Sept. 21, 1937. R. A. BRADEN 2,093,544

CONVERTIBLE BAND PASS RECEIVER

Original Filed May 27, 1930 2 Sheets-Sheet 1

Fig. 1

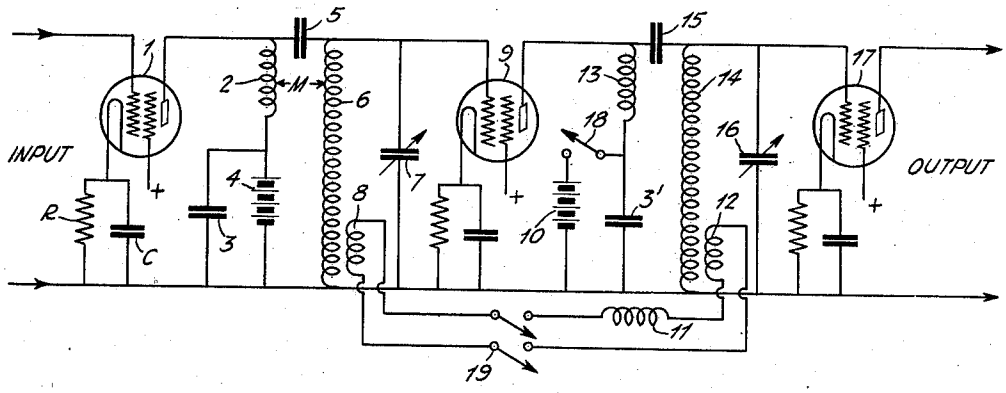


Fig. 2

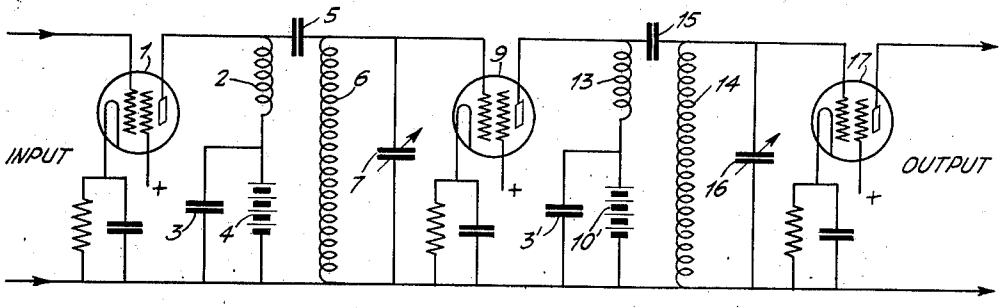
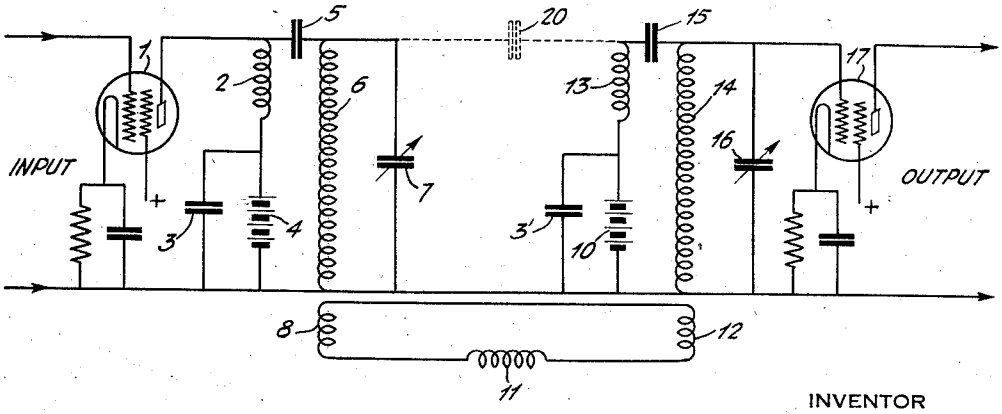


Fig. 3



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Original Filed May 27, 1930 2 Sheets-Sheet 2

