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Bessette

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[54] **HIGH DENSITY ISOLATED MULTI-CHANNEL MAGNETIC CIRCUIT TRANSDUCER**

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[52] **U.S. Cl.** .... **179/100.2 C**
[51] **Int. Cl.** **G11b 5/20,** G11b 5/28
[58] **Field of Search** .... 179/100.2 C, 100.2 K; 340/174.1 F; 346/74 MC

[56] **References Cited**

UNITED STATES PATENTS

2,835,743 5/1958 Muffley .... 179/100.2 C

FOREIGN PATENTS OR APPLICATIONS

882,779 11/1961 Great Britain .... 179/100.2 C

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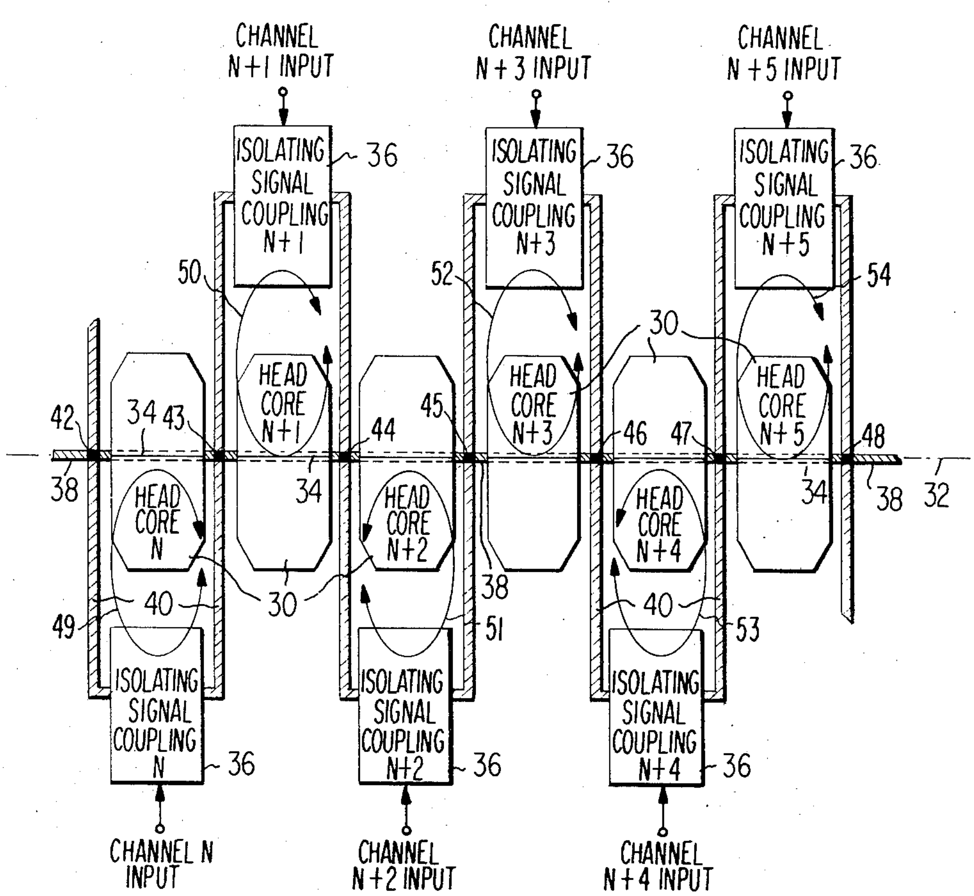
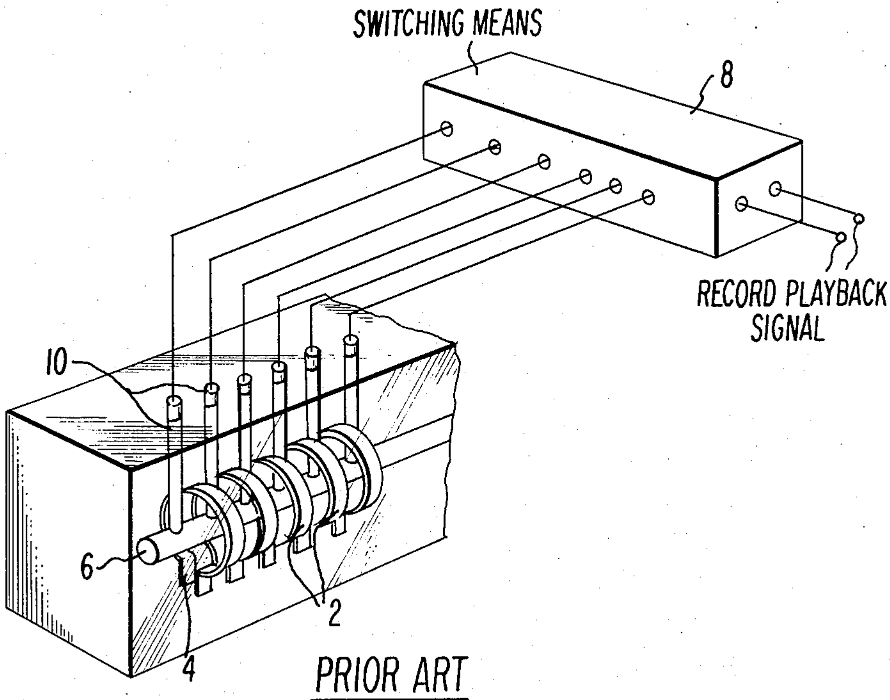
[57] **ABSTRACT**

