

Aug. 30, 1932.

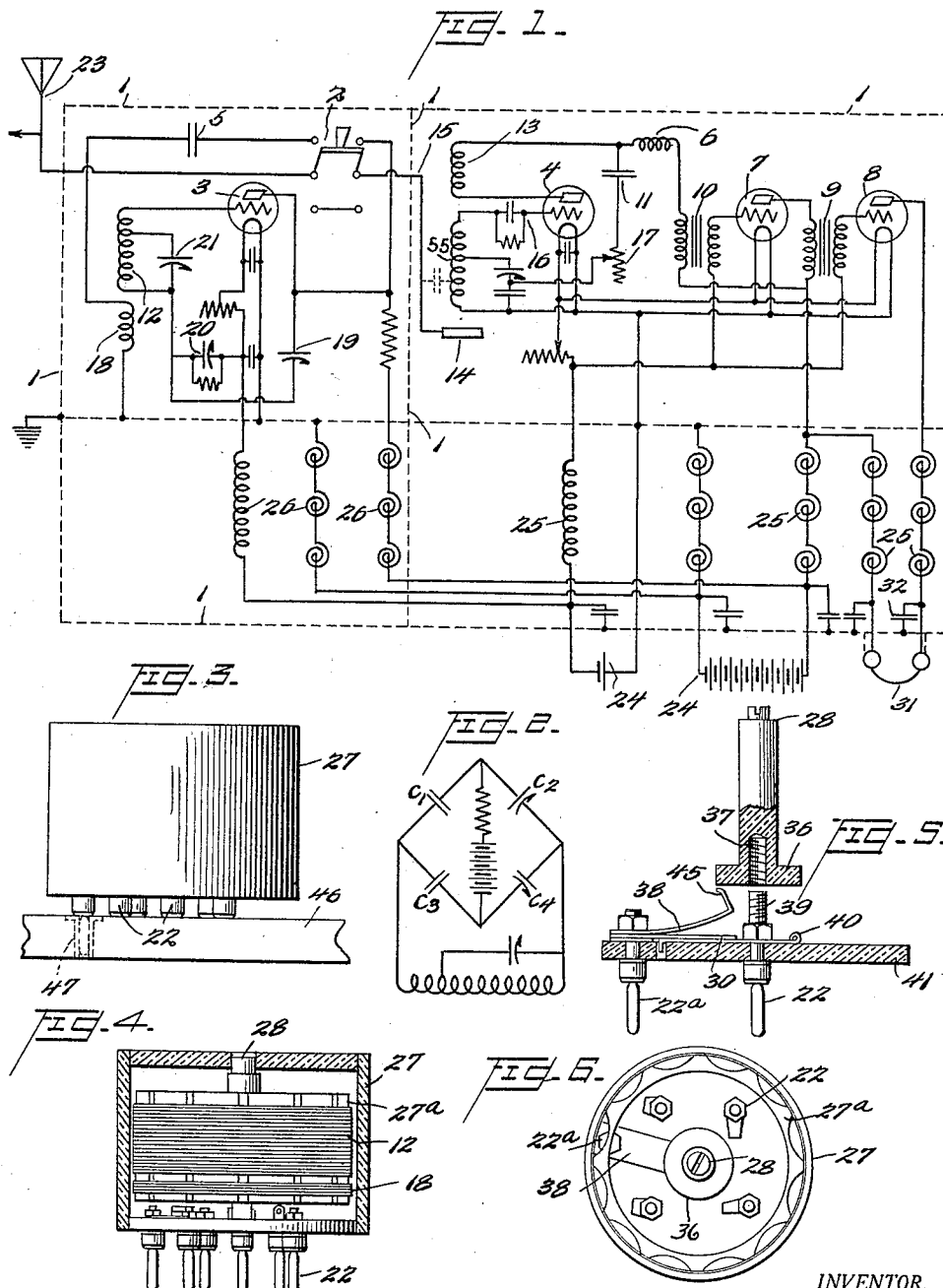
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RADIO RECEIVING APPARATUS