Fig. 4

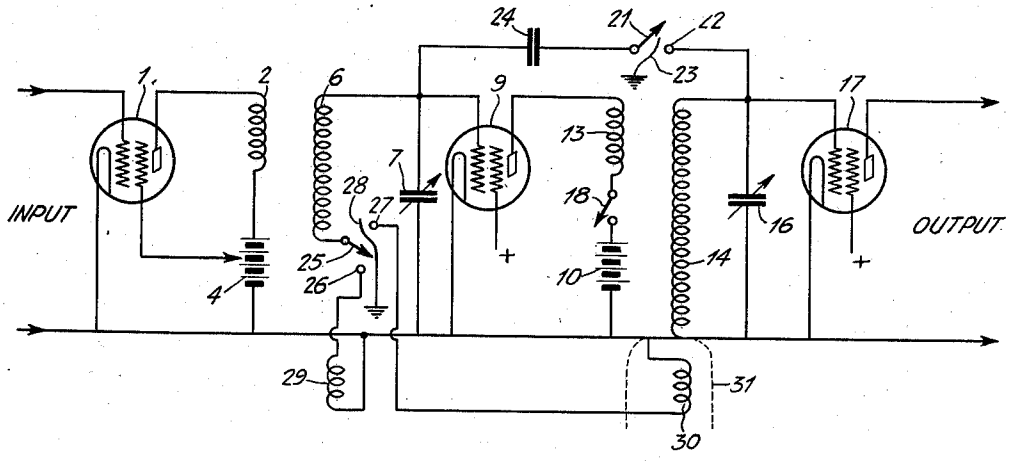
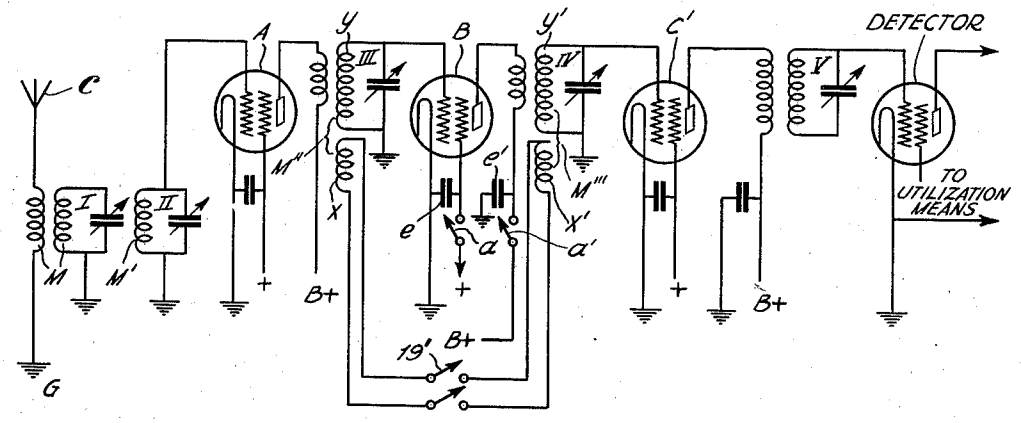


Fig. 5



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Patented Sept. 21, 1937 2,093,544

UNITED STATES PATENT OFFICE

2,093,544

CONVERTIBLE BAND PASS RECEIVER

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Original application May 27, 1930, Serial No. 456,024. Patent No. 1,944,119, dated January 16, 1934. Divided and this application July 7, 1933, Serial No. 679,303

9 Claims. (Cl. 250—20)

My present invention is a division of application Serial No. 456,024, filed May 27, 1930, patented as U. S. P. 1,944,119 on Jan. 16, 1934.

The ideal receiver of radio programs from near-by, powerful broadcasting stations, should possess, among other desirable factors, a high degree of fidelity, and a moderate degree of sensitivity and selectivity. In sharp contrast with the latter, the ideal receiver of radio signals from distant stations should essentially possess a very high sensitivity and selectivity, and only a moderate degree of fidelity. The reasons for the latter requirement may be summed up as follows:

1. Both the background noise which is picked up by a sensitive receiver, and the distortion which the signal suffers during an extensive transmit through space, are rendered less obnoxious if the high note response of the receiver is somewhat less than that which gives perfect reproduction;

2. The selectivity requirements of a receiver of distant signals is entirely incompatible with the maximum fidelity standards.

Now, I have discovered a method of, and devised means for, receiving radio signals from both local and distant points, and at the same time succeeded in satisfying the requirements for ideal local and distant reception as stated above. Essentially, the present invention employs what may be generally expressed as a convertible band pass receiver for both local and distant reception, the receiver operating with a band pass characteristic strongly pronounced when employed for local reception, while, on the other hand, the band pass characteristic is greatly diminished, and even eliminated, when the receiver is employed for distant reception. In other words, I have designed a radio receiver which may be selectively operated for ideal local reception by employing band pass characteristics in the radio frequency circuits, and which may be adjusted for reception of attenuated distant signals by employing the well known and conventional tuned radio frequency circuits.