An arrangement is disclosed for minimizing cross talk between adjacent transducer elements in a compact multi-element transducer assembly. This is accomplished by provision of a multi-element transducer assembly structure wherein common impedance connections for energizing adjacent transducer elements are avoided.

5 Claims, 5 Drawing Figures





PRIOR ART

Fig. 1

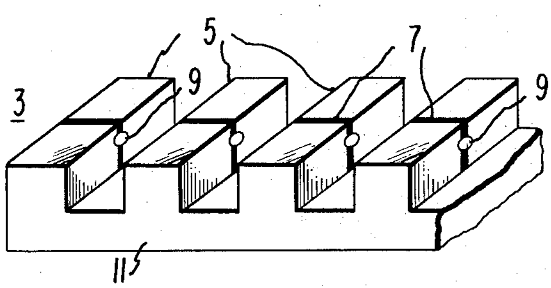


Fig. 2a

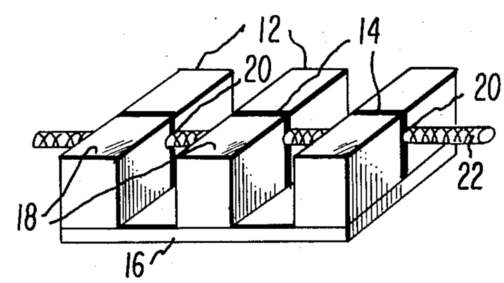


Fig. 2b

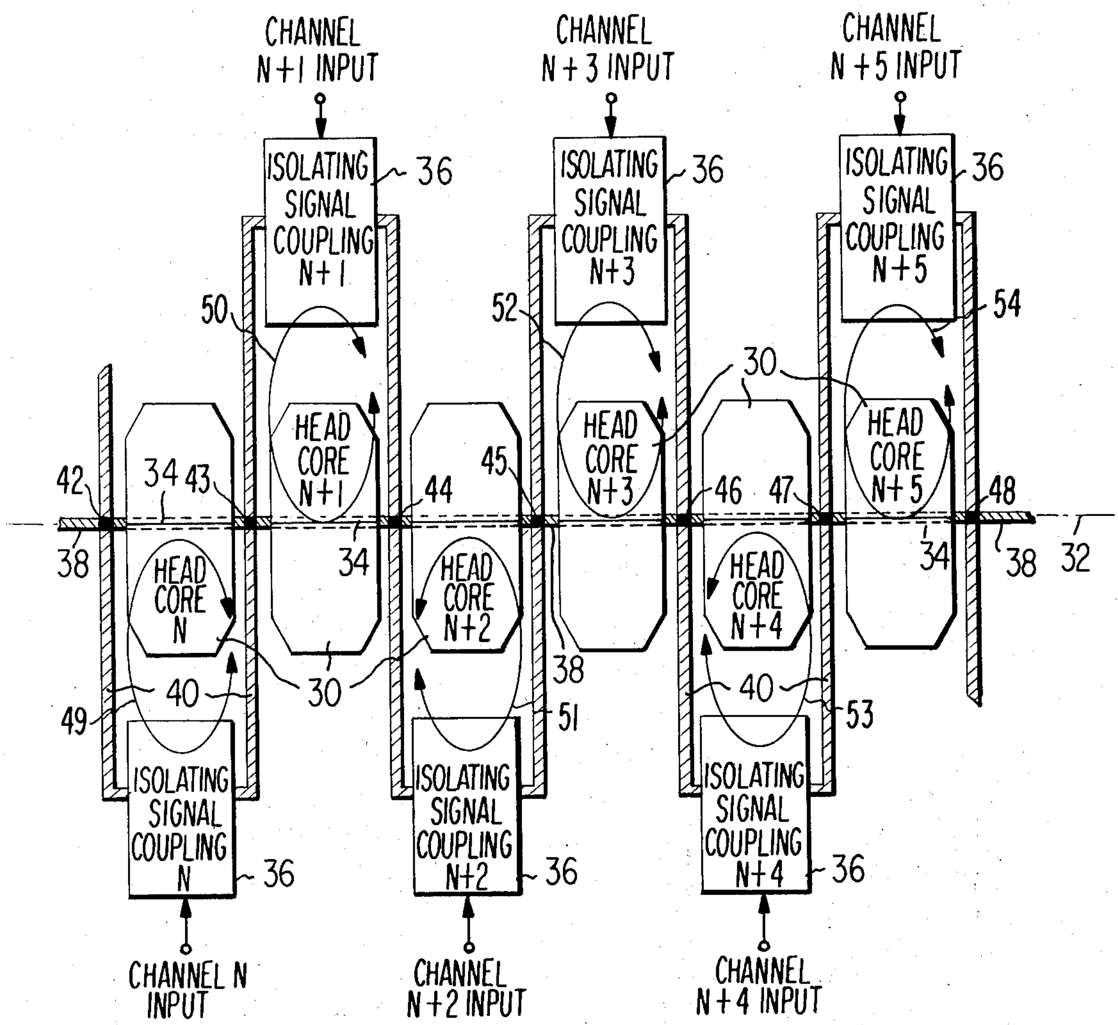

CHANNEL N+1 INPUT
CHANNEL N+3 INPUT
CHANNEL N+5 INPUT
ISOLATING SIGNAL COUPLING N+1
ISOLATING SIGNAL COUPLING N+3
ISOLATING SIGNAL COUPLING N+5
36
50
52
54
30
