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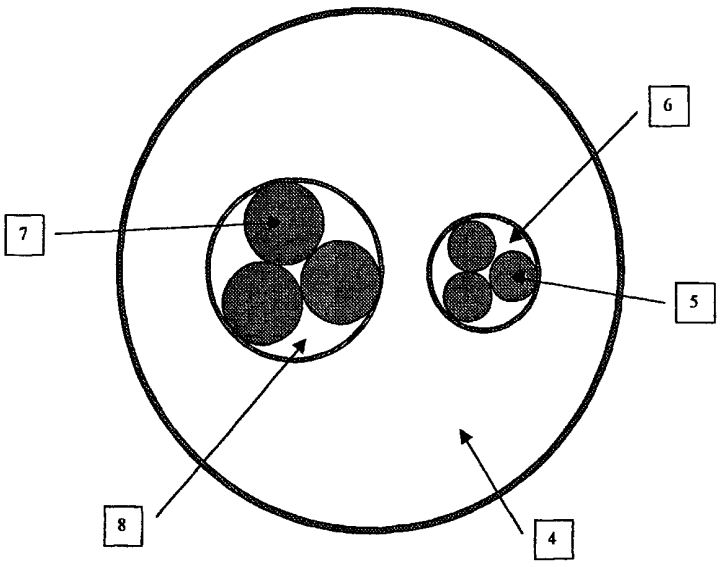
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(54) Title: A SPECIFIC CABLE RATIO FOR HIGH FIDELITY AUDIO CABLES



(57) **Abstract:** Au audio cable in which the return, negative or cold conductor is greater in overall cross sectional area and mass than the signal, positive or hot conductor, based on a specific ratio that balances the flow of electrons, enhances electron movement and as a result improves signal transmission. The ratio is based firstly on the cross sectional area of each signal core/s in relation to each return core/s, and secondly on the diameter of each signal strand in relation to each return strand. The ratio works effectively whether there are one or more strands in each conductor. For cables where the diameter of each strand is the same for both signal and return, the ratio is based on cross sectional area only. For cables comprising conductor strands other than round i.e. square, flat, rectangular, tubular etc. and so long as the same shape is used in both signal and return then the ratio is based on cross sectional area.

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A specific cable ratio for high fidelity audio cables

This invention relates to an improvement in the handling of reactance, improved electron flow balance, enhanced electron movement and subsequent improved sound quality in a high fidelity audio cable design to be used as an interconnect cable with phono or RCA type plug termination (connecting two pieces of electronic equipment such as CD or DVD player to pre-amplifier, pre-amplifier to amplifier etc) and loudspeaker cable (connecting amplifier to loudspeaker) for audio and home theatre applications. The invention is also effective for other audio cable applications such as microphone leads, patch cords and the like, video and digital cables and AC power cables. Furthermore the invention can be used effectively for copper traces for audio circuit boards and in some audio connecting hardware such as RCA type phono plugs and sockets, and spade connectors wherever a signal and return conductor are involved.

As such, this invention has particular but not exclusive application to high fidelity audio cables, and for illustrative purpose reference will be made to such application.

Research and listening tests have shown that the cable used between components can have a significant impact on the overall sound of a high fidelity system.

Many high fidelity cable products however are expensive, complex designs that are difficult to manufacture and appeal to an elite band of enthusiasts.

The complexity of the cable designs come about as designers seek to electrically optimize cables by reducing distortion and coloration to a minimal level. Two types of distortion that are recognized as being problematic are inductive reactance and capacitive reactance.

Variable current flow in a conductor generates inductance and capacitance as well as inductive reactance and capacitive reactance. Inductive reactance is directly proportional to frequency. So, when frequency increases, inductive reactance also increases. Capacitive reactance is inversely proportional to frequency. In other words, as frequency increases, capacitive reactance decreases.

In an audio cable where the signal and return have the same strand number, strand size and mass, the overall inductive and capacitive reactance characteristics are increased (i.e. a doubling effect where reactance in the signal is combined with the reactance in the return) and as such the reactive resistance to each frequency is not balanced. This leads to smearing of sound, harshness and poor sound staging characteristics.

The present invention overcomes problems of reactance in high fidelity audio cables by speeding up the flow of electrons in the return conductor and balancing the reactive characteristics between signal and return. This is achieved by increasing the mass in the return conductor in relation to the mass of the signal conductor by using a specific ratio. When the mass of the return conductor is greater than the mass in the signal conductor the resistance of the return is significantly lower (than that of the signal) thereby providing a faster pathway for electrons to travel.

The return conductor is by its nature always responding to the signal conductor because it is constantly in delay mode. In the present invention the increased size and mass of the return conductor enables the return to respond more rapidly to the signal allowing an unimpeded and speedy flow of electrons.

By enhancing the flow of electrons in the cable, problems such as capacitive and inductive reactance appear to be diminished. A useful analogy is wind effect on a speeding bullet. The faster the bullet, the less influence wind has on its movement.

When using the ratio, the electron flow between signal and return conductors also appears more evenly balanced, with electrons at all frequencies travelling at the same apparent speed.

The subjective benefits of the ratio as implemented in an appropriate audio cable is a clean, controlled sound that is low in coloration and distortion. The sound stage is also improved in the areas of dimensionality and separation.

The ratio at the heart of the present invention is a ratio of firstly the cross sectional area of the signal core in relation to the return core, and secondly the diameter of each electrically conductive strand in the signal in relation to the return, where the mass is intentionally increased in the return core.

The present invention relates to a cable with cores defined as the following:

1: A single strand within an insulated jacket hereinafter called "solid core".

2: A multi-strand core comprising non-insulated strands grouped together within an insulated jacket hereinafter called "multi-strand core".

