Nov. 21, 1950 J. W. MILLION, JR 2,531,231

VARIABLE PERMEABILITY TUNING DEVICE

Filed Dec. 4, 1945

Fig. 1.

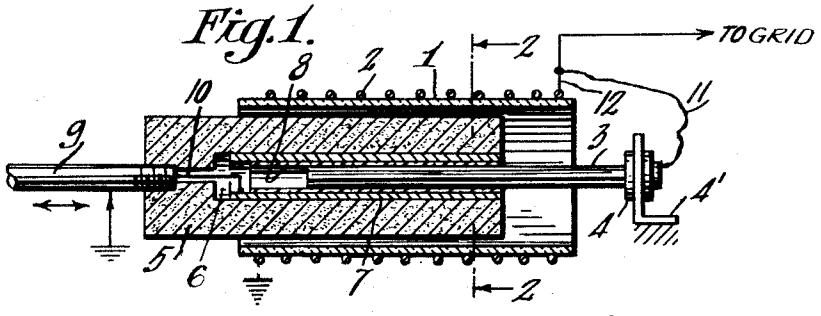


Fig. 2

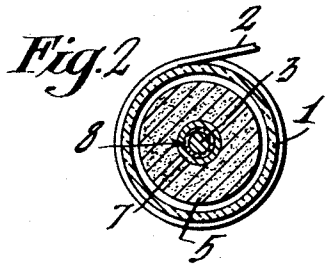
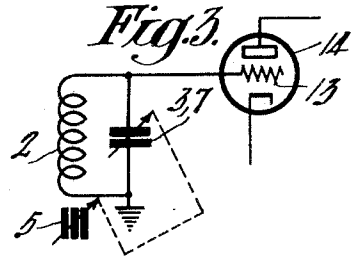


Fig. 3.



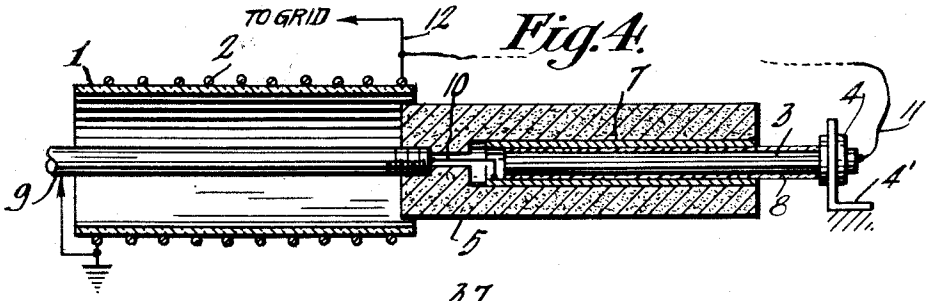
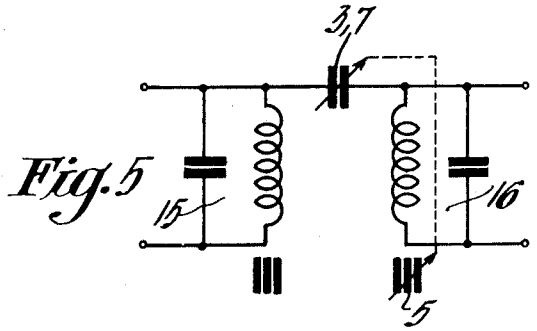


Fig. 4.

Fig. 5



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VARIABLE PERMEABILITY TUNING DEVICE

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10 Claims. (Cl. 250—40)

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The present invention relates to a variable permeability tuning device of the type comprising a coil wound in the form of a solenoid and an axially movable ferro-magnetic core for varying the coil inductance, such devices being commonly employed in radio receivers and other radio apparatus for tuning signal frequency and other circuits to resonance.

An object of the invention is to provide a permeability tuning device of the type mentioned with guiding means for the core whereby throughout its axial movement the core is in exact concentricity relative to the coil, effecting thereby a more precise adjustment, and avoiding also undue frictional contact between the core and coil form.

A further object of the invention is to provide a simple and compact device of the type mentioned which embodies also a cylindrical capacitor, the construction being such that the capacitor is varied at the same time that the inductance is varied.

A more specific object of the invention is to provide a permeability tuning device which comprises an inductance coil wound on a tubular insulating form, a fixed metallic rod disposed in predetermined relation with respect to the coil form, a ferro-magnetic core adapted for axial movement within the coil form, the core being provided with an elongated bore which is adapted to receive the fixed rod, a metallic sleeve fitted within the bore, and a coating of dielectric material interposed between the rod and sleeve, the latter elements constituting the electrodes of a cylindrical capacitor, which is varid simultaneously with variation in the coil inductance upon axial movement of the core relative to the coil.

