

April 1, 1969

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3,436,708

VARIABLE TRANSFORMER HAVING ONE COIL CONDUCTOR WITHIN THE OTHER

Filed Dec. 19, 1966

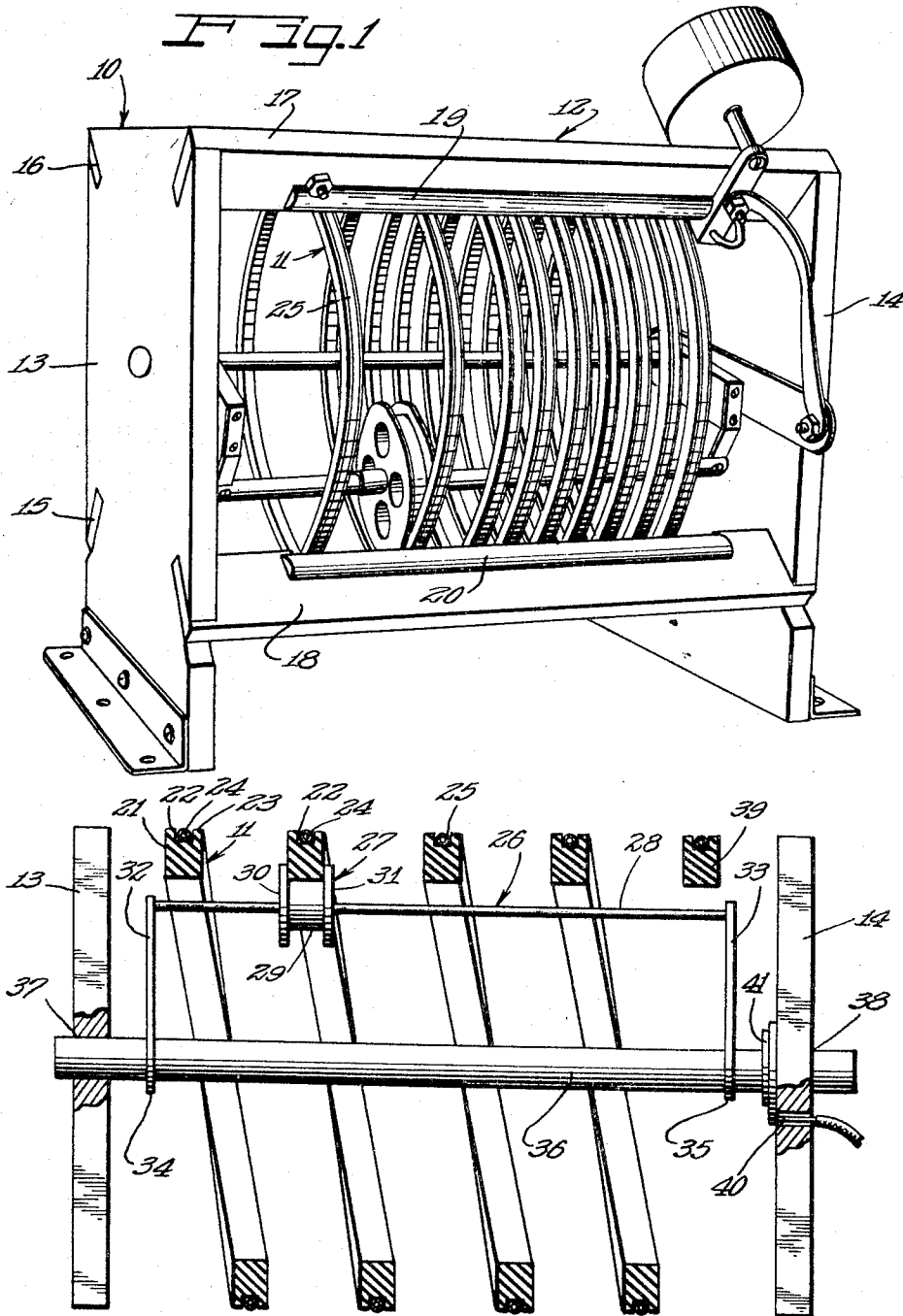


Fig. 2

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Filed Dec. 19, 1966, Ser. No. 602,659

Int. Cl. H01f 29/06, 27/28

U.S. Cl. 336-139

3 Claims

ABSTRACT OF THE DISCLOSURE

A radio frequency tuning coil having first and second helical conductors wound in an ideal transformer relationship such that one of the conductors is physically embedded in the other. The two conductors are electrically isolated, and movable contact means are mounted internally of the helical coil structure for varying the effective inductance of the larger of the two conductors.

This invention relates to a transformer and in particular relates to a radio frequency tuning coil transformer having novel structural features which assure that substantially all flux lines generated by the primary of the transformer also encircle the associated portions of the secondary of the transformer.

