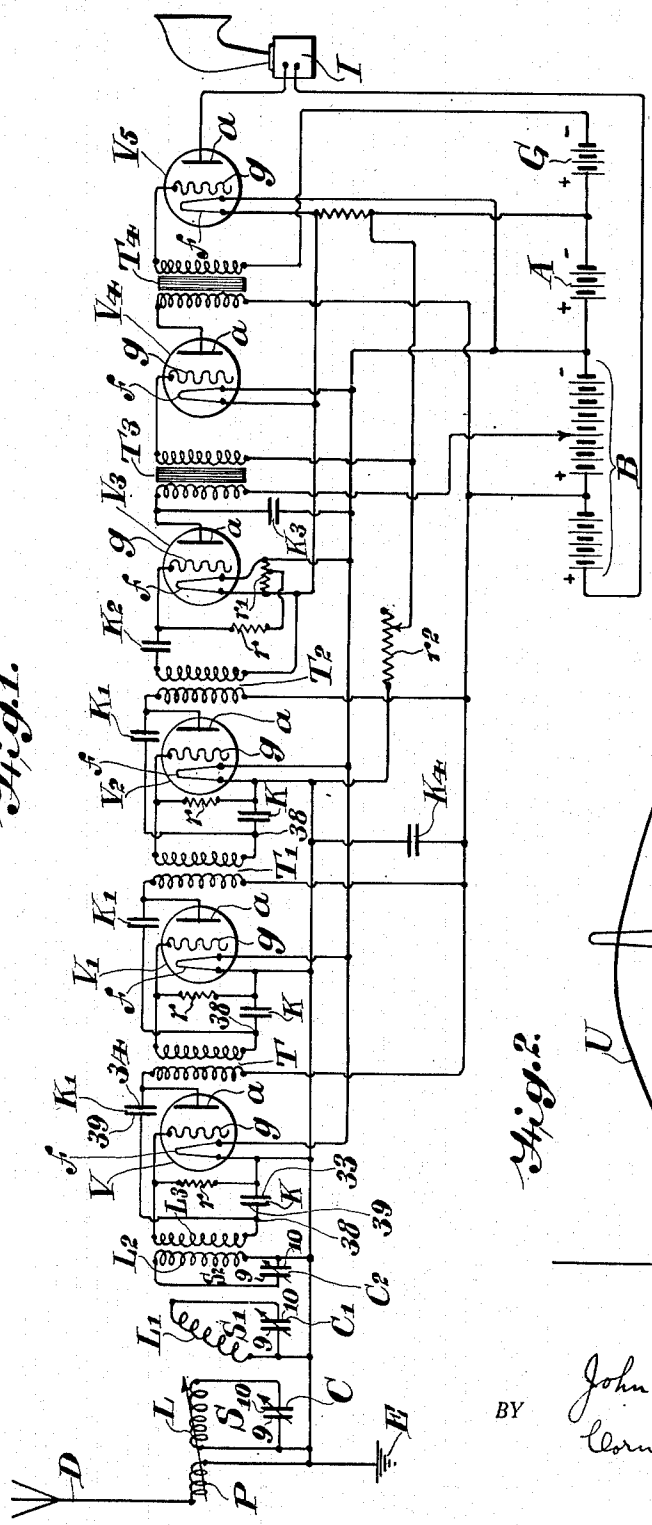
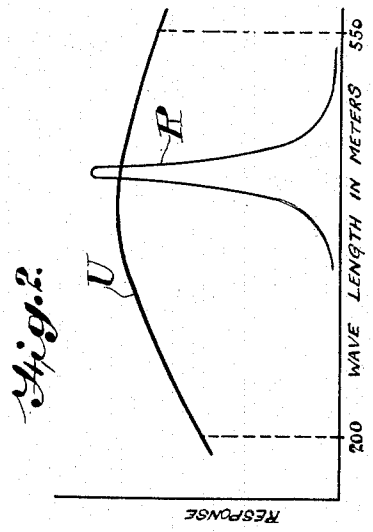
Sept. 30, 1941. J. M. MILLER 2,257,272

RADIO RECEIVING SYSTEM

Filed Nov. 24, 1926 4 Sheets-Sheet 1





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Sept. 30, 1941. J. M. MILLER 2,257,272

RADIO RECEIVING SYSTEM

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Fig. 3.

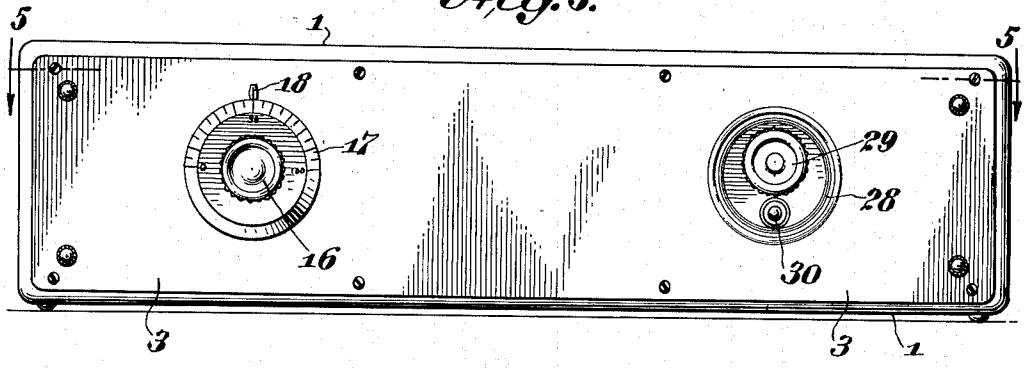


Fig. 4.

