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SIGNAL SPLITTER COMPRISING AN AUTOTRANSFORMER
HAVING FLAT WINDINGS
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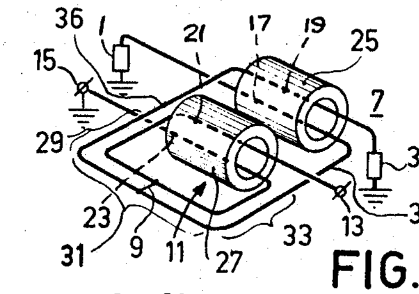

FIG. 2

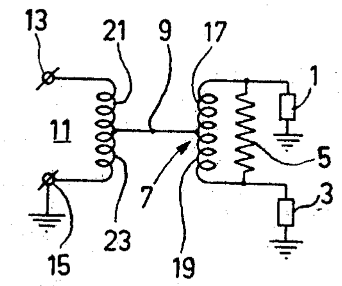

FIG. 1
PRIOR ART

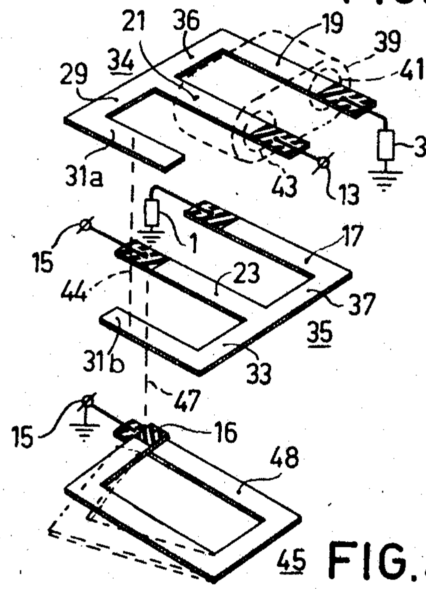

FIG. 4

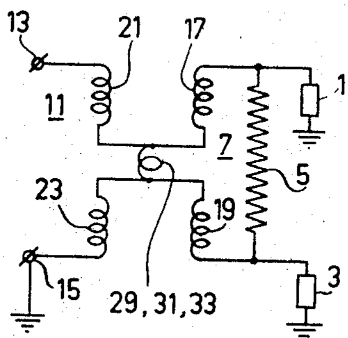

FIG. 3

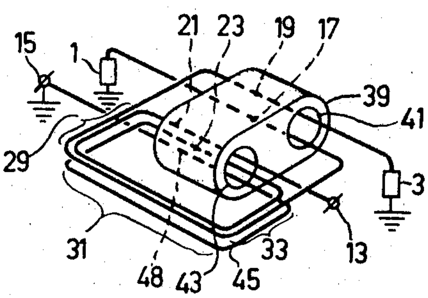

FIG. 5

INVENTOR.
BASTIAAN P. J. WAKKER
BY
Frank R. Trifari
AGENT

United States Patent Office

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SIGNAL SPLITTER COMPRISING AN AUTOTRANSFORMER HAVING FLAT WINDINGS

Bastiaan Petrus Johannes Wakker, Badhoevedorp, Netherlands, assignor to U.S. Philips Corporation, New York, N.Y., a corporation of Delaware

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Int. Cl. H01p *5/12*
U.S. Cl. 333—8 7 Claims

ABSTRACT OF THE DISCLOSURE

A device for coupling a high-frequency voltage source to a pair of independent loads includes first and second thin flat metal winding components each having a pair of parallel limbs and a transverse leg interconnecting corresponding ends of the limbs. The winding components are mounted in two parallel bores in a ferrite block from opposite sides with the limbs oppositely directed and overlapping. At least one winding component has a branch extending outside of the ferrite block and electrically interconnecting the transverse legs of the two winding components.

This invention relates to a splitter device, especially adapted for use at the television frequency bands, for connecting a high-frequency voltage source to two identical consumer impedances which are not interconnected, by means of a coupling coil the ends of which are connected to the impedances and the centre of which is connected to a tap on an autotransformer to which the high-frequency voltage is applied. Such a splitter device may be used, for example, in communal antenna systems, the two impedances which are not interconnected then being two consumer devices connected to the system.