In many circuits it is desirable to provide a transformer wherein the primary and secondary windings have substantially the same A-C voltage. Also, in such transformers it may be highly desirable to have each point on the primary winding maintained at substantially the same voltage level as the corresponding point on the associated secondary winding. In addition, a transformer of the type described may be such that the primary of the transformer is required to carry a substantially larger current load than the secondary.

One requirement for such a transformer is described in my copending United States patent application Serial No. 514,325. As explained in that application, recent developments in high frequency radio transmitters have led to the widespread acceptance of a Pi configured network for coupling the plate circuit of the RF power amplifier to the antenna feed line. The Pi networks have been found to attenuate to a high degree all spurious and harmonic signals above the resonant frequency and to aid in acquiring maximum power transfer to the antenna.

However, the introduction of the Pi and Pi-L networks as amplifier coupling devices has required the application of a plate supply voltage at a point in the circuit that is at a high RF potential. The undesirable effects of applying the plate supply to a high RF voltage point can, however, be substantially eliminated by the direct coupling of the RF potential to the plate supply circuit. This coupling must be accomplished in such a way as to oppose the RF potential at the point of application of the D-C supply source to the Pi network. In this way, large currents in the RF range are eliminated from the D-C supply circuit.

In further considering the transformer as utilized in the Pi network described in my copending patent application Serial No. 514,325, it will be understood that the D-C supply circuit which has the secondary of the transformer connected in series therewith, carries only low level currents, while the primary of the Pi-L network is required to carry substantially larger currents. Also, in order to oppose the RF voltage at the point of applica-

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tion of the supply circuit to the Pi-L network, it is necessary that the RF voltage coupled to the D-C supply circuit be equal to the RF voltage of the tuning coil. Also, each point on the primary and secondary windings of the transformer must be maintained at substantially the same voltage to avoid the presence of internal parasitic resonances.

The transformer of this invention has all of the desirable characteristics required to perform the transformer function described in my copending patent application Serial No. 514,325 and reiterated above.

Accordingly, one of the principal objects of this invention is to provide a transformer which approaches an ideal transformer, which has an improved performance, and which is characterized by a reduced construction cost.

It is also an object of this invention to provide a transformer having a primary winding and a secondary winding wherein each point on the primary winding is substantially equal in A-C voltage to the voltage on a corresponding adjacent point on the secondary winding.

It is also an object of this invention to provide a transformer having a hollow region formed longitudinally through the primary winding and having a secondary winding which is fed through the hollow region for developing a substantially ideal transformer relationship between the primary and secondary windings.

It is a further object of this invention to provide a transformer having a substantially larger primary winding and having a substantially smaller secondary winding wherein the secondary winding is substantially embedded internally of the primary winding for assuring that all flux linkages of the primary winding will also encircle the secondary winding.

It is a further object of this invention to provide a transformer having a primary winding which is substantially larger in cross section than the associated secondary winding, wherein a slot is formed along the outwardly facing periphery of the primary winding, wherein the secondary winding is wound about the primary winding within the longitudinally formed slot, and wherein: a Teflon insulation is provided intermediate the primary and secondary windings thereof.

It is an additional object of this invention to provide a tuning coil having a variable inductance primary winding and having a secondary winding which is effectively disposed internally of the longitudinal orientation of the primary winding for forming a substantially ideal transformer relationship therewith.

These and other objects, features and advantages of the present invention will be understood in greater detail from the following description and the associated drawings wherein reference numerals are utilized in designating an illustrative embodiment and wherein:

FIGURE 1 shows an elevational view of a transformer or tuning coil having the improved primary and secondary winding structure of this invention, and

FIGURE 2 is a sectional view of a transformer similar to the transformer shown in FIGURE 1.

Generally, this invention concerns a transformer having a structure which assures that substantially all of the flux linkages of one of the windings will completely encircle the other winding. Such a design provides that not only will the total voltage across the secondary, for instance, be identical with the total voltage across the primary, but also that the instantaneous voltage at any circuit point in one of the transformer windings will be

identical with the instantaneous circuit voltage at the adjacent point in the other transformer winding.

The preferred embodiment of this invention comprises a transformer having a primary and a secondary winding of substantially different cross-sectional areas such as might be utilized in the Pi-L type network described in my copending application No. 514,325. This difference in the size variation of the associated windings of the transformer enables the accomplishing of the desired result, namely, the developing of an ideal transformer relationship.

Referring to the drawings in greater detail, a transformer 10 as shown in FIGURE 1 comprises a tuning coil 11 which is mounted on a coil support 12. The coil support 12 consists of end walls 13 and 14 and angularly disposed ribs 15, 16, 17 and 18. The coil support 12 is formed of a dielectric material, and the support ribs 15 through 18 are provided with contact portions 19 and 20 for instance. The contact portions 19 and 20 are also formed of a dielectric material, but may be of a less rigid character to more suitably support the tuning coil 11 and provide better insulation intermediate the ribs 15 through 18.