Accordingly, it is one of the main objects of the present invention to provide a method of, and means for, receiving radiated, intelligence modulated radio frequency signals from local or distant points, the method consisting in operating a receiver in such a manner that it may be selectively adjusted for reception of signals from the local or distant point, the adjustment being such that the receiver has a band pass characteristic in the radio frequency circuits for local reception whereby there is no loss of fidelity (that is to say, attenuation of high notes) in these circuits, and the sensitivity is less than is considered essential for reception from distant points while sufficient for reception from local points, the band pass characteristic being reduced, or perhaps substantially eliminated, for reception from distant points whereby the sensitivity of the receiver is considerably increased, the selectivity with respect to closely adjacent wave channels is increased, and the fidelity is reduced.

Another important object of the present invention is to provide a radio receiver employing one or more stages of radio frequency amplification, the radio frequency stages being designed to operate for broadcast reception from local broadcasting stations with a band pass characteristic in the radio frequency circuits, whereby there is no loss of fidelity in these circuits, and the receiver is quite selective, but not sufficiently selective to tune out a strong signal and tune in one on the adjacent wave channel, but which selectivity is nevertheless more than adequate for the separation of local stations which work on well separated wave frequencies, and which radio frequency circuits, additionally, have means associated therewith whereby they may be adjusted for the reception of weak signals, particularly from distant points, whereby the circuits operating with a band pass characteristic are converted into circuits practically identical, in characteristic, with the conventional tuned radio frequency type of amplifier.

Another important object of the present invention is to provide in a radio receiver, an arrangement for adjusting the tuned radio frequency amplifying stages of the receiver in such a manner that the stages may be selectively operated, in an ideal fashion, for local or distant reception, the arrangement comprising an electron discharge device having a tuned input circuit, the output circuit of the tube being coupled to a second tuned circuit, an additional coupling path between the tuned input circuit and the second tuned circuit, and means for rendering the coupling path inoperative when the electron discharge tube is operative and the receiver is employed for receiving distant signals, the means also being adapted to render the tube inoperative when the coupling path is made operative to receive local signals.

Another object of the invention is to provide a radio receiver of the band pass amplifier type which includes one or more band pass amplifier stages and a detector stage having a tuned input circuit, at least one of the band pass stages in-

cluding an electron discharge tube having a tuned input circuit, and having its output circuit coupled to a second tuned circuit, the detector input circuit being tuned to the center of the resonance curve of the band pass stages whereby the over-all resonance curve of the receiver is made flat without the addition of resistance to the tuned circuits, and an additional coupling path between the tuned input circuit of the band pass tube and the second tuned circuit, and means for adjusting the receiver for alternative ideal reception of local and distant stations, the adjustment of which means results in rendering the band pass tube inoperative for local station reception, and operative for distant reception.

Still other objects of the invention are to improve generally the efficiency of radio receivers, particularly of the band pass type, and to provide a convertible band pass receiver which is not only durable and reliable for local and distant reception, but ecomonically manufactured.

The novel features which I believe to be characteristic of my invention are set forth in particularity in the appended claims, the invention itself, however, as to both its organization and method of operation will best be understood by reference to the following description taken in connection with the drawings in which I have indicated diagrammatically several circuit organizations whereby my invention may be carried into effect.

In the drawings,

Fig. 1 diagrammatically shows a convertible band pass radio frequency amplifier stage,

Fig. 2 diagrammatically shows the equivalent electrical circuit of the circuit in Fig. 1, when the latter is employed for distant reception,

Fig. 3 shows the electrical equivalent circuit of the circuit in Fig. 1 when the latter is utilized for local reception,

Fig. 4 shows a circuit embodying a modified form of the invention,

Fig. 5 diagrammatically shows a receiving circuit in which a modified form of the invention is incorporated.

Referring to the accompanying drawings in which like characters of reference indicate the same elements in the different figures, there is shown in Fig. 1, a convertible band pass radio frequency amplifier stage to be connected between the antenna circuit and the detector circuit, the latter two circuits not being shown in order to simplify the description and drawings.

