

Oct. 31, 1933.

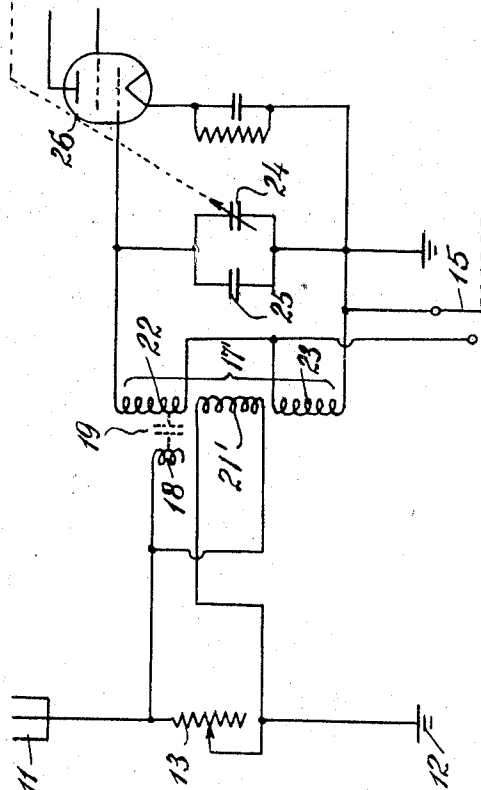
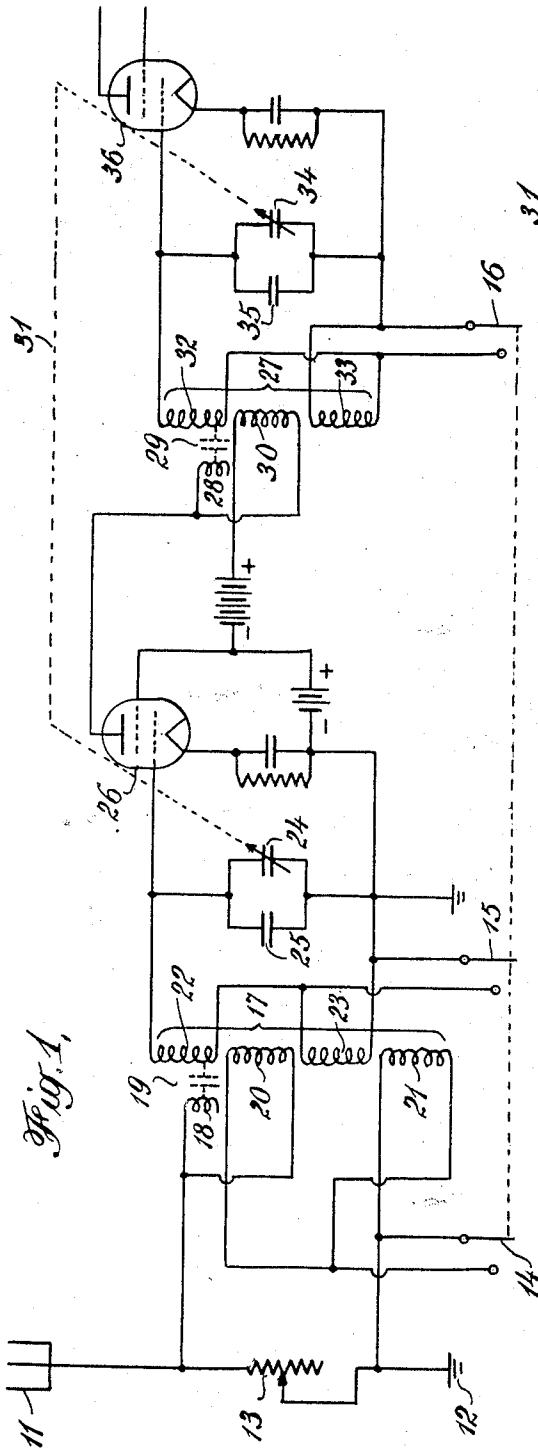
H. A. WHEELER

1,933,402

DOUBLE BAND RECEIVER

Filed July 16, 1931

3 Sheets-Sheet 1



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Fig. 5.

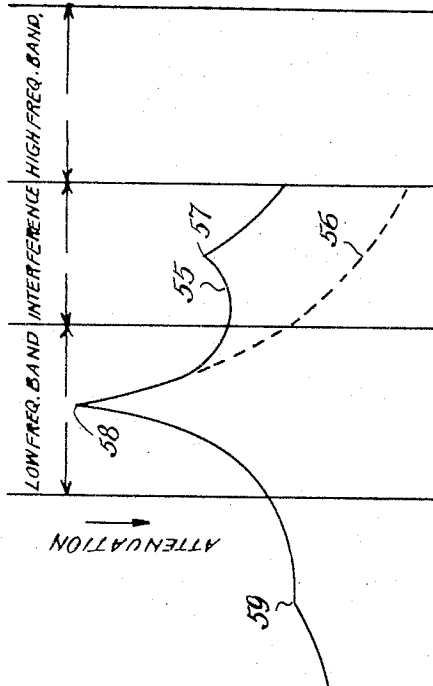


Fig. 6.