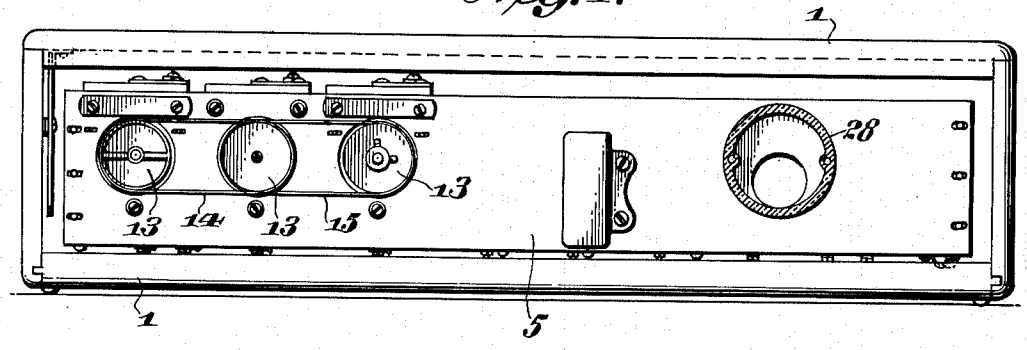
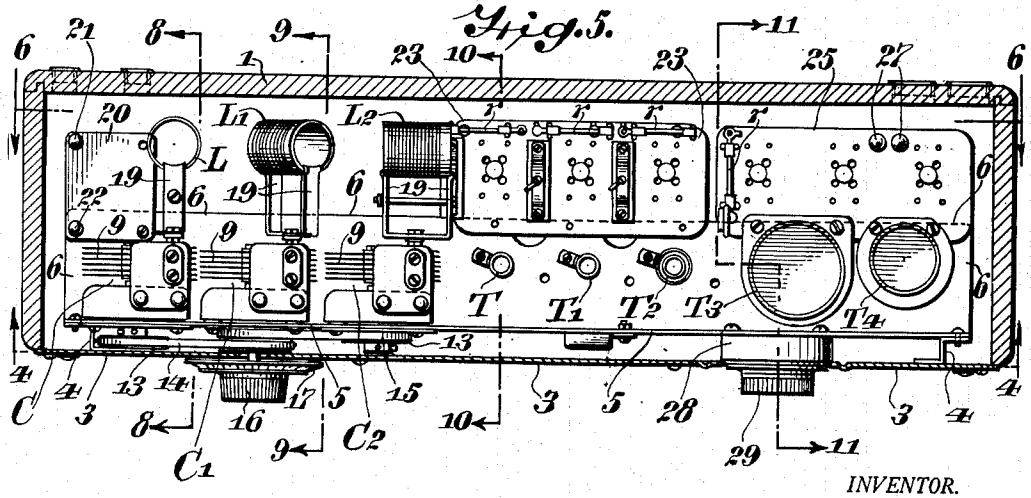


Fig. 5.



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Sept. 30, 1941. J. M. MILLER 2,257,272

RADIO RECEIVING SYSTEM

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Fig. 6.

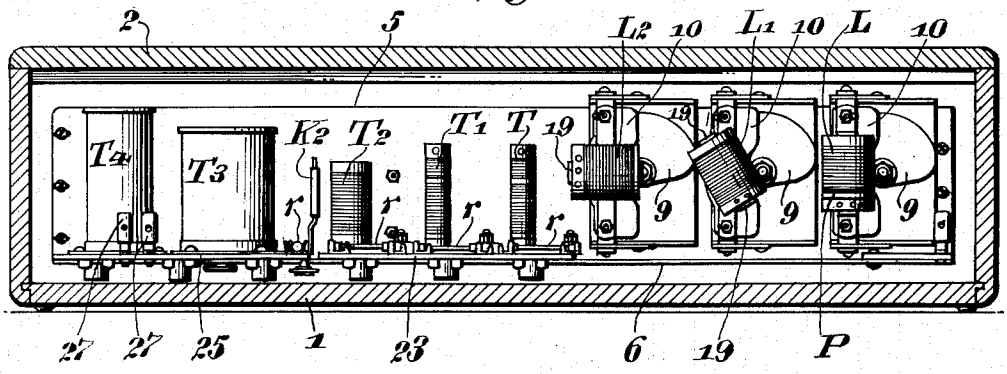


Fig. 7.

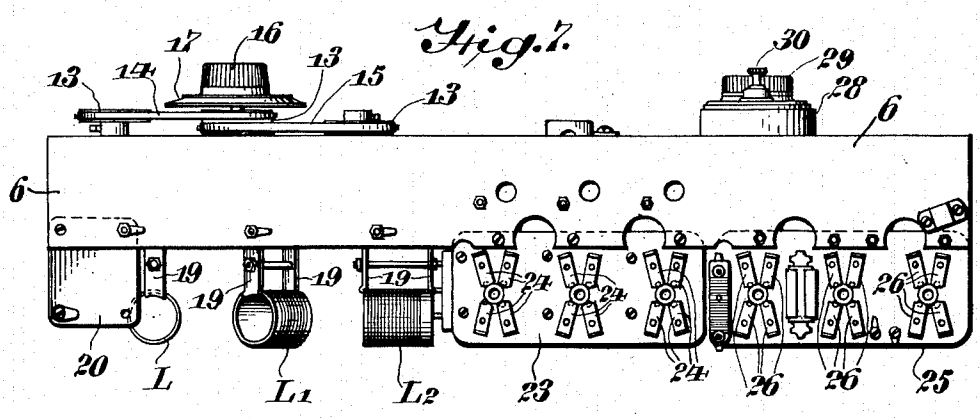


Fig. 13.

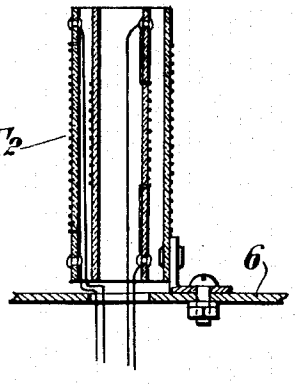
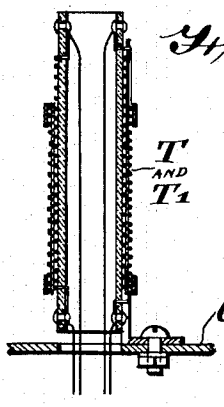


Fig. 12.



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Fig. 8.