An object of the invention is to provide a device which can be manufactured in quantity at low cost and which needs substantially no trimming after the manufacture. A device according to the invention is characterized in that the winding of the coupling coil and that of the autotransformer, together with the connection between them, are combined into an assembly comprising at least two flat winding components punched from sheet material, each consisting of at least two limbs extending approximately in parallel and a transverse connecting piece connecting two corresponding ends of the limbs, at least one transverse connecting piece having an extension which reaches beyond one of the limbs. In this assembly, the components are placed on one another with their limbs oppositely directed in such manner that the limbs partly overlap one another, each two overlapping limb portions being surrounded by a closed ferromagnetic circuit and the transverse connecting pieces being electrically connected together by the extension external of the ferromagnetic circuit. This arrangement affords several advantages, in addition to the advantage inherent in windings formed of sheet material, for example, it avoids the time consuming operation of threading wires through closed coil cores. Another important advantage is that the shape of the windings is exactly reproducible and may therefore previously be chosen so that asymmetries are avoided. Hence, I avoid the need of subsequent corrections by means of additional capacitors or inductors the values and positions of which have to be determined by special measurements. When using windings wound of wire, such measurements would in practice be unavoidable, which naturally implies an increase in cost price.

In order that the invention may be readily carried into

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effect, it will now be described in detail, by way of example, with reference to the accompanying diagrammatic drawing, in which:

FIGURE 1 shows a known circuit which underlies the device according to the invention;

FIGURE 2 and FIGURE 3 show respectively a perspective view and a circuit which serves to explain the invention;

FIGURE 4 shows two embodiments of the device according to the invention, and

FIGURE 5 serves to clarify the second embodiment of FIGURE 4.

The known circuit shown in FIGURE 1 serves to connect a high-frequency voltage source, for example, the output circuit of the amplifier of a communal aerial system, to two identical consumer impedances **1** and **3**, for example, two television receivers which are not coupled together. This is effected by means of a coupling coil **7** shunted by a resistor **5**. The ends of the coil are connected to the impedances **1** and **3** and the center tap of the coil is connected by means of a connection **9** to a tap on an autotransformer **11**. The high-frequency voltage from the voltage source, represented by two connecting terminals **13** and **15**, is applied to the ends of the autotransformer. As is well-known, the currents produced by said voltage source in the two halves **17** and **19** of the coupling coil **7** are oppositely directed and the magnetic fields produced in said coil halves neutralise each other so that the impendance of the two coil halves, for the current from the voltage source, is substantially nil, and said currents are supplied to the consumer impedances **1** and **3** without attenuation, and with a suitable choice of the impedance of the consumers **1**, **3** and that of resistor **5** and of the voltage source **13**, **15**, the coupling between the consumer impedances **1** and **3** through the coupling coil **7** and the resistor **5** is substantially negligible. The autotransformer **11**—in fact a tapped coil—serves to match the impedance of the voltage source to the impedance of the assembly **1, 3, 5, 7**.

FIGURE 2 shows diagrammatically the form in which the circuit of FIGURE 1 is fundamentally obtained in accordance with the invention. The resistor **5**, which is not an essential part of the device according to the invention, has been omitted in FIGURE 2 for the sake of clarity. This figure shows that the coupling coil **7** and the autotransformer **11** each substantially comprise the straight portions **17**, **19** and **21**, **23**, respectively, of each two turns arranged approximately in a horizontal plane. The straight portions are surrounded pairwise by closed ferromagnetic circuits in the form of ferrite tubes **25** and **27**, respectively. The closure parts, to be described hereinafter, which form the said straight portions into complete turns, extend externally of the ferromagnetic circuits, as shown, and thus contribute very little to the inductance of the coils **7** and **11**, respectively. The connection **9** (see FIGURE 1) between the coils **7** and **11** could be formed by a short connecting wire in the manner shown in FIGURE 2, which connecting wire is likewise indicated by reference numeral **9** in FIGURE 2.

It has been found that, without affecting the operation of the device to any appreciable extent, the said connection can be extended to the full length of the portions of the coils **7** and **11** indicated by three accolades **29**, **31** and **33** in FIGURE 2, producing in fact the circuit shown in FIGURE 3. The said extension is permissible only if all of the coils are made of sheet material so that their conductors (turns) have a comparatively great width and hence may have a low inductance per unit length. In fact, the inductance of the portion **29**, **31**, **33** common to the two coils **7** and **11**, which portion lies outside the ferromagnetic circuit (see FIGURE 2), is in this case so low that the symmetry of the coupling coil 7 is substantially not disturbed, not even if the autotransformer **11** is connected to ground at one end, as shown in FIGURE 3, and hence is asymmetrical.

