(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number : **0 616 340 A1**

(12) **EUROPEAN PATENT APPLICATION**

(21) Application number : **94301869.7**

(51) Int. Cl.[5] : **H01B 11/12**

(22) Date of filing : **16.03.94**

(30) Priority : **16.03.93 ZA 931841**

(43) Date of publication of application :
21.09.94 Bulletin 94/38

(84) Designated Contracting States :
AT BE DE DK ES FR GB IT NL SE

(71) Applicant : **Schmid, Walter**
12 South Main Road,
Koregaon Park
Pune 411 001 (IN)

(72) Inventor : **Schmid, Walter**
12 South Main Road,
Koregaon Park
Pune 411 001 (IN)

(74) Representative : **Smith, Philip Antony et al**
REDDIE & GROSE
16 Theobalds Road
London WC1X 8PL (GB)

(54) **A cable for electronic equipment.**

(57) A cable (10) for electronic equipment, includes a first set (12) of elongate electrically conductive elements interspersed with a second set (14) also containing electrically conductive elements. Each member of the first set (12) is electrically connected to every other member of the first set (12) and each member of the first set (12) is electrically insulated from every member of the second set (14). The current flow in the first set (12) is in one direction, and the current flow in the second set (14) is in the opposite direction. This enables the magnetic field, created by the first set (12), to cancel the magnetic field created by the second set (14). The inductivity of the cable (10) is thereby substantially reduced.

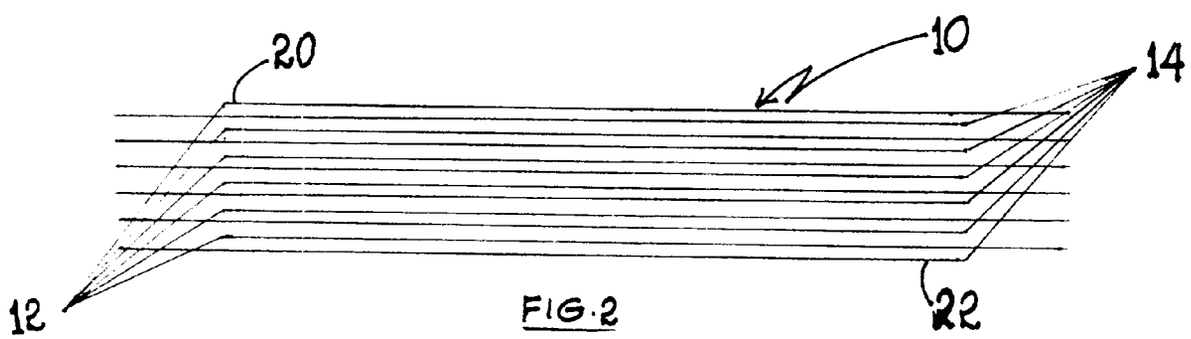

FIG.2

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BACKGROUND OF THE INVENTION

1. Field of the invention

THIS invention relates to cables for electronic equipment. Particularly, this invention relates to low impedance cables for electronic equipment, which can supply high currents with low distortion.

2. Brief description of the prior art

Electronic equipment, such as, loud speakers, need to be supplied with high currents from the amplifier, particularly at low or high frequencies, or both depending upon the loudspeaker. Because of the high current, a certain amount of distortion is created at the final output, as a result of the inductance of the cable and the mechanical vibrations created due to the magnetic field along the length of the cable. The longer the cable, the greater the inductance. The inductance, along with the capacity of the output, such as an electrostatic loud speaker, creates a resonant circuit which results in a distortion in the reproduced frequency and in phase response. This distortion depends upon the length of the cable, the ohmic resistance of the cable, and the magnitude of the capacitive load applied.

OBJECT OF THE INVENTION

In view of the foregoing, it is the aim of the invention to achieve the following objects, either alone or in combination:

to provide a low impedance cable for electronic equipment;

to provide a cable for electrical/electronic equipment which can supply high currents with low distortion;

to provide a cable which attenuates the mechanical vibrations due to the magnetic forces between the conductors; and

to provide a cable which will reduce distortion in the reproduced frequency and phase response in audio circuits.

SUMMARY OF THE INVENTION

According to this invention, there is provided a cable for electronic equipment, which includes a first set containing at least one elongate electrically conductive element interspersed with a second set containing at least one electrically conductive element, each member of the first set being electrically connected to every other member of the first set and each member of the first set being electrically insulated from every member of the second set and each member of the second set being electrically connected to every other member of the second set and being electrically insulated from every member of the first set, in such a manner that the current flow in the first set is in one direction, and the current flow in the second set is in the opposite direction, enabling the magnetic field, created by the first set, to cancel the magnetic field created by the second set, thereby at least substantially reducing the inductivity of the cable.

