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D. L. HEMMIE
BALUN SUITABLE FOR USE THROUGHOUT THE ULTRA
HIGH FREQUENCY TELEVISION BANDS

3,357,023

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2 Sheets-Sheet 1

Fig. 1

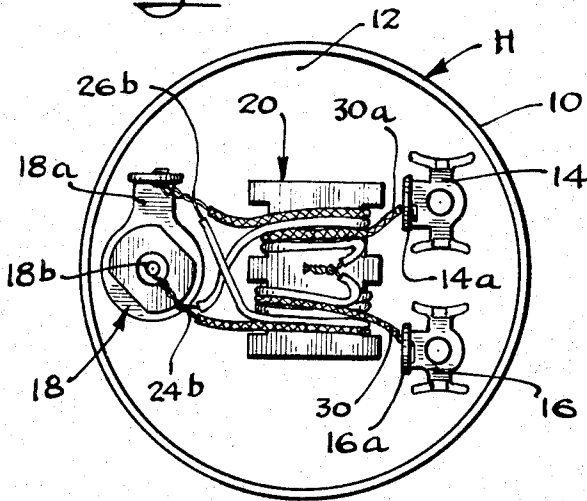


Fig. 3

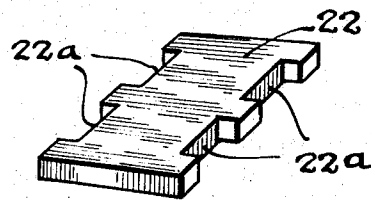


Fig. 2

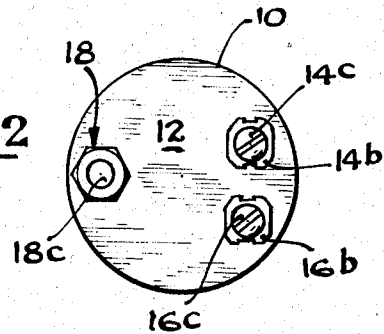
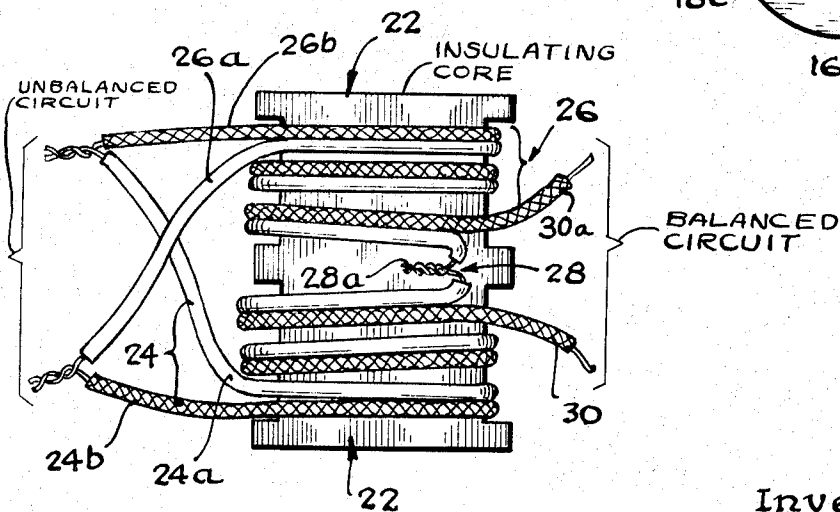