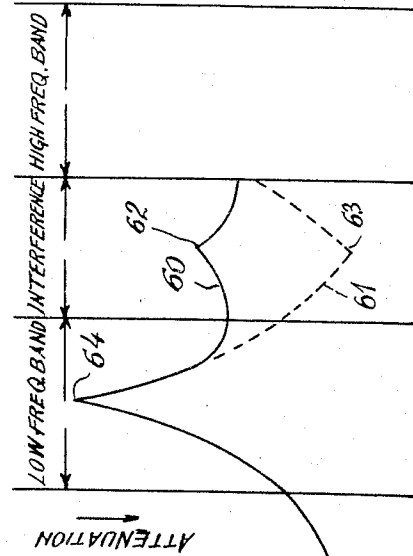


Fig. 3.

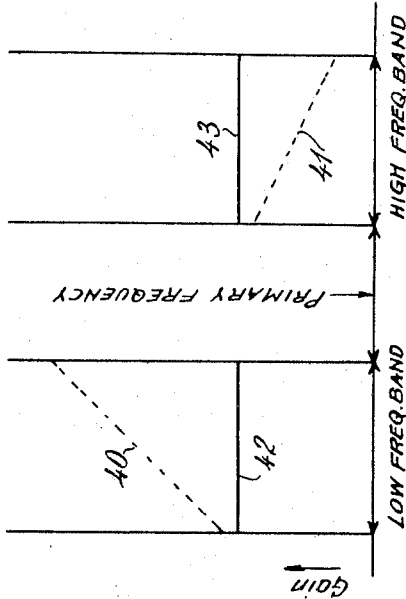
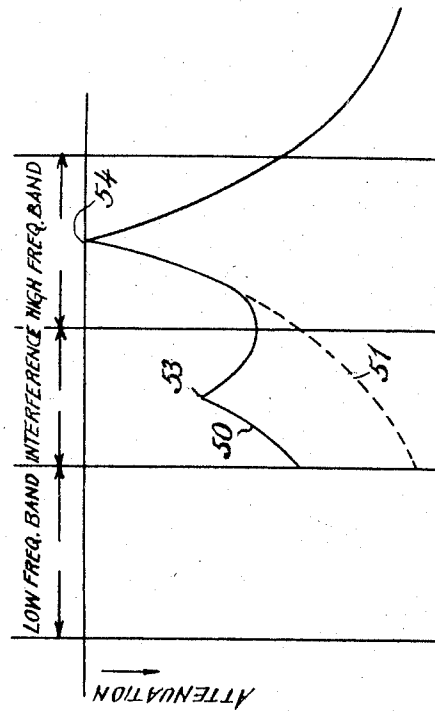


Fig. 4.



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3 Sheets-Sheet 3

Fig. 7,

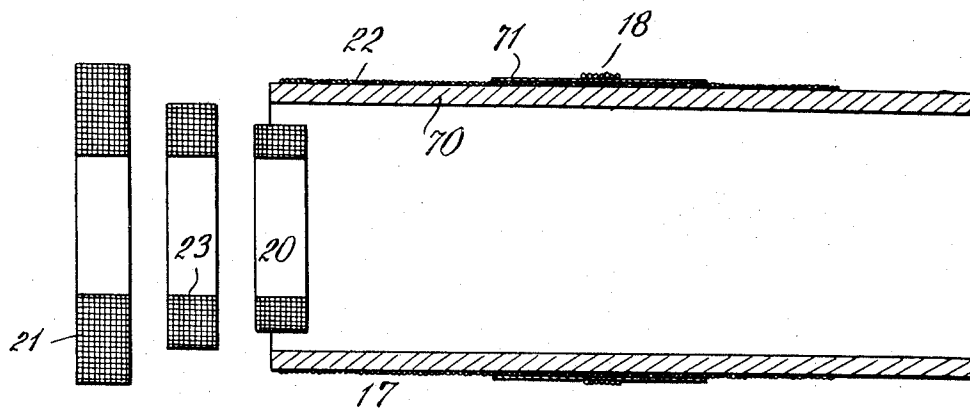


Fig. 8,

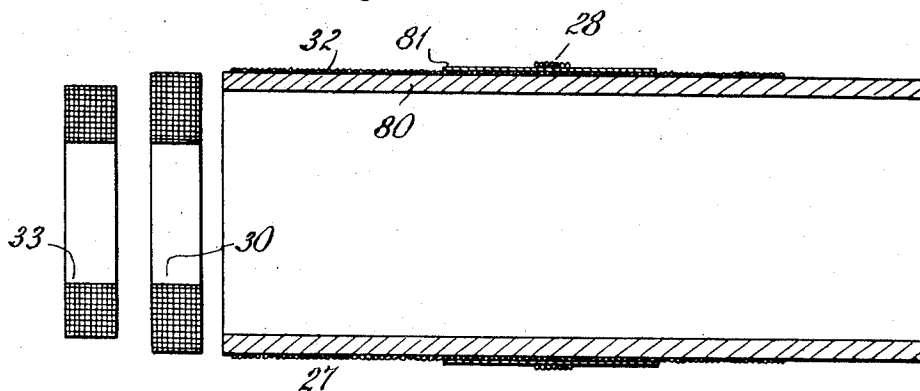
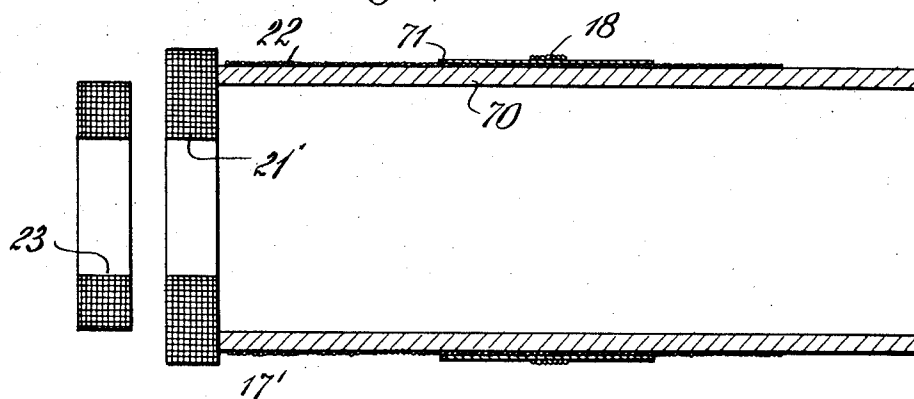