Incoming signal energy is impressed on the input terminals of the electron discharge device 1, the latter being preferably shown as a screen grid tube. The input energy is impressed across the control electrode and the cathode of the tube 1, the cathode including a resistance R shunted by a capacity C, in one of its legs.

The screen grid element is positively biased in a manner well known to those skilled in the art, and will not therefore be gone into in detail at this time, the biasing means not being shown but being designated by a plus sign. In the output circuit of the tube 1 is disposed an inductance coil 2 connected to the positive terminal of an anode current source 4, the latter being shunted by a capacity 3 to by-pass radio frequency currents.

A tuned circuit, consisting of an inductance coil 6 and a variable condenser 7, is connected to the input terminals of an electron discharge device 9, also preferably a screen grid tube. Signal energy is transferred from the screen grid tube 1 to the screen grid tube 9 by inductive coupling between the coils 2 and 6, the coupling being generally expressed by the letter M between the two coils. In the anode circuit of the tube 9 is connected an inductance coil 13, similar to the inductance coil 2, which coil 13 is coupled inductively to an inductance coil 14 in the input circuit of a third screen grid tube 17.

The coil 14, with the variable condenser 16, forms a tuned circuit connected to the input terminals of the tube 17. A fixed capacity 5 is connected between the high potential ends of the coils 2 and 6, while a fixed capacity 15 is connected between the high potential ends of the coils 13 and 14. The inductance coil 13 is connected to the anode source of current 10 for the anode of tube 9, through a switch 18, the switch and source being shunted by a fixed capacity 3' for by-passing radio frequency currents.

A small inductance coil 8 coupled to the inductance coil 6, a similar coil 12 coupled to the inductance coil 14, and a coil 11, connected in series with the coils 8 and 12, constitute a link coupling between the tuned input circuit of the tube 9 and the tuned input circuit of the tube 17, as has been disclosed in detail in my copending application, Serial No. 390,468, filed on September 5, 1929, Patent No. 2,055,996, September 29, 1936. A single-throw, double-pole, switch 19 is inserted in the link coupling circuit. The amplified output from the tube 17 may be impressed upon the input terminals of a detector stage (not shown) and the detector signals then utilized in any desired manner.

In Fig. 2 I have shown the electrical equivalent of the circuit in Fig. 1 when the switch 18 is closed, and the switch 19 in the link coupling circuit is opened. It will be obvious that when the switches are manipulated in such a manner, the two tubes 9 and 17 and the two tuned circuits 6, 7 and 14, 16 form two complete radio frequency amplifier stages, each stage having a single tuned circuit. This adjustment is employed for the reception of weak signals, preferably from a distant point, the receiver in which the circuit in Fig. 2 is embodied then being practically identical in construction and characteristics with a conventional multi-stage tuned radio frequency amplification receiver.

The coil 13 is a small "Universal-wound" coil which is placed inside the secondary coil 14, so as to be inductively coupled thereto. Coil 13 has so many turns that it is tuned by its own capacity and the plate-ground capacity of tube 9 to a frequency of 300 or 400 kilocycles, that is to say, below the radio broadcast spectrum. At the low frequency end of the broadcast spectrum, therefore, this coil is near resonance, and the energy transfer to coil 14 is therefore great.

At the high frequency end of the broadcast spectrum, however, the coil 13 is no longer effective, being partially by-passed by the above mentioned capacities, and there being no building-up of current in the coil by resonant action at frequencies so far from 300–400 kilocycles. Therefore, the condenser 15 is added to give capacity coupling which is effective at the high frequency end of the broadcast spectrum. By means of this combination of inductive and capacity coupling, uniform amplification at all frequencies throughout the broadcast spectrum, that is from 550 to 1500 kilocycles, is secured. The coil 13 is so connected that the inductive coupling adds to the capacitive coupling.

If the switch 18 in the circuit in Fig. 1 is now opened, and the switch 19 is closed, the tube 9 no longer acts as an amplifier tube; its sole effect on the circuit then depending on its interelectrode capacities. The capacities between the grid and filament of the tube and between the plate and filament, respectively, add to the tuning capacities 7 and 16. The capacity between grid and anode in such case acts as a coupling capacity between the tuned circuits 6, 7 and 14, 16. The electrical equivalent of Fig. 1 is shown diagrammatically in Fig. 3, the circuit in Fig. 3 resulting when the switches 18 and 19 are operated as described in the preceding paragraph.

