Aug. 28, 1934. E. F. W. ALEXANDERSON 1,971,762

RADIORECEIVER

Original Filed May 25, 1923 2 Sheets-Sheet 1

Fig. 1

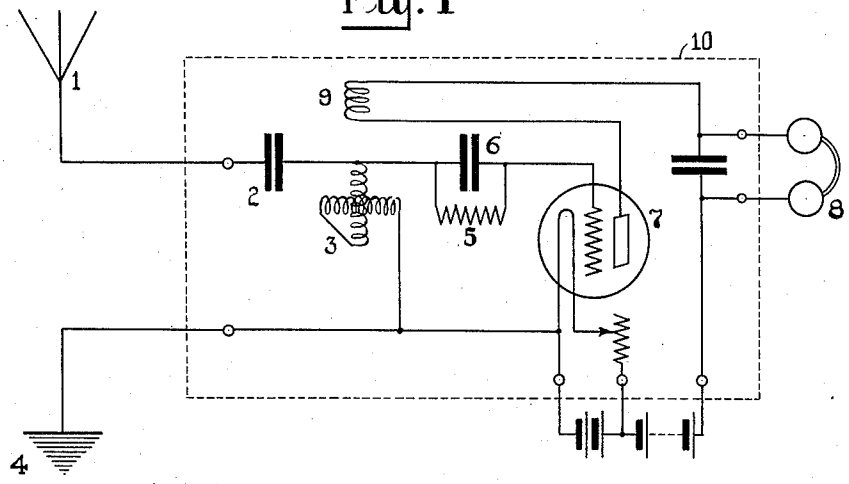


Fig. 2

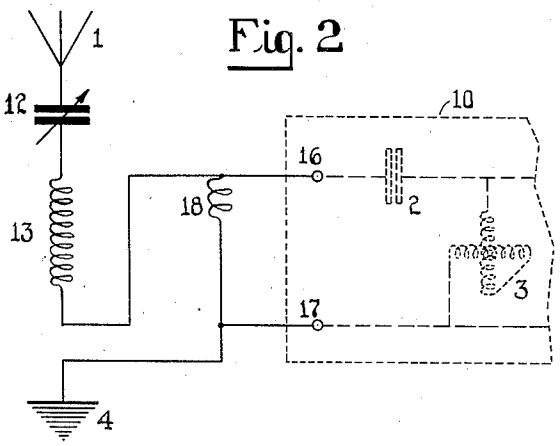
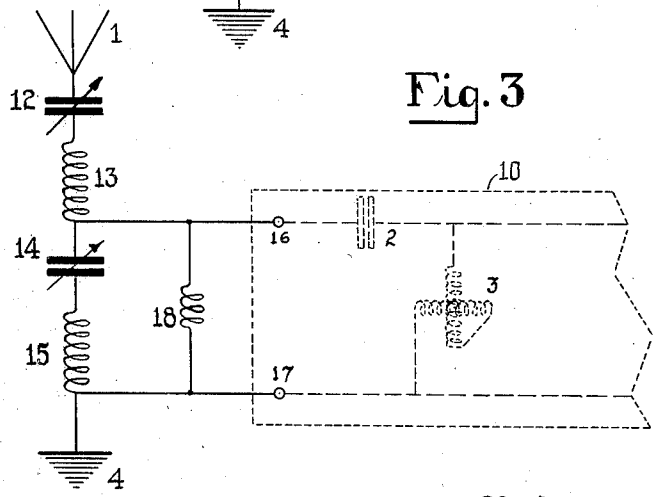


Fig. 3



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Original Filed May 25, 1923 2 Sheets-Sheet 2