3: Multiple strands individually insulated which may be grouped together within an insulated jacket hereinafter called "Litz style core".

4: Any of the above where the signal conductor core is shielded by a braided or foil shield as in a coaxial configuration, hereinafter called "shielded core".

The ratio of cross sectional area of the total signal core in relation to the total return core for solid cores, multi-strand cores and Litz-style cores is between 1: 2.6 and 1: 3.6 with the preferred ratio being 1: 2.77.

When using a shielded core, the preferred ratio of cross sectional area of the total signal core in relation to the total return core is 1: 3.188.

The increase in ratio used for a shielded core (for example coaxial style 75 Ohm or 110 Ohm video or digital cable) appears to be due to a capacitive

and/or inductive effect caused by an interaction between signal conductor and the surrounding shield, and return conductor and the shield.

The ratio of stranding size of individual solid strand/s within the signal core in relation to individual solid strand/s within the return core of solid cores, multi-strand cores and Litz-style cores, and based on the diameter of each strand, is 1: 1.6 to 1: 1.9, with the preferred ratio being 1: 1.675. When using a shielded core, the preferred ratio is 1: 1.786.

The preferred high fidelity audio cable design is one that uses the cross sectional area ratio and the diameter ratio together.

For cables comprising multi-strand cores or Litz style cores and where the diameter of each individual strand is the same for both signal and return, the ratio is based on the cross sectional area between the signal and return core and is between 1: 2.6 to 1: 3.6 with the preferred ratio being 1: 2.77. When using a shielded core, the preferred ratio is 1: 3.188.

Using the ratio with multi-strand cores or Litz style cores, the signal transmission appears to improve when the least number of strands are used. From our understanding of reactance this makes sense: less strands means that less reactance distortion effects are generated. Further, when using multi-strand cables, small diode or rectification effects arise from imperfect contact among the strands. Again, fewer strands are better.

For cables comprising conductor strands other than round i.e. square, flat, rectangular, tubular etc and so long as the same shape is used in both signal and return then the ratio is based on cross sectional area.

There are currently five types of geometry's utilized in high fidelity audio cables, the coaxial, the twisted pair, the woven, the helical pair and the parallel pair.

The present invention is preferably utilized in a parallel configuration (not necessarily parallel pair configuration) where each conductive core needs to be laid beside each other and not twisted together.

Twisting of cores increases inductive and capacitive reactance in cables. However, where specific impedance is required i.e. 75 Ohm or 110 Ohm for digital and video use, then cores may be twisted to achieve the desired impedance.

To date, there has not been a high fidelity audio cable design that addresses and minimizes the effects of the above mentioned reactance problems by using a specific ratio as per the present invention. There is therefore a need for this invention.

In order that this invention may be more easily understood and put into practical effect, reference will now be made to the accompanying drawings which illustrate the embodiment of the invention using the ratio, wherein: -

FIGURE 1 is a cross-sectional end view of an audio cable that is constructed in accordance with the present invention utilizing one solid core for both the signal and return conductors.

FIGURE 2 is a cross-sectional end view of an audio cable that is constructed in accordance with the present invention utilizing multi-strand conductors in both signal and return cores.

FIGURE 3 is a cross-sectional end view of an audio cable that is constructed in accordance with the present invention utilizing multi-strand conductors wherein each strand is of the same diameter in both signal and return cores.

FIGURE 4 is a cross-sectional end view of an audio cable that is constructed in accordance with the present invention utilizing Litz style cores

where the shaded cores are signal cores, and non-shaded cores are return cores.

FIGURE 5 is a cross-sectional end view of an audio cable that is constructed in accordance with the present invention utilizing Litz style cores where each core is of the same diameter, and where the shaded cores are signal cores, and non-shaded cores are return cores.

FIGURE 6 is a cross-sectional end view of an audio cable that is constructed in accordance with the present invention utilizing Litz style cores for both signal and return cores.

FIGURE 7 is a cross-sectional end view of a balanced audio cable that is constructed in accordance with the present invention utilizing one solid core for both the signal and return conductors, together with a ground core (either multi-strand or solid core).

FIGURE 8 is a is a cross-sectional end view of an audio cable that is constructed in accordance with the present invention in a coaxial or shielded configuration using one solid core conductor for both signal and return.

FIGURE 9 is an isometric view of an audio cable that is constructed in accordance with the present invention showing the signal and return cores laid in a parallel configuration.

Referring to FIGURE 1, which comprises one solid core for both the signal and return conductors, the parts shown are signal conductor 1, return conductor 2, conductor insulation material 3, and solid filler material 4.

Return conductor 2 has a greater cross-sectional area, diameter and hence mass than signal conductor 1 based on the preferred cross-sectional area ratio of 1: 2.77 and preferred diameter ratio of 1: 1.675.

Conductor insulation material 3 is preferably a low dielectric material such as polypropylene or Teflon while solid filler material 4 is preferably a soft, flexible PVC or equivalent material used to hold the cores in a parallel configuration.

Referring to FIGURE 2, which comprises multi-strand conductors in both signal and return cores, the parts shown are signal conductive strands 5, signal core 6, return conductive strands 7 and return core 8.

Return core 8 has a greater cross-sectional area (that is achieved by adding together the cross sectional areas of all three strands) than signal core 6 based on the preferred cross-sectional area ratio of 1: 2.77. Each individual return conductive strand has a greater diameter than each individual signal conductive strand based on the preferred diameter ratio of 1: 1.675.

Referring to FIGURE 3, which comprises multi-strand conductors in both signal and return cores wherein the diameter of each individual strand in the signal and return cores is the same. The parts shown are signal strands 9, signal core 10, return strands 11 and return core 12.

When the diameter of each strand in the signal and return cores has the same diameter, then the return core 12 is greater in total cross-sectional area than the signal core 10 based on the preferred cross-sectional area ratio of 1: 2.77.

