

March 24, 1931.

L. COHEN ET AL
ART OF RADIOSIGNALING
Filed March 2, 1927

1,798,012

2 Sheets-Sheet 1

FIG. 1.

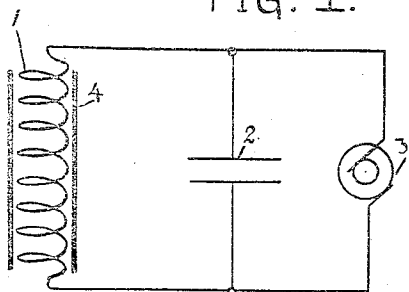


FIG. 2.

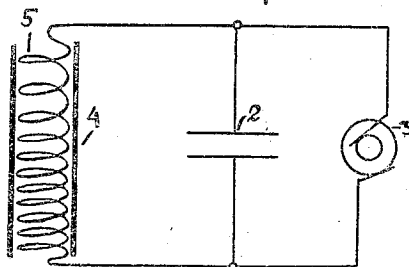


FIG. 3.

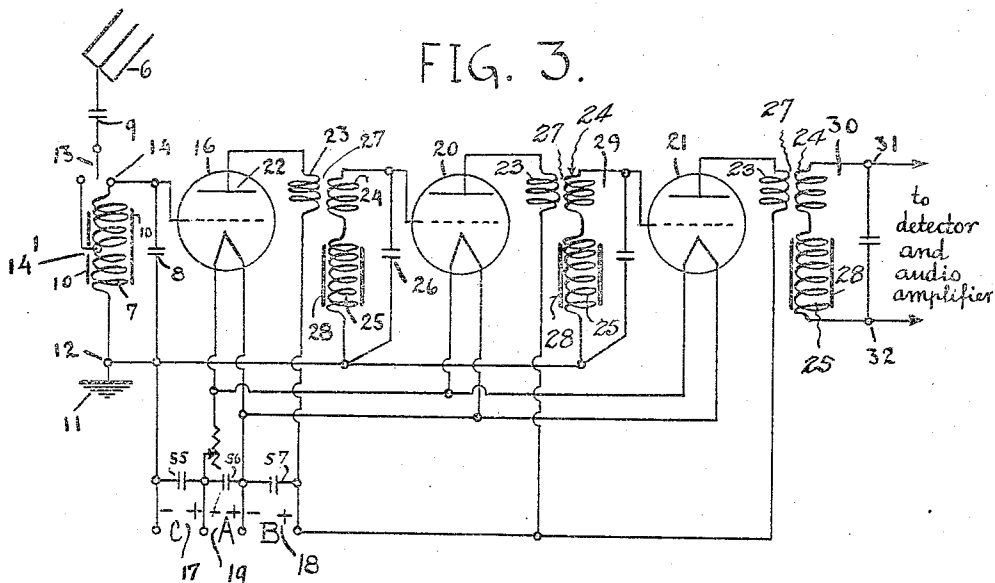
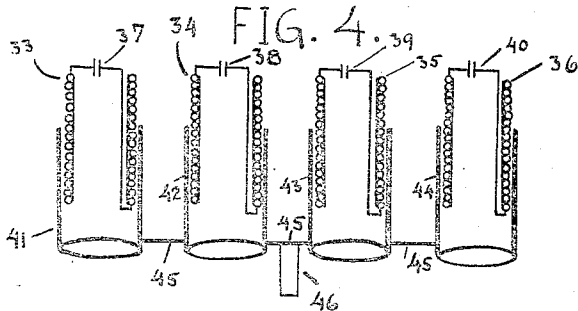


FIG. 4.



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FIG. 5.