In the circuit in Fig. 3 it will be noted that the condenser 20, shown in dotted lines, represents the capacity between the grid and anode of the tube. Where the tube 9 is the screen grid tube, the latter being the preferred construction in the present application, the capacity 20 is so small that its effects are negligible. The two tuned circuits 6, 7 and 14, 16 are coupled by the link circuit 8, 11, 12. This link circuit is adjusted so that the coupling between the two tuned circuits is in the vicinity of the critical coupling value, this adjustment being clearly described in detail in my aforementioned copending application.

It will, thus, be seen that the tube 1 and the two coupled tuned circuits form a band pass radio frequency amplifier stage. When the receiver embodies the circuit of Fig. 1 adjusted to operate as shown in Fig. 3, it then operates with a band pass characteristic in the radio frequency circuits, and there is, therefore, no loss of fidelity (attenuation of high notes) in the latter circuits; the sensitivity is less than is considered essential for receiving some distant station, but is sufficient for reception from a local station, the receiver is quite selective, but not sufficiently selective to tune out a strong signal and tune in one on the adjacent wave channel; but, the selectivity is more than adequate for the separation of local stations which work on well separated wave frequencies.

It is emphasized that the circuit shown in Fig. 1 represents only one of a number of ways in which the invention may be carried into effect. Any of the coupling methods suitable for band-pass radio frequency circuits may be utilized, particular reference being made to coupling methods and devices disclosed for example in my aforementioned co-pending applications, Serial No. 278,105, filed May 16, 1928, and Serial No. 413,450, filed December 12, 1929, Patent No. 2,037,614, April 14, 1936. Basically, it is only necessary to provide a suitable switch, or switches, for opening the coupling circuit, or otherwise making the coupling circuits inoperative when the intermediate tube 9 is operative. It should be further pointed out that there must be no appreciable amount of coupling between the two tuned circuits when the tube 9 is operating; for, such coupling, in effect between the output and input circuits of the tube, would cause regeneration and possible oscillation. When the coupling is inductive, opening or short-circuiting the coupling coil or coils is sufficient, unless there is also an accidental capacity coupling. In such a case, or if a physical coupling condenser is utilized, in addition to opening the circuit, it may be necessary to insert an electrostatic shield between the two parts of the switch.

As an example of the use of different coupling methods, there is shown in Fig. 4 a combined inductive coupling and capacity coupling circuit. In this figure, the tube 1 is shown as having its screen grid element deriving biasing potential from the anode source 4. The input circuit of the tube 9 is tuned by the coil 6 and the variable condenser 7, while the input circuit of the tube 17 is tuned by the coil 14 and variable condenser 16. As in Fig. 1, the coils 2 and 6 are coupled, and the coils 13 and 14 are coupled.

The coupling condenser 24 is connected between high potential points on the coils 6 and 14 through a switch mechanism consisting of a movable blade 21, and the fixed contact point 22. When the switch is opened, a grounded metal plate 23 moves into the space between the two parts of the switch, thus reducing the effective capacity between the coils 6 and 14 to zero. The plate 23 may be attached by an insulating support to the switch blade 21 so as to move with the switch blade, if desired.

The coil 30 of the link circuit is coupled to the coil 14, and is connected in series with the coil 6 when a switch blade 25, the latter being affixed at one end to one terminal of the coil 6, rests on the contact point 27, the latter being connected to one terminal of the inductance coil 30. The circuit 6, 7, 30 is thus inductively coupled to the circuit 14, 16. When the switch blade 25 rests on a contact point 26, the coupling coil 30 is cut out of the circuit, a coil 29 (having the same inductance as coil 30) is connected into the circuit in series with the coil 6 and condenser 7, it being noted that one terminal of the coil 29 is connected to one side of the condenser 7 while the other end of the coil 29 is connected to the contact point 26.

The purpose of the coil 29 is to keep the resonant frequency of the tuned circuit from changing when the switch 25 is changed from one position to the other. An electrostatic shield 31, shown in dotted line, is placed between the coils 30 and 14 to prevent capacity coupling between them. Therefore, when the switch 25 is connected to contact point 26, the coupling coil 30 is almost entirely isolated from the tuned circuit 14, 16. The only remaining coupling is that due to the small current which, by reason of the capacity between the switch blade 25 and the contact point 27, flows to the contact point 27 as a displacement current, and thence through the coil 30.