Filed June 11, 1928

3 Sheets-Sheet 1



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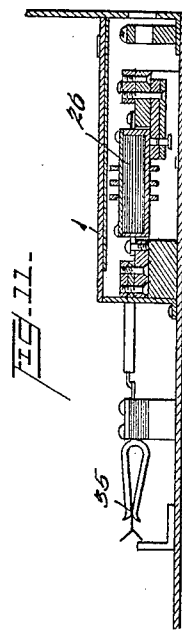
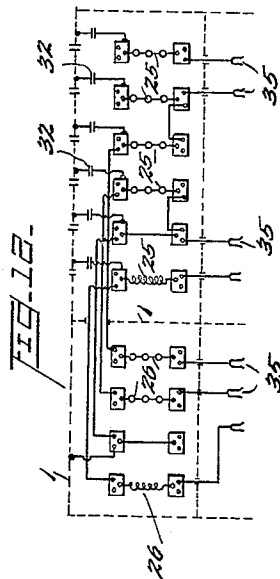
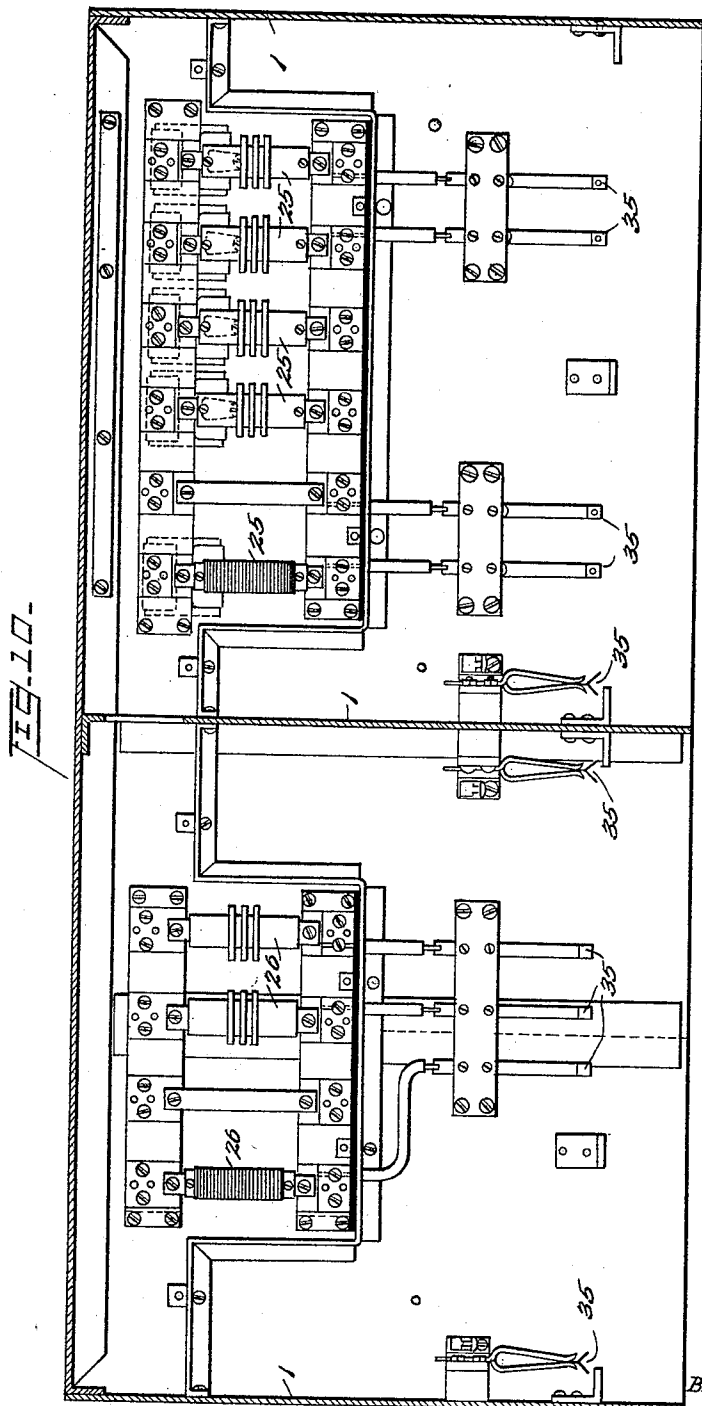
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RADIO RECEIVING APPARATUS

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3 Sheets-Sheet 3



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UNITED STATES PATENT OFFICE

EDWIN L. POWELL, OF WASHINGTON, DISTRICT OF COLUMBIA, ASSIGNOR, BY MESNE ASSIGNMENTS, TO WIRED RADIO, INC., OF NEW YORK, N. Y., A CORPORATION OF DELAWARE

RADIO RECEIVING APPARATUS

Application filed June 11, 1928. Serial No. 284,605.