HEAD CORE N+1
HEAD CORE N+3
HEAD CORE N+5
42
34
43
44
45
46
47
48
38
32
HEAD CORE N
HEAD CORE N+2
HEAD CORE N+4
40
49
51
53
ISOLATING SIGNAL COUPLING N
ISOLATING SIGNAL COUPLING N+2
ISOLATING SIGNAL COUPLING N+4
CHANNEL N INPUT
CHANNEL N+2 INPUT
CHANNEL N+4 INPUT

Fig. 3

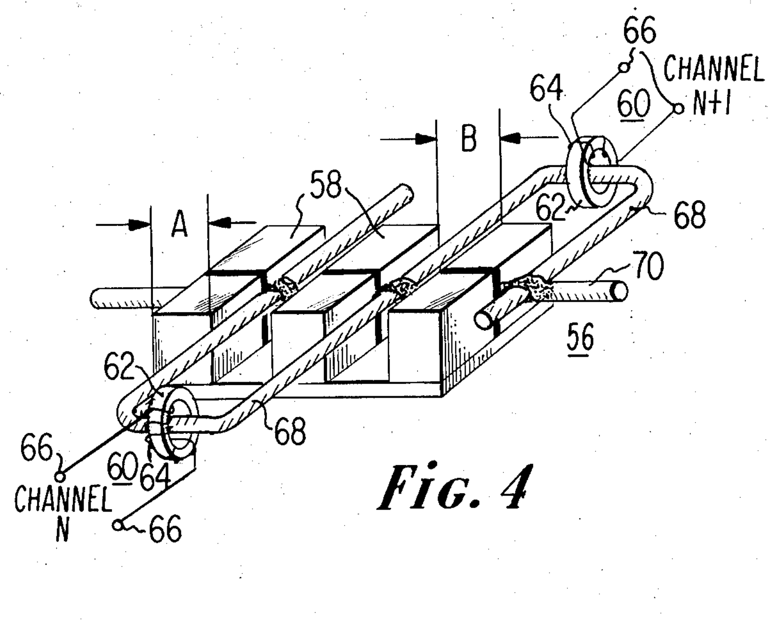

66
CHANNEL N+1
64
60
B
58
A
62
68
70
56
CHANNEL N

Fig. 4

HIGH DENSITY ISOLATED MULTI-CHANNEL MAGNETIC CIRCUIT TRANSDUCER

This invention relates to multi-element magnetic transducers, and more particularly to a compact, high density, record-playback transducer for simultaneously transducing a multitude of independent information tracks with minimal cross talk.