Fig. 4

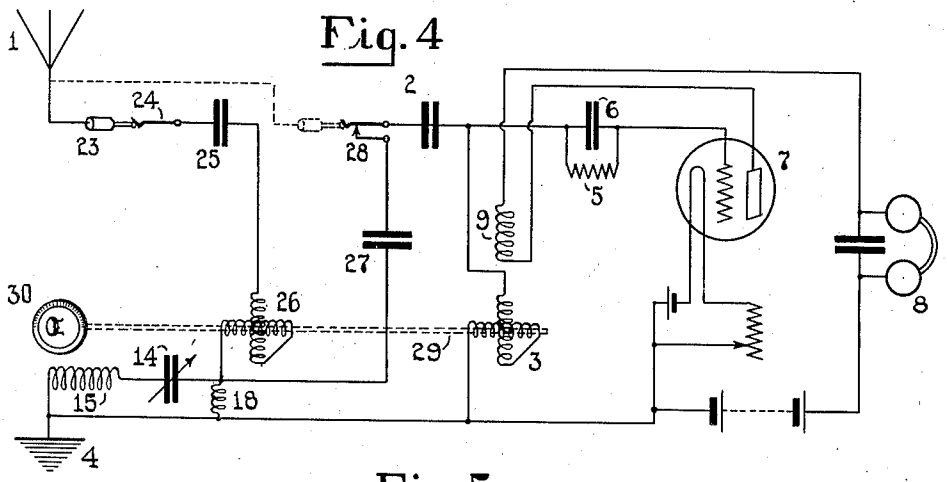


Fig. 5

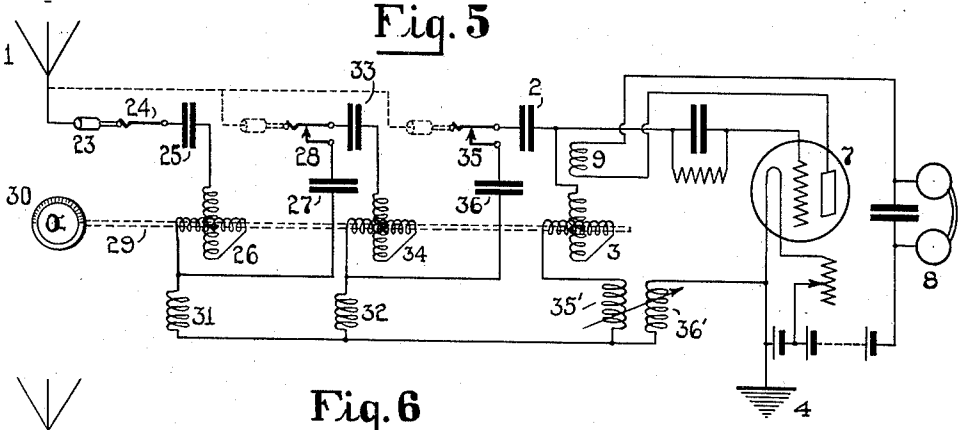
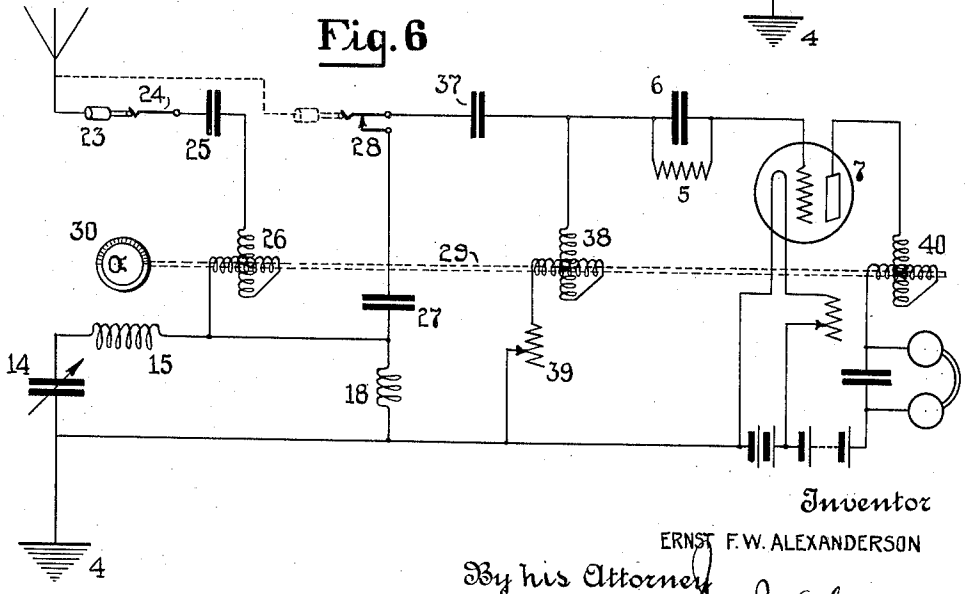