In accordance with one embodiment of the invention, each set comprises a plurality of elongate electrically conductive elements, typically, six strands of electrically conductive wire. Preferably, the strands are of oxygen-free, single-crystal copper, silver or a super conductor material.

The elongate elements may be flexible, in the form of strands strings, films, foils, or rigid, in the form of flats, and may be sheathed or housed in insulating material. In accordance with a preferred embodiment of the invention, insulating material is provided between each member of each set of the cable. The insulating material may even be air or vacuum or foam.

BRIEF DESCRIPTION OF THE FIGURES

The invention will now be described with reference to the accompanying drawings, in which,

Figure 1 illustrates the general principle of the cable in accordance with this invention;

Figure 2 illustrates a schematic view of a relatively flexible cable, in accordance with the invention;

Figure 3 illustrates a schematic view of a relatively rigid cable, in accordance with the invention;

Figure 4 illustrates a schematic of the cable in which the elements of the set are in the form of sheets or foils;

Figure 5 illustrates a schematic view of the cable in accordance with this invention in which the elements of the set are in a three dimensional array;

Figure 6 illustrates a schematic view of the cable in accordance with this invention in which the elements are in arranged in the form of an annulus; and

Figure 7 illustrates a schematic view of the cable in accordance with this invention in which the elements are coiled in the form of a spiral.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to the drawings, a cable, in accordance with this invention, is indicated generally by the reference numeral 10.

The cable 10 in its basic scheme comprises a first set 12 containing at least one elongate electrically conductive element interspersed with a second set 14 containing at least one electrically conductive element, each member of the set 12 (if the set 12 contains more than one elongate electrically conductive element) being electrically connected to every other

member of the set in such a manner that the current flow in the set 12 is in one direction indicated by the arrow 16, and the current flow in the set 14 is in the opposite direction indicated by the arrow 18. The creation of opposite magnetic fields when a current flows through the cable 10, enables the magnetic field created by the set 12 to cancel the magnetic field created by the set 14 since the current flow in the two sets are in opposite directions thereby substantially reducing the inductivity of the cable 10.

As seen in Figure 2, the cable 10, in accordance with the invention, comprises in its basic scheme, as illustrated in Figure 1, one set 12 of strands 20 being flexible elongate elements and another set 14 of strands 22. The strands 20 of the set 12 are all electrically connected to each other.

Similarly, the strands 22 of the set 14 are electrically connected to each other. As can be seen in Figure 2, the strands 20 of set 12 and the strands 22 of set 14 are interspersed in such a manner that a strand 20 of set 12 alternates with a strand 22 of set 14.

Such interspersion can be achieved by connecting alternate strands or elements in a conventional cable to form the sets 12 and 14. The current flow in one set 12 is opposite in direction to the current flow in the second set 14. Because the wires are intimately coupled by interspersion, the magnetic field induced by one strand in one set is cancelled by the magnetic field induced by its neighbor. This results in cancelling inductivity throughout the length of the cable. Increasing the number of strands in each set reduces the inductance value.

Figure 3 illustrates a rigid cable in which the strands are in the form of rigid flat elements 24 and 26 to form sets 12 and 14 respectively. The elements 24 and 26 are electrically connected and interspersed in the same manner as described in the foregoing description for Figure 2.

In both cases, that is, whether the elongate elements are flexible or rigid, preferably, the elongate elements can be sheathed in an insulating medium to reduce the internal resistance of the cable as well as its inductivity. The resonance effects can be reduced to such an extent that it lies beyond the audible range and therefore, distortion of reproduced sound is attenuated.

Figure 4 illustrates a flat flexible resilient cable 10 in which the sets 12 and 14 are made up of insulated foils, sheets or films . The elements of each set are electrically connected by soldering or other means outside the core conductive area designated by the block 30.

Figure 5 illustrates a three dimensional array of elements 32 and 34 of the sets. The advantage of a three dimensional array is that each of the elements of each set is coupled more intimately than in a two dimensional configuration because each element is is surrounded on three or even all sides, depending upon the depth of the array.

Figure 6 illustrates another alternative configuration of the cable 10 in which the elements comprise tubes or sleeves alternately place annularly around one another. For instance the set of elements 36 are electrically connected and the set of elements 38 are electrically connected in accordance with the teachings of this invention.

Figure 7 illustrates the preferred embodiment of the invention in which the elements 40 and 42 are coiled in the form of a continuous spiral, with insulation layers 44 and 46 interspersed between the elements and between the sets respectively. In this configuration the inductance will be almost completely cancelled because the elements are very intimately coupled. The other advantage of such a configuration is that the mechanical resonance is very low and therefore distortion is attenuated to a great extent.