In multi-channel magnetic transducing, it is desirable to minimize spacing between tracks or channels, in order to conserve the amount of storage medium required to handle a particular amount of information. Therefore, consistent with this end, a multi-channel transducing arrangement must possess a degree of compactness. Such compactness however, in prior art arrangements, introduces cross talk between channels. This cross talk is undesirable and may be a problem depending upon the end result desired for the transducer.

For example, consider the arrangement of a typical multi-channel transducer of FIG. **1,** suggested by the prior art. FIG. **1** shows a plurality of magnetic cores **2,** having magnetic gaps **4** therein, mounted along a conductor **6.** A switching means **8** is utilized to sequentially provide a drive signal to given ones of the cores **2,** through the wires **10** coupled to the conductor **6** at opposite sides of each core. Such an arrangement is suitable where it is desired to transduce information with only one channel or tract at a time, or where the same information is transduced with several tracks. For such arrangement, cross talk if existant may not be a significant problem.

However, the requirement of providing transducing of separate and different information simultaneously with adjacent channels or tracks, and the attendant compactness required of the transducer, create further problems in that, appreciable cross talk can't be tolerated for satisfactory performance. An attempt to utilize the arrangement of FIG. **1,** to achieve such a result however, would produce problems. That is, utilizing the arrangement of FIG. **1,** for simultaneous drive of adjacent cores with different signals, requires simultaneously passing two different signals through the common intermediate connecting wires **10.** Since any such wires have a finite impedance, there will be intermixing of the two signals and therefore cross talk between adjacent channels. Making such wires of large diameter and therefore lower impedance would help the cross talk problem. But, it must be remembered, as pointed out, that compactness of the transducer is necessary. However, reducing the size of these wires to accomplish compactness, will increase the impedance of the wires and therefore would further increase the amount of undesirable cross talk and compound the problem.

The present invention is directed to a novel arrangement for minimizing cross talk between adjacent transducer elements in a multi-element transducer assembly, even where the assembly is very compact. Briefly this is accomplished by provision of a multi-element transducer assembly structure, that may be extremely compact, while avoiding common impedance connections for energizing adjacent transducer elements.

These and other advantages of the invention will be better understood upon reading the following description in conjunction with the accompanying drawing wherein:

FIG. **1** illustrates the typical prior art multiple transducer assembly, discussed above.

FIGS. **2**(*a*) and **2**(*b*) are perspective views of examples of magnetic core structures useful in practicing the invention.

FIG. **3** is a plane view showing an embodiment of a multi-element transducer assembly according to the invention.

FIG. **4** is a perspective view of a particular signal coupling means for the multi-element transducer.

FIG. **2**(*a*) shows one example of a core structure for a multi-element magnetic transducer assembly **3.** The assembly **3** comprises a plurality of individual core member pairs **5** arranged in juxtaposed confronting relation to form a series of separate signal transducing gaps **7.** Each of the core members **5** have an aperture **9** therethrough for accommodating a conductive member which is hereinafter discussed. In FIG. **2**(*a*) the core members **5** are formed as projections of a common piece **11** of magnetic material. Any suitable magnetic material such as Ferrite, Alfecon, Sendust may be utilized for the core members **5** of the piece **11.**

FIG. **2**(*b*) shows a further example of a multielement core structure suitable for practicing the invention. In FIG. **2**(*b*) a plurality of core member pairs **12** are provided in juxtaposed confronting relation, to form a series of separate signal transducing gaps **14.** In the arrangement of FIG. **2**(*b*), the core members **12** are separately affixed by means such as bonding, to a common support member **16** formed of a non-magnetic material. As shown in FIG. **2**(*b*), the core members **12** are preferably aligned in substantially parallel longitudinal fashion and include surfaces **18** adapted to cooperate with a magnetic storage medium, not shown. Any suitable magnetic material, such as Ferrite, Alfecon, Sendust, may be utilized for the core members **12.**

Each of the core members **12** of FIG. **2**(*b*) have an aperture **20** therethrough in proximate and communicating relation with the transducing gaps **14.** A conductive element or wire **22,** which is preferably continuous, passes through each of the apertures **20** in the core members **12.** The purpose and function of the element will become clear in the discussion which follows.