Fig. 6



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Patented Aug. 28, 1934 1,971,762

UNITED STATES PATENT OFFICE

1,971,762

RADIORECEIVER

Ernst F. W. Alexanderson, Schenectady, N. Y., assignor to Radio Corporation of America, a corporation of Delaware

Application May 25, 1923, Serial No. 641,309
Renewed August 11, 1930

16 Claims. (Cl. 250—20)

This invention relates to improvements in radio receiving apparatus, and, more particularly, to so-called broadcast receivers for use where strong interference is experienced, such as in large cities where there are many broadcasting stations operating on adjacent wave lengths. My invention is also particularly adapted to be used in the neighborhood of a broadcast transmitter for the purpose of eliminating reception from said transmitter and receiving signals from transmitters located at a distance therefrom.

Although my invention is particularly adapted for broadcast reception, its usefulness is not confined thereto and the same features which render it desirable for broadcast reception also make it of considerable value in other classes of radio reception, such for instance, as reception on ships.

Many types of receivers have been developed and used for local and long distance reception in the past, but the popular interest in broadcast reception has created a demand for a simple and efficient receiver which is capable of being operated by the novice. To supply this demand many so-called single circuit receivers have been installed and a large number of these receivers have only a single tuning control. While this type of receiver gives satisfactory results in sections remote from broadcast transmitters, it has been found that it is not as selective as could be desired and that when located near a broadcast transmitter it is frequently quite difficult to eliminate signals from such transmitter in order to receive from transmitters located in more remote districts. It has also been found that this type of receiver does not tune as sharply as could be desired in order to distinguish between transmitters located at substantially equal distances from the receiver and transmitting on adjacent wave lengths.

My invention contemplates a receiver which shall be simple to operate and therefore be capable of being operated by the novice in the same manner as the present type of single control receivers and which shall, at the same time, be sharply selective as to the frequency of the signal to be received, thus distinguishing between stations transmitting on adjacent wave lengths and located at distances of substantially the same order of magnitude. It also contemplates a receiver which may be made unresponsive to some particular interfering frequency without affecting the tuning to the desired signal, such a receiver being particularly adapted to be used in the neighborhood of a broadcast transmitter.

One object of my invention is to provide a receiver having what may be termed "acceptor" and "rejector" adjustments independent of each other; the one for selecting the signal desired and the other for eliminating the undesired signal.

It is another object of my invention to provide an attachment which may be connected to existing receivers by the novice without changing the receiver connections, for the purpose of realizing the aforesaid objects.

It is a still further object of my invention to provide the equivalent of a double or triple circuit receiver which may, nevertheless, be tuned in the same manner as the single circuit receiver by means of a single tuning control.

It is a further object of my invention to provide such a receiver which may be used by the novice as a single, double or triple circuit tuner as desired, and without the necessity of changing any of the connections in said receiver.

It is a further object of my invention to provide such a receiver having a single tuning means for controlling all of the circuits used for "acceptor" adjustment and an independent means for controlling the "rejector" adjustment without interfering with the "acceptor" adjustment. Still other objects of my invention will be apparent from the specification.

