July 7, 1931. H. D. CURRIER 1,813,232

RECEIVING CIRCUIT

Filed April 30, 1925

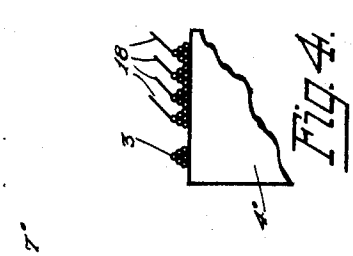

Fig. 4.

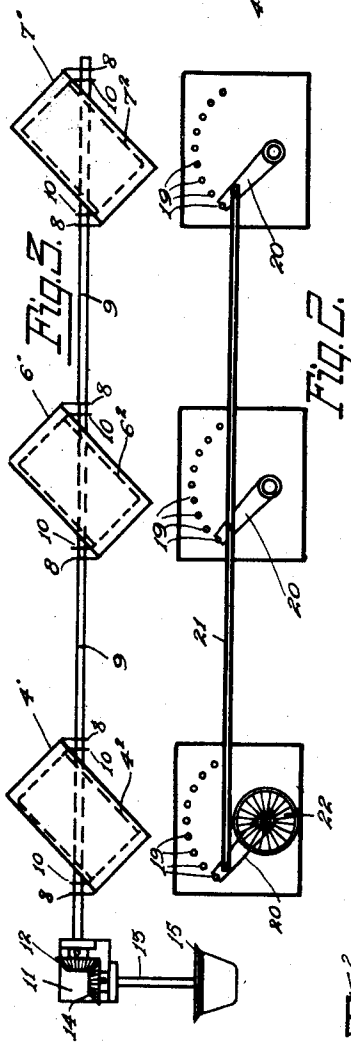

Fig. 3.

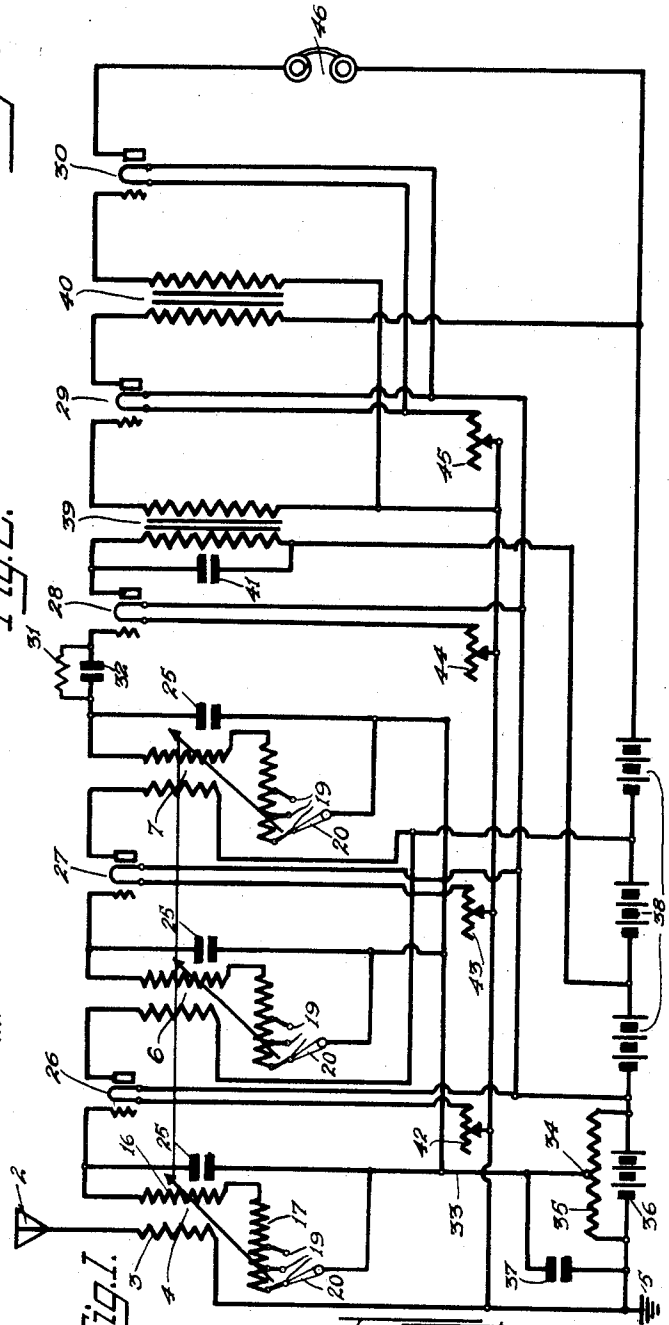

Fig. 2.