The displacement current flowing in the coil 30 induces an electromotive force in the coil 14, against which the electrostatic shield 31 is no protection. The coupling resulting from this cause may be reduced to an extremely small value by designing the switch 25 so that the parts are physically small and are separated, and by suitable disposition over fixed, metallic surfaces; or may be entirely prevented by arranging a movable, grounded, electrostatic partition 28 which will be disposed between the switch 25 and contact 27 when the switch is connected to the contact point 26, and will move out of the way when the switch 25 connects to the point 27. The construction of this shielding member may be the same as in the case of the member 23.

The operation of the circuit in Fig. 4, with respect to its adjustment for local signals and distant signals, may be explained as follows. When the tube 9 is working, the switch 21 is open and the coil 30 is cut out of the circuit. This produces two tuned radio frequency amplifier stages, similar in their general characteristics to those shown in Fig. 2. When the tube 9 is not working

(the switch 18 rendering the tube inoperative) the switch 21 is closed and the coil 30 is in the circuit. This produces one band pass amplifier stage, similar in characteristics to that shown in Fig. 3.

In Fig. 5 there is shown a complete receiver in which one convertible band pass amplifier stage is incorporated, the stage subsequent to the detector not being shown, it being understood however, that the subsequent stages may be one or more stages of audio amplification, and/or any well known type of utilization means such as a loud speaker, head phones, and the like. Generally speaking, the receiver consists of a grounded antenna circuit C, G, the antenna circuit being coupled as at M, to a tuned circuit I. A second tuned circuit II is disposed in the input circuit of the first electron discharge tube, preferably a screen grid tube, A, the second tuned circuit being coupled to the first tuned circuit I by the mutual inductance M' between the inductance coils of both tuned circuits. The output circuit of the tube A is coupled to the tuned input circuit III of an intermediate screen grid tube B, the output of the latter being coupled to the tuned input circuit IV of a third screen grid tube C'. The tuned input circuit V of a detector tube is coupled to the output circuit of tube C', and the detector output is impressed upon the terminals (not shown) of any well known utilization means already referred to.

The tuned circuits III, IV, are coupled by a link coupling circuit which includes a small inductance coil x coupled, as at M'', to the inductance coil y of the tuned circuit III, and a second inductance coil x', in series with the coil x, coupled, as at M''' to the inductance coil y' of the tuned circuit IV. When adjusted for local reception the two tuned circuits I and II, and the screen grid tube A, form a band pass amplifier stage, and the single tuned circuit V constitutes the detector input circuit.

The tube B is inoperative, but the wires connecting it to the tube circuits III and IV are not removed, as the capacity between grid and filament forms part of the tuning capacity of circuit III, and the capacity between the plate and filament forms part of the tuning capacity of circuit IV. The tube B is preferably rendered inoperative by cutting off the screen and plate voltages, it being particularly noted that the sources for these voltages are not shown, but switches a, a' in each of the leads from the sources are conventionally shown.

The by-pass condensers e, e' from the screen element to the cathode of the tube B, and from the positive plate voltage terminal to the cathode must be left connected. As long as the screen grid element is connected through the by-pass condenser e, to the cathode (and ground) the capacity between the control grid and plate is extremely small. If the screen grid element is entirely disconnected and left "floating" there will be capacity between the control grid and the anode.

This capacity, which acts as a coupling capacity between the two tuned circuits forming a band pass amplifier stage would generally be too large, being of the order of 5 to 10 micromicrofarads, while the largest coupling capacity which I have found suitable for use in connection with inductive coupling to give constant band width between the limits of 550 and 1500 kilocycles, is of the order of 0.5 to 1.0 micromicrofarads.

The combination of two band pass stages with a single tuned detector input circuit, as shown in Fig. 5, has been found to be more desirable than other arrangements using either five or six tuned circuits. The two band pass stages, when adjusted for optimum operation, have a resonance curve which has a pronounced depression at the center when tuned to frequencies around 550 to 800 kilocycles. The detector input circuit is tuned to the center of the resonance curve of the band pass stages, and its peaked resonance curve falls in the depression. The over-all resonance curve is thus made flat without the addition of resistance to the tuned circuits.