The tuning coil 11 consists of a primary conductor 21 having a relatively large rectangular cross-sectional area, as shown in FIGURE 2, and being wound in the form of a helix to take on the coil configuration as illustrated in both FIGURES 1 and 2. The conductor 21 is provided with a longitudinal slot 22 which is formed along the outwardly facing periphery 23 of the coil 11 and which provides a helical groove for supporting a secondary conductor 24.

The secondary conductor 24 has a substantially round relatively small cross-sectional area and is disposed longitudinally within the helical groove 22 as shown in FIGURES 1 and 2. A suitable insulation coating such as the coating 25 is formed about the conductor 24 and provides conduction isolation between the windings 21 and 24. Due to the fact that the construction of windings of this invention provides a substantially ideal transformer, the insulation layer 25 provided intermediate the conductors 21 and 24 may be formed of a thin coating such as a Teflon (polytetrafluoroethylene) coating or the like. Essentially the conductors 21 and 24 will maintain substantially the same RF voltages at adjacent points, and only a thin dielectric coating need be provided to establish circuit separation of the associated conductors.

In the embodiment shown in FIGURE 2, the diameter of the secondary conductor 24 is provided to be substantially less than the depth of the longitudinally formed slot 22. This assures that the conductor 24 will be entirely embedded within the conductor 21. In this way, substantially all of the flux lines associated with the conductor 21 will encircle the conductor 24 and maintain the substantially ideal transformer relationship desired.

The inductance of the tuning coil 11 may be varied via a provision for a rotatable rack 26 and a roller 27 which is mounted to slide on carriage rod 28 of the rack 26. The roller 27 has a bearing surface 29 and circular side or end flanges 30 and 31. Adequate electrical contact is maintained between the roller 27 and the winding 21 as well as between the roller 27 and the carriage rod 28 of the rack 26.

The carriage rod 28 of the rack 26 is supported at pivot arms 32 and 33 which are in turn pivotally mounted as at 34 and 35 about a supporting shaft or hub 36. The hub 36 may be fixedly mounted within the end walls 13 and 14 as at points 37 and 38.

Accordingly, if the point 39 on the conductor 21 is connected to one lead wire of a Pi-L network, for instance, and the shaft 36 is connected to the opposite lead of the network, the inductance of the conductor 21 can be varied by rotating the rack 26 about the shaft

36 and causing the contact roller 27 to be carried along the inner surface of the coil. It is to be noted that the circular flanges 30 and 31 in conjunction with the bearing surface 29 provides a guide for receiving the winding 21 such that rotation of the rack 26 will cause the roller 27 to be moved axially along the carriage rod 28 in response to the tracing of the helical winding 21. The shaft 36 may be connected to a circuit lead wire by a connection 40 to a sleeve 41 which is mounted at the end wall 14 and which makes an electrical contact with the shaft 36. As mentioned, the end supports 13 and 14 are formed of an electrically insulating material for the purpose of insulating the high voltage shaft 36 from the associated equipment on which the transformer is to be mounted.

It will be understood that various modifications and combinations of the above disclosed embodiments may be accomplished by those skilled in the art, but I desire to claim all such modifications and combinations as properly come within the scope of my invention.

I claim as my invention:

1. A radio frequency tuning coil comprising:

a coil support structure,

a first conductor wound substantially in the form of a helix and mounted on said coil support structure, said first conductor having a relatively large current carrying capacity and having a longitudinal slot formed along the outwardly facing periphery thereof, a second conductor having a diameter less than the depth of the slot formed within the first conductor and having a relatively small current carrying capacity,

said second conductor being wound within said slot and being conduction insulated from the first conductor, movable contact means operably mounted on said coil support structure for varying the effective inductance of said first conductor without substantially altering the inductance of said second conductor.

2. A transformer comprising:

a coil support means,

a first conductor wound substantially in the form of a helix and mounted on said coil support means, said first conductor having a slot formed longitudinally along the outwardly facing periphery thereof, a second conductor embedded with said slot and maintained in substantial conduction isolation from said first conductor,

said slot being sufficiently deep within said first conductor such that said second conductor is embedded entirely below the adjacent surface of said first conductor,

an inductance adjustment arm being operable disposed internally of the helically wound first conductor, said adjustment arm being movably positioned at the inwardly facing periphery of the first conductor for varying the effective inductance associated with said first conductor, and

means for connecting said first and second conductors respectively to separate circuits.

3. A radio frequency tuning coil comprising:

a coil support structure,

a first conductor wound substantially in the form of a helix and mounted on said coil support structure, said first conductor having a relatively large current carrying capacity and having a longitudinal opening formed along the length thereof,

a second conductor having a diameter less than the diameter of said opening and having a relatively small current carrying capacity,

said second conductor being wound within said opening and being conduction insulated from the first conductor, movable contact means operably mounted on said coil support structure and contacting said first conductor for varying the effective inductance of said

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first conductor without substantially altering the inductance of said second conductor.

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U.S. Cl. X.R.
336—195; 338—143