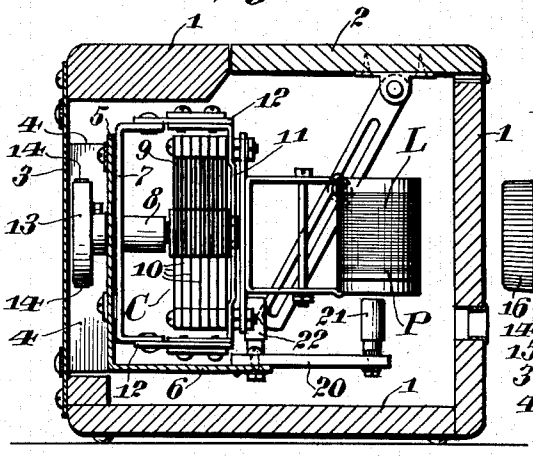


Fig. 9.

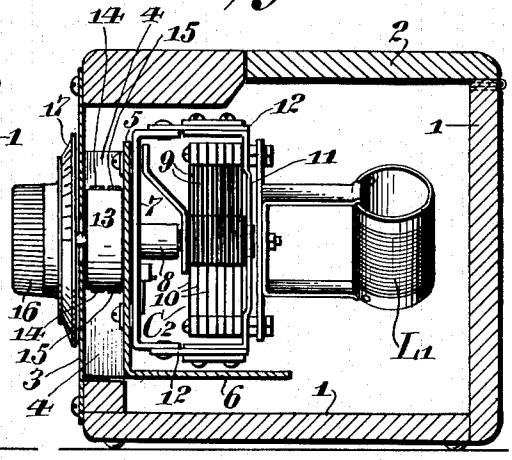


Fig. 10.

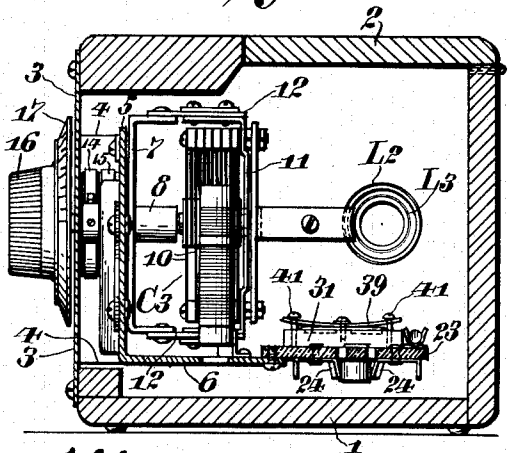


Fig. 11.

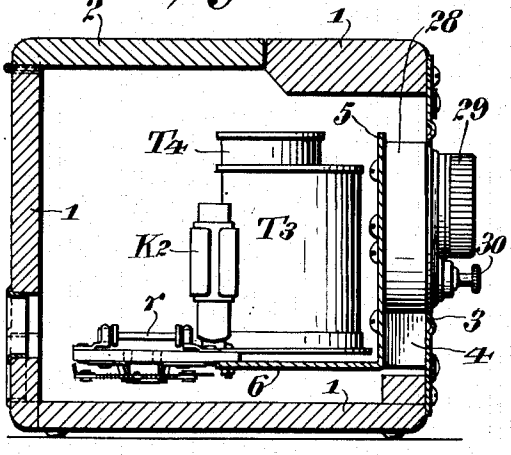


Fig. 14.

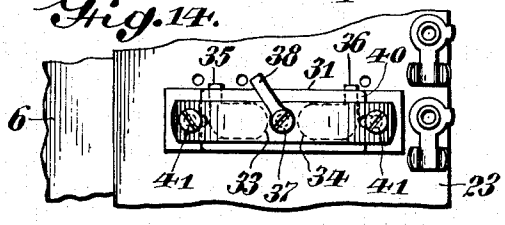


Fig. 16.

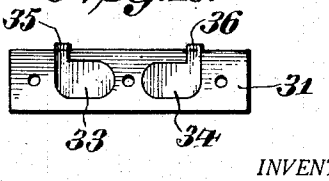
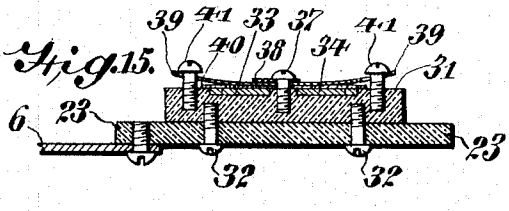


Fig. 15.



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Patented Sept. 30, 1941

2,257,272

UNITED STATES PATENT OFFICE

2,257,272

RADIO RECEIVING SYSTEM

John M. Miller, Philadelphia, Pa., assignor, by mesne assignments, to Radio Corporation of America, New York, N. Y., a corporation of Delaware

Application November 24, 1926, Serial No. 150,571

17 Claims. (Cl. 250—20)

My invention relates to radio receiving apparatus, and more particularly to a system comprised of devices, parts and connections disposed in compact arrangement in a set for reception of speech and music broadcast by transmitting stations utilizing the various wave lengths of a wide range.

Heretofore systems for broadcast reception have commonly comprised in advance of the detector or demodulator of the audion type one or more thermionic radio frequency amplifiers preceded and followed by circuits tunable to the various wave lengths of the broadcast range, constituting an arrangement generally of the character proposed in Alexanderson Patent 1,173,079, February 22, 1916, and of which it is characteristic that a relay, more specifically of the audion type, intervenes between the tunable circuits for so-called tuned radio frequency amplification.

In accordance with my system tuned radio frequency amplification is entirely dispensed with in that the tuning or selectivity is entirely effected independently of the radio frequency amplification which is effected independently of tuning or selectivity by recourse to aperiodic coupling or couplings between untuned output circuit or circuits and following untuned input circuit or circuits, and more particularly by coupling transformers having such characteristics that the amplification for all the wave lengths within the broadcasting range is approximately uniform as to magnitude.