Fig. 4

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Fig. 5

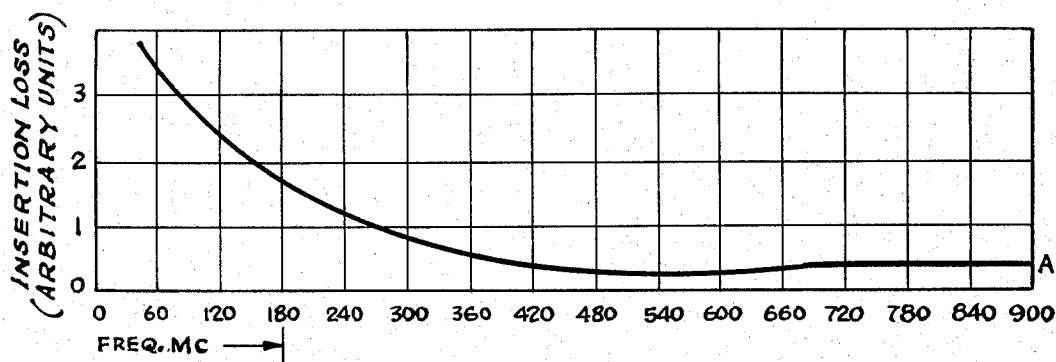


Fig. 6

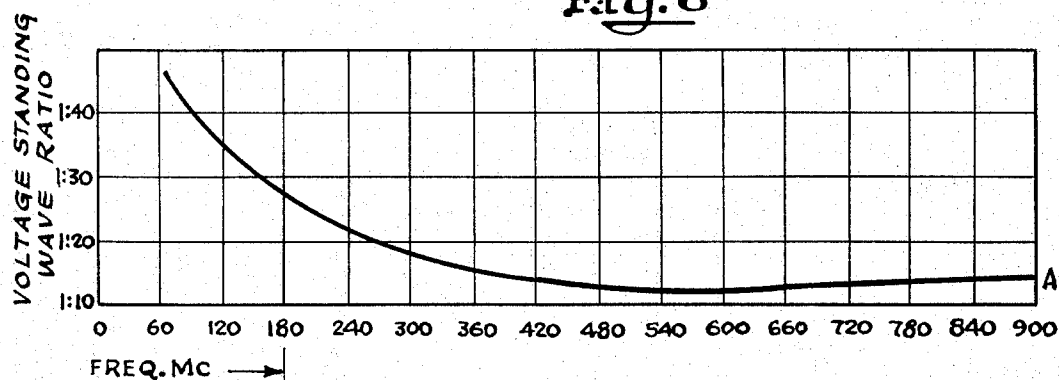
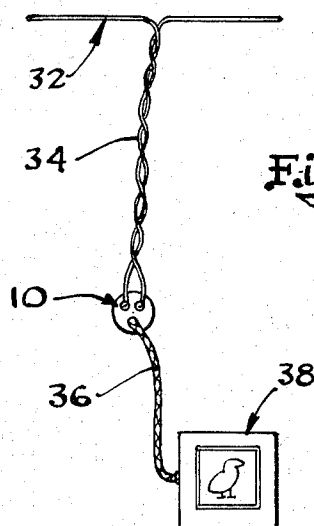


Fig. 7

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BALUN SUITABLE FOR USE THROUGHOUT THE ULTRA HIGH FREQUENCY TELEVI- SION BANDS

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6 Claims. (Cl. 343-821)

ABSTRACT OF THE DISCLOSURE

A balun impedance transformation device especially suitable for operation in the UHF television band. The device in its preferred form includes an insulating, flat, non-magnetic core piece upon which a pair of windings spiral inwardly toward one another with the ends thereof forming a pair of balanced terminals on one side and a pair of unbalanced terminals on the other side.

This invention relates to an improved balun transformer capable of connecting a balanced transmission line of approximately 300 ohms to an unbalanced transmission line of approximately 70 ohms in an effective manner for television reception in the ultra high frequency bands and to a television receiving system including such balun.

Ultra high frequency television channels 14 to 83 occupy the frequency spectrum from about 470 mc. to 890 mc. For reception in these frequencies it is usually desirable to feed the received energy to a 72 ohm coaxial cable having its outer jacket grounded and its inner jacket carrying the signal. This unbalanced load differs in impedance from the approximately 300 ohm balanced twin lead that is usually connected to the receiving antenna. It is accordingly desirable to provide a balancing transformer or balun that serves both to provide the requisite impedance match and to accommodate the respective balanced and unbalanced transmission lines.

Balun transformers have been successfully used in the very high frequency range of television, that is channels 2-13, inclusive. Also balun transformers can and have been made with ferrite cores that operate throughout a wide frequency band, such as channels 14 through 83. However, the use of such cores introduces losses that have to date prevented the attainment of a practical and commercially useful balun for channels 14 through 83. Surprisingly, the rather simple and inexpensive construction of the present invention has been found effective to provide operation in all the ultra high frequency television channels (that is, channels 14 through 83). It is not known just why this is so, but it is believed to be due largely to the simple and neat mechanical arrangement achieved.