Fig. 1.

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UNITED STATES PATENT OFFICE

HIRAM D. CURRIER, OF CHICAGO, ILLINOIS, ASSIGNOR TO KELLOGG SWITCHBOARD AND SUPPLY COMPANY, OF CHICAGO, ILLINOIS, A CORPORATION OF ILLINOIS

RECEIVING CIRCUIT

Application filed April 30, 1925. Serial No. 26,835.

My invention relates to radio circuits and apparatus for use in wireless telegraphy and telephony systems, and resides in novel circuit arrangements and apparatus for such systems.

My invention as shown is adapted for the reception of radio signals, but it is to be understood that it may be used for other than receptive purposes. It is an object of my invention to provide a novel and improved organization of the elements and apparatus comprising such a system, which arrangement provides sharpness of tuning, power, and clearness in respect to the signals received.

My invention as illustrated in the drawings is shown in a receiving circuit arrangement, having radio frequency amplification, detection and audio frequency amplification, and is particularly illustrated in an arrangement in which inductances are varied to tune the stages of radio frequency amplification.

A feature of the invention resides in my method of varying the inductance of the secondaries of the transformers, to tune the set over the band of wave lengths, which it is adapted to receive.

A feature of my invention resides in the simplified control of the tuning arrangement.

A still further feature of my invention resides in the construction, arrangement and control of the apparatus used in my system. I vary the inductance of the secondaries of the couplers or transformers in steps, by means of a multiple control arrangement, and I vary the inductance within the steps of inductance by means of a separate multiple control arrangement.

A still further feature of my invention is the provision of a multiple, unit control tuning arrangement which provides large movement of the tuning device for a small variation in tuning inductance. In place of resonating the secondaries of the transformers by individual condensers, I vary the inductance of the secondaries of the transformers, by both a multiple step control arrangement and a second multiple control arrangement, for varying the inductances of said secondaries within the steps of variation brought about by the step control arrangement, thereby securing many degrees of movement for said second control device over the wave band which the set is adapted to receive.

For a more complete understanding of my invention reference may be had to the accompanying drawings in which like reference characters in the different views denote like parts and in which:

Fig. 1 is a diagrammatic circuit arrangement of my invention;

Fig. 2 diagrammatically illustrates my method of varying the inductance by steps;

Fig. 3 diagrammatically illustrates my method of varying the inductances within the different steps of inductance; and

Fig. 4 illustrates one method of bank winding in groups the coils upon the stator of the transformer.

Referring to Fig. 1 of the drawing, 2 represents the ordinary antenna or collector device which is connected through the primary 3 of the variable transformer device 4 to ground 5. A secondary of the device is partly wound on the stator and is partly wound on the rotor of the variable transformer. The part of the secondary winding on the stator of the device is tapped, and the taps are brought out to terminal points, for cooperation with a contact wiper. The variable transformer and inductance devices 6 and 7 are similar in construction to that of device 4. The number of turns on the devices, however, may vary.

Referring more particularly to Fig. 3, it will be noted that each of the variable devices 4, 6 and 7 is provided with a stator tube or supporting device 4′, 6′ and 7′ respectively. Mounted within the stator devices are rotatable tubes or rotor elements 4^2, 6^2 and 7^2. The stator coil supporting devices 4′, 6′ and 7′ are provided with brackets 8 in which a rod 9 is rotatably mounted. The rotor coil supporting tubes 4^2, 6^2 and 7^2 are provided with brackets 10, through which the said rod 9 extends. Brackets 10 are secured to the rod 9 so that

