Sept. 4, 1951 W. J. POLYDOROFF 2,566,746

VERY HIGH-FREQUENCY TUNING CIRCUITS

Filed May 11, 1949

FIG. 1.

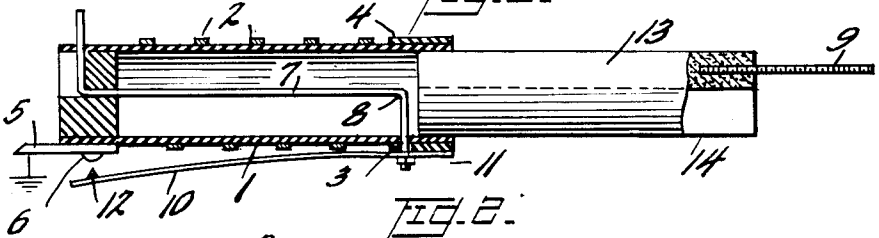


FIG. 2.

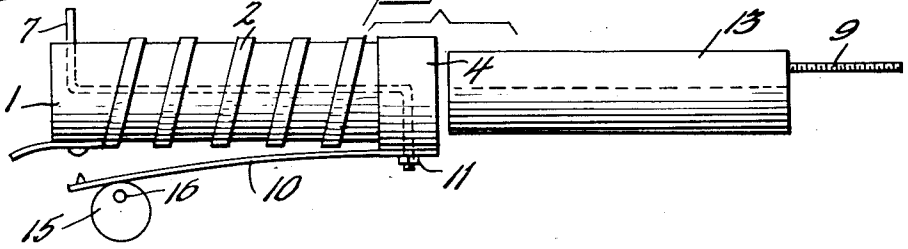


FIG. 3.

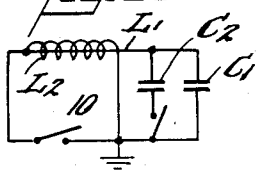


FIG. 4.

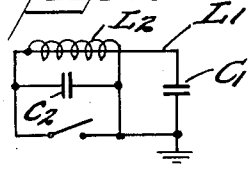


FIG. 5.

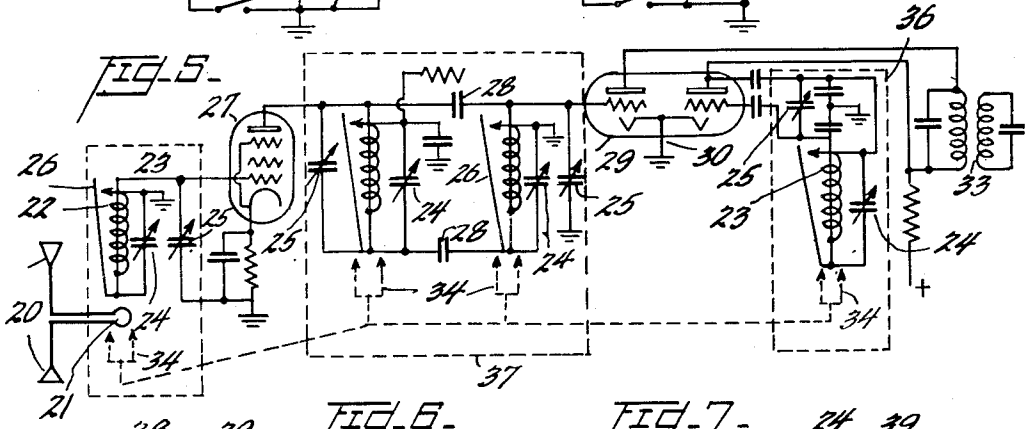


FIG. 6.

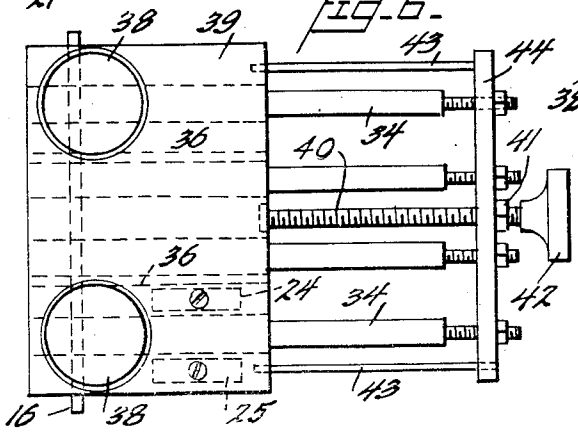
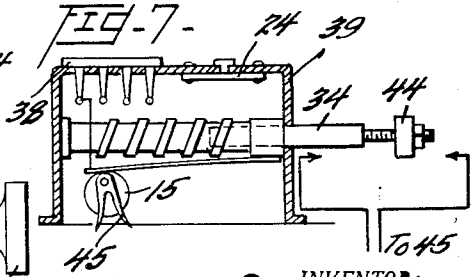