My invention will best be understood by reference to the specification and attached drawings describing and showing ways of carrying it out, but its scope will be particularly pointed out in the accompanying claims. I wish it to be understood, however, that my invention is not limited to the precise form or forms shown and described, but that modifications and changes may be made without departing from the spirit of my invention, as will be readily understood by those skilled in the art.

In the drawings,

Fig. 1 shows a common form of single circuit receiver to which my invention may be applied;

Fig. 2 shows one form of my invention attached to such a receiver;

Fig. 3 shows a modification thereof;

Fig. 4 shows a double circuit receiver provided with "acceptor" and "rejector" tuning;

Fig. 5 shows a triple circuit receiver having "acceptor" tuning and a different form of "rejector";

Fig. 6 shows a different form of regenerative receiver according to my invention.

Referring to Fig. 1 which forms no part of my invention, but which should be understood in order that certain advantages of my invention

may be appreciated, 1 represents an antenna which is connected to the antenna terminal of the receiver designated as a whole as 10. From the antenna terminal a conductor leads to one side of condenser 2 and from the other side thereof to one side of variometer 3, the other terminal of which is connected to the ground lead of the set which is connected to ground at 4. From the common point of variometer 3 and condenser 2 a conductor extends to grid condenser 6 shunted by grid leak 5 and thence to the grid of the three-electrode vacuum tube 7. The plate circuit of said tube includes the so-called "tickler" or "feed-back" coil 9 and a suitable indicator such as telephone receivers 8 and the usual A and B batteries.

The operation of this type of receiver is well understood and will not be described in detail. It is sufficient for the purpose of this invention to say that tuning is carried out by means of variometer 3 and regeneration is controlled by adjustment of the tickler coil 9. In order to bring in any desired signal, the variometer is rotated until the signal is at maximum intensity. Under such conditions, the circuit comprising antenna 1 and condenser 2, variometer 3 and ground 4 is in series resonance with the incoming signal and the circuit is of substantially zero impedance. The effective resistance of the antenna and receiver may also be made substantially zero by adjusting the tickler coil to provide for regeneration which is almost, but not quite sufficient to cause the tube to oscillate. Under such conditions, the grid circuit is tightly coupled to the receiving circuit and interfering signals, particularly those of a frequency close to those desired, are apt to be heard since under such conditions the receiver circuit is almost at the point of series resonance and the impedance is therefore very low to the interfering signal as well as to the desired signal frequency.

In general there are two known methods of securing increased selectivity; one, by means of increasing the number of tuning circuits and the other by the use of loose coupling between tuning circuits. It has been found, however, that a receiver involving more than two "acceptor" tuning circuits cannot be successfully operated by the novice nor could he, prior to my invention, successfully convert a single circuit receiver into a double or triple circuit receiver, since it was thought necessary in such cases to alter the connections of the receiver.

I have found that by the use of my invention it is possible to materially improve the selectivity of existing receivers without in any way disturbing the internal connections of the same and without destroying the simplicity of operation. By this method I increase the number of tuning circuits from one to two and also provide loose coupling between such circuits as to interfering frequencies and I may at the same time provide a rejector or by-pass for a particular interfering frequency if such is desired.

This form of my invention is shown in Fig. 2, wherein 10 designates a receiver such as shown in Fig. 1 provided with tuning means comprising condenser 2 and variometer 3. According to my invention, I connect aerial 1 to variable condenser 12, the other side of which is connected to loading coil 13 from which a connection is made to the antenna terminal 16 of the receiver. The ground terminal 17 of the receiver is connected to ground at 4 in the usual manner and I provide a coil 18 shunted across the antenna and ground terminals of the receiver. This coil 18 is preferably of low resistance and low impedance and may, for example, consist of 8 to 10 turns of low resistance wire, such as ordinary bell wire.