Other objects and advantages of the invention will best be understood by a consideration of the following description taken together with the accompanying drawing, in which:

Fig. 1 is a longitudinal cross-section through a permeability tuning device constructed in accordance with one embodiment of the invention;

Fig. 2 is an enlarged cross-sectional view taken on the line 2—2 of Fig. 1;

Fig. 4 is a view similar to Fig. 1 showing a device in accordance with another embodiment of the invention; and

Figs. 3 and 5 are schematic circuit diagrams illustrating various uses of the devices shown in Figs. 1 and 4, respectively.

Referring to Fig. 1 there is shown at 1 a tubular insulating form on which there is wound an

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inductance coil 2, the inductance of which it is desired to vary. Concentrically arranged within the coil form 1 is a metal rod 3 which is supported at one end within an insulating grommet 4 carried by a bracket 4', the other end of the rod extending into the coil for a substantial distance. At 5 is shown a rod-like ferro-magnetic core which is adapted for axial movement within the coil form 1 to vary the coil inductance in a manner well-known in the art. The core 5 is formed with a cylindrical elongated bore 6 which is adapted to receive the metal rod 3, and fitted within the bore is a metal sleeve 7, the inner surface of which is coated with a thin coating 8 of insulating material, such as ceramic. By providing a close fit between the rod 3 and the coated metal sleeve 7, the rod forms a guide whereby the core and coil maintain exact concentricity throughout the core travel, greater accuracy of calibration being obtained thereby. This construction permits also the use of a smaller clearance between the core and the coil form without causing undue friction therebetween.

A rod-like member or wire 9 is screw-threaded into, or otherwise attached to, the end of the core 5 remote from the end which receives the guide rod 3 and serves as the manual operating member for axially adjusting the core with respect to the coil inductance 1. The operating member 9 is connected to ground in the usual manner and an electrical connection 10 is provided between said member and the metallic sleeve 7. A second electrical connection 11 is connected between the metal guide rod 3 and one end 12 of the coil which is adapted for connection to the signal grid 13 of an electron discharge tube 14, as shown in Fig. 3.

The elements constituting the cylindrical capacitor may be variously constructed. For example, instead of forming the thin coating 8 of dielectric material on the inner surface of the metallic sleeve 7, such coating may be formed on the surface of the fixed metallic guide rod 3. Also, instead of the metallic sleeve 7, a metallic film deposit may be formed on the inner surface of the bore in which case the coating of dielectric material 8 may be formed on the metal rod 3, as shown in Fig. 4, or else take the form of a cylindrical insulating sleeve fitted within the thus metallized bore.

In the embodiment of Fig. 1, it will be noted, the inductance and capacitance changes are in the same sense, that is, as the inductance is increased or decreased the capacitance is also in-

creased or decreased. An example of the use of a permeability tuner according to this embodiment is shown in the circuit of Fig. 3, wherein like elements are indicated by the same reference characters as in Fig. 1. The coil 2 and tubular capacitor 3, 7 constitute a resonant circuit which may be the signal frequency circuit of a radio receiver. By reason of the simultaneous variation of the circuit constants (inductance and capacitance) in the same sense, the tuning range is extended beyond that obtainable with a variation in either inductance or capacitance alone.

In the embodiment disclosed in Fig. 4, the arrangement is such that the inductance and capacitance changes are in the opposite sense; in other words, an increase or decrease in inductance is accompanied, respectively, by a decrease or increase in capacitance. The construction of Fig. 4 differs from that of Fig. 1 in that the metal guide rod 3 is positioned almost entirely outside of the coil (or coil form) and is in coaxial relation therewith in contradistinction to the concentric arrangement of Fig. 1. The dielectric coating 8 is formed on the surface of rod 3. In the position of adjustment shown in Fig. 4, the device is adjusted for maximum capacitance and minimum inductance. As the magnetic core 5 is moved more and more into the coil, the inductance increases towards a maximum while the capacitance decreases towards a minimum.

An example of the use of a permeability tuner of the latter construction is shown in Fig. 5. The pair of tunable circuits 15 and 16 are capacitively coupled by the tubular capacitor 3, 7 which is varied simultaneously in the opposite sense with change in the inductance of circuit 16. This provides a variable coupling between the circuits which decreases more rapidly with increasing frequency than with the use of a fixed capacity coupling.