It is therefore a general object of the present invention to provide an improved balun and television receiving system suitable for use in television channels 14 through 83, that is about 470 megacycles to about 890 megacycles.

Another object of the present invention is to provide a balun and television receiving system suitable for television channels 14 through 83 that includes no capacitors, resistors, or ferrite core members, and is composed solely of a simple wound construction.

Still another object of the present invention is to provide a balun and television receiving system suitable for television channels 14 through 83 that incorporates small 150 ohm twin line in a simple wound arrangement in which the line forms a total of eight ends so positioned that they can be connected together and to the respective input and output line terminals without resort to cumbersome and undesirable cross-connections or connections

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of sufficient length to impart resonance effects or otherwise degrade the balun performance.

Yet another object of the present invention is to provide a balun and television receiving system suitable for television channels 14 through 83 that is of simple construction, can be readily manufactured, is reliable, and in other respects is especially suitable for inexpensive manufacture and use in home and commercial television receiving systems.

The novel features which I believe to be characteristic of my invention are set forth with particularity in the appended claims. My invention itself, however, together with further objects and advantages thereof, will best be understood by reference to the following description, taken in connection with the accompanying drawings, in which:

FIGURE 1 is a top plan view of a mounted balun constructed in accordance with the preferred form of the present invention;

FIGURE 2 is a bottom view on a smaller scale of the balun of FIGURE 1;

FIGURE 3 is a view in perspective of the core member of the balun of FIGURES 1 and 2;

FIGURE 4 is an enlarged top plan view of the core and winding structure of the balun of FIGURES 1 and 2;

FIGURE 5 is a diagram showing the insertion loss of the balun of FIGURES 1 and 2 in the 60 to 900 megacycle range;

FIGURE 6 is a diagram showing the voltage standing wave ratio of the balun of FIGURES 1 and 2 in the 60 to 900 megacycle range; and

FIGURE 7 is a diagram showing a television receiving system including the balun of the present invention.

Referring now to FIGURE 1, the balun in its preferred form consists of a cup-shaped housing H having a circular peripheral upstanding edge 10 as seen in FIGURE 1 and a web portion 12 spanning the edge. In the form of the invention shown, the diameter of housing H is about 1.75 inches and the vertical extent of edge 10 is about one half inch. The housing is of molded insulating plastic material and, if desired, is provided with a top cover (not shown) that may be placed in position to protect the unit from dust, water, etc. The web or base portion 12 of the housing serves as a mounting board for the balanced and unbalanced line terminals. The former terminals are in the form of spaced connectors 14 and 16 of conventional construction. On the inside of the housing H these connectors form upstanding soldering lugs 14a and 16a, respectively. On the outboard side of the housing (seen in FIGURE 2) these connectors define conducting faces 14b and 14c, respectively, against which the connected transmission line wires bear in contact making relation when sandwiched between the overhanging faces of the screws 14c and 16c in conventional fashion. The unbalanced line terminals are defined by the coaxial jack 18, which is of conventional construction. This jack on the inside of the housing defines a soldering lug 18a which connects to the outside jacket of the connected coaxial cable and is upstanding from the web 12 as seen in FIGURE 1. The jack includes an insulating sleeve which supports the inside terminal 18b which is upstanding as seen in FIGURE 1 and connects to the center conductor of the connected coaxial cable. On the outside of the housing, as seen in FIGURE 2, the jack 18 forms an upstanding threaded sleeve 18c which is electrically connected to the lug 18a and threadably receives the screw terminal of the coaxial cable. The interior of this sleeve carries the end of conductor 18b, which is insulatingly supported therein and receives the center conductor of the coaxial cable.

The balun proper is indicated generally at 20, FIG-

FIGURE 1. It is supported within the housing by its connections with the respective soldering lugs 14a, 16a, 18b and 18a. All of these are upstanding from the plane of the web 12, as seen in FIGURE 1. With the unit 20 in position, the connections to the soldering lugs provide a firm and adequate support which sustains the unit in spaced relation to the web 12.