Fig. 9,



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DOUBLE BAND RECEIVER

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Application July 16, 1931. Serial No. 551,175

26 Claims. (Cl. 178—44)

The present invention relates to a radio broadcast receiver of the type adapted to receive signals covering two or more frequency bands.

In the past considerable difficulty has been experienced in producing a radio broadcast receiver which will efficiently receive and reproduce signals covering a plurality of frequency bands. In designing a receiver for double band reception, it is a customary practice to provide a plurality of transformer coils which may be plugged in as required to cover the various frequency bands. The plug-in coil type of receiver is expensive to manufacture and involves a considerable disadvantage in changing the coils.

Various attempts have been made to produce a receiver in which switching means are provided to connect and disconnect the appropriate transformer coils needed to cover the various bands. These latter mentioned devices involve considerable loss of efficiency. This type of receiver is also expensive to manufacture.

Both of these types of double band receiver have the additional disadvantage that the signals are not received with uniform intensity throughout the entire range of their various bands.

It is the object of the present invention to produce a radio receiver which will efficiently cover several broadcast bands and which shall obviate each of the above noted difficulties.

A further object of this invention is to produce a radio receiver in which the signals in the various frequency bands will be received with practically uniform gain, and to produce a receiver in which little interference will be experienced from signals lying outside the frequency bands.

These and further objects of this invention will become apparent from the following description when considered in connection with the drawings.

In accomplishing the objects of the present invention, there is provided between each of the amplifying tubes included in the radio frequency portion of the receiver a special interstage coupling comprising a transformer including a pair of secondary windings and a single primary winding. The coupling of the primary winding to the secondary windings is so arranged that, when the receiver is being operated over the low frequency band with both secondaries in use, the voltages induced in the two secondaries will be opposite. However, the voltage induced across the high frequency secondary at the low frequencies is very much less than that induced across the low frequency secondary and so may be neglected.

A switch is provided to short-circuit the low frequency secondary when it is desired to use the coupling to transmit signals in the high frequency band.

The primary winding is so proportioned that it, together with the capacity associated therewith, is resonant to a frequency between the bands which it is desired to receive.

A special open end winding is connected to the primary and is closely associated with the high frequency secondary winding to give a capacitive coupling effect to assist in maintaining the gain of the coupling system uniform throughout the frequency range.

The antenna coupling system may include a second primary winding which is tuned to a frequency below the lowest of the frequency bands, in addition to the single primary tuned to the frequency between the frequency bands. The voltages induced in the secondary winding in this transformer are in phase, however. A switch operated simultaneously with the switch which short-circuits the low frequency secondary winding of the interstage coupling and the low frequency secondary of the antenna coupling, also short-circuits the last mentioned primary winding when it is desired to operate the receiver in the high frequency band.

An alternative form of antenna coupling system may be provided in which the primary circuit includes a single winding, which, together with the capacity associated therewith, is resonant to a frequency below the low frequency band.

Having thus briefly described the invention, attention is invited to the accompanying drawings in which:

Fig. 1 shows the tuned radio frequency portion of a radio receiver constructed in accordance with this invention;

Fig. 2 shows a modification of the antenna coupling system shown in Fig. 1;

Fig. 3 is a diagram giving the approximate gain characteristics of the radio receiver of Fig. 1, covering the two frequency bands which it is adapted to receive;

Figs. 4, 5 and 6 are diagrams showing the approximate attenuation characteristics of a receiver constructed in accordance with the present invention, relative to signals of frequencies above and below that for which the receiver is adjusted to respond;

Fig. 7 is a diagram showing an arrangement of the windings of antenna coupling transformer 17 of Fig. 1;

Fig. 8 is a diagram of the arrangement of the

windings of interstage coupling transformer 27 of Fig. 1; and

Fig. 9 is a diagram of the modified antenna coupling transformer 17' of Fig. 2.

5 In Fig. 1, which shows the tuned radio frequency portion of a receiver designed to selectively receive signals within two frequency bands, the antenna circuit, when the receiver is set to operate over the low frequency band, includes antenna 11 and ground 12 and primary coils 20 and 21 shunted by the variable volume control resistor 13. Also included in the primary circuit at the high potential end of the primary 20 is an open end coil 18 which is capacitively related to the high frequency secondary winding 22 of the transformer 17, as indicated at 19. The secondary circuit includes a low frequency secondary 23 in addition to the secondary 22. The circuit including both secondaries is tuned by the variable condenser 24 which is shunted by the adjustable padding condenser 25 for aligning the circuit to permit uni-control tuning.