Referring to FIGURE 4, which comprises Litz style cores in both signal and return, the parts shown are signal conductive cores 13 (shaded), return conductive cores 14 (non-shaded) and inner insulation or shield (braid or foil) 15.

Return cores 14 have a greater total cross-sectional area than signal cores 13 based on the preferred cross-sectional area ratio of 1: 2.77. Each individual return conductive core has a greater diameter than each individual signal conductive core based on the preferred diameter ratio of 1: 1.675.

FIGURE 4 is also an example of how shielding can be incorporated into a cable using the ratio.

Referring to FIGURE 5, which comprises Litz style cores wherein the diameter of each individual core in the signal and return is the same. The parts shown are signal cores 16 (shaded), and return cores 17 (non-shaded).

When the diameter of each individual core in the signal and return cores has the same diameter, then the total cross-sectional area of return cores 17 is greater than the total cross-sectional area of signal cores 16 based on the preferred cross-sectional area ratio of 1: 2.77.

Referring to FIGURE 6, which comprises Litz style conductors in both signal and return cores, the parts shown are signal conductive strands 18, signal core 19, return conductive strands 20 and return core 21.

Return core 21 has a greater cross-sectional area than signal core 19 based on the preferred cross-sectional area ratio of 1: 2.77. Each individual return conductive strand 20 has a greater diameter than each individual signal conductive strand 18 based on the preferred diameter ratio of 1: 1.675.

Referring to FIGURE 7, which comprises one, solid core for both the signal and return conductors plus one independent solid core or multi-strand core as ground for use in creating a balanced cable connected to XLR plugs. The parts shown are signal conductor 1, return conductor 2 and ground 22.

Return core 2 has a greater cross-sectional area, diameter and hence mass than signal core 1 based on the preferred cross-sectional area ratio of 1: 2.77 and preferred diameter ratio of 1: 1.675. Ground core 22 can be either a solid core or multi-strand core of any diameter, and is not involved in the calculation of the ratio.

Referring to FIGURE 8, which comprises one solid core for both the signal and return conductors, where the signal core is surrounded by a coaxial type shield. Parts shown are signal core 23, return core 24, coaxial shield 25 and dielectric insulation material 26.

Return core 24 has a greater cross-sectional area, diameter and hence mass than signal core 23 based on the preferred cross-sectional area ratio of 1: 3.188 and preferred diameter ratio of 1: 1.786.

Coaxial shield 25 can be designed to provide specific impedance matching i.e. 75 Ohm or 110 Ohm to suit video or digital cables. Return core 24 may or may not be connected to the coaxial shield at either end or continuously along its length.

Referring to FIGURE 9, which comprises an isometric view of an audio cable showing the signal and return cores lying parallel to each other, and kept in a parallel position by means of a filler material. The parts shown are signal conductor 1, return conductor 2 and filler material 4.

Positioning the conductors in a parallel configuration helps minimize inductance and is the preferred means of cable construction when using the ratio.

It will of course be realized that the above has been given only by way of illustrative example of the present invention and that all such modifications and variations thereto as would be apparent to persons skilled in the art are deemed to fall within the broad scope and ambit of this invention as is herein before defined in claims.

Claims

1. A high fidelity audio cable comprising solid cores, multi-strand cores or Litz style cores of electrically conductive material such that the ratio of the cross sectional area in the signal core in relation to the return core is between 1: 2.6 and 1: 3.6 (with the preferred ratio being 1: 2.77) and the ratio of the diameter of each strand is between 1: 1.6 and 1: 1.9 (with the preferred ratio being 1: 1.675).

2. The cable of claim 1 wherein the cross sectional area of each core and the diameter of each strand of electrically conductive material is dependent on the effective current carrying capacity required i.e. for low-current, low-voltage signals (up to 2 volts at 250 milli-amps or so) typical of interconnect leads, and for large signals of up to several hundred watts or more, which applies to cables connecting amplifiers to loudspeakers.

3. The cable of claim 1 wherein the conductive core or cores are laid beside each other in a parallel configuration i.e. not twisted.

4. The cable of claim 1 wherein the conductive cores are twisted together to create a specific impedance i.e. 75 Ohm or 110 Ohm to suit video or digital requirements.

5. The cable in claim 1 configured as a single ended design terminated in RCA type connectors, or balanced design incorporating an additional ground conductor and terminated in XLR connectors.

6. A high fidelity audio cable comprising multi-strand or Litz style cores of electrically conductive material such that the diameter of each individual solid strand is the same in both signal and return cores and the ratio of the cross sectional area of the signal core in relation to the

return core is between 1: 2.6 and 1: 3.6 (with the preferred ratio being 1: 2.77).

7. The cable of claim 6 wherein the cross sectional area of each core and the diameter of each strand of electrically conductive material is dependent on the effective current carrying capacity required i.e. for low-current, low-voltage signals (up to 2 volts at 250 milli-amps or so) typical of interconnect leads, and for large signals of up to several hundred watts or more, which applies to cables connecting amplifiers to loudspeakers.

8. The cable of claim 6 wherein the conductive core or cores are laid beside each other in a parallel configuration i.e. not twisted.

9. The cable of claim 6 wherein the conductive cores are twisted together to create a specific impedance i.e. 75 Ohm or 110 Ohm to suit video or digital requirements.

10. The cable in claim 6 configured as a single ended design terminated in RCA type connectors, or balanced design incorporating an additional ground conductor and terminated in XLR connectors.

11. A high fidelity audio cable comprising a shielded signal core and unshielded return core of electrically conductive material, such cores being either solid cores, multi-strand cores or Litz style cores, and such that the ratio of the cross sectional area in the signal core in relation to the return core is between 1: 2.6 and 1: 3.6 (with the preferred ratio being 1: 3.188) and the ratio of the diameter of each strand is between 1: 1.6 and 1: 1.9 (with the preferred ratio being 1: 1.786).