This recognition makes it possible for the device of FIGURE 2 to be designed in the form shown in FIGURE 4, which is very advantageous for a cheap manufacture. To permit the various elements of FIGURE 4 to be readily identified with the elements of FIGURE 2, the same reference numerals are used as far as possible in FIGURE 4. In the device shown in FIGURE 4, the winding of the coupling coil **7** and that of the autotransformer **11**, together with the connection **9** between them, are combined into an assembly which, in the simplest case, comprises two flat winding components **34** and **35** punched from sheet material, for example, copper sheet. Each winding component comprises at least two limbs **19**, **21** and **17**, **23**, respectively, which extend approximately in parallel (see also FIGURE 2), and a transverse connecting piece **36** and **37**, respectively, which connects two corresponding ends of the limbs **19**, **21** and **17**, **23**, respectively. At least one of the connecting pieces **36** and **37**, both in the case shown, has an extension **29**, **31***a* and **33**, **31***b*, respectively, which extends beyond one of the limbs, in this example beyond the limbs **21** and **23**, respectively (see also FIGURE 2). In the said assembly, the components **34** and **35** are placed on one another with their limbs oppositely directed and mutually insulated in such manner that the limbs **21**, **23** and **17**, **19**, respectively, and preferably also the extensions **29**, **31***a* and **33**, **31***b*—which, as shown in FIGURE 4, have rectangularly bent portions **31***a* and **31***b*—partly overlap. Each pair of overlapping limb portions **19**, **17** and **21**, **23**, respectively, are surrounded by a closed ferromagnetic circuit and the overlapping portions **31***a* and **31***b* of the extensions are electrically connected together externally of the said circuit. In the manner shown in broken line in FIGURE 4, the ferromagnetic circuit is preferably in the form of a ferrite block **39** having two bores **41** and **43** into which the winding components **34** and **35** may readily be introduced from opposite sides. For the sake of clarity, FIGURE 4 shows the two winding components **34** and **35** with some spacing one below the other and only the limbs **19** and **21** of the winding component **34** are shown within the bores **41** and **43**. However, it will be evident, also with reference to FIGURE 2, that in the operating condition the limbs **17** and **23** of the winding component **35** are also situated within the bores **41** and **43**. The cross-hatched terminal portions of the winding components may be tin-plated and serve as soldering tongues for connection to the impedances **1** and **3** and to the voltage source **13**, **15**. The broken line **44** indicates that the extensions **31***a* and **31***b* are electrically connected together. All elements of the device of FIGURE 4 can readily be identified by comparison with FIGURE 2.

As previously mentioned, the important advantage provided by winding components **34** and **35** punched from sheet metal consists in that their shape is accurately reproducible and that the manufactured device, after assembly of the components, is fully identical with all those previously manufactured. This implies that, assuming of course that the dimensions are matched to one another in the proper way, all manufactured devices have the required predetermined properties without any subsequent processing or trimming.

In practice, it is often desired to connect a voltage source **13**, **15** of a given impedance, for example, 25 ohms, to two consumer impedances **1** and **3** each of 75 ohms. At the connection **9** the impedance is in this case 37.5 ohms. Matching with sufficient approximation may be obtained with an autotransformer having portions **21** and **23** consisting of one turn and two turns, respectively. As shown in FIGURE 5, such a device needs an additional turn **45** extending through the bore **43**, which turn

preferably lies straight under the winding portions **23**, **29**, **31**, **33** in the manner shown and which may in practice be formed in the manner shown below in FIGURE 4. This turn constitutes a third component punched from sheet material (also indicated by reference numeral **45** in FIGURE 4) which, as can be seen from FIGURE 4, forms a complete turn and comprises a portion which extends substantially in accordance with the two interconnected extensions **29**, **31***a*, **31***b*, **33** and is connected at its free end **16** to the adjacent limb **23** of the winding component—preferably due to the two cross-hatched ends located one above the other in FIGURE 4 being soldered together, see broken line **47**—and also comprises a limb **48** which substantially overlaps the adjacent limb **23**. The end of the voltage source which is connected to ground and represented by the connecting terminal **15**, is connected to the free end of the limb **48**. In manufacturing the component **45**, it may be punched in a slightly different shape, as shown in broken line in FIGURE 4, whereafter the punched component is shaped by bending into the form shown in full line in FIGURE 4. This bending operation may readily be effected with an accuracy sufficient to fulfil the required tolerances.