Both of the primary windings 20 and 21 are connected in the same direction and the secondary windings 22 and 23 are connected in the opposite direction. The capacity coupling 19 assists the electromagnetic coupling between the primary and secondary, and its effect increases with frequency through both frequency bands.

30 A switch 14 is adapted to short-circuit the low frequency primary winding 21 and a switch 15, arranged to be controlled simultaneously therewith, is adapted to short-circuit the low frequency secondary winding 23.

35 The secondary circuit is connected to the input of the amplifier tube 26, which is shown as a screen grid tube although any appropriate amplifying device may be used in place of that shown. The tube 26 is provided with the usual cathode heating current and screen grid and plate potentials from any appropriate sources.

The winding 20 is so proportioned that when the switch 14 is closed the primary circuit is resonant to a frequency between the bands which the receiver is adapted to receive. The winding 21 is so proportioned that, with the switch 14 open, the entire primary circuit is resonant to a frequency below the lowest of the two frequency bands.

50 The amplifier tube 26 is coupled to the tube 36 by means of the interstage coupling transformer 27 which will now be described.

The output circuit of the amplifier tube 26 includes the primary 30 of the transformer 27 and the high potential source. The primary 30 is inductively related to the secondary windings 32 and 33, the latter of which is adapted to be short-circuited by the switch 16, operated simultaneously with the switches 14 and 15. Also connected to the output of the tube 26 is the winding 28 capacitively related to the high frequency secondary winding 32, as indicated at 29. The secondary windings are tuned by means of the variable condenser 34, which is mechanically linked to the condenser 24. In shunt with the condenser 34 is an adjustable padding condenser 35 for aligning purposes.

The short wave secondary winding 32 is connected in one direction, and the primary winding 30 and the long wave secondary winding 33 are connected in the opposite direction. Therefore, the voltages induced across windings 32 and 33 are opposite when the switch 16 is open. However, in the low frequency band the voltage in coil 32 is relatively small so that it can be neg-

lected. The capacity 29 gives a capacitive coupling voltage between the primary and secondary which assists the electromagnetic coupling between the coils 30 and 32 in the high frequency band when the switch 16 is closed, and opposes the magnetic coupling between primary winding 30 and secondary winding 33 when switch 16 is open. The secondary circuit is connected to the input of the amplifier tube 36. The output of the amplifier tube 36 may be connected to the succeeding amplifier tubes or to a detector as desired, through couplings similar to transformer 27.

Fig. 2 shows an antenna coupling transformer similar to the transformer 17. In this figure the antenna circuit comprises the antenna 11 and ground 12 connected through the primary 21' of transformer 17'. A volume control variable resistor 13 is shunted across the primary winding 21'. The primary winding is so proportioned that it, together with its associated circuit, is resonant to a frequency below the lowest band which the receiver is designed to receive. An open-end winding 18 is provided, connected to the antenna and capacitively related to the secondary 22 of the transformer 17', as indicated at 19. The secondary winding 23 of the secondary of transformer 17' is adapted to be short-circuited by means of switch 15 which may be operated in a uni-control fashion with the remaining switches in short-circuiting the low frequency windings of the interstage transformers. Secondary windings 22 and 23 are in this instance arranged so that their voltages are additive. The winding 21' is connected opposite to windings 22 and 23.

The secondary circuit is tuned by the condenser 24, which is adapted to be operated in a uni-control manner by means of the linkage 31 as in the receiver shown in Fig. 1. The condenser 24 is shunted by an adjustable padding condenser 25 for alignment purposes. The secondary circuit is connected to the amplifier tube 26, the output of which is connected by means of coupling transformers of the type shown in Fig. 1 to the succeeding radio frequency amplifier tubes.

The operation of transformer 27 is best understood by reference to Fig. 3, to which attention is now invited.

Neglecting the capacity coupling 29, the gain characteristics of the coupling system, including the transformer 27, are as shown in dotted lines 40 and 41. As has been stated, the primary circuit, including the primary 30, is resonant to a frequency between the frequency bands. Therefore, whereas the magnetic coupling effect increases with frequency in the low frequency band as shown at 40, the primary circuit is capacitively reactive to frequencies in the high frequency band and therefore the magnetic coupling effect decreases with frequency in the high frequency band as shown at 41.

It is to be noted that the gain of this coupling circuit for the low frequency band tends to be greater than for the high frequency band, due to the fact that the same tuning condenser 34 is used for tuning over both bands and therefore the impedance of the tuned circuit is greater for the low frequency band, resulting in a higher gain.

The capacity coupling 29 increases with frequency through the high frequency band, and is in aiding phase relative to the winding of the secondary 32. This causes the overall gain of

the coupling system to be substantially uniform throughout the high frequency band, as indicated by curve 43. The electromagnetic coupling between primary 30 and secondary 33 is out of phase with that between primary 30 and secondary 32, so that with the switch 16 open and the receiver operating over the low frequency band, the magnetic coupling between the primary 30 and the low frequency secondary winding 33 predominates and is opposed by the electrostatic coupling 29. The latter, increasing with frequency, causes the overall gain of the coupling circuit to be substantially uniform throughout the band as indicated by the curve 42. Therefore, it can be seen that with the interstage coupling system constituting part of the present invention, a substantially uniform gain is attained throughout both of the frequency bands.