FIG. 7.



INVENTOR

Wladimir J. Polydoroff

Patented Sept. 4, 1951

2,566,746

UNITED STATES PATENT OFFICE

2,566,746

VERY HIGH-FREQUENCY TUNING CIRCUITS

Wladimir J. Polydoroff, Bethesda, Md.

Application May 11, 1949, Serial No. 92,695

5 Claims. (Cl. 250—40)

1

The present invention relates to very high frequency circuits and describes methods of tuning said circuits over relatively wide bands of frequencies.

It is know that tuning of very high frequency circuits present considerable difficulties when it is desired to cover bands of substantial width. The size of variable condensers, if such are to be used, is limited by their residual inductance and if inductive tuning is chosen by means of the moving ferromagnetic cores the tuning range is restricted because of necessary reduction of core material's permeability in order to limit core losses, at these frequencies.

Since the present invention describes the new method of tuning by ferromagnetic cores it is appropriate to mention here that in the frequency region from 50 to 200 mc. the practical permeability of more materials is about 6 when measured in a toroidal specimen and is further reduced in actual constructions to about 2.5 when effective permeability is measured in elongated solenoidal coils with corresponding cylindrical cores.

One object of the present invention is to provide tuned circuits for very high frequencies, which circuits are capable of being tuned over wide bands of frequencies.

Another object is to provide simple means to extend the frequency range of operation of said circuits.

Still another object is to provide simple switching means which transfer the inductors to another mode of operation.

Still another object is to construct a simple and compact assembly which can be easily applied to high frequency apparatus for tuning purposes.

The invention will be better understood if reference is made to the accompanying drawings in which:

Fig. 1 shows the construction of a variable inductor of the present invention.

Fig. 2 shows another view of the inductor.

Figs. 3 and 4 shows schematically very high frequency circuits to which present invention is applied.

Fig. 5 shows a general circuit of a very high frequency tuner as employed in the present invention.

Figs. 6 and 7 show the general layout of a tuner embodying the circuit of Fig. 5.

Referring now to Fig. 1, a modification of a variable inductor is shown such as was described in my co-pending U. S. Letters Patent Serial Number 2,518,930 of August 15, 1950. The inductor then described comprised a helical portion and a linear

2

portion both connected in series said linear portion being placed inside of the helical portion coaxially thereof and a cylindrical ferromagnetic core with an elongated slot, which was moved in and out of the coil thereby simultaneously affecting the inductance of both portions. A similar inductor but of different mode of operation is shown in Fig. 1. A thin Bakelite tubing 1 is used as a coil former around which several turns of flat wire are wound thus forming a solenoidal coil 2. One end of the coil is fixed to the tubing 1 by means of a tightly fitted sleeve 4 and, in addition, the coil is cemented to the tubing 1. The other end may be secured to tubing 1 by means of a rivet or a screw 6. A coaxial wire 7 is stretched through the tubing, one end 8 of the wire is bent at a right angle and metallically connected at 3 with the coil 2. The protruding portion of the wire 7 is also connected with a thick wire or springy blade 10, one end of which being firmly held by means of a nut or a rivet 11. The other end of the blade 21 may make direct contact with the end of the coil at 12, thus shunting the helical portion of the coil. A movable ferromagnetic core 13 may enter in the coil to vary the inductance of both portions of the inductor. When the contact of the blade 10 is open the inductor comprises a linear portion 7 in series with the helical portion 2 both simultaneously "tuned" by the moving core. Thus position may correspond to a certain band of very high frequencies, as later described. When contact 12 is closed and the helical portion is shunted, a much smaller inductance, composed of the straight wire 7 and its blade 10 remains and is tuned by the same core 13. Thus we have two different values of inductance offered in a single device especially adaptable for very high frequency applications, each inductance value being altered or tuned by the movement of a single core. Fig. 2 shows a side view of the inductor of Fig. 1. The blade 10 is shown to be actuated by a disc or drum 15 which is eccentrically rotated on its shaft 16.