When the receiving circuit in Fig. 5 is adjusted for reception of distant stations, the tube B is in operation, and the additional coupling path between the tuned circuits III and IV is cut out by means of a switch 19' similar to the switch 19 in Fig. 1. The two tuned circuits I and II can be converted into two amplifier stages, but it is preferable not to do so; that is to say, it is extremely desirable to retain the band pass characteristics of the circuits I, II ahead of the first tube A. Thus, for distant reception, and with the additional coupling path x, x' cut out of the circuit, tuned circuit III and tube B constitute one tuned radio frequency amplifier stage; tuned circuit IV and tube C' constitute a similar tuned radio frequency stage; and tuned circuit V constitutes the tuned input circuit of the detector stage. With this connection the receiving circuit is 50 to 100 times more sensitive than with the local reception connection; the selectivity is much greater, and the fidelity is reduced to a value which is suitable to distant station reception.

For local reception, the tube B is rendered inoperative by opening the switches a and a' in the screen grid and anode circuits respectively, the additional coupling path being connected in circuit by closing the suitably connected switch 19'. The capacity 20, in Fig. 3, represents the grid-plate capacity of the tube 9. Although this tube is not working as an amplifier, its interelectrode capacities are in the circuit. It is not desirable to completely remove 9 from the circuit, as its grid filament capacity and plate filament capacity form part of the tuning capacity of the input and output circuits, respectively. For this reason 9 should be a screen grid tube, so that 20 will be so small (around .005 micromicrofarads) as not to act as a coupling capacity. This grid-plate capacity of tube B, in Fig. 5, replaces the tube when inoperative.

It may be pointed out that a similar arrangement may be used in connection with the intermediate frequency amplifier of a superheterodyne receiver and the same advantages obtained. While I have indicated and described several systems for carrying my invention into effect, it will be apparent to one skilled in the art that my invention is by no means limited to the particular organizations shown and described, but that many modifications in the circuit arrangements, as well as in the apparatus employed, may be made without departing from the scope of my invention as set forth in the appended claims.

What I claim is:

1. In combination, in a radio receiver, a signal collecting circuit, an electron discharge tube, at least two tunable coupled oscillation circuits connected between said circuit and the input electrodes of said tube, said tunable circuits being adapted to tune the receiver through a frequency range extending at least between 550 to 800 kilo-

cycles, a second tube, at least two tunable oscillation circuits disposed between the output circuit of the first tube and the input electrodes of the second tube, means for coupling said last two tunable circuits, the latter circuits being tunable through said frequency range, a detector stage having a tunable input circuit and including an electron discharge tube having its input electrodes connected to said tunable input circuit, said tunable input circuit being tunable through said frequency range, said two pairs of tunable oscillation circuits having a resonance curve characteristic which has a pronounced depression at the center thereof, when said circuits are tuned through said range, and said detector input circuit having a single peaked resonance curve characteristic whose peak falls in the said depression when said detector input circuit is tuned to the same frequency as said four circuits whereby the over-all resonance curve of the receiver is made flat without the addition of resistance to the said tuned circuits.

2. In combination, in a radio receiver, an electron discharge tube, at least two tunable coupled oscillation circuits connected between the input electrodes of said tube, said tunable circuits being adapted to tune the receiver through a frequency range extending at least between 550 to 800 kilocycles, a second tube, at least two tunable oscillation circuits disposed between the output circuit of the first tube and the input electrodes of the second tube, means for coupling said last two tunable circuits, the latter circuits being tunable through said frequency range, a detector stage having a tunable input circuit and including an electron discharge tube having its input electrodes connected to said tunable input circuit, said tunable input circuit being tunable through said frequency range, the stages including said two pairs of tunable oscillation circuits having a resonance curve characteristic which has a pronounced depression at the center thereof, when said circuits are tuned through said range, and said detector input circuit having a single peaked resonance curve characteristic whose peak falls in the said depression when said detector input circuit is tuned to the same frequency as said four circuits whereby the over-all resonance curve of the receiver is made flat without the addition of resistance to the said tuned circuits.

3. In combination, in a radio receiver, a signal collecting circuit, an electron discharge tube, at least two tunable coupled oscillation circuits connected between said circuit and the input electrodes of said tube, said tunable circuits being adapted to tune the receiver through a frequency range, a second tube, at least two tunable oscillation circuits disposed between the output circuit of the first tube and the input electrodes of the second tube, means for coupling said last two tunable circuits, the latter circuits being tunable through said frequency range, a detector stage having a tunable input circuit and including an electron discharge tube having its input electrodes connected to said tunable input circuit, said tunable input circuit being tunable through said frequency range, the stages including said two pairs of tunable oscillation circuits having a band pass resonance curve characteristic which has a pronounced depression at the center thereof, when said circuits are tuned through said range, and said detector input circuit having a single peaked resonance curve characteristic whose peak falls in the said depression when said detector input circuit is tuned to the same frequency as said four circuits whereby the over-all resonance curve of the receiver is made flat without the addition of resistance to the said tuned circuits.