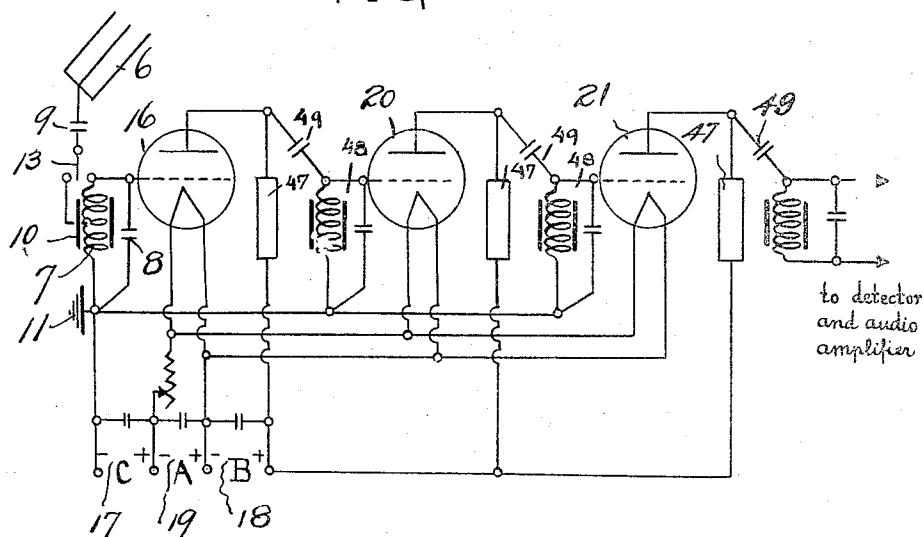
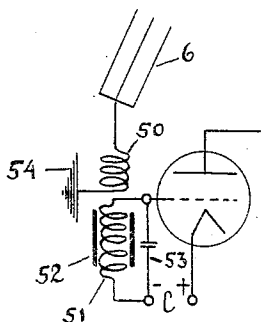


FIG. 6.



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ART OF RADIOSIGNALING

Application filed March 2, 1927. Serial No. 172,016.

This invention relates to an improvement in the art of reception of radio signals.

The object of the invention is to provide an improved method of tuning. Another object is to provide a tuned radio frequency amplifier in which the improved method of tuning is employed. Still another object is to secure elimination of regeneration in the tuned radio frequency amplifier.

10 In the reception of radio signals, particularly broadcast reception, where considerable volume is required, tuned radio frequency as well as audio frequency amplifiers are used. It is the general practice at present to use
15 two or more stages of tuned radio frequency amplification, a detector tube and two stages of audio frequency amplification. The greatest difficulty experienced in receivers of this kind is the regeneration due to the inevitable
20 interaction between plate and grid circuits of each unit in the tuned amplifier due to the plate grid capacity within the tube itself, and also due to the interaction, magnetic and static, of the tuning elements of the several radio frequency tuning units, which is
25 particularly marked when more than two stages of radio frequency amplification is employed. Several methods of neutralization or stabilization have been proposed to overcome this difficulty, all of which have certain advantages as well as disadvantages. It is the purpose of this invention to provide a novel method of tuning which when employed in connection with a tuned radio frequency amplifier automatically counteracts
30 any tendency towards regeneration, thus securing stability, freedom from electrical impulses caused by regeneration, frequently causing what is commonly designated as
35 "whistling", and at the same time simple in design and operation.

In the drawings:—

45 Figures 1 and 2 show tuning units illustrating the method of tuning employed in this invention.

Figure 3 illustrates a typical embodiment of the tuning elements in a complete radio receiver.

50 Figure 4 shows an arrangement for the simultaneous tuning of several circuits all

embodying the method of tuning of this invention.

Figure 5 is another modification showing a somewhat different method for connecting the tuning circuits in a complete radio receiver, and

Figure 6 is a modification in which the antenna is coupled to the receiver.

In Figure 1, a typical tuning circuit is shown comprising an inductance coil 1, a fixed condenser 2, connected in series. Alternating current energy may be supplied to the circuit by any of the well-known methods, either through direct connection of an energy source 3 as shown in the figure, or through a coupling of some kind. The inductance coil 1 is surrounded by a metal tube 4 with sufficient separation between the coil and the metal tube, to permit free movement of the coil within the metal tube, that is the sliding of the coil in and out of the metal tube, and it is by this movement of the coil, with respect to the metal tube that tuning is effected. When the coil is all the way in the metal tube, the variable magnetic field of the coil produced by a variable current flow in the coil induces circular currents in the closed metallic tube, which in turn set up a magnetic field substantially in opposite direction to that originally produced by the current in the coil, partly neutralizing the original magnetic field, and thus reducing the effective inductance of the coil. Also, because of the close proximity of the metal tube to the coil, the current in the coil is partly shunted through condenser effects from the coil to the metal tube to other portions of the coil, and thus assist further in reducing the effective inductance of the coil. As the coil is gradually removed from the metal tube, the inductance of the coil is gradually increased until it regains its normal value when it is completely removed from the metal tube. We have found in practice that it is entirely feasible to design a coil in the matter of diameter and windings to secure a considerable range of inductance variation which when combined with a condenser of suitable size will give a tuning range to cover a desired range of wave lengths. With a coil of one

inch in diameter wound with 125 turns to a length of about three inches, and a metal tube of about three inches and with a condenser of .0005 mf., we had a tuning range from 220 to about 500 meters, covering the present broadcast range. To cover any other range of wave lengths is merely a matter of changing the dimensions of the coil and the sizes of the condenser. It is immaterial whether the coil is moved with respect to the metal tube or the metal tube is moved with respect to the coil. Various mechanical devices may be readily devised to effect the movement of the coil with respect to the metal tube or vice versa.

