fluctuates, so also does the induced electromagnetic field. The fluctuation of the induced electromagnetic field is believed to induce, in turn, a fluctuating voltage across the coil which is passed through the speaker coil producing a further unwanted movement and hence sound waves from the speaker. It is believed that this is a major cause of the distortions or so-called "rumble" which can be heard in speaker systems and this distortion is generally considered to be undesirable by the great majority of listeners.

It will of course be understood that in most of the speaker systems to which the invention relates, the speakers will be of the moving coil type. Such speakers inherently incorporate their own integral coil means. Such speaker coils will in themselves develop a back EMF, induced as the voice coil moves through the magnetic field of the permanent magnet which surrounds the voice coil. This factor is a "given" in almost all speaker systems, and may also be, in itself, a cause of distortion.

DISCLOSURE OF THE INVENTION

With a view to providing a damping circuit for improved performance of speaker systems of the type containing at least one speaker means having input and output connection means, the invention comprises a damping circuit means comprising matching coil means defining matching coil input and output connection means, with said matching coil output connection means connectable with said speaker input connection means, damping coil means defining damping coil input and output connection means, with said damping coil input connection means connectable to said speaker output connection means, and said matching and damping coil means being wound together on a common support with the turns of one coil alternating with the turns of the other coil, with their said input connection means adjacent one another and their said output connection means adjacent one another whereby currents will flow through said matching and damping coil means in the same direction and whereby transient signals in a respective first one of said matching and damping coils set up magnetic fields around the common support which fields then induce out of phase transient signals in the respective second of said matching and damping coils, said induced out of phase transient signals acting to reduce in strength, or damp, the initial transient signals.

The invention further comprises a method of damping audio signals in a speaker system, by passing the same through a damping circuit means, the damping circuit means having matching coil means and damping coil means, said matching and damping coil means each having a first coil end and a second coil end, and having respective input and output connection means, said matching coil means and damping coil means being woun together in the same direction about a common support and having said respective input connection means at coincident first coil end, and having said respective output connection means at respective coincident second coil end; said matching coil means and damping coil means being wound in a manner to provide unity coefficient of coupling between said matching and damping coil means, said matching coil connected in series with a coil driven speaker having input connection means and output connection means, with said matching coil output connection means being connected to the input connection means of the loudspeaker and, said damping coil means being connected in series with the same coil driven loudspeaker, and having speaker output connection means connected to damping coil input connection means in such a manner as to provide a continuous circuit between the matching coil input connection means and the damping coil output connection means, whereby currents will flow through said matching and damping coil means in the same direction whereby transient signals in a respective first one of said matching and damping coils set up magnetic fields which fields then induce out of phase transient signals in the respective second of said matching and damping coils, said induced out of phase transient signals acting to reduce in strength, or damp, the initial transient signals.

A further feature is that said matching coil may be of a first predetermined inductance and said damping coil may be of a second predetermined inductance different from said matching coil means.

A further features is that variable means may be provided for varying the inductance of one of the matching and damping coils relative to the other.

A further feature is such a speaker system wherein there are at least, high frequency speaker means and low frequency speaker means, and incorporating a first high frequency damping circuit for said high frequency speaker means and further a low frequency damping circuit for said low frequency speaker means.

A further feature is such a system wherein there are at least three separate speakers in each speaker system, and there being respective damping circuit for said speakers in said speaker system.

The matching and damping coils are preferably formed with equal numbers of turns or windings in each coil, with the individual turns of one coil be separated by the individual turns of the other coil, wound on a common support. There are several layers of windings with the turns of one coil in one winding layer overlying the turns of the other coil in the next adjacent winding layer.

The various features of novelty which characterize the invention are pointed out with particularity in the claims annexed to and forming part of this disclosure. For a better understanding of the invention, its operating advantages and specific objects attained by its use, reference should be had to the accompanying drawings and descriptive matter in which there are illustrated and described preferred embodiments of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is an electrical circuit diagram showing a single damping circuit in accordance with the invention for application to a single speaker;

Figure 2 is a detail of the bifilar winding of the matching coil and the damping coil of the invention;

Figure 3 is a side elevation of Figure 2, partially cut away;

Figure 4 is an electrical circuit diagram illustrating a typical audio loudspeaker system comprising a plurality of speakers and showing damping circuits according to the invention;

Figure 5 is an electrical circuit diagram showing a damping circuit according to the invention provided with a variable tapping on the windings of the damping coil means whereby the inductance of that coil may be changed;

Figure 6 is a diagram showing a further preferred embodiment for two speakers, and,

Figure 7 is a diagram showing a further preferred embodiment for three speakers.

MODES OF CARRYING OUT THE INVENTION

Referring first of all to Figure 1, it will be seen that the invention is there illustrated in connection with a speaker system comprising a single speaker 10 having an integral voice coil 12 and speaker input connection means 14 and speaker output connection means 16. The damping circuit 18 has a matching coil 20 and a damping coil 22, each having respective input connection means 24, 26 and having respective output connection means 28, 30. Matching coil 20 and damping coil 22 are wound in a mode known as "unity coefficient of coupling", in bifilar style i.e. two conductors of the same or very nearly the same thickness placed adjacent one another and wound on a common support as illustrated in Figure 2 and 3.

The matching and damping coils are preferably formed with equal numbers of turns or windings in each coil, with the individual turns of one coil being separated by the individual turns of the other coil, wound on a common support. There are several layers of windings with the turns of one coil in one winding layer overlying the turns of the other coil in the next adjacent winding layer.

As Figures 2 & 3 indicate, matching and damping coils 20, 22 are wound about a common support 36. Common support 36 maybe for example, a bobbin, of plastic or the like (Figures 2 & 3), having non-magnetic properties, or in some cases may be formed of iron-steel, nickel-steel, or any other core which may be advantageous in a given situation.

In Figure 3, the turns of coil 20, where they are cut away, are shown with speckle hatching. The turns of coil 22 are shown with diagonal line hatching. It will be seen that the turns of coil 22 in one winding layer, overlay the turns of coil 20 in the next adjacent winding layer, and so on.

Figure 3 also illustrates the two ends of the coil 20, adjacent to the two ends to the coil 22.

The two adjacent ends would constitute the input of the two coils and the other two adjacent ends would constitute the output of the two coils.

In operation, it will be appreciated that the driving circuit will supply power via the input 32 which is connected to matching coil input connection means 24. Matching coil output connection means 28 is connected to speaker input connection means 14 and power passes through integral voice coil 12 to speaker output connection means 16. Power then flows from speaker output connection means 16 to damping coil input connection means 26, through damping coil 22 to damping coil output connection means 30 from whence it passes to the negative side of the driving circuit 34.

It is believed that the damping circuit as herein described relies on induced currents to function. As a signal is fed into the circuit moving first through the matching coil, a very nearly equal current is induced in the damping coil. The current induced in the damping coil would, however, be approximately 180 degrees out of phase with that passing through the matching coil if the coils were merely shorted out. In other words, the two currents, when added, would very nearly cancel one another. If the speaker was removed from the damping circuit, and a current was applied with a measuring instrument such as a galvanometer connected between the coil output connection means, there would be a very limited electrical potential measured.

However the presence of the loudspeaker coil in the circuit provides a phase shift of approximately 90 degrees in the current flowing through the circuit. It is believed that this phase shift allows the damping circuit means to perform its job of damping transient signals induced in the system without impairing the quality of the original, sound signal.

There are three different electrical signals which are easily identified and flow within the standard speaker circuit at a given instant. The first is the primary signal or applied voltage. The second is the induced current created by the passage of the primary current through the standard cross-over coil, believed to be one source of noise or distortion. The third is the "back EMF" produced in the voice coil of the loudspeaker, believed to be another source of noise or distortion. It is believed that the design of the present damping circuit provides, for each of the second and third unwanted noise signals in the circuit, a very nearly equally strong signal which is 90 degrees out of phase with the respective noise signals.