Claims

1. A cable for electronic equipment, which includes a first set containing at least one elongate electrically conductive element interspersed with a second set containing at least one electrically conductive element, each member of the first set being electrically connected to every other member of the first set and each member of the first set being electrically insulated from every member of the second set and each member of the second set being electrically connected to every other member of the second set and being electrically insulated from every member of the first set, in such a manner that the current flow in the first set is in one direction, and the current flow in the second set is in the opposite direction, enabling the magnetic field, created by the first set, to cancel the magnetic field created by the second set, thereby at least substantially reducing the inductivity of the cable.

2. A cable for electronic equipment as claimed in Claim 1, in which said each set comprises a plurality of elongate electrically conductive elements.

3. The cable for electronic equipment as claimed in Claim 1 or Claim 2, in which the conductive elements are strands of oxygen-free, single-crystal copper.

4. A cable for electronic equipment, as claimed in Claim 1, in which the elongate elements are rigid in the form of flats.

5. A cable for electronic equipment, as claimed in

Claim 1, in which each of the conductive elements of each set are in the form of a film or foil.

6. A cable for electronic equipment as claimed in Claim 1, in which the members of each set are arranged in a three dimensional array.

7. A cable for electronic equipment as claimed in Claim 1, in which each set contains one conductive film type element insulated from the conductive element of the other set and both conductive elements are coiled in the form of a spiral to form an elongate element.

8. A cable for electronic equipment as claimed in any one of the preceding claims, in which each member of the first and the second set is sheathed or housed in insulating material.