In Figure 2 a modification is shown in which the windings on coil 5 are not uniformly spaced, the separation between adjacent turns gradually increasing along the coil from one end of the coil to the other end, which is for the purpose of securing a more nearly uniform tuning, that is more nearly equal movement of coil with respect to the metal tube or vice versa, for equal changes in frequency over the range of frequencies for which the circuit is designed.

Figure 3 illustrates our invention showing the embodiment of the method of tuning described in connection with Figures 1 and 2, in a complete receiver including 3 stages of tuned radio frequency amplification. The antenna 6 is coupled to the tuning circuit 7-8 by a small condenser 9, the tuning of the circuit 7-8 is effected by the movement of the metal tube 10; the terminal 12 of the tuning circuit, a junction point of the inductance coil 7 and condenser 8, is grounded at 11. A switch 13 is also provided for connecting the coupling antenna condenser 9 either to the upper junction point 14 of the tuning circuit, or to some other point on the inductance coil 7 at 14', the latter connection giving somewhat sharper tuning of the antenna circuit system. The terminals 12 and 14 of the antenna tuning circuit are connected to the grid and filament of the first amplifier tube 16, the connection to the filament being through a biasing grid battery (C) 17; common plate battery 18; filament battery 19 and grid bias battery 17 to all three amplifier tubes 16, 20 and 21 as indicated in the drawings, 55, 56 and 57 are bypass condensers. The plate 22 of amplifier tube 16 is connected through a coupling coil 23 to the positive terminal of the plate battery 18. The tuned grid filament circuit of the second amplifier tube 20, which comprises inductance coils 24 and 25 and condenser 26 is coupled through transformer 27 to the plate circuits 22, 23, 18, of the first amplifier tube 16. The tuning of the circuit is effected by the sliding movement of the metal tube 28 over the inductance coil 25. The movement of the metal tube 28 along the inductance coil 25 is to extend only up to

the lower part of the coil 24 which is the secondary of the transformer 27. The inductance coils 25 may be of the uniform winding type described in connection with Figure 1, or the non-uniform winding type described in connection with Figure 2. The coupling of amplifier tube 20 to the tuning circuit 29 and the method of tuning circuit 29 is precisely the same as that described in connection with the circuit 24, 25, 26 and its coupling to 23. Similarly the tuning of circuit 30, and its coupling to the plate circuit of amplifier tube 21 is also the same as that described in connection with the tuning circuit 24, 25, 26. The terminals 31 and 32 of the tuning circuit 30 connect to a detector tube which may be succeeded by an audio amplification in the usual way.

In all of the radio frequency circuits the tuning of the circuits are effected by the movement of the metal tubes over the inductance coils. This offers several important advantages; eliminates the use of variable condensers; simpler to effect simultaneous control of the tuning of the several circuits; and most important of all regenerative effects are practically eliminated. The greatest difficulty in multi-stage radio frequency amplification is that due to regeneration caused by either the interior of the valve action of each individual unit, or the interaction, magnetic and static between the circuits of the different amplifying units which tends to create a condition of instability. Various methods had to be resorted to in overcoming this difficulty, neutralization or stabilization of some form and also shielding. By the method of tuning of this invention, the regenerative effects are automatically eliminated without the aid of any additional means of any sort. This is brought about apparently because of the additional resistance introduced in each circuit due to the eddy-current losses in the metal tubes which slide over the inductance coils, and this indirect addition of resistance in each circuit is not constant, but increases as the metal tube is moved more and more over the coil, which means that more and more resistance is introduced into each circuit as the circuit is tuned for higher and higher frequency which is just what is necessary to avoid instability due to regeneration at all frequencies. Also the inclosure of the inductance coils in metal tubes serves as a means of shielding in some degree which assists further in preventing regeneration. This is fully supported by experience; we have built and operated a three-stage tuned radio frequency amplifier which gives good amplification and selectivity for the entire broadcast range without any regenerative effects which could be in any way perceived in the practical operation of the system. This system is well adapted for use

in connection with short waves below 200 meters.