Fig. 3 schematically shows the application of such variable inductor to a simple resonant circuit. The inductance portions L_1 and L_2 respectively represent linear and solenoidal parts of the inductor of Figs. 1 and 2 and capacitors C_1 and C_2 are shunted across the inductance to form resonant circuits responding to two different bands of frequencies. Switch 10 represents the shunting blade of the previous figures to which additional contact is added so that at one position, as shown on Fig. 3; two condensers are added in parallel, while a single condenser C_1 re-

mains in the circuit at another position. Fig. 4 shows a simplified arrangement, where condenser C_2 is permanently shunted across the solenoidal portion. In this case a single point contact is necessary to switch the circuits from one range to another. The condenser across the larger inductance also acts as a by-pass for the higher frequency range in addition to the contact of 10. The additional circuit formed by L_1C_1, being effectively in parallel with the circuit L_2C_2, acts as a suppressor of undesired higher frequencies, such as harmonics of an oscillator.

In the practical example of the present invention the following values may be used: The helical portion is wound on a 1½" long, ¼" diam. tube with 7 turns of conductive ribbon ⅛" wide to an inductance of 0.12 μH which includes the inductance of the linear portion, the latter calculated to be of the order of 0.03 μH, if made of #18 wire. With a total capacity of 30 $\mu\mu$F this circuit resonates from 50–80 mc. with the core in and out of the inductor, when the effective permeability of the core is 2.55, when it varies both linear and helical portions. With a shunted helical portion and the new circuit capacity C_1=10$\mu\mu$f the circuit responds from 165–200 mc., thus indicating L_1=.05 μH and μeff=1.5. It is to be noted that when such circuit is applied to the input or output of a thermionic tube the tube capacitances will add to the total capacitances so that C_1 and C_2 must be re-adjusted.

Two different frequency bands, such as above quoted, are generally used in television receivers where it is relatively simple to tune a lower frequency band with conventional coil and core, but the higher frequency band presents real difficulties when a 1–2 turn coil has to be tuned by a core.

The present invention demonstrates the simplicity of the arrangement when it is applied to the tuner circuit as shown on Fig. 5. In this figure the dipole antenna is represented by 20—20, and it may be coupled through a transmission line to a coupling turn 21 which acts as a magnetic coupler for the lower range and as a capacitive element for the other range. The first tuned circuit 23 is built in accordance with Fig. 3 or 4 and contains the essential elements including an inductor 22 of Fig. 1 and capacitors 24 and 25 with switching means 26. Circuit 23 feeds into a pentode type tube 27. A similar circuit may be placed in the output of tube 27, in its plate circuit. In order to provide a wide band tuning, such as required in television, a third similar circuit may be coupled to the second one. Small coupling condensers 28 couple second and third circuits to form a band-pass. It is evident from the radio receiver circuit illustrated in Fig. 5 that the bottom condensers 28 act as couplers when switches 26 are open, which corresponds to the lower frequency band. A third tuned circuit is connected to the input of a tube 29—30 which is of double triode type. Triode 29 acts as radio frequency tube and the mixer and has in its output an I. F. transformer 33. Triode 30 is an oscillator of the Colpitts type with a potential divider 36, two adjustable condensers 24 and 25 for two frequency ranges and an inductor 23 of the same type as in other circuits.

The inductors are made variable by a synchronized movement of ferromagnetic cores 34 as indicated by dotted line connection. Dotted lines connecting the switches indicate their unified control. The certain parts of the circuits should be magnetically and electrostatically shielded from other circuits as shown by dotted boxes 37.

In this type of the tuner it is also possible to substitute the first, input, tunable circuit by an input band-pass filter, which broadly admits one entire frequency band or the other. Similar switching will then be employed to interchange one or the other band-pass input circuit.