It will be evident that this arrangement provides two elements which may be tuned to the signal desired: the antenna circuit comprising condenser 12 and loading coil 13, and the receiver circuit comprising condenser 2, variometer 3 and ground 4. It will also be evident that coil 18 forms the coupling between these two circuits and inasmuch as the inductance of coil 18 is relatively small as compared with the inductance of coil 13 and that in the receiver 10, the coupling between the circuits will be relatively loose.

In operation, the entire circuit will be tuned to provide a zero impedance path to the particular signal frequency desired by adjusting condenser 12 and variometer 3 or in any other suitable manner to obtain the maximum signal. It may be pointed out that this may be obtained under a number of conditions. For instance, the antenna circuit per se including antenna 1, condenser 12 and loading coil 13 may be put in series resonance with the desired signal and the receiver circuit per se comprising condenser 2 and variometer 3 may also be put in series resonance with the same signal frequency. If this is done, a zero impedance path will be provided including antenna 1, condenser 12, loading coil 13, condenser 2, variometer 3 to ground 4. Inasmuch as the resistance of this circuit may be made substantially zero by suitable control of regeneration, practically all of the current of the desired frequency will follow the circuit pointed out, none of it being shunted through coil 18. However, currents of other frequencies will divide through coil 18 and through the receiver in proportion to the impedance of these circuits and as the impedance of the coil 18 is made relatively small, currents of any substantially different frequency from that to which the receiver is tuned will, to a considerable extent, be by-passed through coil 18.

While this form of my invention does not provide for rejecting a particular frequency specifically yet it loosens the coupling between the antenna circuit and the receiver for interfering frequencies in such a manner that the "acceptor" tuning of the receiver and the antenna will ordinarily be sufficient to eliminate interference.

However, in case a "rejector" adjustment is desired, I may shunt coil 18 by a circuit adapted to by-pass a particular frequency as shown by way of example in Fig. 3. This modification is substantially identical with that shown in Fig. 2 with the exception that condenser 14 and loading coil 15 are shown connected in parallel to coil 18. The constants of this coil and condenser will be chosen so that the shunt path around coil 18 may be put in series resonance for the particular interfering frequency which it is desired to eliminate.

It may be pointed out at this time that when the antenna circuit comprising condenser 12, loading coil 13, shunt coil 18 and ground 4 and the receiver circuit comprising condenser 2 and variometer 3 have each been series tuned for the desired signal frequency, condenser 14 and inductance 15 may be then adjusted to provide a series tuned by-pass to a particular interfering frequency without interfering in any way with the previous tuning.

It may be pointed out also that coil 18 has

another function, which will now be explained. It will be seen that it is possible to tune the circuit comprising antenna 1, condenser 12, loading coil 13, condenser 2, variometer 3 and ground 4 to series resonance with the incoming signal without at the same time having condenser 12 and coil 13 in series resonance with the signal and condenser 2 and variometer 3 in series resonance with the signal. This condition will be realized, for example, when condenser 12, and coil 13 have a capacitive reactance and condenser 2 and variometer 3 have an equal inductive reactance. Under this condition or in fact under any similar condition, when the reactance of condenser 2 and variometer 3 is unequal to zero a change in the tuning of the by-pass circuit, (condenser 14 and coil 15) would seriously affect the tuning of the receiver system, if coil 13 were not provided. However, the inclusion of this coil renders the system stable, so to speak; that is regardless of whether each component part of the receiving circuit is in itself in series resonance with the desired signal, tuning the "rejector" circuit will not affect the receiver circuit tuning except for a frequency for which the resultant reactance of the "rejector" circuit is substantially equal to that of coil 13.