Furthermore the damping coil provides a magnetic braking effort on the voice coil of the speaker. This causes the voice coil to move almost exclusively in response to the primary signal, and dampens any movement of the voice coil which would otherwise give rise to unwanted noise sounds and obscure subtle sounds in the primary signal.

The invention further comprises a method of damping audio signals in a speaker system, by passing the same through a damping circuit means, said damping circuit means comprising matching coil means and damping coil means, said matching and damping coil means each having a first coil end and a second coil end, and having respective input and output connection means, said matching coil means and damping coil means being wound together about a common support and having respective input connection means at coincident first coil end, and having respective output connection means at respective coincident second coil end; said matching coil means and damping coil means being wound in a manner to provide unity coefficient of coupling between said matching and damping coil means, said matching coil connected in series with a coil driven speaker having input connection means and output connection means, with said matching coil output connection means connected to the input connection means of the loudspeaker, said damping coil means being connected in series with the same coil driven loudspeaker and having the speaker output connection means connected to the damping coil input connection means in such a manner as to provide a continuous circuit between the matching coil input connection means and the damping coil output connection means, whereby currents will flow through said matching and damping coil means in the same direction thereby acting to reduce in strength, or damp, the unwanted signals.

More frequently, the invention will be used in a speaker system employing a plurality of loudspeakers interconnected through a matching circuit. By way of illustration, Figure 4 shows the invention in a system having three separate speakers, namely, a low frequency speaker 38, a mid-range frequency speaker 40, and a high range frequency speaker 42. Each of the speakers is of the moving coil type, and the speakers are together intended to handle the entire audible range of sound waves, with, in most cases, a certain degree of overlap between the adjacent speakers, in a manner well known in the art and requiring no description. Low range frequency speaker 38 has an input 44 and an output 46, indicated respectively as positive and negative. The mid range speaker 40 has an input connection 48 and an output connection 50 indicated respectively as positive and negative. The high range frequency speaker 42 has an input connection 52 and an output connection 54 indicated respectively as positive and negative.

It is assumed that the speaker system comprising the three speakers 38, 40, and 42 is intended to be connected to a source of audio frequency signals, coming from a suitable source such as some form of sound reproduction device either a disc or tape type device, or for example from a radio receiver, or directly for example from a microphone or series of microphones with amplifiers and other equipment as needed (not shown). All of these different systems are very well known in the art and require no further description.

The connections for such systems are indicated generally as 56 and 58 being indicated respectively as positive and negative. As is well known in the art, in the normal speaker system, there would be, between the main connections 56 and 58, and the speakers 38, 40, and 42 a series of what are known as "crossover" circuits. The purpose of the crossover circuits is to filter out or separate the high-frequency, mid-range, and low-frequency signals, so that they are directed to the appropriate speakers for reproduction therein, and are excluded from the other speakers. As mentioned, in most crossover circuits and speaker systems, some small degree of overlap is provided, the exact degree being dependant upon the design of the speakers and the requirements of the system, all as is well known in the art. It will be appreciated that in Figure 4 no such typical prior art crossover circuits are illustrated.

In place of the conventional crossover circuits, there are provided, in this example, low range matching and damping coils 60 and 62, and high range matching and damping coils 64 and 66. Low range matching coil 60 has an input 68 and an output 70 and low range damping coil 62 has an input 72 and an output 74. High range matching coil 64 has an input 76 and an output 78. High range damping coil 66 has an input 80 and an output 82. Each of the respective pairs of coils 60-62 and 64-66 are wound in a bifilar manner concentrically together about respective common supports (indicated generally as 84 and 86) as shown and as described above (Figs 2 and 3), providing unity coefficient of coupling. The inputs of the coils adjacent one another at respective first matching and damping coil ends, and their outputs are adjacent one another at respective second matching and damping coil ends. Low range matching coil 60 is connected with its input 68 connected to the input side of the driving circuit 56. The output 70 of low range matching coil 60 is connected to the input side 44 of low range speaker 38. The input 72 of low range damping coil 62 is connected to the output 46 of low range speaker 38. The output 74 of low range damping coil 62 is connected to the negative side 58 of the driving circuit. In this way, the currents flowing through the matching coil 60, and the damping coil 62 both input from the same adjacent ends, at input 68 and 72, and output at two adjacent ends 70 and 74. Both coils being wound in the same direction, the two coils thus carry their respective currents from their input ends to their output ends, around windings being wound in the same direction.

A suitable condenser 88 is incorporated where necessary, in the connection between the output 50 of mid range speaker 40, and the input 44 of low range speaker 38. In addition, a further connection, together with a condenser 90, extends between the output 50 of mid range speaker 40, and the negative side 58 of the driving circuit.

In the high range matching and damping coils 64 and 66, the input 76 of high range matching coil 64 is connected to the positive side 56 of the driving circuit through condenser 94a.

The output 78 of high range matching coil 64 is connected to the input 52 of the high range speaker 42. The input 80 of high range damping coil 66 is connected to the output 54 of the high range speaker 42. The output 82 of the high range damping coil 66 is connected through a condenser 94b to the negative side 58 of the driving circuit. The coils 64 and 66 are wound and connected in the same manner as described in connection with coils 60 and 62, so that currents flow through the respective coils from their respective inputs to their respective outputs, around coils being wound in the same direction.

Suitable auxiliary coils 92, and condenser 94c are provided to filter super-sonic transients.

Figure 5 is an example of a variant of the damping circuit. It may be desirable for the user to control the inductance of the damping coil, thereby altering the performance of the damping circuit. In order to vary the inductance of the damping coil, a series of tappings 11, 13, 15, 17, and 19 are provided along the damping coil. These tappings are connected into multi-position selector switch indicated generally as 21. Selector switch 21 provides a convenient method of altering the connection point of the outlet side 34 of the driving circuit and damping coil 22, thereby altering the number of effective windings of damping coil 22 and hence its inductance. It can be appreciated that damping circuits having variable tappings may be utilised in multi-speaker systems such as those shown in Figure 4, Figures 6 and 7.

Figure 6 is a diagram of a further preferred embodiment of the inventive circuit in a loudspeaker system having two speakers namely a high and middle range frequency speaker 100, and a low range frequency speaker 102. The benefits of providing different speakers for the reproduction of different frequency ranges are well known in the art and therefore will not be described here. Each speaker is provided with a damping circuit, indicated generally as 104, and 106 arranged, and connected, in the manner described in respect of Figures 1 and 4. In the circuit of Figure 6, capacitors 108, 110 are connected in the circuit to filter unwanted frequencies from respective speakers.

Figure 7 is a diagram of a further preferred embodiment of the inventive circuit in a loudspeaker system having three speakers namely, a high frequency speaker 112, a middle range frequency speaker 114, and a low range frequency speaker 116. The benefits of providing different speakers for the reproduction of different frequency ranges are well known in the art and therefore will not be described here. Each speaker is provided with a damping circuit, indicated generally as 118, 120, 122 arranged, and connected in the manner described in connection with Figures 1 and 4. In the circuit of Figure 7, capacitors 124, 126, 128, 130 are connected in the circuit to filter unwanted frequencies from respective speakers.

The foregoing is a description of a preferred embodiment of the invention which is given here by way of example only. The invention is not to be taken as limited to any of the specific features as described but comprehends all such variations thereof as come within the scope of the appended claims.

Claims

1. A damping circuit for speaker systems of the type containing at least one coil driven speaker means (10; 38, 42) having a predetermined inductance and input and output connection means, (14, 16; 44, 46, 52, 54) for reproducing audio signals and comprising;

a matching coil (20; 60, 64) having a predetermined inductance and defining matching coil input and output connection means (24, 28; 68, 70, 76, 78), said matching coil output connection means being adapted to be connected in series with said input connection means (14; 44, 52) of said coil driven speaker means;
a damping coil (22; 62, 66) having a predetermined inductance and defining damping coil input and output connection means (26, 30; 72, 74, 80, 82), said damping coil input connection means being adapted to be connected in series with said output connection means (16; 46, 54) of said coil driven speaker means (10; 38, 42);
said matching and damping coils (20, 22; 60, 62, 64, 66) defining windings being wound together in the same direction, about a common support (36; 84, 86), with their said input connection means (24, 26; 68, 72, 76, 80) juxtaposed to one another and with their said output connection means (28, 30; 70, 74, 78, 82) juxtaposed to one another whereby currents will flow through said matching and damping coils (20, 22; 60, 62, 64, 66) in the same direction, from their said inputs to their said outputs, whereby to at least partially damp out noise signals.