The unit 20 includes a core 22 which is of suitable plastic material, such as molded phenolic resin. The construction of this core is best seen in FIGURE 3. In the preferred form of the invention shown, the core is approximately five-eighths of an inch long, one-half inch wide and about one-sixteenth of an inch thick. The length of the core defines an axis for the windings hereinafter described. Complementary pairs of notches 22a are provided in the edges of the core 22 to form recesses into which the windings respectively fit. It will be noted that these notches define a pair of axially spaced winding portions on the core 22.

The windings on core 22 are seen best in the enlarged top plan view of FIGURE 4. As shown, there are two separate windings, indicated at 24 and 26, respectively. Each is wound with 150 ohm small size twin lead conductor. This conductor includes 26 gage wires, each having a plastic insulation coating of about .010 inch thickness, although specific conductor size and spacing are not critical. The wires are molded with a thin section between them, so that they can be handled as a unitary transmission line, or, alternatively, can be peeled apart to define separate conductors. The wires are differently colored, preferably, such as the black and white colors shown in the drawings.

In the preferred form of the balun shown in the drawings, the windings 24 and 26 are wound in a complementary conformation. Starting at the top of the core as seen in FIGURE 4, the winding 26 is wound two and one-half turns spiralling from the outboard edge of the winding towards the interior or inboard edge of the winding. Similarly, the winding 24 is wound in two and one-half turns spiralling from the bottom outboard edge of the winding towards the interior or inboard edge of the winding. The windings are made with the flat side of the 150 ohm transmission line conductors laid against the core 22, as shown.

The "white" conductors 26a and 24a of the windings, respectively, terminate adjacent each other at 28. The insulation is peeled back from the ends at these terminations and the two conductors wound together and soldered at 28a to form a connection. As shown in FIGURE 1, the corresponding ends 30 and 30a of the "black" conductors 24b and 26b extend outboard the core 22 and are soldered at 16a and 14a, respectively, to the balanced line terminals 14 and 16.

The outboard and opposite ends of the conductors 24a, 24b, 26a, and 26b extend outboard the core 22 as shown in FIGURES 1 and 4. Each "white" conductor (24a and 26a) extends over to the opposite "black" conductor (26b and 24b) and is twisted about the same and soldered thereto. One of these joint conductors (24b) extends to the center pin 18b of the coaxial line jack 18 and is soldered thereto to form the center conductor connection. The other of these joint conductors (26b) extends to and is connected by soldering to the lug portion 18a of the coaxial line jack 18 for the connection to the outer coaxial line conductor.

It will be observed that the conductor pair 26a and 26b forms closely spaced insulated conductors wound about the core 22 at the winding portion defined by the upper notches 22a of the core. Moreover, when traced from the left hand end as seen in FIGURE 4, this winding spirals along the axis of the core 22 towards the other winding portion, namely 24. The conductors 24b and 24a form a second pair of closely spaced insulated conductors wound about the core 22 and the winding portion defined by the other notches 22a of the core 22.

This winding, indicated at 24, is wound in the same sense to the winding 26 and spirals along the axis of core 22 towards the first winding, namely 26. The fact that the windings 24 and 26 are of the same sense can be determined by tracing the current path through the "white" conductors 24a and 26a. It will be observed that this path encircles the core axis two and one-half turns in the same direction in each case.

FIGURES 5 and 6 show, respectively, the insertion loss and the voltage standing wave ratio curves of the balun of FIGURES 1-4 over the frequency range of 60 mc. to 900 mc. These curves are highly favorable for operation over the frequency ranges of the ultra high frequency television bands (about 470 mc. to 890 mc.) and represent an unusually effective balun operation.

It is important to the effective operation of the balun to bring the "white" conductors 24a and 26a as close together at point 28 as is possible. Very close proximity can be provided without difficulty in the construction of the present invention since the conductors naturally come to this closely spaced relation in response to the winding arrangement where the pairs of the conductors are wound flat and come together as the windings spiral towards each other.

It is also important to minimize the lengths of the conductors 24a, 24b, 26a, and 26b on the left hand side of the balun as seen in FIGURES 1 and 4. Since the coaxial cable jack 18 defines conductor-receiving terminals spaced approximately the distance between the outboard ends of the two windings, these lengths can be readily made small, as shown.