Whereas the radio broadcast programs may exist in two distinct frequency bands, considerable transmission in the nature of commercial traffic may exist between the two broadcast bands. This interference is often at high power, and it is a special object of the present invention to prevent the reception of signals over the intervening or interference band. It is to be noted also that, whereas the primary circuit of the interstage coupling system constituting part of the present invention may be tuned to some point in the interference or intermediate band, the antenna coupling system as shown in Fig. 2 is adapted to attenuate the signals within this band, and the capacitive coupling provided in the interstage coupling system is arranged to oppose the magnetic coupling at the interfering frequencies and prevent the reception of undesired signals. These features are illustrated more specifically in Figs. 4, 5 and 6, to which attention is now invited.

In Fig. 4 the curve 50 represents the attenuation characteristics of the antenna coupling circuit of Fig. 1 with the system tuned to some point giving a peak at 54 in the high frequency band. By this curve, which is the one obtained by the antenna coupling circuit with the primary winding 20 tuned to a frequency intermediate the frequency bands, there is a peak 53 in the interference band. The dotted curve 51 is that given by the antenna coupling of Fig. 2 with the primary 20 eliminated.

With particular reference to Fig. 5, the curve 55 represents the attenuation characteristics of the antenna coupling system of Fig. 1 when the switches 14 and 15 are open and the secondary circuit is tuned to a frequency within the low frequency band giving a peak at 58. It is to be noted that, in view of the fact that the primary winding 21 is tuned to a frequency below the low frequency band, there is produced a peak 59 below the low frequency band. However, this peak is somewhat reduced due to the volume control resistor 13 which broadens the tuning of the primary coil. The curve shows a peak 57 in the interference band due to the resonance characteristics of the coil 20, which, it is to be noted, is tuned to a frequency between the two frequency bands. The dotted curve 56, however, shows the change in the attenuation curve when the circuit of Fig. 2 is used, in which the winding 20 has been eliminated.

Fig. 6 gives a similar attenuation curve for the interstage coupling transformer of Fig. 1. In this figure the curve 60 represents the attenuation of various signals when the secondary is tuned to a frequency within the low frequency band

giving a peak at 64. The curve 60 is that which would be obtained if it were not for the capacitive coupling 29, the peak 62 resulting from the resonance characteristics of the primary coil 30. However, with the capacitive coupling 29 added, the effect of which increases with the frequency, the attenuation of the circuit is as shown in curve 61, reaching a maximum attenuation at point 63, at which point the total resultant coupling reverses in phase.

The capacitive coupling may be obtained by winding a few turns of wire on a celluloid spacer over the middle part of the high frequency secondary coil. However, a small coupling condenser may be used for this purpose. The value of the capacity 29 alone affects the capacity coupling effect relative to the low frequency band, and therefore the capacity is regulated to give the proper gain of the circuit throughout the lower frequency band. The position of the capacity coupling turns relative to the secondary winding 32 has very little effect in the low frequency band and so, having determined the correct value of the capacity for the low frequency band, its effect in the high frequency band is adjusted by varying the position of the coil with respect to the secondary 32. Both the position and the capacity value are equally important in the high frequency band, but the exact value of either alone is not important provided the two values cooperate to give the desired result, which is in this case uniform gain throughout the high frequency band.

Fig. 7 is a diagram showing the arrangement of the windings of the antenna coupling transformer 17 of Fig. 1. The high-frequency secondary 22 is a helical winding wound on any appropriate form 70. Although any appropriate winding having the same inductance may be used, an appropriate winding for a receiver designed to carry out the principles of the present invention may comprise 117 turns of No. 30 B. & S. gauge enameled copper wire, wound 88 turns per inch on a one-inch diameter cylindrical form. The high-frequency primary winding 20, the low-frequency secondary winding 23, and the long-wave primary winding 21 are self-supporting multilayer coils wound on $\frac{1}{2}$ -inch diameter cylindrical forms and positioned coaxially to the winding 22 as shown. The high-frequency primary comprises 200 turns of No. 38 B. & S. gauge single-silk-covered enameled copper wire. The low-frequency secondary 23 comprises 470 turns of No. 38 B. & S. gauge single-silk-covered enameled copper wire, and the low-frequency primary winding 21 comprises 900 turns of No. 38 single-silk-covered enameled copper wire. The capacity coupling effect 19 is obtained by the winding 18, which comprises 9 turns of No. 30 enameled wire closely wound upon a sleeve 71 of .015 inch celluloid placed over the high-frequency secondary winding 22 as shown. The position of the winding 18 may be varied although the position indicated in the drawings has been found to be approximately correct. The relative proportions, and positions of the various coils, are shown in the drawings. The inductances and mutual inductances of the windings comprising the transformer illustrated in this figure are given below. The high-potential end of coil 22 is the end nearer the other coils 20, 21 and 23.