2. A damping circuit as claimed in claim 1 wherein said matching (20; 60, 64) and damping (22; 62, 66) coils are of equal inductance to one another.

3. A damping circuit as claimed in claim 1 wherein said matching coil (20; 60, 64) and said damping coil (22; 62, 66) are of differing inductance.

4. A damping circuit as claimed in claim 1 wherein means (11, 13, 15, 17, 19, 21, 30) are provided for varying the inductance of said damping coil (22; 62, 66).

5. A damping circuit as claimed in claim 1 wherein there are at least, high frequency coil driven speaker means (42; 100; 112) and low frequency coil driven speaker means (38; 102; 116) and including high frequency matching and damping coils (64, 66; 104; 118) for said high frequency coil driven speaker means (42; 100; 112) and low frequency matching and damping coils (60, 62; 106; 122) for said low frequency coil driven speaker means (38; 102; 116).

6. A damping circuit as claimed in claim 5 wherein there are at least three separate coil driven speaker means (38, 40, 42; 112, 114, 116) in each speaker system, and there being respective pairs of matching and damping coils (60, 62, 64, 66; 118, 120, 122) for at least two of said coil driven speaker means in said speaker system.

7. A damping circuit as claimed in claim 1 wherein said matching (20; 60, 64) and damping (22; 62, 66) coils define an equal number of windings.

8. A damping circuit as claimed in claim 1 wherein said matching coil (20; 60, 64) is of an inductance suitable to filter out unwanted frequencies of electrical signals.

9. A damping circuit as claimed in claim 1 wherein said matching coil (20; 60, 64) and said damping coil (22; 62, 66) are wound together in a bi-filar manner, on said common support (36; 84, 86).

10. A method of damping distortion in audio signals in an audio speaker system including coil driven speaker means (10; 38, 42) comprising the steps of;

passing the audio signals through damping circuit means, said damping circuit means comprising,
a matching coil and a damping coil (20, 22; 60, 62, 64, 66);
said matching and damping coils (20, 22; 60, 62, 64, 66) each having a first coil end and a second coil end, and having respective input and output connection means (24, 28, 26, 30;

68, 70, 72, 74, 76, 78, 80, 82);
said matching coil and damping coil being wound together in the same direction about a common support (36; 84, 86) and having said respective input connection means (24, 26; 68, 72; 76, 80) at a coincident first coil end, and having said respective output connection (28, 30; 70, 74; 78, 82) means at a respective coincident second coil end;
said matching coil and damping coil (20, 22; 60, 62, 64, 66) being wound in a manner to provide unity coefficient of coupling between said matching and damping coils;
said matching coil (20; 60, 64) being connected in series with a coil driven speaker means (10, 38, 42) having input connection means (14; 44, 52) and output connection means (16; 46, 54), with said matching coil output connection means (28; 70, 78) connected to said input connection means (14; 44, 52) of said speaker (10; 38, 42);
said damping coil (22; 62, 66) being connected in series with the same coil driven speaker means (10; 38, 42) and having the speaker output connection means (16; 46, 54) connected to the damping coil input connection means (26; 72, 80) in such a manner as to provide a continuous circuit between the matching coil input connection means (24; 68, 76) and the damping coil output connection means (30; 74, 82);
whereby currents will flow through said matching and damping coils (20, 22; 60, 62, 64, 66) in the same direction and thereby at least partially damp out noise signals.

11. A method of damping distortion as claimed in claim 10 including the step of varying the inductance of said damping coil (22; 62, 66).

12. A method of damping distortion as claimed in claim 10 in which at least three separate coil driven speaker means (38, 40; 42; 112, 114, 116) are provided in each speaker system, there being respective pairs of matching and damping coils (60, 62, 64, 66; 118, 120, 122) for at least two of said coil driven speaker means in said speaker system.

13. A method of damping distortion as claimed in claim 10 in which said audio speaker system comprises a plurality of coil driven speaker means (100, 102; 112, 114, 116) each coil driven speaker means provided with a damping circuit (104, 106; 118, 120, 122).

14. An audio signal reproduction system for reproducing audio signals from a source of audio signals and comprising;
at least one coil driven speaker means (10; 38, 40, 42) having input and output connection means for input and output of audio signals thereto;
a matching coil (20; 60, 64) having a predetermined inductance and defining matching coil input and output connections (24, 28; 68, 70, 76, 78), said matching coil input connection (24; 68, 76) being adapted to be connected in series with said audio signal source and said matching coil output connection (28; 70, 78) being connected in series with said input connection (14; 44, 52) of said coil driven speaker means (10; 38, 40, 42);
a damping coil (22; 62, 66) having a predetermined inductance and defining damping coil input and output connections (26, 30; 72, 74, 80, 82), said damping coil input connection (26; 72, 80) being connected in series with said output connection (16; 46, 54) of said coil driven speaker means (10; 38, 40 ,42) and said damping coil output connection (30; 74, 82) being adapted to be connected in series with said audio signal source;
said matching and damping coils (20, 22; 60, 62, 64, 66) defining windings being wound together in the same rotational direction, about a common support means (36; 84, 86), with their said input connections (24, 26; 66, 72, 76, 80) adjacent one another and their said output connections (28, 30; 70, 74, 78, 82) adjacent one another whereby currents will flow through said matching coil (20; 60, 64) and said speaker coil and said damping coil (22; 62, 66) in series and whereby said currents will flow through said matching coil (20; 60, 64) and said damping coil (22; 62, 66) in the same rotational direction.

15. An audio signal reproducing system as claimed in claim 14 and wherein said matching (20; 60, 64) and damping (22; 62, 66) coils are of equal inductance to one another.

16. An audio signal reproducing system as claimed in claim 14 wherein means (11, 13, 15, 17, 19, 21, 30) are provided for varying the inductance of said damping coil (22; 62, 66).

17. An audio signal reproducing system as claimed in claim 14 wherein there are at least, a high frequency coil driven speaker means (42; 100, 112) and a low frequency coil driven speaker means (38; 102, 116) and including high frequency matching and damping coils (64, 66; 104; 118) for said high frequency coil driven speaker means (42; 100, 112) and low frequency matching and damping coils (60, 62; 106, 122) for said low frequency coil driven speaker means (38; 102, 116).

18. An audio signal reproducing system as claimed in claim 14 and wherein said matching and damping coils (64, 66; 104; 118) define an equal number of windings wound together in the same rotational direction.

19. An audio signal reproducing system as claimed in claim 14 wherein said matching coil and said damping coil (64, 66; 104, 118) are wound together in a bi-filar manner in the same rotational direction.