In accordance with my invention, sharp or high degree of selectivity is obtained, either in advance of or subsequently to the radio frequency amplification, by two or more cascaded tuned or resonant circuits each preferably comprising a variable tuning condenser and inductance with extremely loose magnetic coupling between the inductances of neighboring tuned circuits, yielding both high selectivity and high or maximum energy transfer from tuned circuit to tuned circuit.

Further in accordance with my invention, in a selective system of the character referred to, when comprising three tuned circuits, the inductances or coils in the first and third circuits are so positioned or disposed with respect to each other that there is substantially no magnetic coupling between them, and the second or interposed inductance or coil is so disposed or positioned with respect to the first and third that there is effected coupling between the first and second coils and between the second and third coils, yielding, in effect, a cascade coupling in the sense that the transfer of energy by magnetic coupling is solely from one circuit to the next adjacent, that is, from the first coil to the second and from the second to the third, without direct coupling from the first to the third.

Further in accordance with my invention, the radio frequency amplification utilized with an independent selective system is aperiodic or untuned and the one or more stages of radio frequency amplification amplifies and transfers with approximate uniformity the oscillations of all frequencies within the broadcast range. It is characteristic of my radio frequency amplifying system that it of itself is not selective and is incapable of transferring oscillations of one frequency to the exclusion of oscillations of other frequencies lying within the same broadcast range. This characteristic is defined or illustrated by the fact that if the first input circuit of the radio frequency amplifying system is connected or coupled without intervention of tuning means to an untuned antenna or equivalent absorption structure, oscillations of all the frequencies within the broadcasting range will pass through the radio frequency amplifying system with substantially equal facility with consequent confusion and interference when two or more broadcasting stations are simultaneously transmitting.

Further in accordance with my invention, in a selective system of the character referred to, the movable elements or rotors of two or more of the tuning condensers are mechanically coupled to effect so-called single-dial tuning or operation, and for this purpose it is preferred that each of the condensers be of the "straight line capacity" type, that is, of the type in which for equal increments of angular adjustment of the rotor or movable element the capacity increases with substantially equal increments, because the increments of capacity are equal for equal angular displacements or increments of adjustment of the rotor or movable element; and it is further desirable that the mechanically coupled condensers be matched or similar to each other in the sense that a unit angle of adjustment of their rotors causes in all the condensers substantially the same magnitude of change in capacity.

My invention resides in a system of the character hereinafter described and claimed.

For an illustration of one of the various forms my invention may take, reference is had to the accompanying drawings, in which:

Fig. 1 is a diagrammatic view of a receiving system embodying my invention.

Fig. 2 is a graphic representation of selective and aperiodic characteristics.

Fig. 3 is a front elevational view of a radio receiving set embodying the features of my invention.

Fig. 4 is a front elevational view, partly in vertical section, on the line 4—4 of Fig. 5.

Fig. 5 is a horizontal sectional view, partly in plan, on the line 5—5 of Fig. 3.

Fig. 6 is a rear elevational view, partly in vertical section, on the line 6—6 of Fig. 5.

Fig. 7 is a bottom plan view of a portion of the structure shown in top plan view of Fig. 5.

Fig. 8 is a vertical sectional view, partly in elevation, on the line 8—8 of Fig. 5.

Fig. 9 is a vertical sectional view, partly in elevation, taken on the line 9—9 of Fig. 5.

Fig. 10 is a vertical sectional view, partly in elevation, taken on the line 10—10 of Fig. 5.

Fig. 11 is a vertical sectional view, partly in elevation on the line 11—11 of Fig. 5.

Fig. 12 is a vertical sectional view of one of the radio frequency coupling transformers.

Fig. 13 is a vertical sectional view of another form of radio frequency coupling transformer.

Fig. 14 is a top plan view of a balancing condenser structure.

Fig. 15 is a longitudinal sectional view of the structure shown in Fig. 14.

Fig. 16 is a plan view of a part of Figs. 14 and 15.

Referring to Fig. 1, the electro-radiant energy transmitted by various transmitting stations, as broadcasting stations, is absorbed by the antenna D between which and the earth or counter capacity E is connected the primary P of a radio frequency transformer. It will be understood, however, that other types of energy absorbing structures or circuits may be employed, including loop or coil antennae or so-called frame aerials.

V, V1 and V2 indicate three-electrode thermionic devices utilized as radio frequency amplifiers. Each comprises as usual a filament or cathode *f*, a grid or equivalent control electrode *g*, and an anode or plate *a*. These devices and their associated circuits constitute the radio frequency amplifying system which, while indicated as comprising three stages, may comprise one or other suitable number of stages.

This radio frequency amplifying system is aperiodic or non-selective in that the output circuit or circuits and the following input circuit or circuits are untuned or substantally aperiodic, transferring or responding with substantially equal facility to oscillations of all the frequencies within a predetermined range, such as a broadcasting range.

Intervening between the antenna D and the radio frequency amplifying system is the highly selective system comprising the cascaded tuned, resonant or selective circuits S, S1 and S2, comprising, respectively, the pairs of inductance coils and variable tuning condensers L, C, L1, C1 and L2, C2.

Such a cascaded system of two or more resonant circuits is of the character and mode of operation of the cascaded tuned circuits disclosed in prior Letters Patent to Stone, No. 714,756, December 2, 1902, in that it effects tuning in geometric progression, yielding high degree of selectivity or exclusion of the energies of those transmitting stations which operate at wave lengths different from that of a particular wanted station. Cascaded tuned or resonant circuits effect high degree of exclusion of unwanted wave lengths with selection of a wanted wave length, with a characteristic which may in a general way be represented by the resonance curve R, Fig. 2, which is sharply contrasted with untuned, non-selective or a periodic reception having a characteristic represented in a general way by the second curve U, Fig. 2.

Of the selective circuit S the inductance L is coupled to the transformer primary P in the antenna path. This coupling may be close whereby tuning of the circuit S effects to substantial degree a tuning of the antenna path. This coupling P, L may be fixed, or, as indicated by the arrow, variable for control of volume of the music, speech or messages reproduced.