For further details regarding the structure and fabrication of magnetic cores, such as shown in FIGS. **2**(*a*) and (*b*), see U.S. Pat. No. 3,544,982 entitled, "Multi-Head Magnetic Transducer," which is assigned to the assignee of the present application.

If reference is made to FIG. **3,** there is shown an embodiment of a multi-element, multi-channel magnetic transducer assembly according to the invention. In FIG. **3,** a plurality of magnetic head cores members **30** are preferably arranged in substantially parallel fashion along an imaginary axis, denoted by dashed line **32,** through the respective signal transducing gaps **34.** Each of the core members **30** form a portion of separate individual channels denoted N through N + 5, which provide signal transducing with separate signal tracks of a magnetic storage medium, not shown.

For each of the core members **30** of channels N through N + 5, there is provided a separate isolating signal coupling element **36.** The element **36** serves as a means of providing separate signals to its associated core member **30** and recovering signals from that core member **30.** The isolating signal coupling means **36** may be a suitable well-known type of transformer or push-pull drive circuitry, which provide a double ended drive for the signal passed through the core member **30.**

Individual signal paths between each of the core members **30** and their corresponding signal coupling means **36** are provided as follows. A common conductor means such as the wire **38** is disposed through each of core member **30,** in the manner shown and described with respect to FIG. 3(*b*). The signal path for each core member **30** is completed by a plurality of pairs of further conductive means such as the wires **40,** which are electrically connected, denoted by reference numbers **42–48** of FIG. **3,** to the common conductor means **38** at either side of the core members **30.** This provides a unique path between each of the core members **30,** and its associated signal coupling means **36.** The individual record and playback signal paths for each of the head core members **30** are indicated by the arrows **49** through **54,** which correspond with channels N through N + 5 respectively. For example, in recording, the current passed through the loop for channel N + 2, including the portion between points **44** and **45** of the common conductor **38,** transduced by normal magnetic transform action, where a magnetic field is established proportional to the current in loop N + 2 and the number of turns in the loop N + 2 which link the core member **30** for loop N + 2. As shown in FIG. **3,** the loop N through N + 5 constitute a single turn comprised of the conductive members **38** and **40.** However, the loops N through N + 5 may also be arranged to comprise a plurality of turns linking the particular core member **30** with its corresponding signal coupling means.

Substantially no cross talk or mixing of signal currents between the loops occurs, since but a single contact point is common to adjacent loops. That is, for example, the loop N + 2 has only one point **44** common to loop N + 2 and loop N + 1 and only one point **45** common to loop N + 2 and loop N + 3.

As previously pointed out this is important, since of necessity the connecting conductors such as **38** and **40** have significant impedance. Where an extremely compact multi-element head is desired, for transducing separate information on adjacent channels, the conductors must be made of extremely small cross sectional area, thereby increasing their natural impedance. Therefore avoiding comingling of different channel signals in a given conductor, by the arrangement of the present invention, permits an extremely compact structure while minimizing cross talk between channels.

FIG. **4** shows a multi-element magnetic transducer assembly **56** of the type shown and described with respect to FIGS. **2**(*a*) and (*b*) and FIG. **3.** In FIG. **4,** two channels, N and N + 1, are shown for example purposes, it being understood that one hundred or more such channels may be provided in similar manner. In FIG. **4,** the isolating signal coupling means for each of the core members **58** is a transformer **60.** Each of the transformers **60** comprises, a further core member **62** of magnetic material. As shown, the transformer core members **62** are in the shape of torroids. Each torroidal core **62** has wound thereon a first winding **64.** The winding **64** is preferably a multiple turn winding and includes terminal means **66,** for interfacing transduced signals with appropriate record and playback circuity, not shown. A further winding **68** for each channel is provided in the form of a single turn, which passes through the torroidal core **62** and links the transformer core **62** with its corresponding head core **58.** Each of the further windings **68** are connected, at either side of the corresponding head core **58,** to the common conductor **70** which passes through the head cores **58** as shown. The turns ratio for the windings **64** and **68** may be any desired number to provide the desired step-up or step-down of the transduced signal.