when the same is rotated the rotor elements 4^2, 6^2 and 7^2 rotate therewith. These devices are of the 180 degree coupler type, so that the rotors may be rotated 180 degrees until they are in a plane at right angles to the plane of the stators. Supporting means, for the stator coil supporting members 4', 6' and 7' are provided, but are not shown in the drawings. One end of the shaft 9 extends through a supporting device 11 and is provided with a bevel gear 12, a second shaft 13 is supported by the device 11 and is provided with a bevel gear 14, which meshes with the gear 12 so that when the shaft 13 is rotated the shaft 12 is rotated thereby. Attached to the shaft 13 is a control knob 15 which appears at the front of the panel of the receiving set.

The primaries of the transformer coupler devices may comprise various numbers of turns, depending upon the band of wave lengths to be received and the operation desired. These turns may be bank wound on the stator 4' as illustrated in Fig. 4. The secondary windings consists of two sections, one section of which is wound on a rotary tube such as 4^2, and the other section 17, is wound on the stator, such as 4', and as illustrated in Fig. 4. The winding 17 may be wound by the bank group method of winding, as illustrated in Fig. 4, and the groups of turns provided with taps 18. The taps of the coils are connected to stationary contacts 19, as shown in Figs. 1 and 2. The number of secondary turns on the stator tube depends upon the breadth of the wave band, over which the device is to be operated. Cooperating with the contacts 19 are wipers 20. The wipers 20 are connected together by a rod 21. To the switch arm 20 on one of the tap switches is connected a control knob 22 which may be operated to simultaneously move the wipers 20 in unison over their contact points 19. The secondary part of the winding 17 is so wound and tapped and arranged with respect to the primary 3 that when the device is operated to receive the longer wave lengths, the coupling between the primary 3 and the secondary winding 17 is increased, and for the lower wave lengths the coupling between the primary winding 3 and the part 17 of the secondary winding is decreased. Bridged across the secondaries of the devices are condensers 25. These condensers are preferably made variable, but after they are once adjusted, they may be locked in their adjusted position and do not need to be thereafter changed.

From the foregoing description, it will be noted that when the control member 15 is operated to vary the rotors 4^2, 6^2 and 7^2, that the position of the parts of the secondary windings of the said rotors are changed with respect to the parts of the secondary windings on the stators, thereby simultaneously changing the inductances of the secondaries.

The wipers 20 operate to change the inductance in comparatively coarse steps, while the control knob 15 operates to vary the inductance of the secondaries within the steps of inductance between taps.

Audion tubes 26 and 27 are radio amplifiers, audion tube 28 is the detector, and audion tubes 29 and 30 are audio frequency amplifiers. These tubes are each provided with the customary grid, plate and cathode elements. Connected in the grid circuit of the detector audion 28 is the usual grid leak 31 and grid condenser 32. The grid returns of audions 26, 27 and 28 are connected through the wipers 20 to the conductor 33, which extends to the middle point 34 on the resistance 35, which is connected across a primary battery 36, which battery is used for furnishing heating current to the filaments or cathodes of the audion tubes. Bridged from point 34 to ground is a by-pass condenser 37. Batteries 38 are the usual secondary or B batteries for furnishing current to the plates of the audion tubes. The audio frequency transformers 39 and 40 are provided with iron cores. Across the primary of audio frequency transformer 39 is a by-pass condenser 41.

Rheostats 32 and 43 control the supply of heating current to audion tubes 26 and 27 respectively. Rheostat 44 controls the supply of heating current to the filament of audion tube 28, and rheostat 45 controls the supply of heating current to the filaments of audion tubes 29 and 30. At 46 I show a pair of receivers in the plate circuit of the last audion tube, for receptive purposes, however, the device 46 may be replaced by the usual loud speaker now in use.