Patentansprüche

1. Dämpfungsschaltung für Lautsprechersysteme der Art mit mindestens einem dynamischen Lautsprechermittel (10; 38, 42) mit einer vorbestimmten Induktivität und Eingangs- und Ausgangsverbindungsmitteln (14, 16; 44, 46, 52, 54) zur Wiedergabe von Tonsignalen und mit folgendem:

   einer paarigen Spule (20; 60, 64) mit einer vorbestimmten Induktivität und mit paarigen Spulen Eingangs- und Ausgangs-Verbindungsmitteln (24, 28; 68, 70, 76, 78), wobei die besagten paarigen Spulen Ausgangsverbindungsmittel in Reihe mit den besagten Eingangsverbindungsmitteln (14; 44, 52) des besagten dynamischen Lautsprechermittels geschaltet werden können;
   einer Dämpfungsspule (22; 62, 66) mit einer vorbestimmten Induktivität und mit Dämpfungsspulen-Eingangs- und Ausgangsverbindungsmitteln (26, 30; 72, 74, 80, 82), wobei die besagten Dämpfungsspulen Eingangsverbindungsmittel in Reihe mit den besagten Ausgangsverbindungsmitteln (16; 46, 54) des besagten dynamischen Lautsprechermittels (10; 38, 42) geschaltet werden können;
   wobei die besagten paarigen und Dämpfungsspulen (20, 22; 60, 62, 64, 66) in derselben Richtung um einen gemeinsamen Träger (36; 84, 86) herum zusammen gewickelte Wicklungen definieren, wobei ihre besagten Eingangsverbindungsmittel (24, 26; 68, 72, 76, 80) nebeneinander gelegt sind und ihre besagten Ausgangsverbindungsmittel (28, 30; 70, 74, 78, 82) nebeneinander gelegt sind, wodurch Ströme die besagten paarigen und Dämpfungsspulen (20, 22; 60, 62, 64, 66) in derselben Richtung von ihren besagten Eingängen zu ihren besagten Ausgängen durchfließen werden, um dadurch Rauschsignale mindestens teilweise abzudämpfen.

2. Dämpfungsschaltung nach Anspruch 1, wobei die besagten paarigen (20; 60, 64) und Dämpfungsspulen (22; 62, 66) gleiche Induktivität zueinander aufweisen.

3. Dämpfungsschaltung nach Anspruch 1, wobei die besagte paarige Spule (20; 60, 64) und die besagte Dämpfungsspule (22; 62, 64) unterschiedliche Induktivität aufweisen.

4. Dämpfungsschaltung nach Anspruch 1, wobei Mittel (11, 13, 15, 17, 19, 21, 30) zum Verändern der Induktivität der besagten Dämpfungsspule (22; 62, 66) vorgesehen sind.

5. Dämpfungsschaltung nach Anspruch 1, wobei mindestens dynamische Hochfrequenzlautsprechermittel (42; 100; 112) und dynamische Niederfrequenzlautsprechermittel (38; 102; 116) vorgesehen sind und hochfrequente paarige und Dämpfungsspulen (64, 66; 104; 118) für die besagten dynamischen Hochfreguenzlautsprechermittel (42, 100; 112) und niederfrequente paarige und Dämpfungsspulen (60, 62; 106; 122) für die besagten dynamischen Niederfrequenzlautsprechermittel (38; 102; 116) enthalten.

6. Dämpfungsschaltung nach Anspruch 5, wobei in jedem Lautsprechersystem mindestens drei getrennte dynamische Lautsprechermittel (38, 40, 42; 112, 114, 116) vorgesehen sind und für mindestens zwei der besagten dynamischen Lautsprechermittel im besagten Lautsprechersystem entsprechende Paare von paarigen und Dämpfungsspulen (60, 62, 64, 66; 118, 120, 122) vorgesehen sind.

7. Dämpfungsschaltung nach Anspruch 1, wobei die besagten paarigen (20; 60, 64) und Dämpfungsspulen (22; 62, 66) eine gleiche Anzahl von Wicklungen definieren.

8. Dämpfungsschaltung nach Anspruch 1, wobei die besagte paarige Spule (20; 60, 64) eine zum Ausfiltern von ungewünschten Frequenzen elektrischer Signale geeignete Induktivität aufweist.

9. Dämpfungsschaltung nach Anspruch 1, wobei die besagte paarige Spule (20; 60, 64) und besagte Dämpfungsspule (22; 62, 66) bifilar auf dem besagten gemeinsamen Träger (36; 84, 86) zusammen gewickelt sind.

10. Verfahren zum Dämpfen von Verzerrung in Tonsignalen in einem Tonlautsprechersystem mit dynamischen Lautsprechermitteln (10; 38, 42) mit folgenden Schritten;

    Durchführen der Tonsignale durch Dämpfungsschaltungsmittel, die folgendes umfassen:
    eine paarige Spule und eine Dämpfungsspule (20, 22; 60, 62, 64, 66);

wobei die besagten paarigen und Dämpfungsspulen (20, 22; 60, 62, 64, 66) jeweils ein erstes Spulenende und ein zweites Spulenende aufweisen und entsprechende Eingangs- und Ausgangsverbindungsmittel (24, 28, 26, 30; 68, 70, 72, 74, 76, 78, 80, 82) aufweisen;
wobei die besagte paarige Spule und Dämpfungsspule in derselben Richtung um einen gemeinsamen Träger (36; 84, 86) herum zusammen gewickelt sind und die besagten entsprechenden Eingangsverbindungsmittel (24, 26; 68, 72, 76, 80) an einem zusammentreffenden ersten Spulenende aufweisen und die besagten entsprechenden Ausgangsverbindungsmittel (28, 30, 70, 74; 78, 82) an einem entsprechenden zusammentreffenden zweiten Spulenende aufweisen;
wobei die besagte paarige Spule und Dämpfungsspule (20, 22; 60, 62, 64, 66) so gewickelt sind, daß sie einen Kopplungskoeffizienten von Eins zwischen den besagten paarigen und Dämpfungsspulen bereitstellen;
wobei die besagte paarige Spule (20; 60, 64) in Reihe mit einem dynamischen Lautsprechermittel (10, 38, 42) mit Eingangsverbindungsmitteln (14; 44, 52) und Ausgangsverbindungsmitteln (16; 46, 54) geschaltet ist, wobei die besagten Ausgangsverbindungsmittel (28; 70, 78) der paarigen Spule mit den besagten Eingangsverbindungsmitteln (14; 44, 52) des besagten Lautsprechers (10; 38, 42) verbunden sind;
wobei die besagte Dämpfungsspule (22; 62, 66) in Reihe mit demselben dynamischen Lautsprechermittel (10; 38, 42) geschaltet ist, und die Lautsprecherausgangsverbindungsmittel (16; 46, 54) so mit den Eingangsverbindungsmitteln (26; 72, 80) der Dämpfungsspule verbunden sind, daß sie einen durchgehenden Stromkreis zwischen den Eingangsverbindungsmitteln (24; 68, 76) der paarigen Spule und den Ausgangsverbindungsmitteln (30; 74, 82) der Dämpfungsspule bereitstellen;
wodurch Ströme die besagten paarigen und Dämpfungsspulen (20, 22; 60, 62, 64, 66) in derselben Richtung durchfließen und dadurch Rauschsignale mindestens teilweise abdämpfen werden.

11. Verfahren zum Dämpfen von Verzerrung nach Anspruch 10 mit dem Schritt des Veränderns der Induktivität der besagten Dämpfungsspule (22; 62, 66).

12. Verfahren zum Dämpfen von Verzerrung nach Anspruch 10, wobei mindestens drei getrennte dynamische Lautsprechermittel (38, 40, 42; 112, 114, 116) in jedem Lautsprechersystem vorgesehen sind, wobei entsprechende Paare von paarigen und Dämpfungsspulen (60, 62, 64, 66; 118, 120, 122) für mindestens zwei der besagten dynamischen Lautsprechermittel im besagten Lautsprechersystem vorgesehen sind.

13. Verfahren zum Dämpfen von Verzerrung nach Anspruch 10, wobei das besagte Tonlautsprechersystem eine Mehrzahl von dynamischen Lautsprechermitteln (100, 102; 112, 114, 116) umfaßt, wobei jedes dynamische Lautsprechermittel mit einer Dämpfungsschaltung (104, 106; 118, 120, 122) versehen ist.

