Jan. 24, 1961 R. J. ROWLEY 2,969,460

ADJUSTABLE HIGH-FREQUENCY TUNING UNIT

Filed Oct. 14, 1957 2 Sheets-Sheet 1

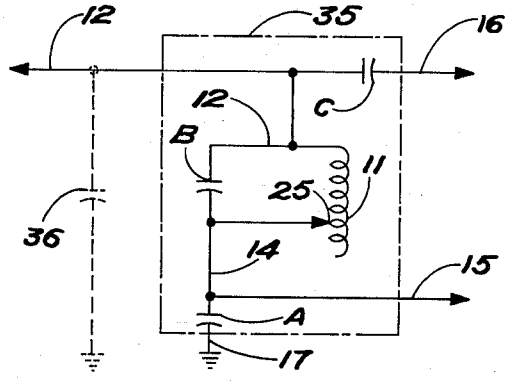


FIG 1

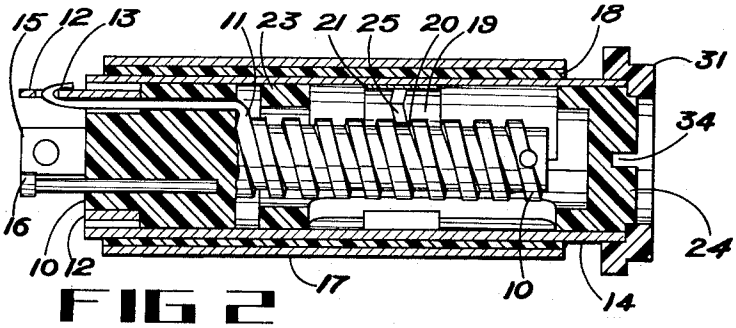


FIG 2

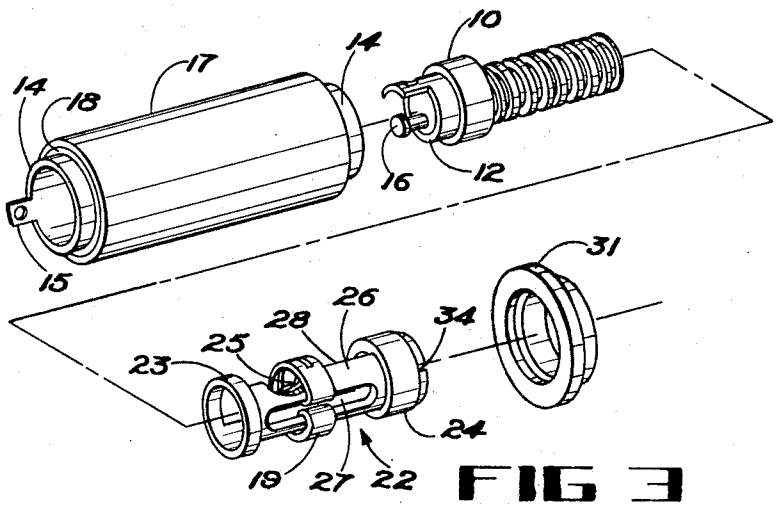


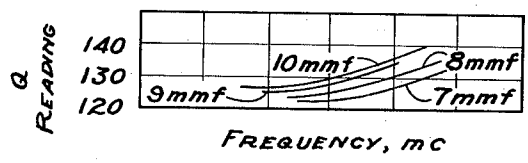
FIG 3

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ADJUSTABLE HIGH-FREQUENCY TUNING UNIT

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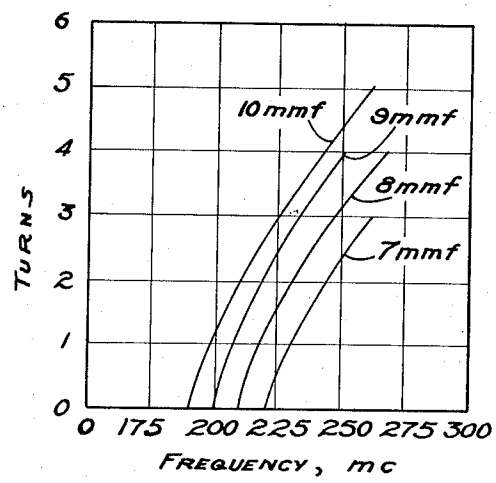