12. The cable of claim 11 wherein the cross sectional area of each core and the diameter of each strand of electrically conductive material is dependent on the effective current carrying capacity required i.e. for

low-current, low-voltage signals (up to 2 volts at 250 milli-amps or so) typical of interconnect leads and for large signals of up to several hundred watts or more, which applies to cables connecting amplifiers to loudspeakers.

13. The cable of claim 11 wherein the conductive core or cores are laid beside each other in a parallel configuration i.e. not twisted.

14. The cable of claim 11 wherein the signal conductive core is placed within a coaxial type shield to create a specific impedance i.e. 75 Ohm or 110 Ohm to suit video or digital requirements.

15. The cable in claim 11 configured as a single ended design terminated in RCA type connectors, or balanced design incorporating an additional ground conductor and terminated in XLR connectors.

Figure 1

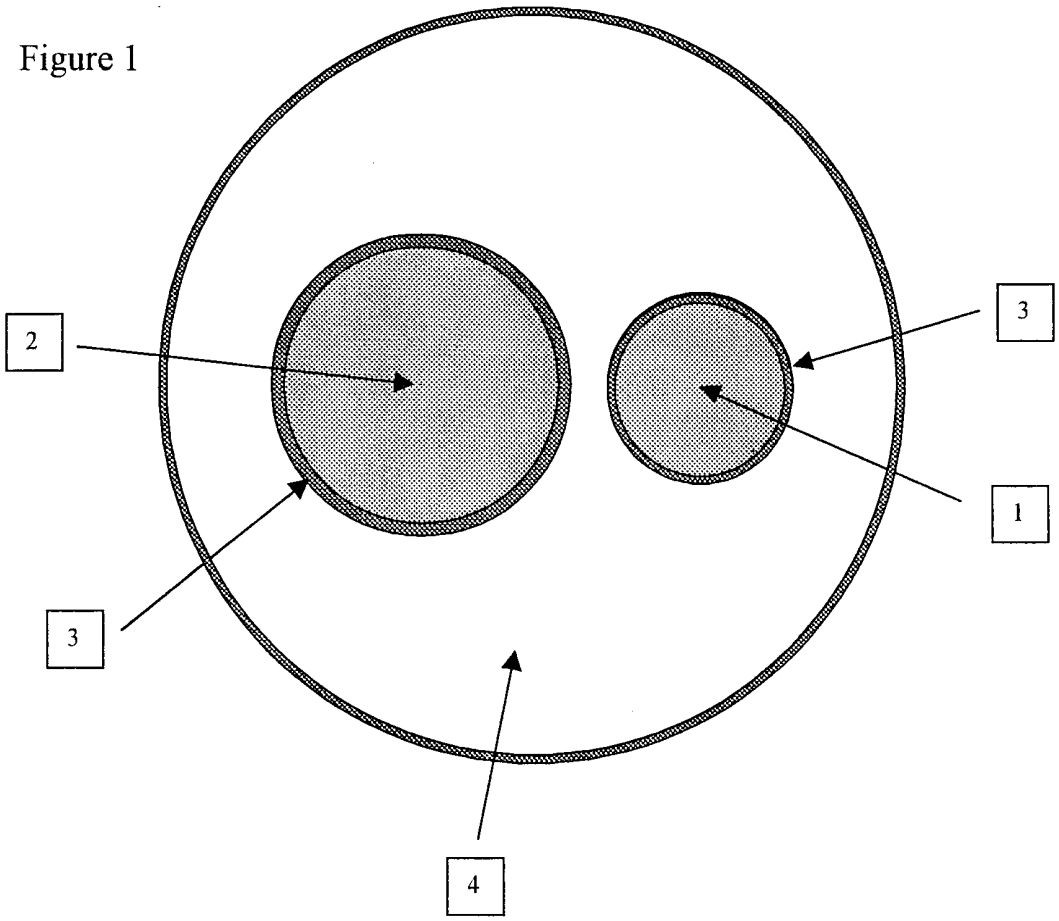


Figure 2

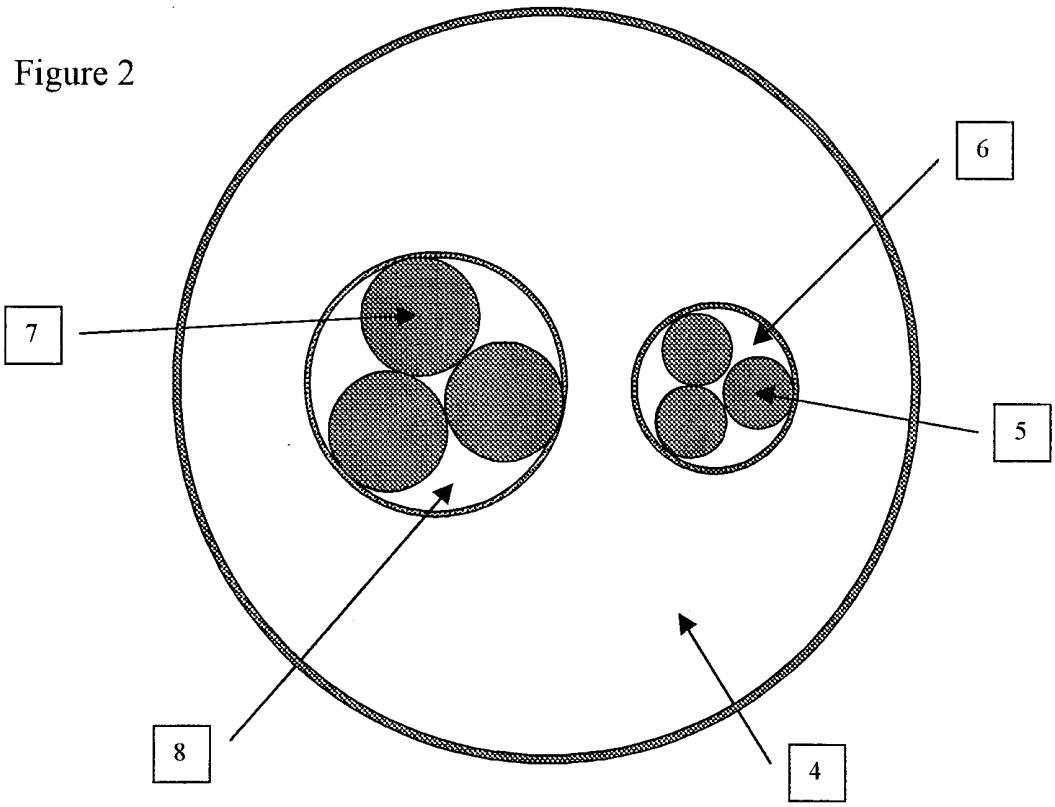


Figure 3

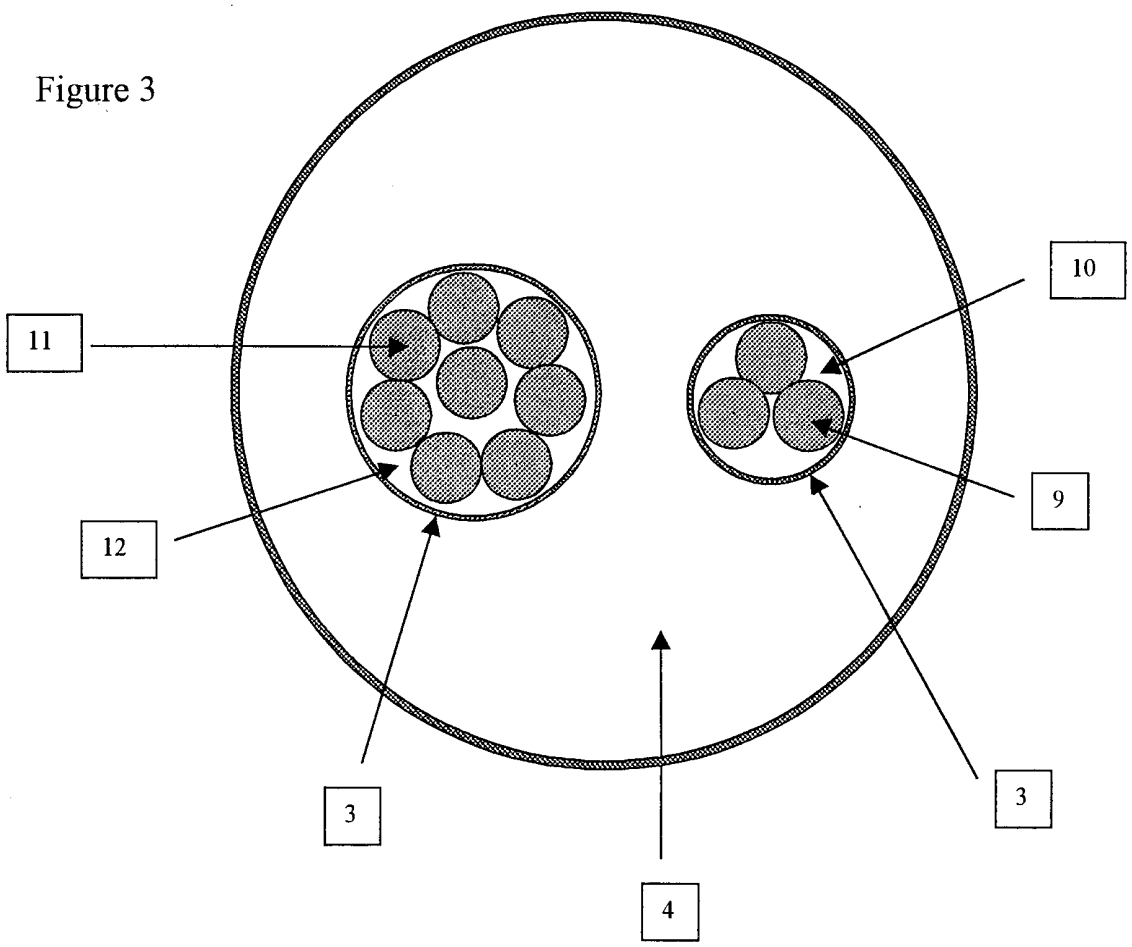


Figure 4

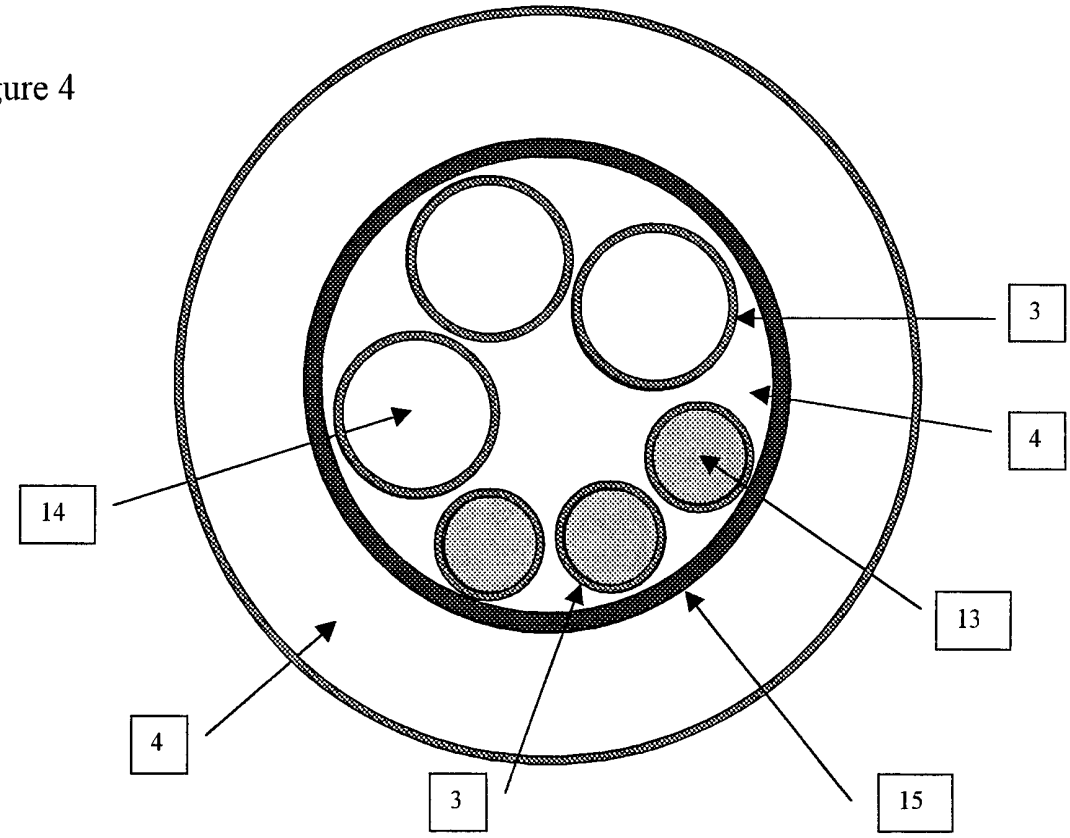