14. Tonsignalwiedergabesystem zur Wiedergabe von Tonsignalen von einer Quelle von Tonsignalen und mit folgendem;

mindestens einem dynamischen Lautsprechermittel (10; 38, 40, 42) mit Eingangs- und Ausgangsverbindungsmitteln zur Eingabe und Ausgabe von Tonsignalen zu diesen;
einer paarigen Spule (20; 60, 64) mit einer vorbestimmten Induktivität und mit Eingangs- und Ausgangsverbindungen (24, 28; 68, 70, 76, 78) der paarigen Spule, wobei die Eingangsverbindung (24; 68, 76) der besagten paarigen Spule in Reihe mit der besagten Tonsignalquelle geschaltet werden kann und die besagte Ausgangsverbindung (28; 70, 78) der paarigen Spule in Reihe mit der besagten Eingangsverbindung (14; 44, 52) des besagten dynamischen Lautsprechermittels (10; 38, 40, 42) geschaltet werden kann;
einer Dämpfungsspule (22; 62, 66) mit einer vorbestimmten Induktivität und mit Eingangs- und Ausgangsverbindungen (26, 30; 72, 74, 80, 82) der Dämpfungsspule, wobei die besagte Eingangsverbindung (26; 72, 80) der Dämpfungsspule in Reihe mit der besagten Ausgangsverbindung (16; 46, 54) der besagten dynamischen Lautsprechermittel (10; 38, 40, 42) geschaltet ist und die besagte Ausgangsverbindung (30; 74, 82) der Dämpfungsspule in Reihe mit der besagten Tonsignalquelle geschaltet werden kann;
wobei die besagten paarigen und Dämpfungsspulen (20, 22; 60, 62, 64, 66) in derselben Drehrichtung um ein gemeinsames Trägermittel (36; 84, 86) zusammen gewickelte Wicklungen definieren, wobei ihre besagten Eingangsverbindungen (24, 26; 66, 72, 76, 80) nebeneinander liegen und ihre besagten Ausgangsverbindungen (28; 30; 70, 74, 78, 82) nebeneinander liegen, wodurch Ströme die besagte paarige Spule (20; 60, 64) und die besagte Lautsprecherspule und die besagte Dämpfungsspule (22; 62, 66) in Reihe durchfließen

werden und wodurch die besagten Ströme die besagte paarige Spule (20; 60, 64) und die besagte Dämpfungsspule (22; 62, 66) in derselben Drehrichtung durchfließen werden.

15. Tonsignalwiedergabesystem nach Anspruch 14, wobei die besagten paarigen (20; 60, 64) und Dämpfungsspulen (22; 62, 66) gleiche Induktivität zueinander aufweisen.

16. Tonsignalwiedergabesystem nach Anspruch 14, wobei Mittel (11, 13, 15, 17, 19, 21, 30) zum Verändern der Induktivität der besagten Dämpfungsspule (22; 62, 66) vorgesehen sind.

17. Tonsignalwiedergabesystem nach Anspruch 14, wobei mindestens ein dynamisches Hochfrequenzlautsprechermittel (42; 100, 112) und ein dynamisches Niederfrequenzlautsprechermittel (38; 102, 116) vorgesehen sind und mit hochfrequenten paarigen und Dämpfungsspulen (64, 66; 104; 118) für die besagten dynamischen Hochfrequenzlautsprechermittel (42; 100, 112) und niederfrequente paarige und Dämpfungsspulen (60, 62; 106; 122) für die besagten dynamischen Niederfrequenzlautsprechermittel (38; 102, 116).

18. Tonsignalwiedergabesystem nach Anspruch 14, wobei die besagten paarigen und Dämpfungsspulen (64, 66; 104; 118) eine gleiche Anzahl von in derselben Drehrichtung zusammen gewickelten Wicklungen definieren.

19. Tonsignalwiedergabesystem nach Anspruch 14, wobei die besagte paarige Spule und besagte Dämpfungsspule (64, 66; 104, 118) bifilar in derselben Drehrichtung zusammen gewickelt sind.

Revendications

1. Circuit d'amortissement pour les systèmes de haut-parleur du type contenant au moins un moyen de haut-parleur excité par bobine (10; 38, 42) ayant une inductance prédéterminée et des moyens de connexion d'entrée et de sortie (14, 16; 44, 46, 52, 54) pour reproduire les signaux audio et comprenant;

une bobine d'adaptation (20; 60, 64) ayant une inductance prédéterminée et définissant des moyens de connexion d'entrée et de sortie de bobine d'adaptation (24, 28; 68, 70, 76, 78), ledit moyen de connexion de sortie de bobine d'adaptation étant adapté pour être connecté en série avec ledit moyen de connexion d'entrée (14; 44, 52) dudit moyen de haut-parleur excité par bobine;

une bobine d'amortissement (22; 62, 66) ayant une inductance prédéterminée et définissant des moyens de connexion d'entrée et de sortie de bobine d'amortissement (26, 30; 72, 74, 80, 82), ledit moyen de connexion d'entrée de bobine d'amortissement étant adapté pour être connecté en série avec ledit moyen de connexion de sortie (16; 46, 54) dudit moyen de haut-parleur excité par bobine (10; 38, 42);
lesdites bobines d'adaptation et d'amortissement (20, 22; 60, 62, 64, 66) définissant des enroulements enroulés ensemble dans le même sens, autour d'un support commun (36; 84, 86), leurs dits moyens de connexion d'entrée (24, 26; 68, 72, 76, 80) étant juxtaposés l'un à l'autre et leurs dits moyens de connexion de sortie (28, 30; 70, 74, 78, 82) étant juxtaposés l'un à l'autre si bien que les courants passeront à travers lesdites bobines d'adaptation et d'amortissement (20, 22; 60, 62, 64, 66) dans le même sens, depuis leurs dites entrées jusqu'à leurs dites sorties, de manière à amortir au moins partiellement les signaux de bruit.

2. Circuit d'amortissement selon la revendication 1, dans lequel lesdites bobines d'adaptation (20; 60, 64) et d'amortissement (22; 62, 66) sont d'une inductance égale l'une par rapport à l'autre.

3. Circuit d'amortissement selon la revendication 1, dans lequel ladite bobine d'adaptation (20; 60, 64) et ladite bobine d'amortissement (22; 62, 66) sont d'inductances différentes.

4. Circuit d'amortissement selon la revendication 1, dans lequel des moyens (11, 13, 15, 17, 19, 21, 30) sont fournis pour varier l'inductance de ladite bobine d'amortissement (22; 62, 66) .

5. Circuit d'amortissement selon la revendication 1, dans lequel figurent au moins un moyen de haut-parleur excité par bobine haute fréquence (42; 100; 122) et un moyen de haut-parleur excité par bobine basse fréquence (38; 102; 116) et comportant des bobines d'adaptation et d'amortissement haute fréquence (64, 66; 104; 118) pour ledit moyen de haut-parleur excité par bobine haute fréquence (42; 100; 112) et des bobines d'adaptation et d'amortissement basse fréquence (60, 62; 106; 122) pour ledit moyen de haut-parleur excité par bobine basse fréquence (38; 102; 116).

6. Circuit d'amortissement selon la revendication 5, dans lequel figurent au moins trois moyens de haut-parleur excités par bobine séparés (38, 40, 42; 112, 114, 116), et des paires respectives de bobines d'adaptation et d'amortissement (60, 62, 64, 66; 118, 120, 122) existant pour au moins deux desdits moyens de haut-parleur excités par bobine dans ledit système de haut-parleur.

7. Circuit d'amortissement selon la revendication 1, dans lequel lesdites bobines d'adaptation (20; 60, 64) et d'amortissement (22; 62, 66) définissent un nombre égal d'enroulements.

8. Circuit d'amortissement selon la revendication 1, dans lequel ladite bobine d'adaptation (20; 60, 64) est d'une inductance convenant pour filtrer les fréquences parasites des signaux électriques.

9. Circuit d'amortissement selon la revendication 1, dans lequel ladite bobine d'adaptation (20; 60, 64) et ladite bobine d'amortissement (22; 62, 66) sont enroulées ensemble de manière bifilaire, sur ledit support commun (36; 84, 86).