Fig. 8 is a diagram showing the arrangement of the windings in transformer 27 of Fig. 1. In this transformer the high-frequency secondary winding 32 comprises 178 turns of No. 30

B. & S. gauge enameled wire wound 88 turns per inch on a 1" form shown at 80. The primary 30 and a low-frequency secondary 33 comprise self-supporting multilayer coils placed coaxially with the form 80. The primary 30 comprises 600 turns of No. 38 B. & S. gauge single-silk-covered enameled copper wire and the low-frequency secondary 33 comprises 455 turns of No. 38 B. & S. gauge single-silk-covered enameled copper wire, the capacity coupling 29 is provided by means of winding 28 which comprises 9 turns of No. 30 B. & S. gauge enameled wire closely wound on a sleeve 81 of .015 inch celluloid placed over the high-frequency secondary winding 32. Although the position of winding 28 may be varied to control the capacity coupling effect 29, it has been found that the coupling is satisfactory if the winding is placed as in the drawings. The relative proportions and positions of the various coils are shown in the drawings. The inductances and mutual inductances of the windings in transformer 27 are given below. The high-potential end of coil 32 is the end nearer the other coils 30 and 33.

The antenna coupling transformer 17' is illustrated in Fig. 9 to which attention is now invited. In this figure the high-frequency secondary 22 is the same as that of transformer 17 as shown in Fig. 7. This winding 22 is wound upon a form 90, and the primary 21' and the long-wave secondary 23 are individually the same as windings 21 and 23 shown in Fig. 7. However, the primary coil 21' is placed intermediate between the secondary coils 22 and 23. The capacity coupling 19 is provided by means of the winding 18 which is similar to winding 18 shown in Fig. 7. The relative proportions and positions of the various coils are shown in the drawings. The inductances and mutual inductances of transformer 17' are given below. The high-potential end of coil 22 is the end nearer the other coils 21' and 23.

All the above coil systems are designed to be enclosed in 1 3/4-inch square thin aluminum or copper tubes, for shielding. These tubes affect somewhat the characteristics of the coils, but the values given below were measured without these enclosures.

While it is to be understood that the scope of the invention is not to be affected thereby, the following characteristics of the coupling transformers of a receiver built to cover the broadcast bands from 150 to 280 kilocycles and 550 to 1500 kilocycles, which are the broadcast bands used in England, are given for the purpose of illustration:

Antenna transformer 17

$L_{20}=621$ microhenries
 $L_{21}=14.4$ millihenries
 $L_{22}=320$ microhenries
 $L_{23}=3.6$ millihenries
 $M_{20-22}=58$ microhenries $k=13\%$
 $M_{21-23}=2.18$ millihenries $k=30\%$
 $M_{20-23}=325$ microhenries $k=22\%$
 Capacity 19=23 micro-microfarads

Interstage transformer 27

$L_{30}=6.1$ millihenries
 $L_{32}=322$ microhenries
 $L_{33}=3.4$ millihenries
 $M_{30-32}=168$ microhenries $k=11\%$
 $M_{30-33}=1.64$ millihenries $k=36\%$
 Capacity 29=20 micro-microfarads

Antenna transformer 17'

$L_{21'}=14.5$ millihenries
 $L_{22}=297$ microhenries
 $L_{23}=3.5$ millihenries
 $M_{21'-22}=395$ microhenries $k=19\%$
 $M_{21'-23}=2.1$ millihenries $k=29\%$
 Capacity 20 micro-microfarads

In the antenna transformers 17 and 17', the coupling with antenna 11 and ground 12, and the parallel volume control 13, is such that the resonant frequency of the transformer as a whole, determined by the tuning condenser is substantially unaffected by either the antenna capacity or the value of resistance 13, provided the antenna capacity is not less than 100 micromicrofarads. The resonant gain of these antenna circuits is good over both frequency bands. The Fig. 1 antenna transformer 17 has somewhat better gain but somewhat poorer selectivity than transformer 17' in Fig. 2. The effect on selectivity has been explained in connection with Figs. 4 and 5.

A volume control resistor of 5000 ohms has been found satisfactory.

The low frequency secondary coil 23 in the above description is commonly referred to as a secondary loading coil, since its function is to load the secondary inductance up to the value required in order to tune to the low frequencies. The same term is also applicable to the low frequency primary coils 21 and 21' in the antenna transformers.

It is obvious that other characteristics may be used, particularly in the design of a receiver for operation over other frequency bands, but those values given have been found to be quite satisfactory.

It is obvious that whereas the present specification and drawings show the invention as applied to a receiver adapted to receive signals covering two frequency bands, the principles involved may be used equally well in a receiver designed to cover three or more frequency bands.

I claim:

1. A tuned radio frequency coupling system adapted to operate over two frequency bands, said system including a primary winding, two secondary windings inductively coupled thereto, said primary winding being shunted by a capacity of such value that the circuit thus composed is capacitively reactive to one of said frequency bands, a capacity coupling between the circuits including said primary and secondary windings, and a switch to short-circuit one of the secondary windings to change the frequency range of said coupling system from one to another of said frequency bands.

2. A tuned radio frequency coupling system adapted to operate over two frequency bands, including a primary winding, a secondary winding inductively related thereto, a second secondary winding also inductively related thereto, said secondary windings being so connected relative to said primary winding that the voltages induced therein by said primary winding are opposite to one another, and means to short-circuit one of said secondary windings to change the frequency range of said coupling system from one to the other of said frequency bands.

3. A radio frequency coupling system adapted to operate over two frequency bands which system includes a transformer comprising a primary winding, a pair of secondary windings inductively related thereto and connected so that the currents

induced in each winding will be in phase opposition, a capacity coupling between the circuit of said primary winding and one of said secondary windings, and a switch for short-circuiting one of said secondary windings to change the frequency range of said coupling from one to the other of said frequency bands.