My invention relates broadly to radio receiving circuits and more specifically to a stabilized arrangement of electron tubes employed for receiving radio signals.

5 An object of my invention is to provide a coupling system for a plurality of electron tubes wherein provision is made for the electrostatic transfer of signalling energy from one radio frequency circuit to a succeeding radio frequency circuit for securing
10 a high degree of selectivity in the operation of the circuits.

Another object of my invention is to provide a structural arrangement for a radio
15 receiving apparatus wherein means are connected in each of the power supply leads and leads to the sound reproducer for excluding extraneous currents and protecting the receiving circuits from interference.

20 Still another object of my invention is to provide a system of electron tubes for radio receiving circuits wherein a coupling device is provided having a predetermined value of inductance and an adjustable capacity therein
25 for selectively fixing the coupling between the respective circuits of the receiving system.

A further object of my invention is to provide a construction of coupling device including an inductance and an adjustable condenser, the condenser being disposed centrally in the coupling device and adjustable
30 by means of a rotatable member extending through the coupling device and operative from the exterior thereof.

35 An efficient high frequency receiver should be sensitive and selective and capable of being operated in multiple with other receivers on a single antenna without interference from stations other than the one
40 desired to be received. It should continuously cover a wide band of frequencies and give a clear response to either modulated or continuous wave signals without radiation of
45 the local energy employed as the beating source.

50 A better understanding of my invention can be had from the specification to follow and by reference to the accompanying drawings, in which:

Figure 1 is a diagrammatic illustration of a circuit embodying the elements of my invention. Fig. 2 is a diagrammatic view showing the electrical balance obtained in the circuits of my invention; Fig. 3 is a side
55 elevation of the coupling device of my invention; Fig. 4 is a cross-sectional view taken through the coupling device illustrated in Fig. 3; Fig. 5 is a cross-sectional view of the capacity adjusting device in the coupling
60 unit of my invention showing the adjusting device removed from the supporting structure of the coupling unit; Fig. 6 is a plan view of the coupling unit with the cover removed; Fig. 7 is a diagrammatic view of the
65 relationship of the several electron tube circuits and the interference prevention circuits employed in the apparatus of my invention; Fig. 8 is a front view of the assembled receiving apparatus; Fig. 9 is a
70 plan view of a portable carrier for coupling units employed in the receiving apparatus, the carrier being partially broken away to illustrate the interior thereof; Fig. 10 is an enlarged plan view of the shielded compartments assembled in the receiving apparatus
75 of my invention for housing the filter systems; Fig. 11 is a cross-sectional view through one of the filter compartments in the receiving apparatus; and Fig. 12 is a diagrammatic view showing the relationship of filter elements within one of the compartments.

80 My invention comprises an autodyne detector circuit 4 capacitively coupled to a tuned stage of radio frequency amplification 3 and supplemented by two stages of audio frequency amplification 7, 8. "Plug in" coils 12 and 18 for the radio frequency amplifier 3 and 55 and 13 for the detector or
85 rectifier 4, respectively, give the equipment a wide tuning range. The degree of regeneration or strength of oscillation in the detector circuit 4 is controlled by a variable
90 resistor 17 which connects in series with the tickler winding 13 included in the structure of each receiver coil.

95 Among the advantages of my system as compared with others, are that with the system I employ radiation is effectually pre-
100

vented. This is accomplished in my invention by: *a*, providing for completed shielding 1 of the detector 4 and audio frequency amplifier 7 and 8 to prevent interstage coupling; *b*, separate shielding of the antenna input 23 and of the radio frequency amplifier circuits 3; *c*, elimination of the detector circuit oscillations from all battery circuits 24 and telephone 31 is accomplished through the medium of a filter system having renewable cartridge type chokes 25 built into but individually shielded from the receiver compartment; *d*, elimination of the detector circuit oscillations from all battery leads to the radio frequency amplifier circuit 3 is effected through the medium of an additional similar filter system 26 built into but individually shielded from the radio frequency amplifier compartment; and, *e*, I employ a method for complete neutralization of capacitive coupling to the antenna 23 through the radio frequency amplifier tube 3. A system of the type shown in Fig. 2, is used for this purpose, it being a true bridge in which all four arms are capacitive. This is a system which compensates for both the grid-filament and grid-plate capacities in the tube, two adjustable condensers 20 and 19 being employed between the low potential end of the tuned grid input circuit 12, 21 and the filament and plate terminals respectively of the radio frequency amplifying tube 3.