4. In combination, in a radio receiver, a signal collecting circuit, an electron discharge tube amplifier, at least two tunable coupled oscillation circuits connected between said circuit and the input electrodes of said tube, said tunable circuits being adapted to tune the receiver through a frequency range extending at least between 550 to 800 kilocycles, a second amplifier tube, at least two tunable oscillation circuits disposed between the output circuit of the first tube and the input electrodes of the second tube, means for coupling said last two tunable circuits, the latter circuits being tunable through said frequency range, a detector stage having a tunable input circuit and including an electron discharge tube having its input electrodes connected to said tunable input circuit, said tunable input circuit being tunable through said frequency range, the two amplifiers including said two pairs of tunable oscillation circuits having a band pass resonance curve characteristic which has a depression at the center thereof, when said circuits are tuned through said range, and said detector input circuit having a single peaked resonance curve characteristic whose peak falls in the said depression when said detector input circuit is tuned to the same frequency as said four circuits whereby the over-all resonance curve of the receiver is made flat without the addition of resistance to the said tuned circuits.

5. In combination, in a radio receiver, an electron discharge tube amplifier, at least two tunable coupled oscillation circuits connected between the input electrodes of said tube, said tunable circuits being adapted to tune the receiver through a frequency range, a second amplifier tube, at least two tunable oscillation circuits disposed between the output circuit of the first tube and the input electrodes of the second tube, means for coupling said last two tunable circuits, the latter circuits being tunable through said frequency range, a detector stage having a tunable input circuit and including an electron discharge tube having its input electrodes connected to said tunable input circuit, said tunable input circuit being tunable through said frequency range, the amplifiers including said two pairs of tunable oscillation circuits having a band pass resonance curve characteristic which has a depression at the center thereof, when said circuits are tuned through said range, and said detector input circuit having a single peaked resonance curve characteristic whose peak falls in the said depression when said detector input circuit is tuned to the same frequency as said four circuits.

6. In a carrier current receiver, a source of carrier current, a plurality of vacuum tubes and a plurality of coupling systems for coupling said source and tubes in tandem, one of said coupling systems between a source and one of the tubes being doubly resonant within the transmitting band of frequencies and another of said systems between the one tube and a following tube being singly resonant within said transmitting band, said single resonance being located at a frequency between said double resonances.

7. In a carrier current receiver of a carrier signal and its associated sidebands, a source of carrier signal, a plurality of vacuum tubes and a plurality of coupling systems for coupling said source and tubes in tandem; one of said coupling

systems between the source and one of the tubes being resonant at two frequencies which are approximately the extreme frequencies of the side bands, and another of said coupling systems between the one tube and a following tube being resonant approximately at the frequency of said carrier signal, whereby the over-all response of said receiver is substantially uniform over the sideband range of frequency.

8. The combination in a modulated carrier current receiver, of a source of carrier current, a plurality of vacuum tubes and a plurality of coupling systems for coupling said tubes and source in tandem, a first of said coupling systems being between the source and one of the tubes and comprising a pair of syntonously tuned circuits coupled by a coupling impedance which is sufficiently over-optimum to cause said system to be resonant at two frequencies which are separated sufficiently to cause said system to transmit the band of frequencies between and including said resonances, a second of said coupling systems being between the one tube and a following tube and comprising a transformer having primary and a secondary winding relatively closely coupled, one of said windings being shunted by a condenser which tunes the second coupling system to a frequency between the two resonant frequencies of said first coupling system.

9. In a receiver of a carrier signal and its modulation side bands, a source of such signal energy, at least two tubes following said source, at least two coupling networks for coupling said source and tubes in cascade, one of the coupling systems connecting said source to the input electrodes of one of the tubes and having a resonance curve characteristic which has a pronounced depression at the center, the other coupling network connecting the one tube to the tube following it, and having a peaked resonance curve whose center frequency is located at the center frequency of the first characteristic whereby the over-all response of the receiver is substantially uniform.

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