The tuners and other components for the receiving system of Fig. 5 may be arranged into a single compact assembly shown in Fig. 6. It is convenient, in view of the shielding required, to use a metal box as the base of the tuner, which box may be partitioned inside to provide shielded circuits. A plan view of the box 37 is shown with the dotted partitions 36. On top of the box two sockets 38 are provided to accommodate tubes 27 and 29—30. The coils may be arranged between the walls of the box as shown in Fig. 7 with the openings through which the cores 34 may enter into the coils. The cores are adjustably fixed on a common bridle 44 the linear movement of which produces simultaneous tuning of the inductors. As can be seen on Fig. 7 the coils are placed near the tube sockets, thus securing very short leads. Close to the coils are arranged adjustable condensers 24 and 25 thus completing each circuit in its own compartment. Switch actuating mechanism 15, 16 extends through the length of the box to operate all circuits simultaneously. The preferred mechanism to cause unicontrol movement of the cores consists of a screw 40, one end of which is supported in the wall of the box with a nut 41 and the guides 43, the latter to insure the alignment of the system. The rotation of the knob 42 may be synchronized with an indicator of the channels to which the receiver system is tuned. Switch actuating mechanism may be operated manually or so arranged that at both ends of the movements of the cores the switches are closed or opened automatically with the movement of the cores, as schematically shown by conductors 44 and 45 in Fig. 7 of the drawing.

Having thus described the invention what I claim is:

1. A radio circuit tunable throughout two different very high frequency ranges comprising an inductor having an enlongated solenoidal portion and a serially connected linear portion coaxial with said solenoidal portion, two adjustable condensers respectively shunting the entire inductor or one of said portions only to form resonant circuits of different frequencies, a movable ferromagnetic core adapted to enter into said inductor to vary the inductance of both portions and to alter the frequency of each respective circuit and switching means to connect into the circuit the entire said inductor or the linear portion only with one of said adjustable condensers.

2. A radio circuit tunable throughout two different very high frequency ranges comprising an inductor having a solenoidal portion, serially connected linear portion, coaxial with said solenoidal portion, and a contact blade integral with said inductor to shunt said solenoidal portion, a first adjustable condenser effectively shunting the entire inductor to form a circuit responsive to one frequency range, a second adjustable condenser shunting said linear portion to ground to form a circuit responsive to another frequency range, a switching means including said blade to connect either of said condensers across said inductor or said linear portion and a movable fer-

romagnetic core common to said solenoidal and said linear portion of the inductor to tune the circuits to a desired frequency within either frequency range.

3. A band-pass circuit for very high frequency operation at two different frequency ranges comprising a pair of resonant circuits each including a variable inductor having an elongated solenoidal portion and a linear portion, and a ferromagnetic movable core to simultaneously alter the inductance of both portions, a capacitor across the entire inductor to form a higher frequency circuit when said solenoidal portion is short-circuited and an additional capacitor across the solenoidal portion for lower frequency circuit and switching means integral with said inductor to simultaneously short-circuit said solenoidal portion while providing different degree of coupling between said pair of resonant circuits.

4. A tuning unit for very high frequency operation at two different high frequency ranges, including a plurality of radio circuits, each comprising an inductor having a low inductance and high inductance portions serially connected together, the higher frequency portion being in the form of a linear conductor, two capacitors in each circuit to form resonant circuits responsive to higher and lower frequency ranges, ferromagnetic movable magnetic means to alter the inductance of both portions to tune said circuits and common operating members to select respective inductance portions and to interconnect

the capacitive branches of said circuits for higher or lower frequency operation said common operating members being actuated by said magnetic means at the ends of their linear movement.

5. A tuning unit for very high frequency operation at two different high frequency ranges including a plurality of coupled radio circuits, each comprising a low inductance portion in the form of a linear conductor and a higher inductance solenoidal portion, both portions being serially connected together, two capacitors in each circuit one connected across the entire inductor and another across said solenoidal portion, a single ferromagnetic movable means in each circuit to alter inductance of both said portions and common operating members to select the respective inductance portions and to provide different degree of coupling between said coupled circuits for different ranges of operation, said ferromagnetic means being movable simultaneously into all said inductors.

WLADIMIR J. POLYDOROFF.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
2,061,740	Rechnitzer	Nov. 24, 1936
2,095,420	Polydoroff	Oct. 12, 1937
2,217,984	Kirk	Oct. 15, 1940
2,445,700	Vaughn	July 20, 1948