Before the set is adapted for regular use, the condensers 25 are adjusted so that they need not be touched after once adjusted and locked in their adjusted positions. The knob 22 is operated to place switch wipers 20 upon one set of contact points 19, thereby rendering effective a certain amount of the stationary part 17 of the secondary windings. The individual condensers 25 are then adjusted to bring in the test signal with the maximum clearness and volume. After this adjustment of the condensers 25 is once made the rotor plates thereof are locked in their adjusted position, and remain set in such position. To tune the set to different wave lengths, the wipers 20 are set on the contact points which include the wave length of the band within which the desired wave length appears, and then the inductance of the secondaries is varied, minutely, by the turning of the knob or dial 15 until the combination of the inductances of the secondaries and the condensers 25 are such as to pass

the frequency of the desired wave length, Of course, it is necessary to adjust the rheostats until the correct amount of heating current is supplied to the filaments of the various tubes. On the longer wave lengths the coupling between the primary and the stator part of the secondary is increased for reasons well understood.

With my arrangement I have found that a very fine tuning may be obtained for the reasons that the inductances of the secondaries may be varied very slightly, owing to the fact that the couplers are of the 180 degree type and provide 180 degree movement for the band of wave lengths included between adjacent taps of the tap switches. In other words for each point that the tap switch may be moved to, the control dial 15 may be operated 180 degrees to vary the inductances between the adjacent taps, thereby permitting the obtaining of a very fine adjustment.

My arrangement clearly simplifies the tuning, as it is only necessary to operate the control knob 22 to change the inductance of the secondaries by steps and to then operate control dial or knob 15 to select the desired stations within the selected band of wave lengths.

Briefly the incoming oscillations are received by the collector 2 and are passed through the primary of the first transformer, which operates to induce the same into the secondary thereof and upon the grid of the audion tube 26. The signal is operative upon the grid of the tube 26 to repeat the same through the primary of transformer device 6 by means of the plate of tube 26. The signal is then inductively transferred into the secondary of the transformer 6 and is operative upon the grid of the tube 27 to repeat the signal from the plate of tube 27 through the primary of transformer 7. The signal is again repeated and amplified in the tube 28, which tube operates to pass the signal through the primary of the audio frequency transformer 39 and on through the audion tubes 29 and 30 and audio frequency transformer 40 to the receiving device 46. The tuning of the secondaries of transformers 4, 6 and 7 permits only the passage of the desired signal. The secondaries of the transformers and the condensers 25 being in multiple, and the inductance of the secondary being variable by steps and continuously between steps, permits the resonating of the secondaries of the transformers to the desired frequency.

I find that inductances may be constructed to follow each other very closely thereby permitting the multiple tuning of the same without noticeable difference between the different stages after condensers 25 have once been set to resonate the circuit to the test signal.

The preceding description and explanation will enable one skilled in the art to practice the invention, and the analysis given, is believed to indicate the principal effects involved in the results obtained.

While I have illustrated and described one specific embodiment of my invention, it is to be understood that I do not desire to be limited to the exact matter shown, but aim to cover all that which comes within the spirit and scope of the appended claims.

What I claim as new and desire to secure by United States Letters Patent, is:

1. A cascade receiving circuit of the character described including a plurality of audion tubes, a plurality of transformers associated with said tubes and having primary windings and adjustable secondary windings, condensers bridged across said secondary windings, and means for adjusting said secondaries by steps and by rotating portions of said secondary windings relative to other portions thereof to tune the said secondary windings to desired frequencies.

2. A cascade receiving circuit of the character described including a plurality of audion tubes, a plurality of transformers associated with said tubes and having primary windings and secondary windings, condensers bridged across said secondaries, and means for simultaneously adjusting said secondaries by controlling the number of turns thereof in effective relation to the primaries and by rotating portions of said secondary windings relative to other portions thereof to tune the said secondary windings to predetermined frequencies.

3. A cascade receiving circuit of the character described including a plurality of interrelated audion tubes and transformers, primary and secondary windings for said transformers, condensers bridged across said secondary windings, and means for individually setting said condensers to resonate the said secondaries to a predetermined frequency, and means for varying the inductance of said secondary windings by steps and between steps to tune the same.

4. A multiple stage receiving circuit of the character described including a plurality of interrelated audion tubes and transformers, primary and secondary windings for said transformers, condensers bridged across said secondary windings, and means for individually setting said condensers to resonate the said secondaries to a predetermined frequency, and means for simultaneously varying the inductance of said secondary windings first by coarse adjustment and then by fine adjustment to resonate the same to predetermined desired frequencies.