10. Procédé d'amortissement de distorsion dans les signaux audio dans un système de haut-parleur audio comportant des moyens de haut-parleur excités par bobine (10; 38, 42) comprenant les étapes de:

passage des signaux audio au travers de moyens de circuit d'amortissement, lesdits moyens de circuit d'amortissement comprenant:
une bobine d'adaptation et une bobine d'amortissement (20, 22; 60, 62, 64, 66);
lesdites bobines d'adaptation et d'amortissement (20, 22; 60, 62, 64, 66) ayant chacune une première extrémité de bobine et une deuxième extrémité de bobine, et ayant des moyens de connexion d'entrée et de sortie respectifs (24, 28, 26, 30; 68, 70, 72, 74, 76, 78, 80, 82);
lesdites bobine d'adaptation et bobine d'amortissement étant enroulées ensemble dans le même sens autour d'un support commun (36; 84, 86) et ayant lesdits moyens de connexion d'entrée respectifs (24, 26; 68, 72, 76, 80) au niveau d'une première extrémité de bobine coïncidente, et ayant lesdits moyens de connexion de sortie respectifs (28, 30; 70, 74; 78, 82) au niveau d'une deuxième extrémité de bobine coïncidente respective;
lesdites bobine d'adaptation et bobine d'amortissement (20, 22; 60, 62, 64, 66) étant enroulées de manière à fournir un coefficient unitaire de couplage entre lesdites bobines d'adaptation et d'amortissement;
ladite bobine d'adaptation (20; 60, 64) étant connectée en série avec un moyen de haut-parleur excité par bobine (10, 38, 42) ayant un moyen de connexion d'entrée (14; 44, 52) et un moyen de connexion de sortie (16; 46, 54), ledit moyen de connexion de sortie de bobine d'adaptation (28; 70, 78) étant connecté audit moyen de connexion d'entrée (14; 44, 52) dudit haut-parleur (10; 38, 42);
ladite bobine d'amortissement (22; 62, 66) étant connectée en série avec le même moyen de haut-parleur excité par bobine (10; 38, 42) et connectant le moyen de connexion de sortie de haut-parleur (16; 46, 54) au moyen de connexion d'entrée de bobine d'amortissement (26; 72, 80) de manière à fournir un circuit continu entre le moyen de connexion d'entrée de bobine d'adaptation (24; 68, 76) et le moyen de connexion de sortie de bobine d'amortissement (30; 74, 82);
si bien que les courants s'écouleront à travers lesdites bobines d'adaptation et d'amortissement (20, 22; 60, 62, 64, 66) dans le même sens et ainsi amortiront au moins partiellement les signaux de bruit.

11. Procédé d'amortissement de distorsion selon la revendication 10, comportant l'étape de variation de l'inductance de ladite bobine d'amortissement (22; 62, 66).

12. Procédé d'amortissement de distorsion selon la revendication 10, dans lequel au moins trois moyens de haut-parleur excités par bobine séparés (38, 40, 42; 112, 114, 116) sont fournis dans chaque système de haut-parleur, des paires respectives de bobines d'adaptation et d'amortissement (60, 62, 64, 66; 118, 120, 122) existant pour au moins deux desdits moyens de haut-parleur excités par bobine dans ledit système de haut-parleur.

13. Procédé d'amortissement de distorsion selon la revendication 10, dans lequel ledit système de haut-parleur audio comprend une pluralité de moyens de haut-parleur excités par bobine (100, 102; 112, 114, 116), chaque moyen de haut-parleur excité par bobine étant muni d'un circuit d'amortissement (104, 106; 118, 120, 122).

14. Système de reproduction de signaux audio pour reproduire des signaux audio provenant d'une source de signaux audio et comprenant;

au moins un moyen de haut-parleur excité par bobine (10; 38, 40, 42) ayant des moyens de connexion d'entrée et de sortie pour l'entrée et la sortie des signaux audio avec le système;
une bobine d'adaptation (20; 60, 64) ayant une inductance prédéterminée et définissant des connexions d'entrée et de sortie de bobine d'adaptation (24, 28; 68, 70, 76, 78), ladite connexion d'entrée de bobine d'adaptation (24; 68, 76) étant adaptée pour être connectée en série avec ladite source de signaux audio et ladite

connexion de sortie de bobine d'adaptation (28; 70, 78) étant connectée en série avec ladite connexion d'entrée (14; 44, 52) dudit moyen de haut-parleur excité par bobine (10; 38, 40, 42); une bobine d'amortissement (22; 62, 66) ayant une inductance prédéterminée et définissant des connexions d'entrée et de sortie de bobine d'amortissement (26, 30; 72, 74, 80, 82), ladite connexion d'entrée de bobine d'amortissement (26; 72, 80) étant connectée en série avec ladite connexion de sortie (16; 46, 54) dudit moyen de haut-parleur excité par bobine (10; 38, 40, 42) et ladite connexion de sortie de bobine d'amortissement (30; 74, 82) étant adaptée pour être connectée en série avec ladite source de signaux audio;
lesdites bobines d'adaptation et d'amortissement (20, 22; 60, 62, 64, 66) définissant des enroulements enroulés ensemble dans le même sens rotationnel, autour d'un moyen de support commun (36; 84, 86), leurs dites connexions d'entrée (24, 26; 66, 72, 76, 80) étant adjacentes l'un avec l'autre et leurs dites connexions de sortie (28, 30; 70, 74, 78, 82) étant adjacentes l'une avec l'autre si bien que les courants passeront à travers ladite bobine d'adaptation (20; 60, 64) et ladite bobine d'amortissement (22; 62, 66) en série, et si bien que lesdits courants passeront à travers ladite bobine d'adaptation (20; 60, 64) et ladite bobine d'amortissement (22; 62, 66) dans le même sens de rotation.

15. Système de reproduction de signaux audio selon la revendication 14, et dans lequel lesdites bobines d'adaptation (20; 60, 64) et d'amortissement (22; 62, 66) sont d'une inductance égale l'une par rapport à l'autre.

16. Système de reproduction de signaux audio selon la revendication 14, dans lequel des moyens (11, 13, 15, 17, 19, 21, 30) sont fournis pour varier l'inductance de ladite bobine d'amortissement (22; 62, 66).

17. Système de reproduction de signaux audio selon la revendication 14, dans lequel figurent au moins un moyen de haut-parleur excité par bobine haute fréquence (42; 100, 112) et un moyen de haut-parleur excité par bobine basse fréquence (38; 102, 116) et comportant des bobines d'adaptation et d'amortissement haute fréquence (64, 66; 104; 118) pour ledit moyen de haut-parleur excité par bobine haute fréquence (42; 100, 112) et des bobines d'adaptation et d'amortissement basse fréquence (60, 62; 106; 122) pour ledit moyen de haut-parleur excité par bobine basse fréquence (38; 102, 116).

18. Système de reproduction de signaux audio selon la revendication 14, et dans lequel lesdites bobines d'adaptation et d'amortissement (64, 66; 104; 118) définissent un nombre égal d'enroulements enroulés ensemble dans le même sens de rotation.

19. Système de reproduction de signaux audio selon la revendication 14, dans lequel ladite bobine d'adaptation et ladite bobine d'amortissementn (64, 66; 104; 118) sont enroulées ensemble de manière bifilaire, dans le même sens de rotation.