Figure 5

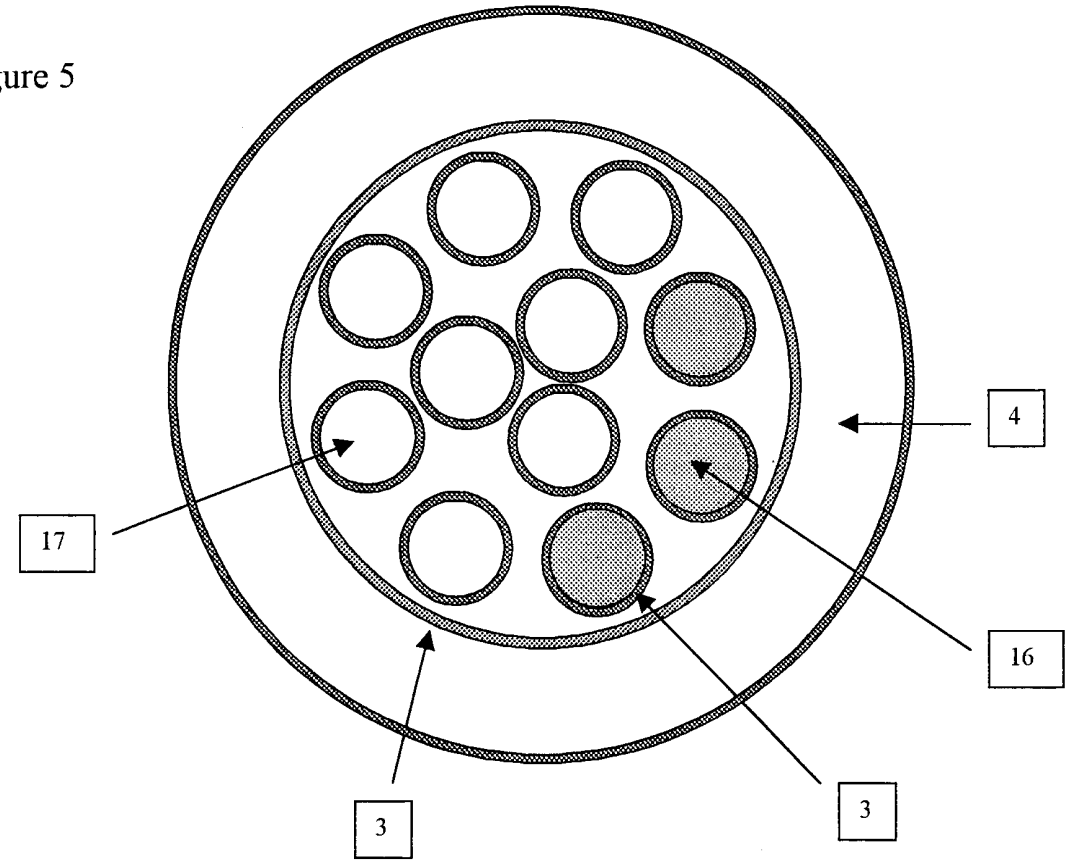


Figure 6

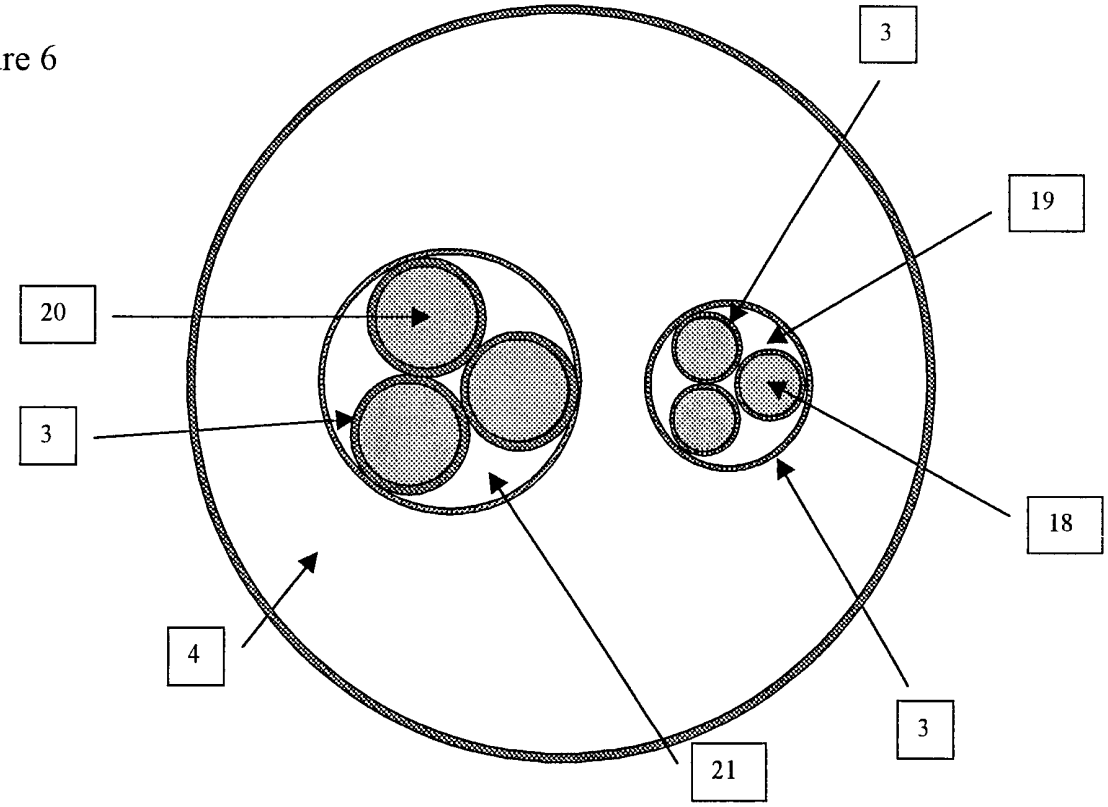


Figure 7

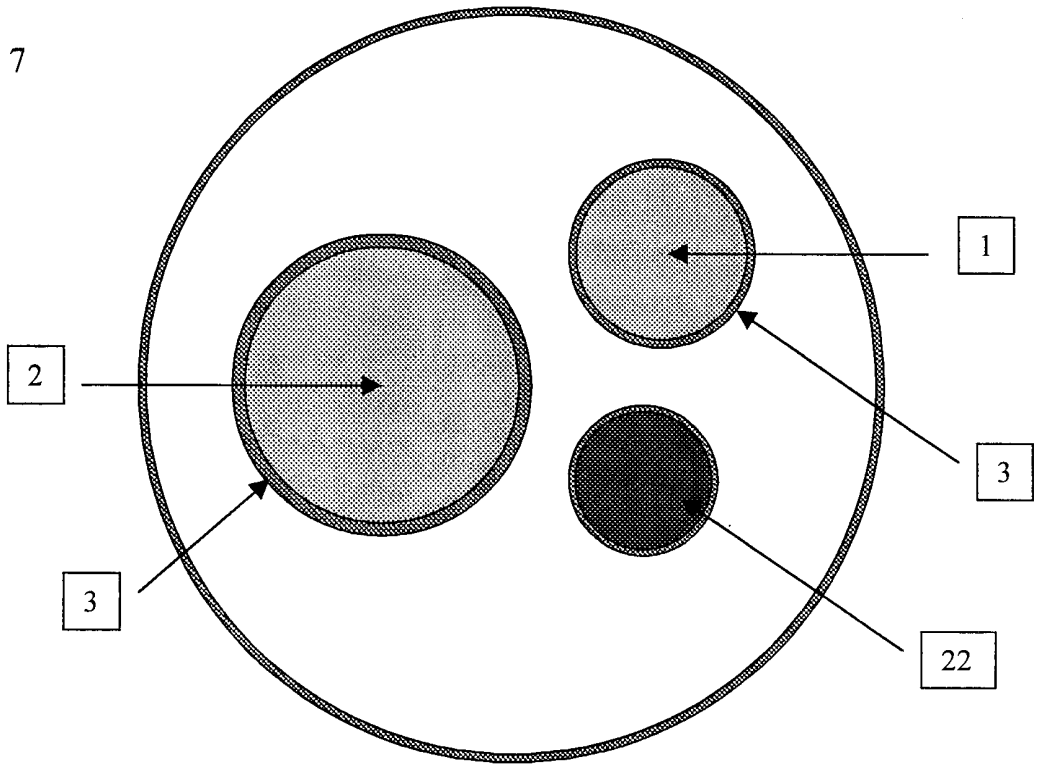


Figure 8

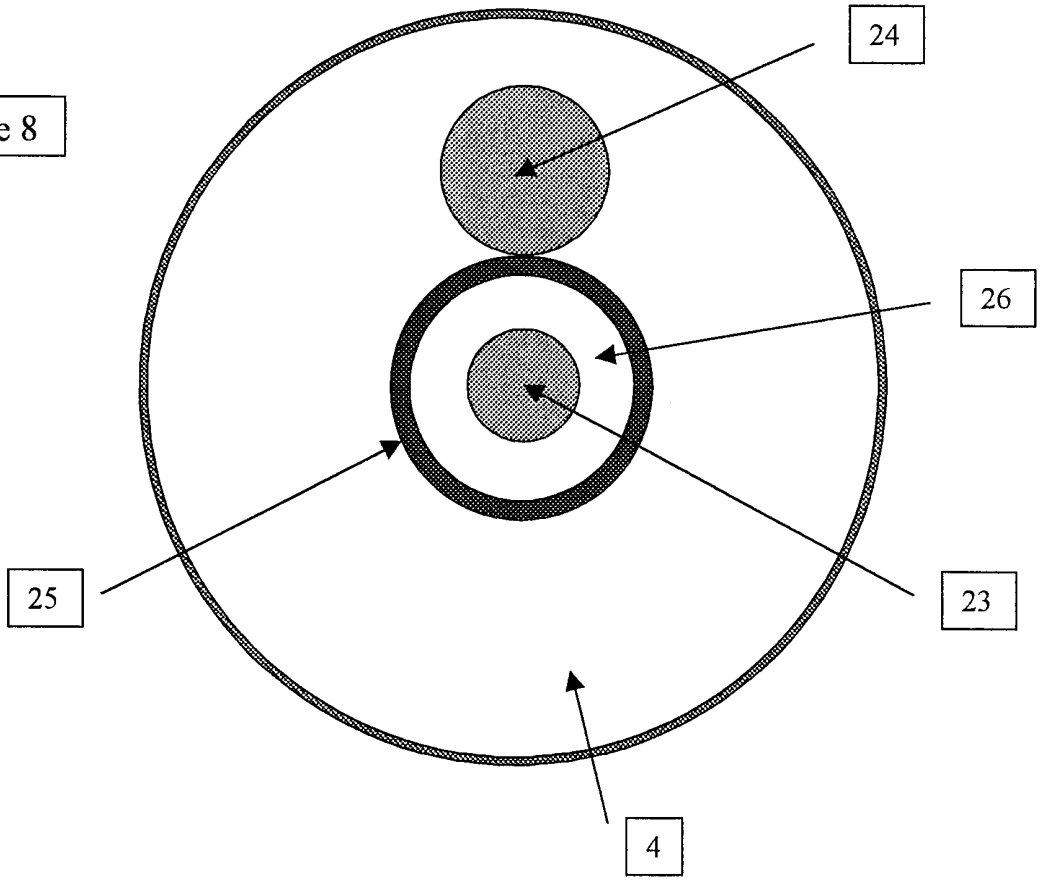
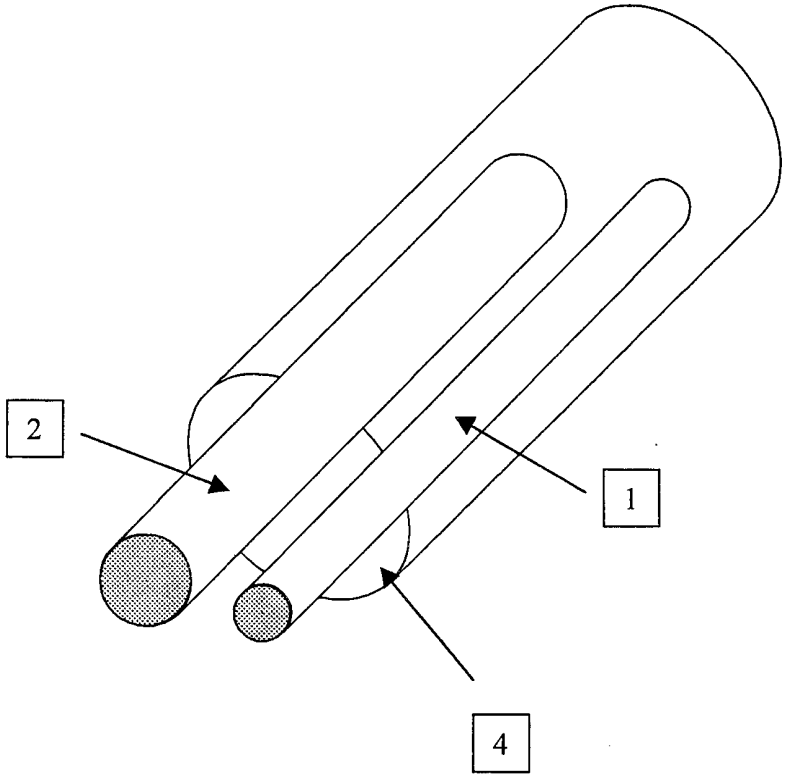


Figure 9



INTERNATIONAL SEARCH REPORT

International application No.
PCT/AU00/00139

A. CLASSIFICATION OF SUBJECT MATTER

Int. Cl. [7]: H01B 7/00, 11/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
H01B 5/-, 7/-, 11/-

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
AU: IPC AS ABOVE

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
WPAT, JAPIO, USPTO: Keywords

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	DE 29719702 U1 (MAGRIS). 6 May 1999. See entire document.	1-10
A	DE 4336280 C1 (GRONEBERG) 23 March 1995. See whole document.	1-10
A	DE 3908830 A (RODER) 20 September 1990. See entire document.	1-10
A	EP 22594 A (PHILIPS GLOEILAMPEN NV) 21 January 1981. See whole document.	1-10

☐ Further documents are listed in the continuation of Box C ☒ See patent family annex

* Special categories of cited documents:

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
10 March 2000	17 MAR 2000
Name and mailing address of the ISA/AU	Authorized officer
AUSTRALIAN PATENT OFFICE PO BOX 200, WODEN ACT 2606, AUSTRALIA E-mail address: pct@ipaustralia.gov.au Facsimile No. (02) 6285 3929	**F.C.PEARSON** Telephone No : (02) 6283 2195

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/AU00/00139

This Annex lists the known "A" publication level patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent Document Cited in Search Report		Patent Family Member					
DE	3908830	EP	416071	WO	90/11604		
EP	22594	CA	1152589	JP	56013611	NL	7905279
		US	4358636				

END OF ANNEX