FIG 4

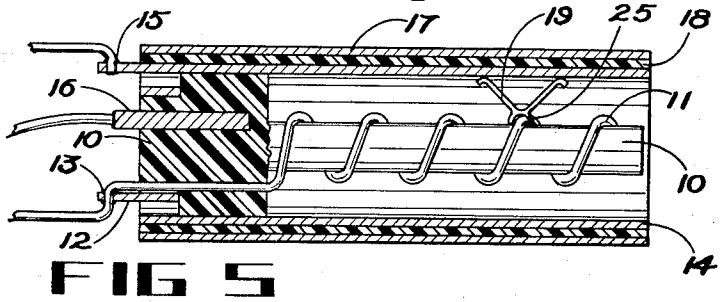


FIG 5

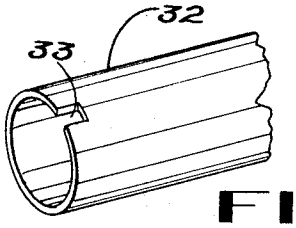


FIG 6

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ADJUSTABLE HIGH-FREQUENCY TUNING UNIT

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4 Claims. (Cl. 250—40)

This invention relates generally to adjustable high-frequency tuning units of the inductance-capacitance type and more particularly to an adjustable tuner for use in the ultra-high-frequency spectrum.

In the design of tuning units for use in the ultra-high-frequency band such as in the range of 235–250 megacycles, difficulties are encountered since this portion of the spectrum lies at the lower end of the coaxial line or cavity type tuner range wherein inductive and capacitive effects are distributed and at the upper end of the frequency range wherein lumped constant inductance and capacitance parameters may be employed. At these high frequencies a design approach based on lumped constants becomes extremely critical in that lead lengths and spacing of the parameters becomes impractical and in many cases prohibitive. On the other hand, the use of a cavity or shorted coaxial line for use in this frequency range necessitates generally a greater size requirement than is ordinarily tolerated in present-day electronics wherein miniaturization and compactness is desired.

It is an object, therefore, of this invention to provide an adjustable tuning unit for use in the ultra-high-frequency range which, by its construction, contains minimum stray inductance, provides efficient shielding of electromagnetic fields contained within the device, is continuously adjustable over a desired frequency range, and provides in one small unit a fixed shunting capacitor, a coupling capacitor, and a by-pass capacitor in conjunction with a variable inductance.

The tuner to be described may be considered as an adjustable coil, fixed-capacitor, shunted circuit with a low-impedance end of the coil used as a grounded shield. It might also be considered as a shorted coaxial line with the outer conductor compressed and the inner conductor retaining its original length but being formed in a spiral shape.

A feature of this invention consists of the provision of two coaxial conductive cylinder members insulated from one another with a coil contained within and means provided to vary the effective length of the coil while maintaining the necessary fixed capacitive effects.

The manner in which the tuner incorporates the advantages of effective electromagnetic field shielding, a high quality factor, and minimum coupling and by-pass inductance may be realized by the following description when read in view of the accompanying drawings in which:

Figure 1 is a schematic diagram of the frequency-determining parameters;

Figure 2 is a sectional view of the physical construction of one embodiment of this invention;

Figure 3 is an exploded isometric of the embodiment of Figure 2;

Figure 4 is a graphical representation of typical operating characteristics;

Figure 5 is a sectional view of a second physical embodiment of this invention; and

Figure 6 illustrates a portion of an adjusting tool to be used in conjunction with the embodiment of Figure 5.

With reference to Figure 5, an insulated core member 10 is seen to have wound thereon a silver-plated wire 11. A metallic sleeve 12 is pressed on to the reduced diameter end of core member 10. Sleeve 12 and wire 11 are electrically connected by soldering or other means at a point 13 on sleeve 12, the point 13 being a projecting tab-like portion on sleeve 12. The assembly of core member 10 and sleeve 12 is pressed into a metallic cylinder 14. A capacitive effect is realized between metallic sleeve 12 and cylinder 14 since from Figure 5 it is to be noticed that sleeve 12 is smaller in diameter than the inside diameter of cylinder 14. This capacitance, with reference to Figure 1, is illustrated as capacitance B and is the main shunt capacitance of the tuner.