9. A cable for electronic equipment as described herein with reference to the accompanying drawings.

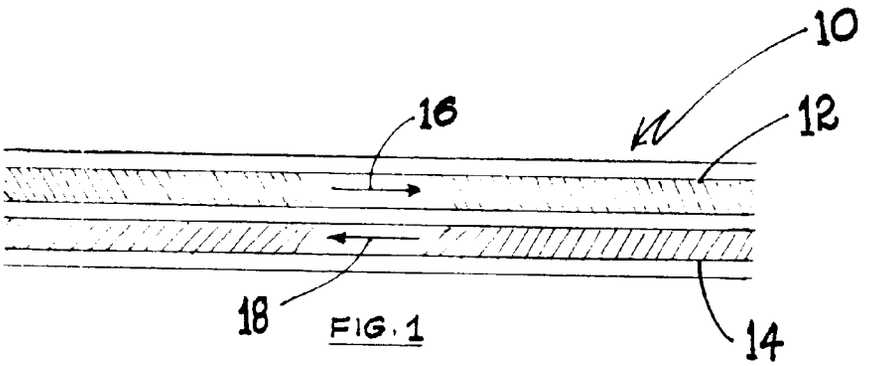

FIG. 1

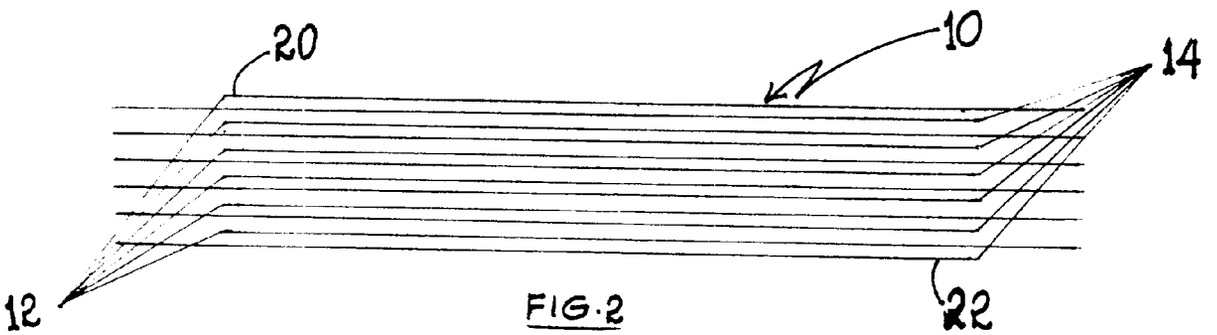

FIG. 2

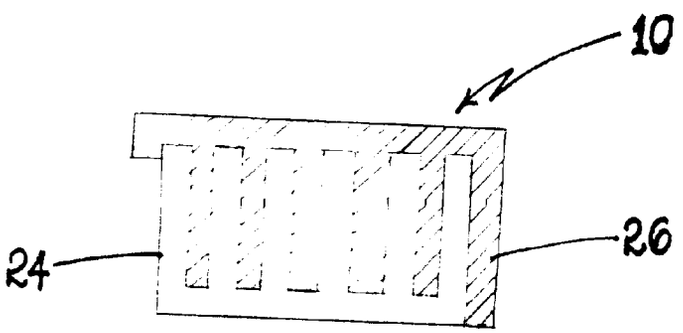

FIG. 3

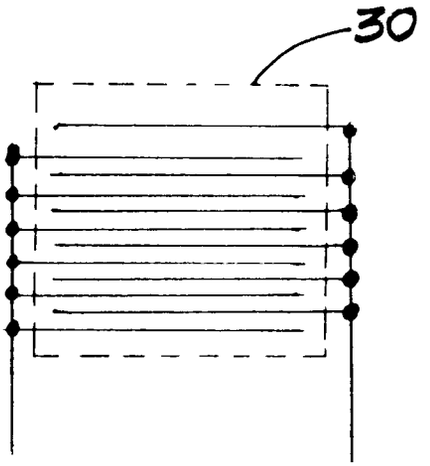

FIG. 4

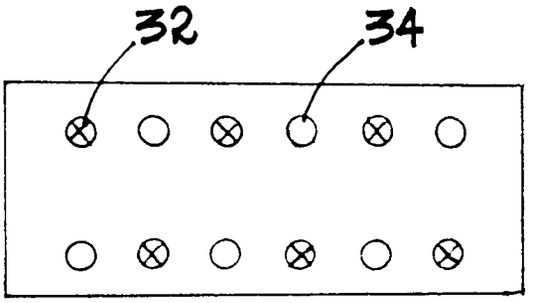

FIG. 5

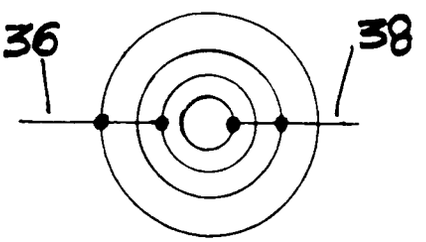

FIG. 6.

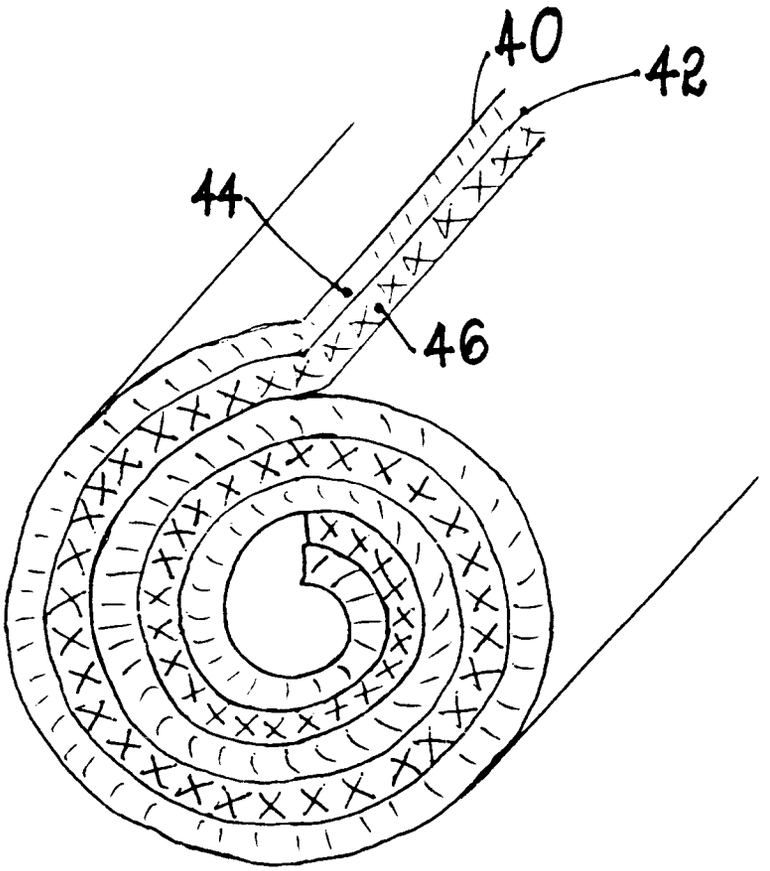

FIG. 7

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 94 30 1869

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.5)
X	US-A-5 122 924 (OKUMURA) * column 3, line 32 - column 5, line 29; figures 3-7 *	1,2,5,6, 8,9	H01B11/12
A	US-A-4 808 773 (CRANDALL) * claims 1-6; figures 4-7 *	1,5-8	
			TECHNICAL FIELDS SEARCHED (Int.Cl.5)
			H01B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	12 July 1994	Demolder, J

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
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