The inductances or coils L, L1 and L2 are preferably the sole or major part of the inductance of each of the circuits S, S1 and S2. These coils or inductances are preferably wound in a single layer as indicated in Figs. 8, 9 and 10, with coupling coil P wound upon L, as indicated in Fig. 8. The first and third coils L and L2 are disposed with their axes substantially at right angles to each other whereby the magnetic coupling between them is substantially nil. The coil L1 has its axis disposed at an angle to the axes of both coils L and L2 and is in consequence effectively magnetically coupled with both, operating as a secondary with respect to the coil L, and as a primary with respect to the coil L2. While the axes of these coils are substantially in the same plane or in alignment with each other, it will be understood that they may depart from this substantial alignment, especially in the sense that the axis of the coil L1 may be out of alignment with respect to the axes of the coils L and L2.

The coupling effected by the system described is cascaded in the sense that energy is transferred by magnetic coupling from the circuit S to circuit S1, and from the latter to S2 without direct coupling effect of the circuit S upon circuit S2.

Another arrangement which lends itself to very loose coupling is one in which the first and third coils, L and L2, are disposed with their axes parallel to each other and at an angle of about 54 degrees to the line joining the centers of the windings. The intermediate coil L1 may have its axis in the same plane with the axes of the other coils but at some angle other than 54 degrees to the line joining the centers of the three coils. In this case again there will be substantially no magnetic coupling between the first and third coils, but with coupling between the first and second and between the second and third coils.

The coupling between the coils L and L1, and again between L1 and L2 is preferably very loose and may be of the order of one per cent or of such low magnitude which will at once yield high selectivity and effect high or optimum magnitude of current induced in each secondary circuit.

This system, of the character of the aforesaid Stone patent, gives particularly good results in radio telephony for the following reasons:

In the case of two similar coupled circuits, each tuned to resonance, it can be shown that the co-efficient of coupling for maximum current in the secondary circuit is equal to the reciprocal of the ratio of reactance (either inductive or capacity) to the circuit resistance. In well designed circuits of low resistance and in the broadcast range this ratio is a hundred or more so that the optimum coupling is of the order of one per cent or less. The system will have two resonant frequencies which are spaced apart by

an amount which in percentage is equal to the coefficient of coupling. With the present broadcast frequencies ranging from 550 to 1500 kilocycles and with a coupling of about one per cent the spacing will be 5.5 to 15 kilocycles. The effect of the two resonant peaks so close together is to flatten or render uniform the transfer over a range of this order while beyond on either side the transfer falls off rapidly. This behavior is ideal for the reception of radio telephony in which, for quality, it is desirable to transmit a band of frequencies of, say, ten kilocycles and in which, for selectivity or separation of different transmitting stations, it is desirable that the transfer fall off rapidly on either side. The use of three coupled circuits permits similar results, only the cut-off on either side is still sharper giving greater selectivity. The resultant high quality of reproduction, particularly clearness of speech, is very noticeable with this system over systems of equal selectivity in which this band effect does not occur.

As indicated in Fig. 1, one armature 9 of each of the tuning condensers C, C1 and C2 is connected to earth or counter capacity E. Preferably these armatures 9 are the rotors or adjustable elements.

While the rotors or adjustable elements 9 of the tuning condensers C, C1 and C2 may be independently adjusted and each provided with a separate knob and dial, the rotors 9, and especially those of condensers C1 and C2, of the tuned circuits remote from the antenna, may be mechanically coupled to effect single knob or dial control and operation, as illustrated in Figs. 4, 5 and 7.

For single control or single dial operation of two or more of the cascaded selective circuits, their tuning condensers have similar characteristics. Preferably each of the mechanically coupled condensers has a straight-line-capacity characteristic in that, for equal increments of angular adjustment of the rotor, the capacity increases with substantially equal increments, that is, the increments of capacity are equal for equal angular increments of adjustment of the rotor. This type of condenser is illustrated in Figs. 5–10.

When the inductance or coil in the same tuned circuit with the condenser is not mounted upon or included in the same mechanical unit with the condenser, the several condensers coupled together are preferably matched in that, for any unit of angular adjustment of the rotor 9, the change in capacity is substantially the same in each of the mechanically coupled condensers. And when, as indicated in Figs. 5, 6, 8–10, the inductances or windings are mounted upon or comprised in the same mechanical units with the tuning condensers, the units are matched, in that, for unit angular adjustment of the rotors 9 the product of the inductance and the increment of capacity is substantially the same for all the tuned circuits the rotors of whose tuning condensers are mechanically coupled.

Closely coupled to the inductance L2 of the third tuned circuit S2 is the winding or inductance L3 in the grid or input circuit of the first radio frequency amplifier tube V. As indicated in Fig. 10, the winding L3 may be disposed within the winding L whereby the latter more or less completely shields the coil L3 from direct capacitive coupling with the antenna.

The output circuits, of the radio frequency amplifier tubes V, V1 and V2 are coupled to the input circuits of the radio frequency amplifier tubes V1 and V2 and the detector tube V3 by the radio frequency transformers T, T1 and T2. These transformers are aperiodic or untuned in the sense that their primary and secondary circuits are aperiodic or untuned, whereby they do not effect selectivity, which function is performed entirely by the two or more cascaded tuned circuits S, S1 and S2. Each of these radio frequency coupling transformers has a substantially flat characteristic in the sense that oscillations of the various frequencies comprehended within the broadcasting band or range are with substantially equal facility transferred from circuit to circuit and are to substantially like degrees amplified.

In Fig. 2 the curve U indicates in a general way the characteristic of the combined effects of these three coupling transformers and of the amplification effected by the tubes in whose plate circuits their primaries are connected. The curve indicates that selectivity is not obtained and that, which is the fact, if the winding L3 were, without the use of any selective circuit or means, included in or coupled to the antenna D, and any number of transmitting stations were simultaneously in operation at wave lengths distributed throughout the broadcasting range, for example 200 to 550 meters, the energies from all stations would be transmitted and amplified by the radio frequency amplifying system with substantially equal facility, causing interference and confusion in the ultimate telephone or loud speaker, as I, preventing a listener-in from distinguishing a desired station from the others.