As a further example, a permeability tuner of the invention may be employed in the radio frequency stage of a broadcast receiver to improve the over-all gain of this stage. The resonance of the primary circuit of this stage is usually fixed at about 300 k. c., somewhat below the received band of 540 to 1600 k. c. This improves the gain at the low frequency end of the band only. By using a variable capacitor the resonance of the primary circuit can be varied in step with the tuning so that at the high frequency end of the band (1600 k. c.) the primary circuit is tuned to approximately 450 or 500 k. c.

While I have shown and described certain preferred embodiments of my invention it will be understood that various modifications and changes will occur to those skilled in the art without departing from the spirit and scope of this invention.

What I claim is:

1. A permeability tuning device comprising a coil of the solenoid type wound on a tubular insulating form, a magnetic core adapted for axial movement within the coil form and provided with an elongated bore, a fixed metallic rod axially disposed with respect to said bore and adapted to be received therein whereby the rod serves as a guide for the core during its axial movement, a metallic sleeve within the bore, and a thin coating of dielectric material interposed between said rod and sleeve, said latter elements constituting the electrodes of a condenser, the capacity of which is varied simultaneously with variation in inductance of the coil upon axial movement of the core relative to the coil.

2. A permeability tuning device as defined in claim 1 wherein the fixed metallic rod is disposed concentrically with respect to the coil form, and the elongated bore is concentrically arranged within the core.

3. A permeability tuning device as defined in claim 1 wherein the fixed metallic rod is disposed externally of and in coaxial relation with respect to the coil form, and the elongated bore is concentrically arranged within the core.

4. A permeability tuning device as defined in claim 1 wherein the thin coating of dielectric material is formed on the inner surface of the metallic sleeve.

5. A permeability tuning device as defined in claim 1 wherein the thin coating of dielectric material is formed on the outer surface of the fixed metallic rod.

6. A permeability tuning device as defined in claim 1 wherein the metallic sleeve is in the form of a film deposited on the cylindrical surface of the bore and the fixed metallic rod has formed on its surface a coating of dielectric material.

7. A permeability tuning device as defined in claim 1 wherein the metallic sleeve is in the form of a film deposited on the cylindrical surface of the bore and the dielectric material is in the form of a cylindrical sleeve fitted within the so coated bore.

8. A permeability tuning device comprising a coil of the solenoid type wound on a tubular insulating form, a magnetic core adapted for axial movement within the coil form and provided with an elongated bore, a fixed metallic rod disposed within said coil form, said rod being axially disposed with respect to said bore and adapted to be received therein whereby the rod serves as a guide for the core during its axial movement, a metallic sleeve within the bore, and a thin coating of dielectric material interposed between said rod and sleeve, said latter elements constituting the electrodes of a condenser, the capacity of which is varied simultaneously and in the same sense with variation in inductance of the coil upon axial movement of the core relative to the coil.

9. A permeability tuning device comprising a coil of the solenoid type wound on a tubular insulating form, a magnetic core adapted for axial movement within the coil form and provided with an elongated bore, a fixed metallic rod disposed externally of, and in coaxial relation with respect to, said coil form, said rod being axially disposed with respect to said bore and adapted to be received therein whereby the rod serves as a guide for the core during its axial movement, a metallic sleeve within the bore, and a thin coating of dielectric material interposed between said rod and sleeve, said latter elements constituting the electrodes of a condenser, the capacity of which is varied simultaneously and in the opposite sense with variation in inductance of the coil upon axial movement of the core relative to the coil.

10. A radio frequency tuning device comprising an inductance coil of the solenoid type, a ferro-magnetic core arranged for longitudinal movement axially within said coil for varying the inductance of said coil, said core having an elongated concentric bore with an electrically conducting surface, a metallic rod coaxially disposed within said bore in spaced relation from said surface, said core being longitudinally movable

relative to said rod, dielectric means radially spacing said rod and said surface, structure electrically connecting said rod and said surface as electrodes of a variable capacitor in circuit with said coil.

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Certificate of Correction

Patent No. 2,531,231 November 21, 1950

JOHN W. MILLION, JR.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows:

Column 3, line 39, after the word "with" insert *decreasing frequently or increases more rapidly with*;

and that the said Letters Patent should be read as corrected above, so that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 23rd day of January, A. D. 1951.

[SEAL]

THOMAS F. MURPHY,
Assistant Commissioner of Patents.

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