A terminal lug 16 is pressed into a recess in insulating core member 10 and is thus held in close proximity to the sleeve member 12. A second capacitance is then realized between terminal lug 16 and sleeve member 12 and this capacitance acts as a coupling capacitor illustrated in Figure 1 as capacitance C.

With reference once again to Figure 5, an insulating dielectric sleeve 18 is formed about inner cylinder 14 and a second cylindrical metallic member 17 surrounds insulating sleeve 18. A third capacitance is, therefore, realized between outer metallic cylindrical member 17 and inner metallic cylinder 14, the insulating sleeve 18 acting as a dielectric therebetween. This capacitance, with reference to Figure 1, is illustrated as capacitor A and functions as a by-pass capacitor between the low-impedance end of the tank circuit and ground. The ground symbol in Figure 1 represents the grounding of outer cylindrical member 17 when the tuner is connected into a chassis. With reference then to Figures 1 and 5, a terminal 15 on inner cylinder 14 is by-passed to ground by the capacitor A and this terminal 15 would serve as the B+ connector when the tuner is employed in a circuit. Like reference numerals in Figures 1 and 5 indicate the correlation between the physical construction of elements and the schematic representation thereof. Thus terminal 12, the input terminal to the tuner, is the connection to the high-impedance end of coil 11. Terminal 16 is the output terminal of the tuner taken from coupling capacitor C which, as previously described, is the capacitance realized between terminal lug 16 and cylindrical sleeve 12. Terminal 15, in being connected to the inner metallic cylinder, functions as the B+ connector and is by-passed to ground through the physical connection of outer metallic cylinder 17 and a chassis into which the tuner would be installed.

Referring again to Figure 5, a sliding spring contact 19 is seen to form a connection between a point on inductive wire 11 and the inner surface of metallic cylinder 14. Slide contact 19 makes connection with inductive wire 11 at the point indicated by reference numeral 25 and it is seen that in Figure 1 the schematic representation is that of sliding contact 25 on coil 11. Member 19 is formed such that it is spring loaded between a point on inductive wire 11 and the inner surface of cylinder 14. Tuning is thereby accomplished by the insertion of an adjustable tool such as indicated in Figure 6 whereby the tool is inserted within cylinder 14 and sliding contact 19 is engaged in slot 33 of the tool 32 whereby rotation of the tool 32 will cause member 19 to advance along coil 11 and reduce its effective length while maintaining continuous connection between the contacted portion of coil 11 and the inner surface of cylinder 14.

The operation of the tuner may then be summed up in the following manner. The junction of the silver wire 11 and metallic sleeve 12 comprises the high-impedance

end of the tuner while the connection between wire 11 and inner cylinder 14 as maintained by sliding contact 19 comprises the low-impedance end of the tuner. Inner cylinder 14, while it is at B+ potential, is essentially at ground potential to radio-frequency voltage due to the by-pass capacitor A which surrounds this unit. By-pass capacitor A, as previously described, is the capacitance realized between inner cylinder 14 and outer cylinder 17. Because the outer cylinder 17, which forms one plate of capacitance A, is soldered or otherwise electrically connected to a chassis, unwanted capacitor inductance is held to an absolute minimum.

The shunting capacitor, capacitor B in Figure 1, is the fixed capacitance between metallic sleeve 12 and inner cylinder 14 formed between the low-impedance point (inner cylinder 14) and the high-impedance point (metallic sleeve 12). In an embodiment tested, the capacitance B had a value of approximately five micromicrofarads, the capacitor A was larger than 500 micromicrofarads and the capacitor C had a value of approximately one micromicrofarad. The small capacitor C is thus properly coupled to the high-impedance end of the tuner.

Figure 4 represents the frequency of the unit as a function of the number of rotational turns of sliding contact 19 from maximum inductance and the quality factor (Q) as a function of the frequency with the unit being shunted by external capacitors of various values. This external shunting capacitor is indicated as capacitor 36 between input terminal 12 and ground in Figure 1. As indicated in Figure 4, a substantially linear increase in frequency is realized between 225 and 250 megacycles as the sliding contact 19 is turned from maximum inductance. A high and substantially constant Q reading is seen to be realized throughout the range.

