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RADIOSIGNALING

Filed June 30, 1927

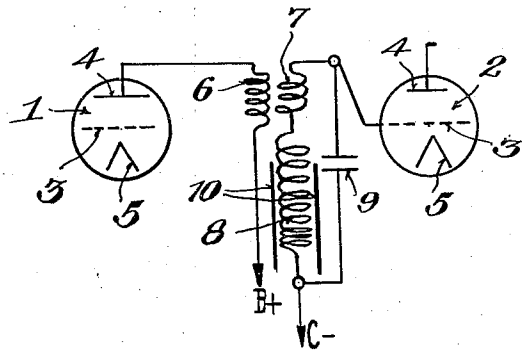


FIG. 1.

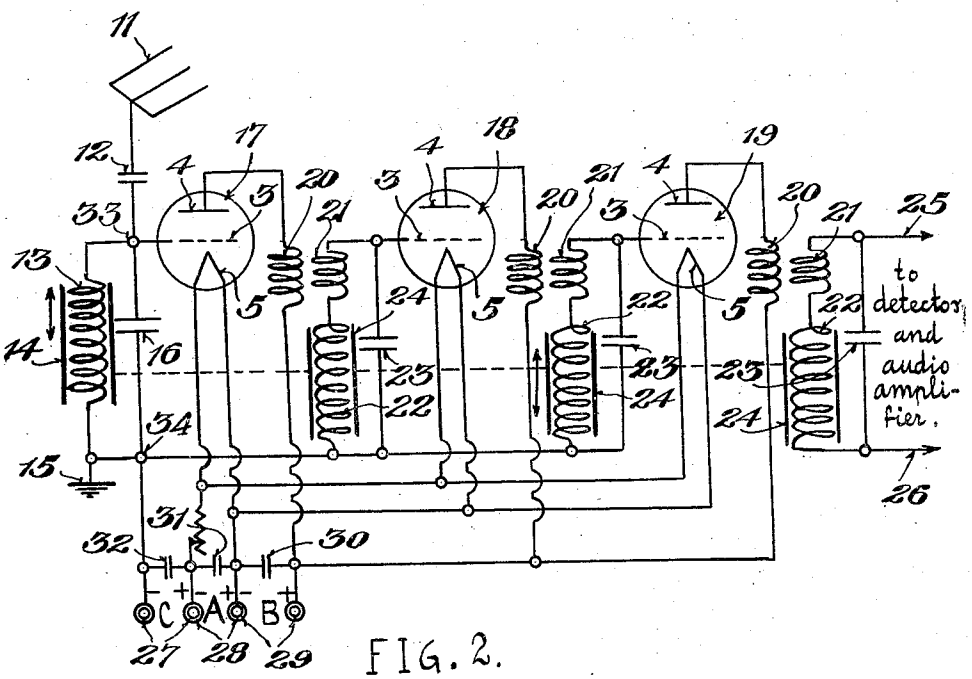


FIG. 2.

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UNITED STATES PATENT OFFICE

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RADIOSIGNALING

Application filed June 30, 1927. Serial No. 202,656.

This invention relates to the art of radio signaling. One object of the invention is to provide improved methods and means for the reception of radio signals. Another object is to provide novel means of tuning. Still another object is the embodiment of the novel method of tuning in a tuned radio frequency amplifier for the reception of radio signals. A further object is to secure tuned radio frequency amplification in the reception of radio signals without causing regeneration.

In our co-pending application, Serial No. 172,016, filed March 2, 1927 we have described a new method for tuning radio circuits in which tuning is accomplished by the sliding of a metal cylinder over the inductance coil of the circuit and using a fixed condenser. We have also described there a system showing the embodiment of this method of tuning in a three-stage tuned radio frequency amplifier receiver, and emphasized the fact that in the use of this method of tuning the system is free from regeneration. This invention embodies the same general principles of tuning but provides modifications and improvements, whereby greater efficiency in the operation of the system is secured. The invention will be best understood by reference to the accompanying drawings, in which:—

Figure 1 shows a single unit of a tuned radio frequency amplifier.

Figure 2 shows a complete radio receiver in which three stages of tuned radio frequency amplification is used.

Having particular reference to the accompanying drawings, in which like reference numerals designate corresponding parts, in Fig. 1, 1 and 2 designate three electrode vacuum tubes, each comprising a grid 3, plate 4, and filament 5. The plate 4 of tube 1 is connected through coil 6 to the positive terminal of a plate battery in the usual manner. The tuning circuit of the second tube 2 comprises inductance coils 7 and 8 and a fixed condenser 9 all connected in series; the windings of the coils 7 and 8 are in opposite directions. The tuning of the circuit 7—8—9 is effected by the sliding of the metal tube 10 over the inductance coil 8 the metal cylinders being insulated from the coils thereby to prevent short circuiting of the turns of the coils when the cylinders are in operative position thereover; effecting thereby a change in the inductance of the coil, as well as a change in the distributed capacity between the metal tube 10 and the coil 8, and it is through the variation of these combined effects that tuning is accomplished.