4. A tuned radio frequency coupling system adapted to operate over two frequency bands, said system including a primary winding, a high frequency secondary winding inductively related thereto, a low frequency secondary winding also inductively related thereto, said secondary windings being so connected that the voltage induced across each winding is in phase opposition with that induced across the other, a capacity coupling between the circuit of said primary winding and one of said secondary windings, and a switch to short-circuit one of said secondary windings to change the frequency range of said coupling system from one to the other of said frequency bands.

5. A radio frequency coupling system adapted to operate over two distinct frequency bands, which system includes a transformer, comprising a primary winding which with its included circuit is capacitively reactive to one of said frequency bands, two secondary windings inductively related to said primary winding and so connected that the currents induced in each winding are in phase opposition, an open-end winding connected to said primary winding and capacitively related to one of said secondary windings, and a switch for short-circuiting one of said secondary windings to change the frequency range of said system from one to another of said frequency bands.

6. A high frequency coupling system adapted to transmit frequencies covering two frequency bands, said coupling comprising a transformer including a primary winding which with its associated circuits is capacitively reactive to one of said frequency bands, a high frequency secondary winding inductively related thereto, a low frequency secondary winding also inductively related thereto, said secondary windings being so connected that the voltages induced in each are opposed relative to the output circuit of said coupling system, and a second primary winding capacitively related to said high frequency secondary winding, and a switch adapted to short-circuit said low frequency secondary winding whereby to change the frequency range of said transformer from one to the other of said frequency bands.

7. A tuned radio frequency coupling system adapted to operate over two distinct frequency bands, which system includes a transformer comprising a primary winding, said primary winding and its associated circuit being resonant to a frequency between said frequency bands, a high frequency secondary winding inductively related to said primary winding, a low frequency secondary winding also inductively related to said primary winding, said secondary windings being so connected that the voltage induced across one winding opposes that induced across the other winding, a second primary winding connected to said first mentioned primary winding and capacitively related to said high frequency secondary winding, and a switch for short-circuiting said low frequency secondary winding to change the frequency range of said transformer, said capacitive coupling being adapted to increase the gain of said coupling system with frequency when operating over the high frequency band and decrease the gain of said coupling system with frequency

when operating over the low frequency band, whereby a substantially uniform gain is obtained by said system throughout said frequency bands.

8. A tuned radio frequency coupling system adapted to receive signals in two distinct frequency bands, which system includes a transformer comprising a primary winding which with its associated circuits is resonant to a frequency between the two signal bands, two secondary windings both inductively related to said primary winding but so arranged that the voltages developed across each winding are in opposition, and a capacity coupling connected to the high potential end of the primary circuit and said high frequency secondary winding, said capacity coupling being adapted to increasingly assist the gain of said system throughout the high frequency band, as the frequency is increased, and increasingly decrease the gain of said system throughout the low frequency band, as the frequency is increased, and said coupling being so proportioned that frequencies between said bands shall be substantially attenuated by means of the opposition between the capacity coupling and magnetic coupling effects between said frequency bands.

9. A tuned radio frequency coupling system adapted to operate over two frequency bands, said system including a transformer, comprising two primary windings, a high and a low frequency secondary winding, and a capacity coupling between the primary and secondary circuits of said transformer, one of said primary windings being inductively related to the high frequency secondary winding and being shunted by a capacity of such value that the circuit thus composed is capacitively reactive to the high frequency band and the other of said primary windings being inductively related to the low frequency secondary and being shunted by a capacity of such value that the circuit thus composed is capacitively reactive to frequencies below the low frequency band, whereby a plurality of couplings between the primary and secondary of said transformer is obtained, and uni-control switching means for simultaneously short-circuiting the low frequency primary and secondary windings to change the frequency range of said coupling system from one to the other of said frequency bands.

10. A tuned radio frequency coupling system adapted to operate over two distinct frequency bands, which system includes a transformer comprising a high frequency primary winding, said primary winding and its associated circuits being resonant to a frequency between the frequency bands, a low frequency primary winding which with its associated circuits is resonant to a frequency below the low frequency band, a high frequency secondary winding inductively related to said high frequency primary winding, a low frequency secondary winding inductively related to said low frequency primary winding, said primary and secondary windings being normally arranged in series in the primary and secondary circuits respectively, and an open-end winding connected to the high potential end of said primary circuit and capacitively disposed relative to the high frequency secondary winding, whereby a plurality of couplings between said primary and secondary circuits is obtained, and simultaneously operable switches for short-circuiting said low frequency primary and secondary windings respectively to change the frequency range of the coupling from the high to the low frequency band.