Figs. 3, 4, 5 and 6 show a method of coil structure the coil form 27, 27*a* including a coupling coil winding 18, grid circuit inductance 12, balancing condenser comprising members 28, 40, and 38, and coil connecting plugs 22. Fig. 5 shows the balancing condenser adjusting screw 28, having an internally threaded bore 37 and having a flange 36 at the lower end thereof. Threaded stud 39 which may be integral with contact plug 22, is electrically connected to a condenser plate 40. A second condenser plate 38, which has a suitable inherent resiliency or spring tension is secured to the base 41 by means of a second contact plug 22*a*. Condenser plates 40 and 38 are insulated electrically from each other by any suitable dielectric 30, which can be of mica. Threaded bore 37 is rotatable over the threaded stud 39. Flange 36 of threaded member 37 engages the upturned edge 45 of condenser plate 38. By adjusting the coupling between threaded bore 37 and threaded stud 39, condenser plates 38 and 40 are brought in closer relation and the capacity of the condenser is thereby increased.

Fig. 6 is an illustration showing a plan view of the coil structure, one of the condenser plates 38, adjusting screw 28, flange 36, contact plugs 22 and 22*a*, coil form 27*a* and cover 27. Fig. 3 is an illustration showing the coil unit mounted on an insulated sub-panel 46 and contact plugs 22 and 22*a* forming con-

nection with contact jacks 47. Fig. 7 also shows contact plugs 22, and contact jacks 47 and illustrates how contact plugs 22 are connected to the coil windings and vacuum tube circuits. Fig. 2 is a schematic diagram of a bridge circuit showing inter-electrode capacities C_1 , C_2 of the thermionic vacuum tubes 3 or 4, the capacity C_2 corresponding to reference character 20 of Fig. 7, C_4 corresponding to reference character 19 of Fig. 7. As shown in Fig. 7, capacity 20 is included in the interchangeable coil unit and corresponds to the adjustable capacity unit illustrated on an enlarged scale in Fig. 5.

Connecting plugs and jacks 35 illustrated in Fig. 7 provide interconnection between the power and filter circuits 24, 25, 26, 32 and the individually shielded circuits of the thermionic vacuum tubes 3, 4, 7 and 8 respectively. The same type of connecting plugs and jacks 35 are employed for connecting the antenna-ground system 51 to the receiving system proper, and for inter-coupling the radio frequency circuits of thermionic vacuum tubes 3 and 4. These connecting plugs and jacks 35 are also shown in Figs. 10, 11 and 12.

Reference character 14 of Fig. 7 identifies a plate or free-end coil electrostatically coupled to inductance 55. This plate corresponds to plate 38 of Fig. 5 and may be constructed the same as the condenser in Fig. 5 by employing a second plate 40 connected to the inductance coil 55. This capacity provides the proper coupling to the grid circuit of the detector tube and is matched with the inductance unit upon which it is mounted. Fig. 7 also shows the individual shielding 1 of the radio frequency amplifier 3, of the detector 4, the audio frequency amplifier 7 and 8, and the individual filter systems 25, 26 and 32. Fig. 8 shows a front view of a suitable cabinet for the equipment with the various controls mounted thereon. Handles 33 are provided on the panel for removing the apparatus from the cabinet and replacing it therein. Fig. 9 shows an illustration of a suitable carrying case for the coils employed in my system. Fig. 10 shows an illustration of the filtering systems 25 and 26 showing individually shielded compartments 1 for neutralizing the stray field of the filter coils. Fig. 11 shows a fragmentary view partially in cross section of the shielded compartment 1 enclosing the filter systems 25 and 26. Fig. 12 shows another illustration of the filter systems 25 and 26 and individually shielded compartments 1 for neutralizing any stray field of the filter coils or induction from the radio frequency, detector and audio frequency compartments. Individual shielding is essential to efficient operation thus reducing all inter-stage coupling and assisting neutralization of the inter-element capacities of the vacuum tubes employed.