Figure 4 illustrates a method for the simultaneous control by one movement the tuning of several independent circuits. In this figure four tuning circuits are shown each consisting of an inductance coil and a fixed condenser indicated by 33—37; 34—38; 35—39; 36—40. The tuning of each of these circuits is effected by the movement of the metal tubes indicated by 41, 42, 43 and 44 over each of the inductance coils of the circuit. The four metal tubes 41, 42, 43 and 44 are rigidly connected mechanically through the arms 45 and all can be operated by the handle 46 which controls the simultaneous movement of all of the four metal tubes, and thus controls the simultaneous tuning of all of the four circuits.

The embodiment of the invention illustrated in Figure 5 is a modification of that shown in Figure 3 which consists in a different method of energy transfer between adjacent radio frequency amplifier tubes. An impedance 47 is provided in the plate circuits of each radio frequency amplifier tube, connected in between the plate and the positive terminal of the plate battery, and the tuned grid circuit of the succeeding tube is connected through condenser 49 to the plate of the preceding amplifier tube. By this arrangement the impedance 47 which may be either a choke coil or simply a resistance provides a ready path for the direct current flow between filament and plate, and shunts the high frequency current resulting from the effect of the received signals into the tuned circuit 48. The condenser 49 serves the purpose of preventing the plate voltage of each tube from biasing the grid of the succeeding tube.

Another modification is shown in Figure 6 in which the antenna 6 is connected through coupling coil 50 to ground 54; the antenna circuit being coupled to the first tuned circuit 51, 53 through a transformer action from 50 on 51.

We claim:—

1. In a multi-tuned circuit system comprising several independent tuning circuits, each of said independent tuning circuits consisting of an inductance coil and condenser, a metal tube surrounding each of said inductance coils, means for connecting all of the said metal tubes whereby the tuning of all of said tuning circuits may be effected simultaneously by a movement of the metal tubes over the said inductances.

2. In a multi-tuned circuit system comprising several independent tuning circuits, each of said independent tuning circuits consisting of an inductance coil and condenser, a metal tube surrounding each of said inductance coils, means for connecting all of the said metal tubes whereby the simultaneous

tuning of each of said independent circuits may be effected by a single movement of the said connected metal tubes.

3. In a system for the reception of radio signals comprising an antenna circuit, a tuned multi-stage radio frequency amplifier, a detector and an audio frequency amplifier; the plate circuit of each tube of the said radio frequency amplifier being coupled through a transformer to a tuned circuit which connects to the grid filament of the succeeding tube; each of said tuning circuits comprising an inductance and a fixed condenser, the said inductance of each said tuned circuit being surrounded by a metal tube, and the tuning of each of said circuits being effected by the movement of the said metal tube over the said inductance coil.

4. A system for tuned radio frequency amplification, comprising several stages of amplification, each amplifying unit including an independent tuning circuit comprising an inductance coil, wherein the spacing between turns is non-uniform, and a condenser, a metallic tube surrounding said inductance coil and capable of relative movement thereto, whereby the tuning effect and resistance is proportional to the relative position of the coil and the metal tube surrounding the same.

5. A system for tuned radio frequency amplification, comprising several stages of amplification, each amplifying unit including an independent tuning circuit comprising an inductance coil, wherein the spacing between turns is non-uniform, and a condenser, a metallic tube surrounding said inductance coil and capable of relative movement thereto, whereby the tuning effect and resistance is proportional to the relative position of the coil and the metal tube surrounding the same, whereby a direct linear relation is obtained between the relative movement of the metal tube with respect to the coil and the frequencies for which the system is tuned.

6. In a system for radio frequency amplification, a plurality of amplifying units, each unit including an independent tuning circuit comprising an inductance coil and a condenser, a metallic tube surrounding said inductance coil and means for mechanically connecting all of said tubes whereby said metal tubes can be moved simultaneously by a single control member thereby effecting simultaneously the tuning of all of the said tuning circuits of the said amplifying system, and also automatically introducing the necessary amounts of resistances in each of said tuning circuits to prevent regeneration in either of these amplifying units.

In testimony whereof we hereunto affix our signatures.

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