11. A tuned radio frequency coupling system

- adapted to operate over two distinct frequency bands, which system includes a transformer comprising a primary winding, a high and a low frequency secondary winding inductively related to said primary winding, and a capacity connected between the high potential end of the primary circuit and said high frequency secondary winding, whereby to increase the gain of the coupling system at the high frequency end of the frequency band, said primary circuit being resonant to a frequency below the low frequency band to prevent reception of signals between said frequency bands.
12. A tuned radio frequency coupling system adapted to operate over two distinct frequency bands, which system includes a transformer comprising a primary winding which with its associated circuits is resonant to a frequency below the lowest of the two frequency bands to which said receiver is responsive, a high and a low frequency secondary winding inductively related to said primary winding, and a capacity connected between the high potential end of the primary circuit and said high frequency secondary winding, whereby to increase the gain of the coupling system at the high frequency end of the frequency band, said primary circuit being resonant to a frequency below the low frequency band to prevent reception of signals between said frequency bands, and a switch for short-circuiting said low frequency secondary winding to change the frequency range from the high to the low frequency band.
13. A tuned radio frequency system adapted to operate over two distinct frequency bands, which system includes a transformer comprising a single primary winding which with its associated circuits is resonant to a frequency below one of the two frequency bands to which said receiver is responsive, a high and a low frequency secondary winding inductively related to said primary winding, and an open-end winding wound closely adjacent said high frequency secondary and connected to the high potential end of the primary circuit, whereby to increase the gain at the high frequency end of the frequency bands, and a switch for short-circuiting one of said windings to change the frequency range of said coupling system from one to another of said frequency bands.
14. A tuned radio frequency coupling system adapted to operate over two frequency bands, said system including a transformer comprising a primary winding, two secondary windings inductively related to said primary winding, and a condenser coupling between said primary and secondary, said condenser consisting of one element electrically connected to the high potential end of the primary winding, said element being disposed adjacent one of said secondary windings, whereby the latter becomes a second element of said condenser coupling, and a switch to short-circuit the other of said secondary windings to change the frequency range of said coupling system from one to another of said frequency bands.
15. A tuned radio frequency coupling system adapted to couple a pair of input terminals to a pair of output terminals, said system comprising a primary winding, a high frequency secondary winding, a low frequency secondary winding, said windings being connected in series relative to the output circuit of said coupling, and an open-end coil closely adjacent said high frequency secondary winding and connected to the high potential end of said primary winding whereby said system includes capacitive as well as electromagnetic couplings.
16. A tuned radio frequency coupling system designed to transmit, from a pair of input terminals to a pair of output terminals, signals covering two frequency bands, comprising a primary winding so proportioned relative to the primary circuit that it is capacitively reactive to one of said frequency bands, two secondary windings, and an open-end winding connected to the high potential end of the primary winding and capacitively related to one of said secondary windings, whereby said coupling includes capacitive and inductive couplings.
17. A radio frequency coupling system adapted to couple two portions of a radio receiver and to operate over two frequency bands, comprising a primary winding, a pair of secondary windings inductively related thereto and connected so that the currents induced in each winding will be in phase opposition, and a capacity coupling between the circuit of said primary winding and one of said secondary windings.
18. A radio frequency coupling system adapted to couple two portions of a radio receiver and to operate over two distinct frequency bands, comprising a primary winding which with its included circuit is capacitively reactive to one of said frequency bands, two secondary windings inductively related to said primary winding and so connected that the currents induced in each winding are in phase opposition, and an open-end winding connected to said primary winding and capacitively related to one of said secondary windings.
19. A tuned radio frequency coupling system adapted to couple two vacuum tubes of a radio receiver in tandem and to operate over a plurality of frequency bands, said system including a plurality of primary windings, a plurality of secondary windings connected in series relative to the output of said coupling system, and an open-end winding connected to the high potential end of one of said primary windings and disposed adjacent one of said secondary windings, thus providing a capacity coupling effect between the primary and secondary windings.
20. A tuned radio frequency coupling system adapted to couple two portions of a radio receiver and to operate over two distinct frequency bands, said system comprising a single primary winding, a high and a low frequency secondary winding inductively related to said primary winding, and a condenser one element of which is connected to the high potential end of said primary winding and the other element of which comprises said high frequency secondary winding, whereby to increase the gain of the system at the high frequency end of the frequency bands, said primary circuit being resonant to a frequency below the low frequency band to prevent reception of signals between said frequency bands.
21. Means for capacitively coupling two circuits, one of said circuits including in series a coupling coil and a loading coil, said loading coil having a switch connected in shunt therewith, said means comprising in a series path, a coupling capacity, a portion of said coupling coil, said loading coil, and at least part of the other said circuit, said loading coil being removed from said path whenever said switch is closed.
22. Means for capacitively coupling two circuits, one of said circuits including in series, a low inductance and a high inductance, said high inductance having a switch connected in shunt

therewith; said means comprising in a series path, a coupling capacity, a portion of said low inductance, said high inductance, and at least part of the other of said circuits, the effect of said coupling being determined mainly, when said switch is open, by said capacity and high inductance, and when said switch is closed, by the capacity and said portion of the low inductance.

operating in the upper part of the higher of said frequency bands.

25. A tunable amplifier comprising in combination an amplifying vacuum tube having an output circuit, and a coupling system according to claim 23, said output circuit including said network of said system.

26. A tunable amplifier system, tunable over two frequency bands and comprising in combination an amplifying vacuum tube having an output circuit, the said output circuit comprising a network resonant to a frequency between said band, a closed series circuit including a tuning condenser, a low inductance and a high inductance, a path including in series a coupling capacity, a portion of said low inductance, said high inductance, and at least part of said network, said network having inductive coupling with unlike polarity to said low inductance and with like polarity to said high inductance, said high inductance having in shunt therewith a switch which is closed only when operating in the higher of said bands, and said system having a value of coupling capacity sufficient to oppose part of said inductive coupling when operating in the upper part of the lower of said frequency bands and having values of said capacity and said portion sufficient to substantially assist said inductive coupling when operating in the upper part of the higher of said frequency bands.

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35	110
40	115
45	120
50	125
55	130
60	135
65	140
70	145
75	150