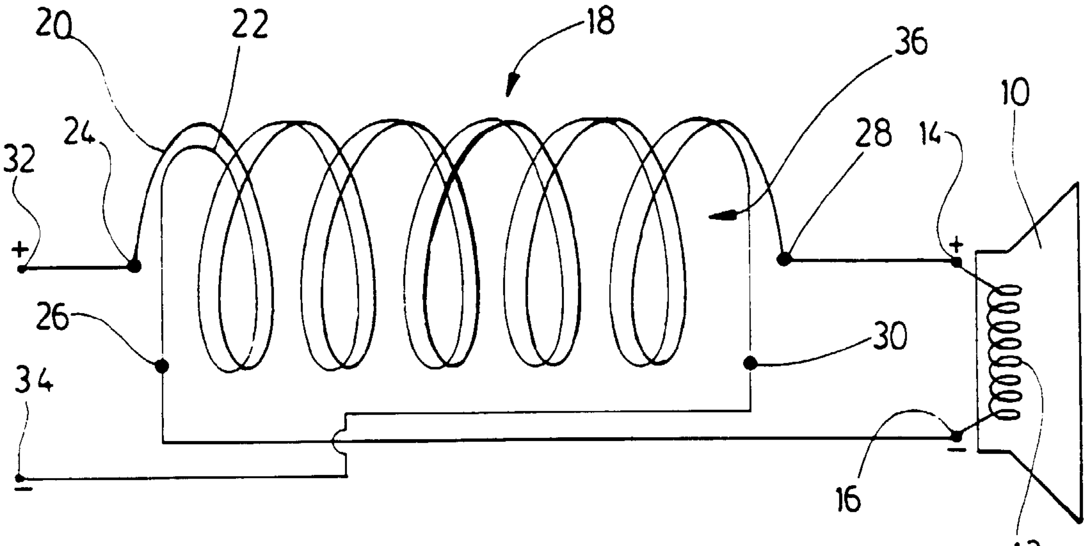


FIG. 1

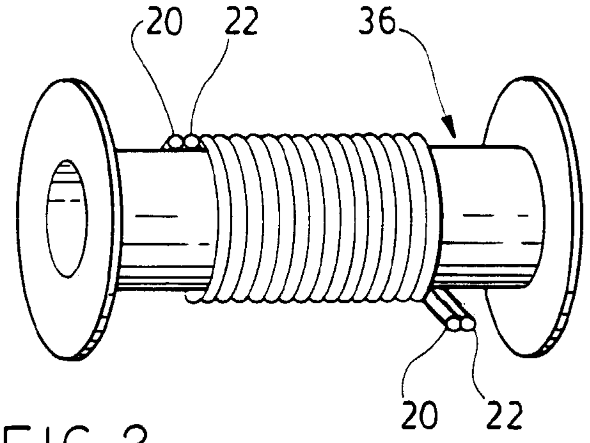


FIG 2

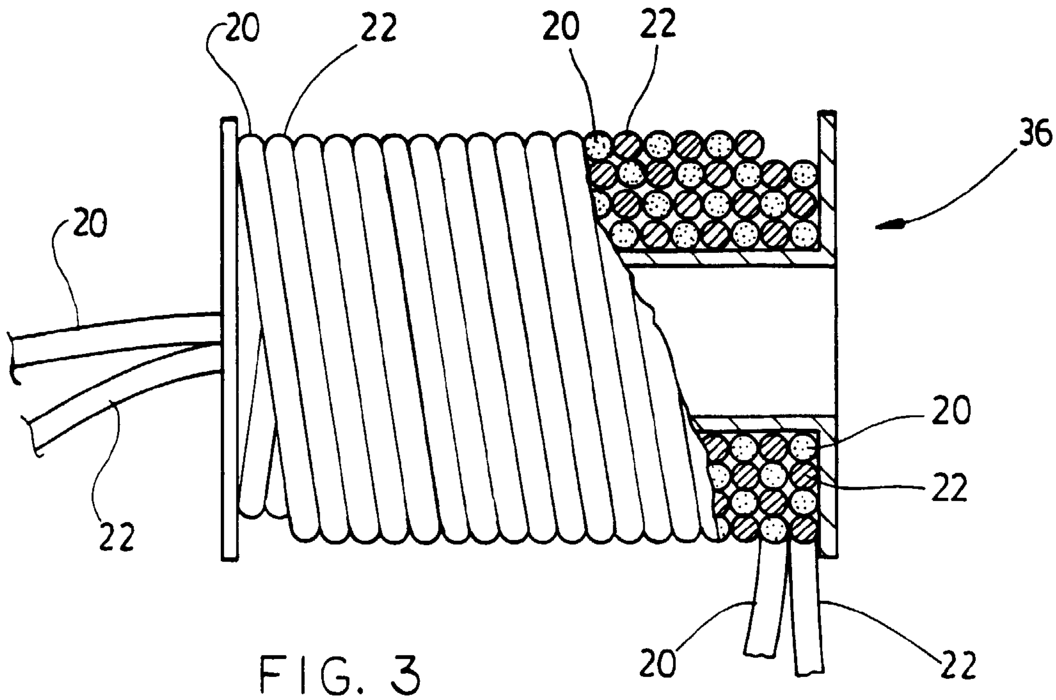
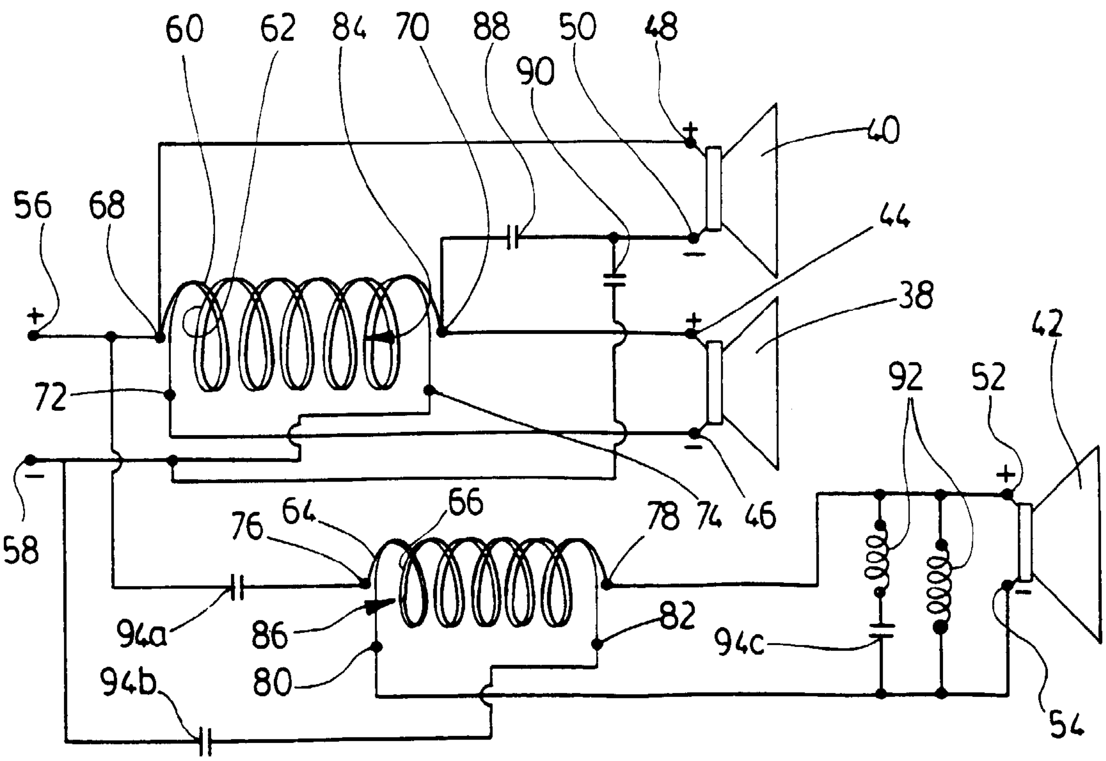

20
22
20
22
36
20
22
20
22
20
22

FIG. 3


60
62
84
70
88
50
48
90
40
56
68
44
38
72
42
92
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58
76
64
66
78
74
46
94a
86
82
94c
94b
80
54