The coils 7 and 8 are wound on the same core as a single coil, but the directions of the windings of the coils 7 and 8 are reversed with respect to each other. The plate coil 6 is in close mutual inductive relation to coil 7, and it is also necessarily in mutual inductive relation to coil 8; obviously the mutual inductance between 6 and 8 is of opposite direction to the mutual inductance between the coils 6 and 7, and is also of considerable smaller value. It is preferable to have tight coupling between the coils 6 and 7 which is effected by winding these two coils in close mutual inductive relation. It is clear that a current flow in the plate coil 6 induces electromotive forces of opposite directions in the coils 7 and 8 respectively, and the current flow in the tuned circuit 7—8—9 is due to the difference in these two induced electromotive forces acting on the circuit. The difference between the electro-motive force induced in the coil 7 and that induced in the coil 8, is not however, a constant quantity, but varies with the position of the metal cylinder 10 on the coil 8. As the cylinder is advanced more and more over the coil 8 the electro-motive force induced in the coil 8 from the coil 6 becomes less and less, and the resultant electro-motive force becomes accordingly greater until when the metal cylinder 10 completely encloses the coil 8 the only electro-motive force acting on the circuit 7—8—9 is practically that due only to the inter-action between the coils 6 and 7. We have then here a condition whereby the induced electro-motive force in the tuned circuit 7—8—9 from the current flow in the plate coils 6 varies automatically as the circuit is tuned by the moving or the sliding of the metal tube 10 over the coil 8. This is

highly important, affording a means for varying the effective electro-motive force induced in the tuned circuit 7—8—9 inversely in proportion to the extension of the metal tube 10 over the coil 8.

It must be noted that in the method of tuning used in this invention the resistance of the tuned circuit varies, increasing as the frequency increases, because of the greater extension of the metal cylinder over the coil in which more eddy-currents are generated, thereby increasing the effective resistance of the circuit more and more as the metal tube 10 is advanced more and more over the coil 8, and to compensate for this progressive increase in resistance as the metal tube 10 is advanced over the coil 8, the electro-motive force induced in the circuit must be progressively increased, and this is accomplished by the expedient of reversing the windings of coils 7 and 8 as explained above. If not for this provision, then if the coupling between the coils 6 and 7 would be made sufficiently large to effect the proper amount of energy transfer when the metal cylinder 10 completely encloses the coil 8, that is, for the higher frequencies, then the coupling would be too large for the lower frequencies when the metal cylinder 10 is partly or completely off the coil, the amplifier would become unstable and regeneration would set in at those frequencies. If on the other hand, the coupling between 6 and 7 would be just sufficient to operate efficiently on the lower frequencies, it would not be right for the higher frequencies when the metal tube 10 completely encloses the coil 8, in which case the resistance of the circuit is materially increased. It is necessary therefore to provide an arrangement whereby the energy transfer is progressively changed as the resistance of the circuit is changed due to the varying position of the metal cylinder 10 on the coil 8, and this is very effectively accomplished by the method described above.

Figure 2 shows the embodiment of the invention in a complete radio receiver including three stages of tuned radio frequency amplification. The antenna 11 is connected through coupling condenser 12 to the tuned circuit 13—16 and ground 15 constituting the antenna circuit. The tuning of this antenna circuit is effected through varying the inductance 13 and the distributed capacity between the coil 13 and metal tube 14 by the movement of the metal tube 14 over it. The terminals 33 and 34 connect to the grid 3 and filament 5, through a C battery 27, of the first tube 17; the plate coil 20 of the tube 17 is in mutual inductive relation to the coils 21 and 22 of the tuned circuit 21—22—23 of the second tube 18. The windings of the coils 21 and 22 are reversed with respect to each other as explained in connection with the description and discussion of Fig. 1. The amplifying tubes 18 and 19 with their associated tuned circuits 21—22—23—24 are connected in the same manner, the two coils of each tuned circuit are magnetically coupled differentially with the plate circuit of its preceding tube. The terminals 25—26 of the last tuned circuit connect to a detector and an audio-frequency amplifier in the usual way in the practice of the radio art. In all the tuned circuits tuning is effected by the movement of the metal cylinders 24 over their corresponding inductance coils 22. The condensers 30—31—32 are the by-pass condensers for the plate battery 29, filament battery 28 and C battery 27.

With this method of tuning uni-control arrangement for the simultaneous tuning of all of the circuits could be readily effected by mechanically connecting all the metal cylinders and operating them simultaneously as has been described in our co-pending application referred to above.