Referring to Fig. 4, I have shown a receiver adapted to be operated as a single or double circuit receiver as desired, but in either case with a single "acceptor" tuning. Antenna 1 is connected to plug 23 adapted to be inserted in jack 24 or jack 28. The contact sleeve of jack 24 is connected to one side of condenser 25, the other side of which is connected to variometer 26 which in turn is connected to one side of variable condenser 14, and thence to coil 15 and to ground at 4. Coil 13 is provided in shunt to condenser 14 and coil 15 as before. The contact sleeve of jack 28 is arranged to be connected to condenser 27 only when the plug 23 is not inserted therein, and the other side of condenser 27 is connected to the common point of condenser 14 and variometer 26. The contact sleeve of jack 28 is also permanently connected to condenser 2, the other side of which is connected to the variometer 3 and thence to ground at 4. The grid circuit is connected across variometer 3. The usual form of tickler coil 9 is provided for the purpose of controlling regeneration and a single shaft 29 is provided for operating variometers 3 and 26. This shaft may be provided with any suitable manual operating means such for instance as knob 30. It should be noted here that variometers 3 and 26 are constructed as far as possible to have identical characteristics. The condensers 25, 27 and 2 and the mechanical coupling between variometers 3 and 26 are selected to be of such value that the primary and secondary tuned circuits will be in tune with each other for any position of the shaft 29. In operation the plug 23 will be inserted in jack 28 and knob 30 will be rotated to tune the receiver. It will be seen that with the plug 23 inserted in jack 28 the receiver is operating as an ordinary single circuit receiver since the connection between the sleeve 28 and condenser 27 is now open. If strong interference is being experienced the plug will be removed from jack 28 and inserted in 24 and it may then be necessary to make a slight readjustment of the tuning. This will ordinarily be sufficient to eliminate any except the strongest interference. If condenser 14 is now readjusted as explained with reference to Fig. 2 the by-pass circuit may be series tuned for the particular interfering frequency which is being experienced and this may be eliminated.

Referring to Fig. 5, I have shown a similar receiver with three tuning circuits but having a different type of rejector. The tuning of the primary circuit is controlled by condenser 25, variometer 26, that of the secondary circuit by the condensers 27 and 33 and variometer 34 and that of the tertiary by condensers 36 and 2 and variometer 3. The plug 23 may be inserted in any one of jacks 24, 28 or 35 according to whether a three, two or single circuit tuner is desired. The coupling between the circuits is in this case untuned and is provided by low impedance coils 31 and 32 which are similar to coil 13 shown in Fig. 3. The "rejector" control is by means of coils 35' and 36', one of which may be arranged to rotate with respect to the other for the purpose of varying the coupling therebetween. It will be noted that coil 36' is directly in the antenna circuit and contains a high ratio of interference to signal, whereas coil 35' is directly in the grid circuit and contains a high ratio of signal to interference and, therefore, it is possible by rotating one of these coils with respect to the other to find some point at which the interfering signal may be neutralized without affecting the desired signal.

Turning to Fig. 6, I have shown my invention as applied to the so-called two variometer regenerative receiver. It is to be noted that in this type of receiver the control of regeneration is not by means of a coil feeding back from the output to the input of the detector, but is obtained by tuning the grid and plate circuits to the frequency of the signals. The closer the tuning of each of these circuits to each other and to the desired signal the stronger will be the regeneration. In order to provide for a single control means in this type of receiver, it is necessary to construct variometers 26, 38 and 40 as before so that for any position of the knob 30 the primary, grid and plate circuits will be closely in tune with each other. This, however, would tend to throw the tube into oscillation and I therefore provide adjustable resistance 39 which may conveniently be a stabilizer or damping control, for example similar to an ordinary filament rheostat for the purpose of controlling the amount of regeneration and for preventing oscillation.

It may be noted in this connection that in order to provide that the receiver shall not need to be readjusted when the antenna plug 23 is removed from one jack and inserted in another, condensers 2 and 27 in Fig. 4, 33 and 27 and 36 in Fig. 5 and 37 and 27 in Fig. 6 should be selected to be of one-half the capacity of the average antenna and condenser 25 will be selected with reference to the particular antenna to be used. Under these conditions only a slight readjustment will be necessary in transferring the antenna plug from the secondary or tertiary circuit to the primary circuit.