A preferred embodiment of the invention is illustrated in Figures 2 and 3. This embodiment operates on the identical principle of that illustrated in Figure 5 but includes a novel inductor construction and sliding contact means whereby adjustment may be made by means of a screw driver adjustment, thus requiring no special tool.

The embodiment of Figure 2 is shown in cross section excepting the inductance core element. Figure 3 represents an exploded isometric view of the embodiment of Figure 2. As in the construction previously described of the embodiment of Figure 5, the tuner of Figure 2 once again is seen to be comprised of an inner cylinder 14 and an outer cylinder 17 having an insulating dielectric sleeve 18 therebetween. Insulating core member 10 is pressed within the confines of inner cylinder 14 and has pressed thereon a metallic ring member 12 of smaller diameter than that of inner cylinder 14 such that capacitance B of Figure 1 is once again realized between metallic sleeve 12 and inner cylinder 14. In this embodiment, the inductive wire member differs in that insulating core member 10 is machined with a flat-threaded groove in which is wound a flat silver ribbon wire 11. As indicated in Figure 2, the high-impedance end of the inductive wire 11 is once again electrically connected to a terminal portion of metallic sleeve member 12 at a point indicated by reference numeral 13. A terminal lug 16 is seen to be pressed into the core member 10, and, due to its proximity with metallic sleeve 12, a capacitance corresponding to capacitance C in Figure 1 is realized between terminal lug 16 and metallic sleeve 12. Outer metallic cylinder 17 once again functions as the lower plate of a by-pass capacitor to ground indicated as capacitance A in Figure 1.

In this embodiment, adjustable contact 19 which forms the continuous electrical connection between inner cylinder 14 and inductive wire 11 is made to rotate in the threaded groove of core member 10. With reference to Figure 3 an insulated sleeve member 22 cooperates with sliding contact 19 and facilitates tuning by means of a screw driver slot 34. Without this insulated sleeve member 22, which functions as an adapter, a special tuning tool would be required. With reference to Figure 3 insulating sleeve member 22 is seen to be formed of a hollow cylindrical member comprising end portions 23 and 24 and a center portion 26 of reduced diameter. Center portion 26 is formed with diametrically opposed slotted portions 27 and 28. Slide contact 19 is seen to be formed of a spring-like material such that two ends may be crimped over to form a slidable positioning means along slot 27 on center portion 26 of sleeve 22. A tab-like portion 25 extends inwardly from the member 19 and functions as a spring-loaded contact with metallic wire 11 when sleeve 22 and contact 19 are placed over insulating core member 10. It is thus seen that rotation of sleeve member 22, with respect to insulating core member 10, forces sliding contact member 25 to travel along the grooves within which inductive wire 11 is wound. With reference to Figure 2 a continuous contact is thus maintained by tab portion 25 on inductive wire 11 while the outer surface of sliding contact member 19 maintains a sliding spring-loaded contact against the inner surface of cylinder 14. This construction, therefore, eliminates the need for a special tool and completely encloses the low-impedance end of the tuner. Adjustment may be made by insertion of a screw driver in slot 34 of sleeve member 22.

The embodiment of Figure 2 is additionally provided with an insulator cap 31 which presses over inner cylinder 14 to hold adjusting sleeve member 22 within the confines of the tuner. Cap 31 additionally acts as an insulation ring and may be seated in a hole in a receiver chassis and effect the necessary insulation between inner cylinder 14 and the chassis, inner cylinder 14 being at B+ potential.

It is to be noted that in either of the above discussed embodiments the tuner of this invention provides an almost complete shielding from electromagnetic field radiation. Since the one end of the tuner which is left open for tuning purposes and is not metallically shielded in the low-impedance point of the tuner, very little electromagnetic field radiation from the tuner is possible. Further, and more particularly regarding the embodiment of Figure 2, it is seen that inner metallic cylinder 14 extends substantially beyond the low-impedance end of coil 11 and thus provides additional shielding.

The tuner of this invention provides an extremely compact unit and by its construction lends itself to incorporation in air-cooled module chassis construction. An air-cooled chassis may be air-tight in construction while incorporating one of the tuners of this invention and still be tunable from outside the module.

Further, the physical shape of the tuner of this invention is ideal for use with subminiature tubes in that the length and diameter are comparable to that of a shielded tube.