5. A multiple stage receiving circuit of the character described including a plurality of transformers having primary windings and adjustable secondary windings, au-

dion tubes associated with said transformers, condensers bridged across said secondary windings, and means for varying the inductance of said secondary windings step by step and continuously between steps to tune said secondary windings.

6. A cascade receiving arrangement of the character described involving a plurality of stages of radio frequency amplification including a plurality of transformers, and means for varying the inductance of said transformers by steps and continuously between steps to tune the same to desired frequencies so that said stages operate as cascade amplifying filters.

7. A receiving arrangement of the character described involving a plurality of stages of radio frequency amplification including a plurality of transformers, secondary windings for said transformers having movable portions and stationary portions, and means for simultaneously varying the inductance of said transformers by larger amounts and then by smaller amounts to tune the same to the desired frequency by operating the movable portions of said secondary windings.

8. A receiving circuit of the character described including a plurality of audion tubes, a plurality of transformers having primary and secondary windings associated with said tubes, means for simultaneously varying the inductance of said secondary windings and for increasing the coupling between said secondary windings and said primary windings, and separate means for varying the inductance of said secondary windings.

9. A multiple receiving circuit of the character described including a plurality of audion tubes a plurality of transformers having primary and secondary windings associated with said tubes, a common means for varying the inductance of said secondary windings by steps and for increasing the coupling between said secondary windings and said primary windings, and separate means for simultaneously varying the inductance of said secondary windings.

10. A receiving arrangement of the character described including a cascade amplifying arrangement provided with transformers having primary and secondary windings, audion tubes connected between said transformers, a control device for varying the inductance of said transformers by steps, and an independent control device for gradually and continuously varying the inductance of said transformers.

11. A cascade amplifying arrangement for receiving signals of different frequencies, a single control unit for adjusting said amplifying arrangement by steps, and a second single control unit for continuously adjusting said amplifying arrangement between steps.

12. A multiple receiving circuit provided with a plurality of stages of amplification, means for tuning said stages of amplification, a single control device for adjusting said means by steps, and a second single control device for continuously adjusting said means between steps.

13. A transformer of the character described including a stator portion and a rotor portion, a primary winding for said transformer mounted on said stator portion, a secondary winding for said transformer partly mounted on said stator portion and partly on said rotor portion, a tap switch for the portion of said winding mounted on said stator support, said portion of said winding mounted on said stator support being so related to said primary winding that as the tap switch increases the number of turns operative of said secondary winding the coupling between said primary winding and said secondary winding is increased.

14. A cascade receiving arrangement of the character described including a plurality of stages of amplification, a transformer for each of said stages of amplification having a secondary winding, said secondary windings comprising tapped fixed portions and movable portions, a condenser connected across each of said secondary windings, and means for varying the inductance of said secondary windings by adjusting said movable portions thereof to resonate said windings for the passage of a current of a given frequency.

15. A cascade amplifying arrangement of the character described including a plurality of transformers having primary and secondary windings, a condenser bridged across each of said secondary windings, and a multiple control device for changing the inductance of said secondary windings by steps and continuously between steps to resonate them for the passage of a current of a given frequency.

16. A cascade amplifying arrangement of the character described including a plurality of transformers having primary and secondary windings, a condenser bridged across each of said secondary windings, a common device for changing the inductance of said secondary windings, and a second common device for independently continuously changing the inductance of said secondary windings.

17. A cascade radio receiving arrangement comprising a plurality of stages of amplifying filters including audion amplifiers and transformers, circuit connections between said transformers and audion amplifiers, each of said transformers comprising a fixed primary winding and a secondary winding including a fixed portion and a movable portion, means for simultane-

ously varying the number of turns of the fixed portions of said secondaries effectively related to said primaries, and other means for simultaneously varying the movable portions of said secondaries to simultaneously resonate said secondaries to receive a current of a predetermined frequency, means for detecting said current, and means for thereafter amplifying the same at audio frequency.

Signed by me at Chicago, county of Cook, and State of Illinois, this 28th day of April, 1925.

HIRAM D. CURRIER.