Between the strip-like conductors or limbs **17** and **19**, which extend in parallel with a small spacing between them, a certain parasitic capacitance naturally exists which forms a tuned oscillatory circuit with the inductance of the turns **19**, **36**, **29**, **31**, **33**, **37**, **17** (see FIGURE 2). In the embodiment shown in FIGURE 3, the said parasitic capacitance may be varied by providing a strip of insulating material of a greater or smaller thickness and/or dielectric constant between the limbs **17** and **19** of the punched winding components **35** and **34**. The dimensions required for using the described device for the UHF-television bands are found in practice to be such that it is readily possible to tune the said oscillatory circuit to a frequency close to the highest frequency (approximately 900 mc./s.) of the UHF-region, for example, to a frequency of 800 mc./s. With regard to frequencies close to 800 mc./s. the parasitic capacitance between the conductors **17** and **19** then occurs in a parallel resonance circuit having a very high impedance so that the parasitic capacitance cannot detrimentally affect the uncoupled state of the consumers **1** and **3**. At materially lower frequencies the said parallel circuit is no longer in resonance, but in this case the impedance of the parasitic capacitance in itself is already sufficiently high relative to that of resistor **5** so that it prevents the uncoupled state of the consumers **1** and **3** from being affected to any appreciable extent.

It should be noted that the winding portion **29**, **31**, **33** can be situated to the right of the conductors **17** and **19** instead of (as shown in FIGURE 2) to the left of the conductors or limbs **21** and **23**. In this case the inductance of the oscillatory circuit of which the said parasitic capacitance forms part can be even a little lower since the turn located to the right of the conductors **17** and **19** need not include the turn portions **36** and **37** (see FIGURE 2).

What is claimed is:

1. A splitter device for connecting a high-frequency voltage source to two identical non-connected load impedances by means of a coupling coil the ends of which are connected to the impedances and the center of which is connected to a tap on an autotransformer to which the high-frequency voltage is applied, said coupling coil and said autotransformer together with the connection between them comprising the following assembly: at least two flat winding components formed from sheet material, each winding component including at least two limbs extending approximately in parallel and a transverse connecting piece connecting two corresponding ends of the limbs, at least one of said transverse connecting pieces having a branch which extends beyond one of the limbs, the winding components being placed on one another with their limbs oppositely directed in such manner that corresponding limbs partly overlap one another, a closed ferromagnetic circuit surrounding each two overlapping limb portions, and means including said extension branch for electrically connecting together the transverse connecting pieces externally of the ferromagnetic circuit.

2. A device as claimed in claim **1** wherein the ferromagnetic circuit comprises a ferrite block having two parallel bores through which the limbs of the winding components extend from opposite sides, and wherein the other one of said transverse connecting pieces has a branch extending beyond one of the limbs, the two extension branches being interconnected and extending externally of the ferrite block.

3. A device as claimed in claim **2** comprising a further winding component formed from sheet material so as to form one complete turn, said further winding component comprising a first limb which extends adjacent the two interconnected branch extensions of the other two winding components and having its free end connected to the adjacent limb of one of said two winding components, and a second limb which substantially overlaps the adjacent limb of said one winding component.

4. A device for coupling a high-frequency voltage source to two independent load impedances comprising, a first thin flat metal winding component having first and second parallel limbs and a transverse leg interconnecting two corresponding ends of the limbs, a second thin flat metal winding component having third and fourth parallel limbs and a transverse leg interconnecting two corresponding ends of the limbs, one of said winding components having a branch extension of said transverse leg that extends beyond one of the parallel limbs, said first and second winding components being positioned with said first and second limbs adjacent said third and fourth limbs, respectively, with said limbs being oppositely directed so as to partly overlap one another, a ferromagnetic core surrounding said overlapping limbs, means including said branch extension for connecting together the transverse legs of said first and second winding components externally of the ferromagnetic core, means connecting the free ends of said first and third limbs to individual ones of said two load impedances, and means connecting the free ends of said second and fourth limbs across the terminals of said voltage source.

5. A device as claimed in claim **4** wherein said branch extension comprises a thin flat metal leg integral with said transverse leg and extending parallel thereto and a fifth limb extending perpendicularly from the free end of said integral leg and parallel to the parallel limbs, and wherein said other winding component has an identical branch extension including a sixth limb, but oppositely directed so that said fifth and sixth limbs are in alignment and electrically connected externally of the ferromagnetic core.

6. A device as claimed in claim **4** wherein said first and third limbs and said second and fourth limbs are arranged to be mutually insulated from one another.

7. A device as claimed in claim **4** further comprising a third thin flat metal winding component having two pairs of parallel limbs arranged to form a rectangle, said third winding component being positioned adjacent said first and second winding components so that one pair of parallel limbs thereof overlap said second and fourth limbs and a part of said branch extension, respectively, and means electrically connecting said third winding component to one of said second and fourth overlapping limbs.

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U.S. Cl. X.R.

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