Although this invention has been described with respect to particular embodiments thereof, it is not to be so limited as changes and modifications may be made therein which are within the full intended scope of the invention as defined by the appended claims.

What is claimed is:

1. An adjustable high-frequency tuning unit of the variable inductance type comprising, an insulating core member with an inductive member wound on a first reduced diameter portion thereof, a conductive sleeve member placed over a second reduced diameter portion of said core member, one end of said inductive member electrically connected to said sleeve member, a first external conductor connected to said sleeve member, a hollow conductive cylinder, said core member contained within said conductive cylinder, an outer conductive surface surrounding said conductive cylinder and dielectrically separated therefrom, a conductive rod-like member inserted in said core member in juxtaposed and space-separated relationship with said conductive sleeve member, a second external connector connected to said rod-

like member, a third external connector connected to said conductive cylinder, and adjustable shorting means between said wire turns on said core member and said conductive cylinder.

2. A capacitive-inductive tuner comprising, an insulated cylindrical core member having first and second end sections of reduced diameter, an inductive member wound on the first end section, a conductive sleeve mounted concentrically about the second end section, one end of said inductive member extending through said core member and electrically connected to said conductive sleeve, a first conductive cylindrical member, said core member secured within said first cylindrical member, a conductive lug member received in said second end section of said core member, said lug member radially displaced from the longitudinal axis of said core member and in spacial proximity with the inner surface of said conductive sleeve, a second conductive cylindrical member surrounding said first cylindrical member and dielectrically insulated therefrom, first, second and third terminals connected respectively to said first cylindrical member, said conductive lug member and said conductive sleeve, and a spring contact member maintaining electrical connection between said inductive member and said first cylindrical member, said spring contact member being positionable along said inductive member to vary the effective inductive length thereof.

3. An adjustable high-frequency tuning unit of the variable inductance type comprising, an insulating core member formed with a spiral groove therein, an inductive member wound about said core and recessed in said spiral groove, a conductive sleeve placed over a reduced diameter end portion of said core member, one end of said inductive member electrically connected to said sleeve member, a first external conductor connected to said sleeve, a hollow conductive cylinder, said core member contained within said conductive cylinder, an outer conductive surface surrounding said conductive cylinder and dielectrically separated therefrom, a conductive rod-like member inserted in said core member in juxtaposed and space-separated relationship with said conductive sleeve, a second external connector connected to said rod-like member, a third external connector connected to said hollow conductive cylinder, an insulating adapter sleeve rotatably mounted about said core member, a contact member affixed to said adapter sleeve, said contact member non-rotatably supported by and slidably positionable with respect to said adapter sleeve whereby rotation of said adapter sleeve effects rotation of said contact member along the spiral grooves in said core member, and said contact member being formed to maintain a continuous electrical connection between said inductive member and the inner surface of said conductive cylinder to vary the effective length of said inductive member.

4. An adjustable high-frequency tuning unit of the variable inductance type comprising, an insulating core member formed with a spiral groove therein, an inductive member wound about said core and recessed in said spiral groove, a conductive sleeve placed over a reduced diameter end portion of said core member, one end of said inductive member electrically connected to said sleeve, a first external connector connected to said sleeve, a hollow conductive cylinder, said core member contained within said conductive cylinder, an outer conductive surface surrounding said conductive cylinder and dielectrically separated therefrom, a conductive rod-like member inserted in said core member in juxtaposed and space-separated relationship with said conductive sleeve, a second external connector connected to said rod-like member, a third external connector connected to said conductive cylinder, an insulating adapter sleeve member having a longitudinally extending through-slot therein, said adapter mounted concentrically about and rotatable with respect to the grooved portion of said core member, a spring contact member mounted concentrically about said adapter, said contact member being non-rotatable with respect to said adapter sleeve and longitudinally slidable with respect thereto, a spring tab formed inwardly from said contact member and passed through said through-slot and into engagement with a point on said inductive member, said contact member being adapted to be in spring-loaded slidable engagement with the inner surface of said hollow conductive cylinder, whereby rotation of said adapter sleeve member causes the contact member to rotate along the spiral grooves on said insulating core member and be displaced along said adapter to effect a continuous electrical contact between the inner surface of said conductive cylinder and said inductive member.

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