As contrasted with such confusion or interference is the selectivity obtainable by cascaded tuned or resonant circuits when between two or more of them intervenes one or more radio frequency amplifier tubes coupled by transformers whose circuits are tuned by variable condensers as proposed by the aforesaid Alexanderson patent. The selectivity as proposed by said prior patent is in a general way represented by the curve R, Fig. 2, which is sharply contrasted from the curve U in that the selectivity corresponding with curve R is sharp.

The present system is, therefore, contrasted with tuned radio frequency amplification in that the selectivity, such as indicated by the characteristic R, is procured by two or more cascaded tuned circuits S, S1 and S2, while the radio frequency amplification is aperiodic or substantially non-selective as represented by the characteristic U.

For the coupling transformers T, T1 and T2, which shall have the characteristics of effecting aperiodic or non-selective circuits, with as nearly as possible uniform amplification by the associated tubes of all the wave lengths or frequencies within the broadcasting range, any suitable design and construction may be utilized. By way of example, however, the transformer T may have its primary and secondary windings closely coupled, with as small a capacity effect as possible between its windings; the primary may comprise, for example, 375 turns and the secondary 500 turns, of number 38 wire, wound upon a tube of about 9/16 inch diameter. The primary inductance may be of the order of 0.7 and the secondary of the order of 1.0 millihenry. Transformer T1 may be of similar construction, though the winding of 500 turns may be utilized as the primary and that of 375 turns as the secondary. Transformer T2 may have its primary

and secondary winding loosely coupled and comprise, respectively, 250 turns and 530 turns, both of #38 wire, the primary wound upon a tube of about 9/16 inch diameter, and the secondary wound upon a tube of about 13/16 inch diameter. The primary may have an inductance of the order of 0.4 and the secondary an inductance of the order of 1.6 millihenry. The transformers T and T1 are indicated in section in Fig. 12, while transformer T2 is indicated in section in Fig. 13.

The primary and secondary windings of the coupling transformers T, T1 and T2 may be wound in the same direction, when viewed from the same end. With this mode of winding it will appear from Fig. 1 that there is no relative reversal of the windings or reversal of polarities as between the upper end of each primary, connected to an anode, and the upper end of the associated secondary connected to the grid of the next succeeding tube. Relative reversal of the windings, however, may be effected when suitable or desirable.

To stabilize the radio frequency amplifiers V, V1 and V2, there may be employed any suitable means or system for neutralizing the coupling effected by the grid to plate capacity of each, to prevent regeneration or the development of self-oscillations.

In the example illustrated, in the circuits of each of these amplifiers are provided the capacities or condensers K and K1 forming, in effect, a balanced Wheatstone bridge in one arm of which is the capacity between grid *g* and anode *a*, and in another arm of which is the capacity between the grid *g* and the cathode *f*. Connected from grid to filament of each of these tubes is a high resistance *r*, which, with the aforesaid condensers, forms a neutralizing system of the character disclosed in my prior patent No. 1,787,732, January 6, 1931.

A neutralizing system of this character, or its equivalent, is essential in connection with radio frequency amplifying systems, whether of the character herein disclosed or of the general character proposed by the aforesaid Alexanderson patent which latter is devoid of such neutralizing means essential to successful broadcast reception.

The use of a neutralizing system is of special advantage in connection with the type of amplifier herein described inasmuch as it assists in effecting high and uniform amplification over a broad band of frequencies. To attain this result it is desirable to keep the effective capacities of the coupling transformers at a minimum. It is well known that the input capacity of a vacuum tube amplifier is increased by the presence of a load in the plate circuit. This capacity would be additive to the capacity of the coupling transformers such as T and T1 of Fig. 1, and hence tend to diminish the range which could be effectively covered. When neutralization is employed this enhanced capacity is eliminated and the range is very much improved.

The first amplifier stage being neutralized, there is no introduction of positive or negative resistance into the input circuit of the tube to affect the selectivity of the preceding tunable circuit. The amplifier therefore at these input terminals, grid and filament, acts as a pure reactance, specifically a pure capacitance.

The secondary of the transformer T2 is connected to the grid and cathode of the detector or demodulator tube V3 in whose grid lead is connected the usual grid condenser K2. In the example illustrated, the usual high grid leak resistance *r* is connected from grid to a suitable point upon the resistance *r1* connected across the terminals of the filament *f*.

In the output circuit of the detector tube V3 is the primary, shunted by the condenser K3, of the audio frequency coupling transformer T3 whose secondary is connected in the grid circuit of the audio frequency amplifier tube V4 whose output circuit is coupled by the audio frequency transformer T4 with the input circuit of the audio frequency amplifier tube V5 in whose output circuit is connected the signal translating instrument I which may be a telephone, loud speaker, or equivalent means.

The anode circuits of the several tubes V—V5 are supplied with current from the source of current or battery B; the cathodes are heated by current from the source or battery A; and a source or battery G may be provided for negatively biasing the grids of one or more of the tubes as may be suitable or desirable.

A condenser K4, of relatively high capacity is provided for by-passing radio frequency currents, particularly around the battery B, and serves also in a measure to assist in stabilization of the radio frequency amplifier tube circuits.

A system or apparatus of the character above described in connection with Figs. 1 and 2 may be arranged in a compact receiving set as illustrated in Figs. 3–11, in which 1 is a suitable casing, of wood or other suitable material having the hinged cover 2 and the front panel 3 of sheet metal or other material. Secured to the rear face of the panel 3 are the metal bracket members 4 to which is secured the inner metal panel 5 having the inwardly and rearwardly extending horizontal ledge or extension 6 which, with the members 3, 4 and 5, when of metal are grounded by connection to the aforesaid earth or counter capacity E.

The tuning condensers C, C1 and C2 are of any suitable structure. In the example illustrated, each comprises a bracket 7 secured to the inner panel 5 and supporting the bearing 8 for the rotor shaft upon which are secured rotor plates 9 interleaving with and spaced from stator plates 10 carried by the bracket member 11 secured through insulating members 12 upon the bracket 7. The rotors 9 are accordingly all electrically connected together and to the panel structure and to earth E.