It will be seen that I have provided means whereby existing single circuit receivers may be made more selective without rendering them unnecessarily complicated in adjustment and that I have also provided a receiver which is adapted to be controlled by a single "acceptor" control and which, however, at the same time, may utilize one, two or three circuits, as desired.

Having described my invention, what I claim is:

1. In radio receiving apparatus, the combination of a plurality of circuits coupled together in cascade, and each comprising elements by which it is in itself tuned to a desired signal frequency,

an antenna, switching means associated therewith and with each circuit for permitting connection of said antenna to any one of said circuits, and a single means for simultaneously varying the tuning of each of said circuits by the same amount.

2. In radio receiving apparatus, the combination of a plurality of circuits coupled together in cascade, and each comprising elements by which it is in itself tuned to a desired signal frequency, an antenna, switching means associated therewith and with each of said circuits for permitting the connection of said antenna to any of said circuits, and means for diminishing the response of said apparatus to signals of undesired frequency independently of the tuning of said circuits.

3. In radio receiving apparatus, the combination of a plurality of circuits coupled together in cascade, and each comprising elements by which it is in itself tuned to a desired signal frequency, an antenna, switching means associated therewith and with the plurality of said circuits for permitting said antenna to be connected to any one of said circuits, and for disconnecting the circuits preceding that to which the antenna is attached, a single means for simultaneously varying the tuning of said circuits by the same amount, and means for diminishing the effective flow of interfering signal current in the last of said circuits, independently of the tuning of said circuits.

4. In radio receiving apparatus the combination of an antenna, a plurality of uni-controlled, tunable circuits in cascade, means for loosely coupling said antenna to said circuits and a circuit in shunt with said coupling means including tuning elements whereby it may be tuned independently of the tuning of said cascade connected circuits to exclude undesirable frequencies therefrom without disturbance of the tuning of the uni-controlled circuits.

5. In radio receiving apparatus the combination of an antenna circuit, a plurality of circuits in cascade, tuning means in each circuit and common operating means for tuning all of said circuits simultaneously, means for loosely coupling the antenna circuit to said circuits and a circuit in shunt with said coupling means including tuning means for by-passing undesirable frequencies without interfering with the established tuning of said uni-controlled circuits.

6. In radio receiving apparatus the combination of an antenna circuit, a plurality of circuits connected to said antenna circuit in cascade, additional coupling means for loosely coupling said antenna circuit to the remaining circuits, a circuit in shunt with said loose coupling means including tuning devices for by-passing undesirable frequencies from said circuits and uni-control tuning means for said cascade connected circuits for simultaneously tuning each circuit to any desired frequency, the tuning of said by-pass circuits not affecting the tuning of said uni-controlled circuits.

7. In a radio receiving apparatus, an antenna circuit containing variable tuning elements, a regenerative receiver apparatus connected in sequence therewith, a plurality of circuits for connecting the said receiver to said antenna in cascade, means for simultaneously tuning each of said connecting circuits to the same desired signal frequencies, said tuning means comprising a plurality of variometers each operated from the same control, and tunable rejector means connected between the antenna and receiver for diminishing the response of said receiving apparatus to signals of undesired frequencies, said rejector means operating independently of the tuning of said circuits.

8. In a radio receiving system, a tunable antenna circuit, a plurality of uni-controlled tunable receiving circuits connected in cascade and connected to said antenna circuit, an additional coupling, of high impedance to energy of a desired frequency, between said antenna and receiving circuits in shunt with said receiving circuit, said coupling impedance being so proportioned relative to the impedance of said antenna and receiving circuits that energy of undesired frequencies is by-passed from said receiving circuit when both said circuits are resonant to said desired frequency.