We claim:—

1. In a system for radio frequency amplification comprising several three electrode vacuum tubes, a tuned circuit associated with each of the vacuum tubes, means for differentially coupling magnetically the plate of each of the said vacuum tubes to two parts of the tuning coil of the tuned circuit which is associated with the grid and filament of the succeeding tube, and a metallic cylinder slidable over one of the said parts of each of the said tuning coils of the said tuned circuits for effecting tuning.

2. In a system for radio amplification comprising several three electrode vacuum tubes, the grid and filament of each of the said vacuum tubes being associated with a tuned circuit which consists of a fixed condenser and inductance, a portion of the windings of which is wound in reversed direction to the main winding of the coil, a metallic cylinder slidable over the said main winding of the said inductance effecting tuning; the said portion of the winding as well as the said main winding of the tuning inductance coil being in inductive relation to the plate circuit of its corresponding preceding tube.

3. In a multi-stage tuned radio frequency amplifier comprising three electrode vacuum tubes, the grid and filament of each of said vacuum tubes being associated with a tuned circuit which consists of a fixed condenser and an inductance, a portion of the winding of the said inductance being wound in a reverse direction to that of the main winding of the said inductance, a metal cylinder slidable over the said main winding thereby effecting tuning, and also effecting a change in resistance of the said tuned circuit; the said portion of the winding and the said main winding of the said inductance coil being in reversed inductive relation to the plate circuit of the preceding tube, and the effect

from the said plate circuit to the said tuned circuit being proportional to the difference between the mutual inductive effects of the said plate circuit on the said portion and main windings of the said inductance of the tuned circuit.

4. In a multi-stage tuned radio frequency amplifier comprising several three electrode vacuum tubes, the grid and filament of each of said vacuum tubes being associated with a tuned circuit which consists of a fixed condenser and an inductance, a portion of the winding of the said inductance being wound in a reverse direction to that of the main winding of the said inductance, a metal cylinder slidable over the said main winding thereby effecting tuning and also effecting a change in resistance of the said tuned circuit, the effective resistance of the said tuned circuit increasing more and more as the metal tube is advanced more and more over the said main inductance; the said portion and main windings of the said inductance coil being in reversed mutual inductive relation to the plate circuit of the preceding tube, and the effect from the said plate circuit on the said tuned circuit being proportional to the difference between the mutual inductive effects of the said plate circuit on the said portion and main windings of the said inductance of the tuned circuit.

5. In a multi-stage tuned radio frequency amplifier comprising several three electrode vacuum tubes, the grid and filament of each of said vacuum tubes being associated with a tuned circuit which consists of a fixed condenser and an inductance, a portion of the winding of the said inductance being wound in a reverse direction to that of the main winding of the said inductance, a metal cylinder slidable over the said main winding thereby effecting tuning and also effecting a change in resistance of the said tuned circuit, the effective resistance of the circuit increasing more and more as the metal tube is advanced more and more over the inductance; the said windings of the said inductance coil being in reversed mutual inductive relation to the plate circuit of the preceding tube, and the effect from the said plate circuit on the said tuned circuit being proportional to the difference between the inductive effects of the said plate circuit on the said portion and main windings of the said inductance of the tuned circuit thereby compensating for the change in resistance of the said tuned circuit, and thus effecting a practically uniform amplification for the entire range of frequencies for which the circuit it tunable.

6. In a system for the reception of radio signals comprising an antenna circuit, a multi-stage tuned radio frequency amplifier, a detector and an audio-frequency amplifier, the tuned circuit of each stage comprising a fixed condenser, an inductance wound in two sections, the directions of the windings of the said two sections being reversed with respect to each other; a metal cylinder slidable over each of one of the said sections of each of the said inductances, both of the said sections of each of the said inductance being in magnetic inductive relation to the plate circuit of its corresponding preceding tube.

7. In a system for the reception of radio signals comprising an antenna circuit, a multi-stage tuned radio frequency amplifier, a detector and an audio-frequency amplifier, the tuned circuit of each stage of the said multi-stage tuned radio frequency amplifier comprising a fixed condenser and an inductance, a portion of the winding of the said inductance wound in reverse direction to the main winding of the said inductance, a metal cylinder slidable over the said main winding thereby effecting tuning and also effecting a change in the resistance of the said tuned circuit, the effective resistance of the circuit increasing more and more as the metal tube is advanced more and more over the inductance; the said windings of the said inductance coil being in reversed mutual inductive relation to the plate circuit of its corresponding preceding tube, and the effect from the said plate circuit on the tuned circuit being proportional to the difference between the inductive effects of the said plate circuit on the said portion and main windings of the said inductance of the said tuned circuit thereby compensating for the change in resistance of the said tuned circuit, and thus effecting a practically uniform amplification for the entire range of frequencies for which the circuit is tuned.

In testimony whereof we hereunto affix our signatures.

LOUIS COHEN.
AUGUST HUND.