The rotor shafts extend through the panel 5 and upon their ends between the panels 3 and 5 are secured the metal pulleys 13, the middle one of which is wide enough to accommodate the two phosphor bronze or metallic belts 14 and 15 which engage and drive the two remaining pulleys. In the example illustrated, the wide pulley 13 is upon the shaft of the rotor of the condenser C1. Its shaft extends through the panel 3 to the exterior where there is secured upon it the knob 16 and dial 17, the latter coacting with the fixed index 18.

The inductances or coils L, L1 and L2 may be separately mounted upon a suitable support carried by the ledge 6; or, as illustrated, these windings may be supported upon and constitute a unit with the condensers with which they form tuned circuits. As indicated in Figs. 5–10, these windings or coils are carried by brackets 19 carried in turn by the stator brackets 11. As indicated in Fig. 1, one terminal of each of these windings is connected to the stator of the associated condenser and the other to its rotor. The condensers and coils are preferably so designed as

to have small losses, and the resistance of each tuned circuit, as represented by the losses and the ohmic resistance, is preferably low.

Secured to the left end of ledge 6, Figs. 5 and 7, is the plate of insulating material 20 carrying the antenna binding post 21 and the ground binding post 22 which latter is in electrical connection with the metallic panel system 3—5, 6.

To the right, as viewed in Fig. 5, of the unit C2, L2, there is secured to the inner edge of the ledge 6 the plate of insulating material 23 carrying on its underside the tube contacts 24 with which engage prongs or terminals upon the tubes extending through holes in member 23 which carries the three tubes V, V1 and V2. To the right of the member 23 is the insulating plate 25 carried by the ledge 6 and having on its underside the tube contacts 26 for the tubes V3, V4 and V5. Upon the plate 25 are carried also the binding posts 27 to which are connected the terminals of the instrument I. Attached to the member 25 are also the casings for the audio frequency transformers T3 and T4, and the coupling transformers T, T1 and T2 may be carried upon the plate 23 or ledge 6.

Carried upon the inner panel 5 is the housing 28 for the filament rheostat r2, Fig. 1, adjusted by the knob 29 extending to the exterior of panel 3. The housing 28 carries also the handle 30 of a switch controlling connection of the battery or source A to the several cathodes *f*.

Carried by member 23 are the three pairs of stabilization condensers K, K1. As indicated in Figs. 14–16, each pair of condensers comprises a member or block 31 of insulating material, such as moulded "Bakelite" or the like secured by screws 32 to the member 23. Moulded in or secured in depressions in the face of the block 31 are the armatures 33 and 34 having the laterally extending clips 35 and 36 for connecting them in circuit. The screw 37, threaded into block 31, or into an insert moulded therein, extends through the clip 38 and the resilient flexible metallic armature member 39 which extends adjacent to the armature members 33, 34, but is separated therefrom by the sheet of mica or other insulating material 40. Screws 41 extend through apertures in opposite ends of the member 39 and are threaded into the block 31 whereby turning of either screw adjusts either end of the common armature member 39 toward or from its companion armature 33 or 34. By this structure the magnitudes of the capacities are suitably independently adjusted to effect bridge balance or stabilization. The left end of armature 39 with plate 33 constitutes, for example, a condenser K, while the other end of plate 39 with armature 34 constitutes the condenser K1 of the same pair for the same tube. The terminal 38 is the common terminal of the condensers K, K1, as indicated in Fig. 1.

What I claim is:

1. The method of selectively receiving the transmission band of a modulated signal wave which consists in applying the signal energy to a receiving system, balancing the reactances of the system in pairs at one limiting frequency, balancing the unbalanced reactances of the pairs at another limiting frequency by a reactance common to both pairs, thereby receiving with substantial uniformity all frequencies in the band included between these limiting frequencies, and varying the position of the band of reception in the frequency scale by simultaneously and similarly varying the balanced reactances.

2. In a system for receiving the transmission band of a modulated wave, a band selector unit comprising two reactive couples, each having reactances that are partly balanced at the frequencies included in the transmission band, an untuned reactance common to both couples whose value is so related to the reactances of the couples that the unbalanced portion of those reactances is balanced and the system is made responsive to all freqencies within a definite band, and means for simultaneously and similarly varying the partly balanced reactances, thereby shifting the band of response in the frequency scale while preserving its band character.

3. A system for transferring the transmission band of a modulated signal whose frequency is within the broadcast range of from approximately 550 to 1500 kilocycles and which is modulated at audio frequencies comprising a selective system of cascaded circuits, each tuned to the signal frequency and comprising a single coil and variable tuning condenser, means to effect substantially uniform transfer of all frequencies within said band and sharp discrimination against frequencies outside of said band comprising the mutual inductance between said coils of adjacent circuits which is of such magnitude to effect coupling between said circuits whose coefficient is of the order of one per cent, and means for mechanically coupling said variable tuning condensers for adjustment in unison to preserve the band-pass characteristic of said selective system in tuning from one signal frequency to another signal frequency.

4. A radio receiver comprising a system for selectively transferring the transmission band of a modulated signal comprising a plurality of circuits tuned to the signal frequency and with adjacent circuits having a coefficient of coupling of a magnitude which flattens the transfer of all frequencies within the transmission band with rapid decrease in the transfer on both sides of said band, and a radio-frequency amplifying system having the characteristic that all frequencies within a range not less than the width of said transmission band are substantially uniformly amplified.

5. A radio receiver comprising a system for selectively transferring the transmission band of a modulated signal comprising a plurality of circuits tuned to the signal frequency and with adjacent circuits having a coefficient of coupling of proper magnitude to flatten the transfer of all frequencies within the transmission band with rapid decrease in transfer outside of the band, and a radio frequency amplifying system having an input circuit upon which is impressed the band transferred by said selective system and whose amplification-frequency characteristic is substantially flat for the frequencies transferred thereto by said selective system.