It will be noted that the balun herein shown and described embodies no capacitors, resistances, or inductances. It is believed to operate in a substantially non-reactive fashion aside from the balun action itself. It is believed that this accounts in considerable measure for the favorable performance characteristics. In any event, the unit is very easily manufactured and provides unusually effective performance.

FIGURE 8 shows, in somewhat diagrammatic form a complete television receiving system incorporating the balun of the present invention. This system includes an antenna 32, which may be in the form of a dipole with a suitable reflector (not shown), having a balanced output of about 300 ohms impedance. The 300 ohm twin lead transmission line 34 is connected to this antenna and, as shown, to the balun 10. The latter is of the construction illustrated in FIGURES 1-4, the twin lead 34 being received on terminals 14 and 16. The coaxial unbalanced output jack 18 of the balun receives the 72 ohm coaxial line 36, as shown. This line is connected to the television receiver 38 for reception of channels 14 through 83.

A ferrite core can be added to the balun of the present invention to extend the frequency range even further. However, such extension introduces losses which for many applications cannot be tolerated.

While I have shown and described a specific embodiment of the present invention it will, of course, be understood that many variations and alternating embodiments may be made without departing from the spirit and scope of this invention. I therefore intend by the appended claims to cover all such modifications and alternatives that fall within their true spirit and scope.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. A balun suitable for use throughout the ultra high frequency television bands comprising, in combination:
 - a) an insulating non-magnetic core member having a longitudinal axis and winding portions spaced along said axis;
 - a pair of first and second closely spaced insulated conductors wound about said core member at one of said winding portions in one winding sense and spiralling along the axis towards the other winding portion;

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- a pair of third and fourth closely spaced insulated conductors wound about said core member at the other of said winding portions in the same winding sense to said first and second conductors and spiralling along the axis towards the one winding portion, said windings being so disposed as to define inboard ends on one side of said core member and outboard ends on the opposite side of said core member;
- a pair of balanced line terminals disposed on said one side of said core adjacent said winding portions, respectively;
- means electrically connecting said second and third conductors adjacent said balanced line terminals;
- means connecting said first and fourth conductors, respectively, to said balanced line terminals;
- a pair of unbalanced line terminals disposed on said opposite side of said core adjacent said winding portions, respectively;
- and means connecting the other end of the first and third conductors to one of said unbalanced line terminals and the second and fourth conductors to the other of said unbalanced line terminals.
2. A balun suitable for use throughout the ultra high frequency television bands comprising, in combination:
- an insulating flat non-magnetic core member having a longitudinal axis and spaced edge notches defining winding portions spaced along said axis;
- a pair of first and second closely spaced insulated conductors wound about said core member at one of said winding portions in one winding sense and spiralling along the axis towards the other winding portion;
- a pair of third and fourth closely spaced insulated conductors wound about said core member at the other of said winding portions in the same winding sense to said first and second conductors and spiralling along the axis towards the one winding portion, said windings being so disposed as to define inboard ends on one edge of said core member and outboard ends on the other edge of said core member;
- a pair of balanced line terminals disposed on said one edge of said core adjacent said winding portions, respectively;
- means electrically connecting said second and third conductors adjacent said balanced line terminals;
- means connecting said first and fourth conductors, respectively, to said balanced line terminals;
- a pair of unbalanced line terminals disposed on said other edge of said core adjacent said winding portions respectively;
- and means connecting the other end of the first and third conductors to one of said unbalanced line terminals and the second and fourth conductors to the other of said unbalanced line terminals.
3. A balun suitable for use throughout the ultra high frequency television bands comprising, in combination:
- an insulating relatively flat non-magnetic core member having a longitudinal axis and spaced edge notches defining winding portions spaced along said axis;
- a pair of first and second closely spaced insulated conductors wound about said core member at one winding portion, spiralling along the axis towards the other winding portion, and terminating substantially at one edge of the core member at the outboard end;
- a pair of third and fourth closely spaced insulated conductors wound about said core member at said other winding portion, spiralling along the axis towards said one winding portion, and terminating substantially at said one edge of the core member at the inboard end and substantially at the other edge of the core member at the outboard end;
- a pair of balanced line terminals disposed adjacent