In all neutralizing systems, however, the

condition for balance is not dependent solely on the inter-element capacities of the vacuum tube employed, the circuits associated therewith having a considerable effect on the balance adjustment. Thus, a receiving system employing a stepped inductance, or plug-in coils, must be rebalanced for every change in circuit inductance as well as for tube replacements. A possible remedy for this condition would be to provide a plurality of balancing condensers, one for each value of inductance; but, in the case of such a neutralizing system, all these condensers would have to be readjusted for each tube renewal. The operation of my system has been made practical and the efficiency improved by incorporating a condenser comprising the filament leg of the balance system in each of the plug-in radio frequency amplifier coils and mounting a single condenser forming the plate leg of the system on the radio frequency amplifier panel. In the initial test of the equipment the filament condensers in each plug-in coil are adjusted against a given setting of the plate condenser and sealed. This is done with the equipment connected to a given antenna installation and with a given radio frequency amplifier tube, and gives a permanent automatic compensation for the reactive effect of changing inductances during operation. Thereafter in service, it is only necessary to readjust the single condenser in the plate leg of the neutralizing circuit against the setting of the filament condenser on any one coil in order to compensate for the variation in neutralization on all coils which may result from a tube replacement or any change in the characteristics of the antenna circuit.

It is to be understood that I do not limit my invention to the description and circuit arrangement illustrated in the accompanying drawings. The embodiments of my invention may be used in circuit arrangements widely different from those illustrated, without departing from the spirit of my invention as defined in the following claims.

What I claim and desire to secure by Letters Patent of the United States is:

1. In an apparatus for receiving signaling energy, in combination, a thermionic vacuum tube having grid, filament and plate circuits, tuning means provided in said grid circuit, a variable capacity for neutralizing inter-electrode capacity of said thermionic vacuum tube, said neutralizing capacity being mounted on said tuning means and means for interchanging said tuning means in said circuit without readjusting said neutralizing means for widely different frequencies of said signaling energy.

2. In a system for receiving signaling energy, thermionic vacuum tubes for amplifying and rectifying said signaling energy, said thermionic tubes having grid, filament

and plate circuits, interchangeable inductance coils for the grid circuit of one of said tubes, means for neutralizing the interelectrode capacity of said tube and associated neutralizing means mounted on each of said interchangeable inductance coils whereby said first neutralizing means, without adjustment, provides uniform neutralization of said circuits for a wide band of frequencies.

3. In a system for receiving signaling energy, thermionic vacuum tube amplifiers and rectifiers and associated grid and plate circuits, interchangeable coils for the grid circuit of one of said amplifier tubes to cause it to operate on a wide band of frequencies, and adjustable neutralizing condensers, one of which is mounted on each of said interchangeable coils for effecting uniform neutralization of the system over a wide band of frequencies.

4. In a system for receiving signaling energy the combination of thermionic vacuum tubes having grid, filament and plate circuits, interchangeable inductance coils for the grid circuit of one of said tubes and neutralizing means for neutralizing the interelectrode capacity of said tube said neutralizing means being mounted on one of said inductance coils for effecting uniform neutralization of said inter-electrode capacity irrespective of any selected interchangeable coil.

5. In a system for receiving signaling energy, a thermionic vacuum tube and associated grid and plate circuits, a circuit for supplying said signaling energy to said grid circuit, interchangeable coils for said grid circuit, separate means included in each of said interchangeable coils for neutralizing the inter-electrode capacities of said thermionic tube.

6. In a system for receiving signaling energy, separately shielded thermionic vacuum tube amplifiers and rectifiers, interchangeable coils for the grid circuits of said thermionic tubes, a neutralizing condenser mounted within each of the interchangeable coils for one at least of said tubes for neutralizing the inter-electrode capacity of that tube, and a coupling coil included in each of said interchangeable coils for effecting proper neutralization and coupling between the source of said signaling energy and said vacuum tube circuits over a wide band of frequencies.

7. In a system for receiving signaling energy comprising individually shielded amplifying, rectifying and power supply circuits, interchangeable coil units for said amplifying and rectifying means, contact plugs on said coils for making contact with said amplifying and rectifying means, a rotatable member having a threaded bore disposed centrally in each removable coil unit, a stationary plate and a movable plate, said movable plate connected to one of said contact plugs, said stationary plate electrically connected to an-

other of said contact plugs and having an
upstanding threaded stud connected thereto
and means for adjusting said rotatable mem-
ber to vary the relation between said plates
thereby varying the capacitance between a
5 winding disposed on said coil and one of said
contact plugs.

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