FIG. 4

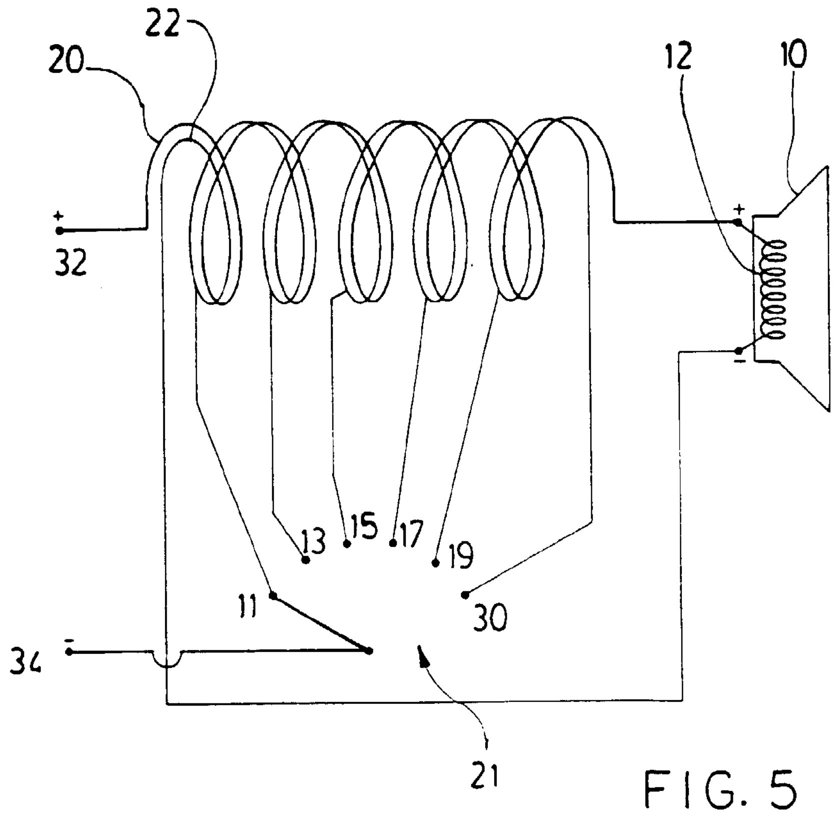

FIG. 5

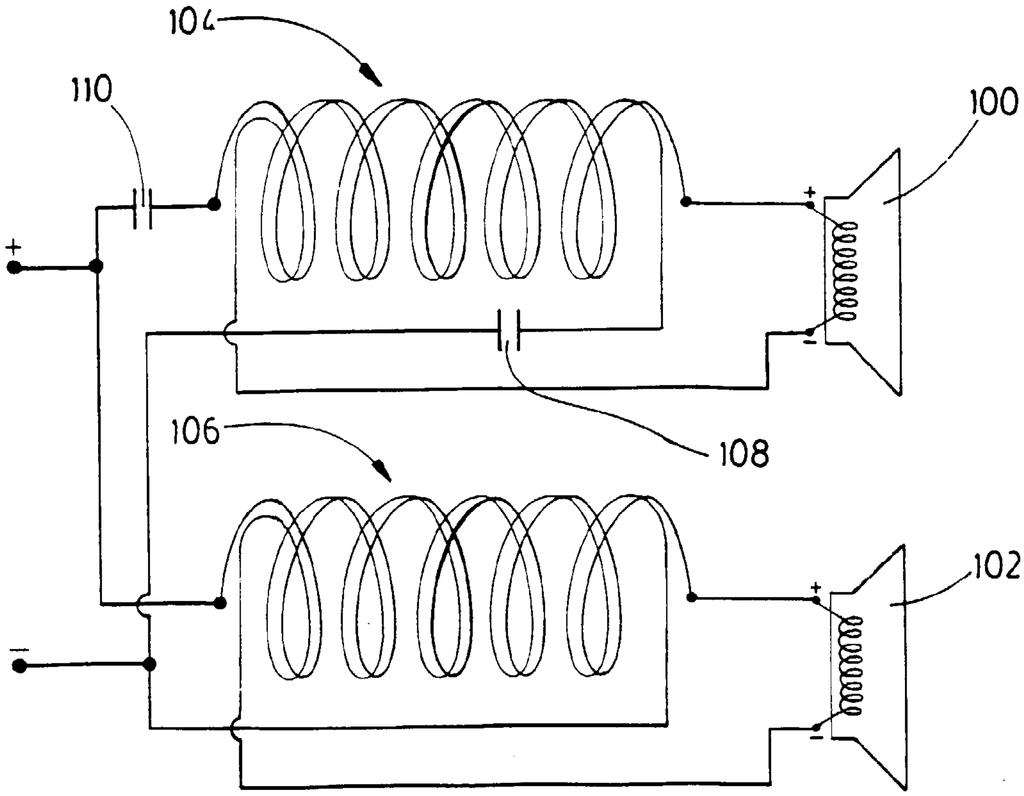

FIG. 6

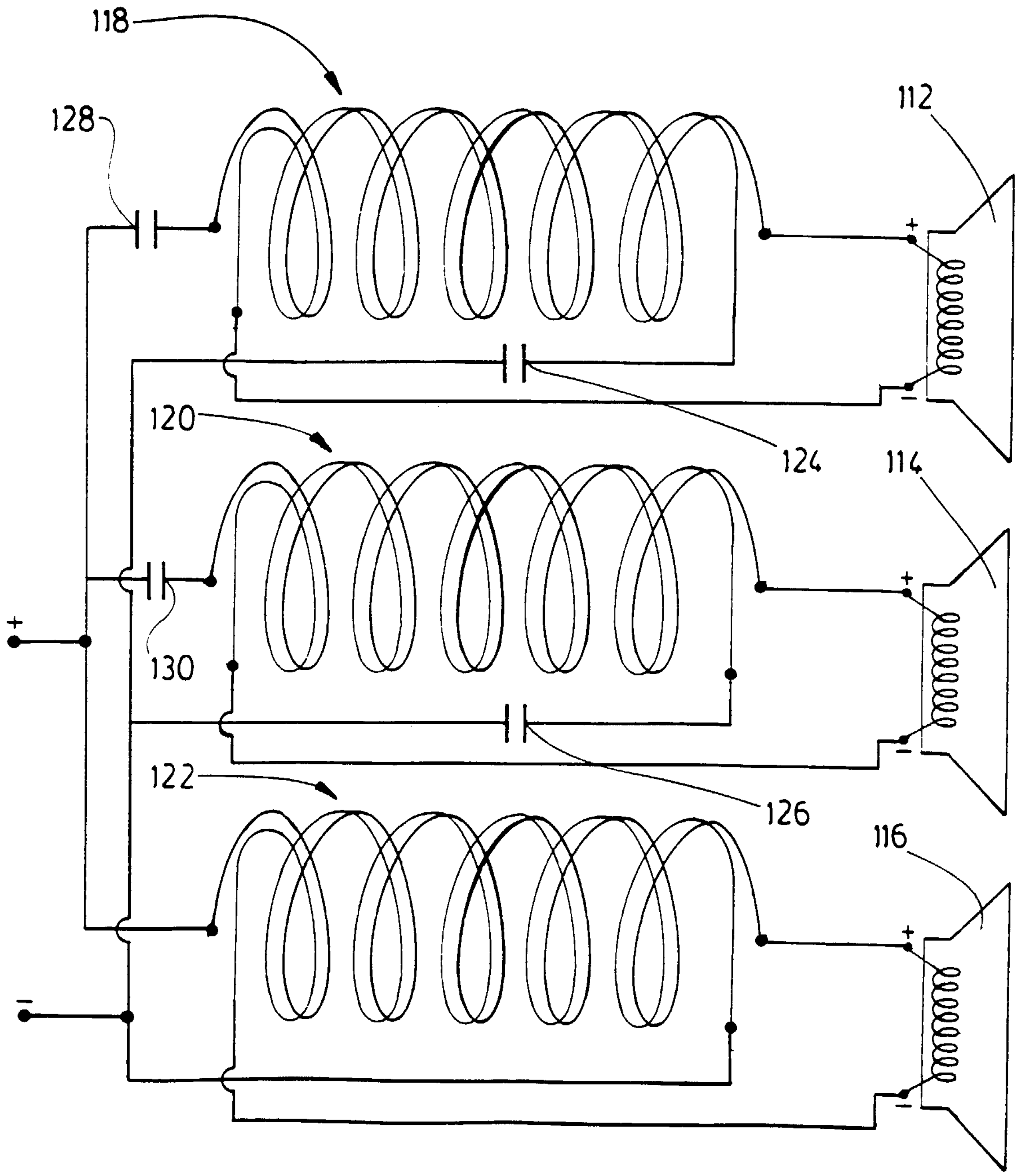

FIG. 7