6. A radio broadcast receiver comprising a preselector system for selectively transferring the transmission band of a sound modulated signal comprising a plurality of circuits tunable throughout the range of broadcast frequencies and having a coupling between adjacent circuits whose coefficient is of the order of one percent for uniform transfer of all frequencies within said band with sharp discrimination against frequencies outside of said band, and a radio frequency amplifying system whose amplification-frequency characteristic is substantially flat throughout said range of frequencies.

7. A system for receiving the transmission band

of a modulated signal whose frequency is within the broadcast range of from approximately 550 to 1500 kilocycles and which is modulated at audio frequencies comprising a selective system of cascaded circuits each tuned to the signal frequency, means to effect substantially uniform transfer of all frequencies within said band and sharp discrimination against frequencies outside of said band comprising reactance mutual to said circuits and of such magnitude to effect coupling between said circuits whose coefficient is of the order of one per cent, devices for tuning said circuits, and means for mechanically coupling said devices for movement in unison to preserve the band-pass characteristic of said selective system in tuning from one signal frequency to another signal frequency.

8. A system for receiving the transmission band of a modulated signal, comprising at least two cascaded circuits tuned to a frequency of the band, a reactance common to each pair of said circuits for coupling them with a coefficient of coupling effecting substantially uniform transfer of all frequencies within said band and sharp discrimination against frequencies outside of said band, and means for tuning said circuits throughout a range of signal frequencies while maintaining the aforesaid characteristics of said band.

9. In a radio receiving system, in combination with an absorption structure and a thermionic tube having input and output electrodes, of a system for transferring from said absorption structure to the input electrodes of said tube the transmission band of a modulated signal, said transfer system including at least two cascaded circuits tuned to a frequency of the band, a reactance common to each pair of said circuits for coupling them with a coefficient of coupling to effect substantially uniform transfer of all frequencies within said band and sharp discrimination against frequencies outside of said band, and means for tuning said circuits throughout a range of signal frequencies while maintaining the aforesaid characteristics of said band.

10. In a radio receiving system, in combination with an absorption structure and a thermionic tube having input and output electrodes, of a system for transferring from said absorption structure to the input electrodes of said tube the transmission band of a modulated signal, said transfer system including at least two cascaded circuits tuned to a frequency of the band, a reactance common to each pair of said circuits for coupling them with a coefficient of coupling to effect substantially uniform transfer of all frequencies within said band and sharp discrimination against frequencies outside of said band, means for tuning said circuits throughout a range of signal frequencies while maintaining the aforesaid characteristics of said band, and an amplifier system, included with said tube in the radio receiving system, for amplifying with substantial uniformity the frequencies comprised in the tuning range of said circuits.

11. In a receiving system for modulated radio frequency energy, the combination of two reactive couples tuned to a frequency of said energy, means for impressing said energy on one of said couples, a coupling reactance common to both couples having such coupling coefficient and such magnitude of reactance relatively to those of the couples as to effect highly uniform and selective transfer of the modulated energy through a frequency range comprising the effective transmission band of the modulated radio frequency energy, means for shifting the position of the frequency range of the energy transfer in the frequency spectrum, and an amplifier, responsive with substantial uniformity to all frequencies included in any selected frequency range, upon which the other of said couples impresses the modulated radio frequency energy.

12. In radio receiving apparatus utilizing cascaded circuits having tuning devices, the method which comprises maintaining a value of coupling between adjacent circuits which effects highly selective transfer of modulated radio frequency energy through a range of wavelengths substantially corresponding to the range of audio frequencies when said circuits are tuned to the same wavelengths, and adjusting the tuning devices simultaneously to resonance at the same wavelength throughout the range to which they are tunable, and maintaining simultaneous adjustment of the tuning devices to insure substantially constant range of wavelengths within which radio frequency energy is transferred by the tunable circuit.

13. In a system for receiving the transmission band of a modulated signal wave, a collector, an amplifier receiving signal energy from the collector, a double-tuned band pre-selector connected between the collector and the amplifier and comprising two variable reactive couples and coupling means for the transfer of oscillatory energy between these couples, said coupling means affording such degree of coupling that the effective frequency response of the selector is substantially broader than the effective response of the component couples and is substantially coextensive in frequency width with the modulation, and single control means for simultaneously varying variable reactance of the couples to shift the band of response of the system in the frequency scale.

14. In a system for selectively receiving any desired transmission band of modulated signal waves, the combination with means for collecting and means for detecting said waves, of a system of balanced reactances operatively connected with the collecting means to receive the collected energy therefrom and operatively connected with the detecting means to impress the selected signal band on the detecting means, means for varying said reactances for selecting at will any desired transmission band without materially modifying the relative intensities of the frequencies included in the selected band, and means for amplifying the entire transmission band of the selected signal to a substantially constant degree.

15. In a system for receiving a signal wave, a plurality of double tuned selector units each comprising two reactive couples having variable reactances with means for the transfer of oscillatory energy between these couples, means for coupling the selector units in cascade, and single control means for simultaneously and similarly adjusting the reactances of the several reactive couples whereby the frequency response of the several selector units is simultaneously and similarly adjusted, said means for the transfer of oscillatory energy not being subject to adjustment by said single control means.

16. In a system for receiving the transmission band of a modulated signal wave, a plurality of selector units each responsive with substantial uniformity to a band of frequencies with a sharp cut-off at the extremities of the band, means for coupling the selector units in cascade, said coupling being sufficiently close to avoid material

loss in transmission and of such a nature that it does not modify materially the band response of the selector units, and single control means for simultaneously and similarly adjusting the position of the bands of response of the several selector units in the frequency scale.

17. In a receiving system for modulated radio frequency energy, the combination of two reactive couples tuned to a frequency of said energy, means for impressing said energy on one of said couples, a coupling reactance common to both couples whose value is so related to the reactances of the couples as to effect highly uniform and selective transfer of the modulated energy through a frequency range corresponding substantially to the range of audio frequencies, and means for aperiodically amplifying the selected modulated radio frequency energy.

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