Utilizing the design of the present invention, compact multi-element transducer assemblies have been fabricated having 160 channels providing 80 tracks per inch, although 100–200 tracks per inch are possible. The transducers have been tested for linear packing densities of from 12,000 to 40,000 bits per inch, at 1–3 megabits per second and at tape speeds in the range of 40–120 inches per second. Tests of crss talk, for static and record play conditions, between adjacent and alternate tracks, where torroidal transformers are used for signal coupling, have yielded values for example of 7 db below the threshold noise level. Tests showed that any cross talk exists almost exclusively between the coupling torroidal transformers under the highest drive levels and highest frequency conditions used. Further cross talk improvements can be realized by optimization of record currents and transformer shielding.

Extremely compact transducers have been fabricated in accordance with the arrangement of this invention. As indicated in FIG. **4,** the dimension A of the individual gapped head cores **58,** provides a track width of 0.007 inches with a track separation B of 0.005 inches. The conductive elements **68** and **70** have been, for example, provided by No. **39** wire which has a diameter of only 0.0035 inches.

What is claimed is:

1. A compact magnetic multi-element signal transducer assembly for transducing with minimal crosstalk a number of independent information signals with corresponding signal tracks on a magnetic storage medium, comprising; a plurality of individual magnetic circuit core members in proximate spaced relation, each of said core members formed of a magnetic material and including an independent transducing gap having a first end portion adapted to cooperate with said storage medium for transducing signals therewith, common conducting means extending through each of said plurality of core members and spaced from said first end portion of said gap, a plurality of individual isolating signal coupling means each of which corresponds with a different one of said plurality of core members, each respective coupling means including its own pair of conductor segments, with adjacent pairs of said segments extending away from opposite sides of said common conducting means providing a separate conductive path between that signal coupling means and that core member corresponding thereto by respective electrical junctions joining said own conductors thereof with said common conducting means at either side of its corresponding core means, for each pair of said conductor segments at least one member conductor of adjacent pairs is connected at the same point to said common conducting means, said conductors of said coupling means and said electrical junctions providing a unique closed loop electrical path solely through each of said signal coupling means and its corresponding core member.

2. The invention according to claim **1,** wherein each of said signal coupling means includes transformer means having a first winding consisting of a plurality of electrical turns and a second winding which is formed of said closed loop path provided by said common conducting means and said conductors.

3. The invention according to claim 1, wherein said core members are disposed in substantially symmetrical manner along a given axis, said coupling means for a given one of said core members being disposed to a first side of said axis, with the coupling means for said core member adjacent said given core member being disposed to the side of said axis opposite said first side.

4. The invention according to claim 1, wherein each of said core members includes an aperture therethrough in proximate relation with said transducing gap, said common conducting means extending through said apertures to form with said conductors a plurality of separate single turn closed loop signal paths for each of said core members.

5. The combination with a compact magnetic multi-element signal transducer assembly having a plurality of individual magnetic circuit core members each including an independent gap therein having a first end portion for cooperating with a record medium for transducing independent information signals with corresponding signal tracks on a magnetic storage medium to provide a plurality of separate signal channels, wherein said transduced signals are coupled to and from said core members through conductive means exhibiting a significant impedance, means for minimizing crosstalk between said channels, comprising; a plurality of individual isolating signal coupling means each of which corresponds with a different one of said plurality of core members, a common conducting means extending through each of said plurality of core members and spaced from said first end gap portion, further signal conducting means forming a plurality of signal conducting wire segment pairs with adjacent pairs of said wire segments extending away from opposite sides of said common conducting means and which exhibit a significant impedance to a signal passed therethrough, wherein for each of said wire segment pairs means are provided for respectively connecting a first portion of each member of said wire segment pairs to said common conducting means at either side of its corresponding core member in a manner providing substantially zero impedance between said common conducting means and said wire pairs, for each of said conducting wire segment pairs at least one wire member of adjacent pairs is connected at the same point to said common conducting means, said common conducting means with said further conducting means providing magnetic flux through said core members and said gap and means coupling a further portion of each of said wire segment pairs to its isolating signal coupling means to form a unique closed loop electrical path solely through each of said isolating signal coupling means and its corresponding core member.

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