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- said one edge of the core member adjacent said winding portions, respectively;
- means electrically connecting said second and third conductors adjacent said balanced line terminals;
- means connecting said first and fourth conductors, respectively, to said balanced line terminals;
- a pair of unbalanced line terminals disposed on said other edge of the core member adjacent said winding portions respectively;
- and means connecting the other end of the first and third conductors to one of said unbalanced line terminals and the second and fourth conductors to the other of said unbalanced line terminals.
4. A balun suitable for use throughout the ultra high frequency television bands comprising, in combination:
- an insulating non-magnetic core member having a longitudinal axis and defining winding portions spaced along said axis;
- a pair of first and second closely spaced insulated conductors wound about said core member at one winding portion, spiralling along the axis towards the other winding portion, and terminating substantially on one side of said core member at the inboard end and substantially at the other side of the core member at the outboard end, said conductors being approximately 2.5 inches in length;
- a pair of third and fourth closely spaced insulated conductors wound about said core member at the said other winding portion and spiralling along the axis towards said one winding portion, said conductors terminating substantially on said one side of said core member at the inboard end and substantially at the other side of the core member at the outboard end, said conductors being approximately 2.5 inches in length;
- a pair of balanced line terminals disposed on said one side of the core member adjacent said winding portions, respectively;
- means electrically connecting said second and third conductors adjacent said balanced line terminals;
- means connecting said first and fourth conductors, respectively, to said balanced line terminals;
- a pair of unbalanced line terminals disposed on said opposite side of the core member adjacent said winding portions, respectively;
- and means connecting the other end of the first and third conductors to one of said unbalanced line terminals and the second and fourth conductors to the other of said unbalanced line terminals.
5. A television receiving system for channels 14 through 83 comprising in combination:
- an antenna having an output impedance of about 300 ohms and of balanced construction; an approximately 300 ohm twin lead transmission line connected at one end to the antenna;
- a balun comprising an insulating non-magnetic core member having a longitudinal axis and defining winding portions spaced along said axis, a pair of first and second closely spaced insulating conductors wound about said core member at one winding portion, spirally along the axis towards the other winding portion, and terminating substantially on one side of said core member at the inboard end and substantially at the other side of the core member at the outboard end, said conductors being approximately 2.5 inches in length, a pair of third and fourth closely spaced insulated conductors wound about said core member at the said other winding portion and spiralling along the axis towards said one winding portion, said conductors terminating substantially on said one side of said core member at the inboard end and substantially at the other side of the core member at the outboard ends, said conductors being approximately 2.5 inches in length,

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a pair of balanced line terminals disposed on said one side of the core member adjacent said winding portions, respectively, means electrically connecting said second and third conductors adjacent said balanced line terminals, means connecting said first and fourth conductors, respectively, to said balanced line terminals, a pair of unbalanced line terminals disposed on said opposite said of the core member adjacent said winding portions, respectively, and means connecting the other end of the first and third conductors to one of said unbalanced line terminals and the second and fourth conductors to the other of said unbalanced line terminals; the other end of said transmission line being connected to the balanced line terminals of said balun;

10 a transmission line of about 72 ohms impedance connected at one end to the unbalanced terminals of said balun; and,

15 a television receiver for the channels 14 through 83, said receiver being connected to the other end of the said last transmission line.

6. A balun suitable for use up through and including the ultra high frequency television bands comprising, in combination:

25 a common core member having a longitudinal axis and winding portions spaced along said axis;

30 a pair of first and second closely spaced insulated conductors wound about said core member at one of said winding portions in one winding sense and spiralling along the axis towards the other winding portion;

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a pair of third and fourth closely spaced insulated conductors wound about said core member at the other of said winding portions and spiralling along the axis towards the one winding portion, said windings being so disposed as to define inboard ends on one side of said core member and outboard ends on the opposite side of said core member;

a pair of balanced line terminals disposed on said one side of said core adjacent said winding portions, respectively;

means electrically connecting said second and third conductors adjacent said balanced line terminals; means connecting said first and fourth conductors, respectively, to said balanced line terminals;

a pair of unbalanced line terminals disposed on said opposite side of said core adjacent said winding portions, respectively;

and means connecting the other end of the first and third conductors to one of said unbalanced line terminals and the second and fourth conductors to the other of said unbalanced line terminals.

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