9. In a radio receiving system, a tunable antenna circuit, a uni-controlled tunable receiving circuit connected in sequence therewith, an additional coupling for said circuits in shunt with said receiving circuit, said coupling having an impedance so proportioned relative to the impedance of the antenna and receiving circuits that energy of undesired frequencies is by-passed from said receiving circuit when both said circuits are resonant to a desired frequency, and a tunable circuit in shunt with said coupling adapted to be tuned to a particular undesired frequency without affecting the tuning of said uni-controlled receiving circuit.

10. In a radio receiving system, a tunable antenna circuit, a tunable receiving circuit, a series of circuits interposed between said antenna circuit and said receiving circuit and each provided with means whereby it may be placed in resonance with a desired frequency, a uni-control means associated with the tuning means in each of said circuits whereby all of said circuits may be tuned simultaneously to said desired frequency, switching means associated with said antenna circuit and with said interposed circuits for permiting said antenna to be connected to any one of said circuits and for disconnecting the circuits preceding that to which the antenna is attached, and tunable means in said antenna circuit for by-passing a particular undesired frequency from said receiving circuit, said last mentioned tuning means adapted to be actuated without disturbance of said uni-control means.

11. In combination, a plurality of coupled tunable resonant circuits, uni-control means for simultaneously tuning said circuits to a desired frequency, additional coupling means of high impedance to undesired frequencies between said circuits, and a tunable circuit connected to the last means for discriminating against a particular undesired frequency.

12. In combination, an antenna circuit, a regenerative receiver having a tuned input circuit, one or more tunable, resonant circuits between the antenna circuit and tuned input circuit, means for selectively coupling the antenna circuit to said resonant circuits or the tuned input circuit, additional loose coupling means between the antenna circuit and the circuit to which the latter is connected, and uni-control tuning means for the resonant and input circuits.

13. In radio receiving apparatus, an antenna circuit, an electron discharge tube amplifier, a signal selector network comprising a pair of circuits coupled together, and disposed between said antenna circuit and the input circuit of said amplifier, and each comprising elements by

which it is in itself tuned to a desired signal frequency, and an independent coupling reactance common to both selector network circuits and having a magnitude which is relatively small as compared with the reactance of like sign in said coupled selector circuits, a single control means for simultaneously varying the tuning of each of said pair of tunable circuits by the same amount, and means electrically connected to said network for controlling the effective resistance thereof.

14. Means for selectively receiving signals comprising an antenna circuit, a selecting system coupled to said antenna circuit and comprising two reactive couples and an untuned reactance common to both couples, said untuned reactance consisting of a coil of low resistance and low impedance, uni-control means for adjusting one of the components of each of the reactive couples, said coil having an inductance value which is relatively small as compared with the values of the inductances of said reactive couples, an electron discharge tube amplifier, and means for impressing between the tube input electrodes differences of potential produced by the flow of current through one of the components of the last reactive couple.

15. In combination, an antenna circuit, an electron discharge tube amplifier, a resonant circuit connected to the input electrodes of said tube, said resonant circuit including means for tuning the circuit to a desired signal frequency and an additional resonant circuit, including means for tuning it to the same desired signal frequency, between said antenna circuit and said first mentioned resonant circuit, an untuned reactance common to both said resonant circuits and coupling them and means for simultaneously adjusting the tuning means in each of said resonant circuits, the untuned reactance consisting of a coil which has a low resitance and an inductance which is relatively small as compared with the inductances of the coupled resonant circuits.

16. Means for selectively receiving signals comprising an antenna circuit, a selecting system coupled to said antenna circuit and comprising two reactive couples and an untuned reactance common to both couples, said untuned reactance consisting of a coil of low resistance and low impedance, uni-control means for adjusting one of the components of each of the reactive couples, an electron discharge amplifier, means for impressing between the tube input electrodes differences of potential produced by the flow of current through one of the components of the last of said reactive couples, means for introducing regenerative effects into said selecting system, and a variable resistor electrically associated with said last means for controlling the degree of said effects.

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