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N. P. CASE

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COUPLING SYSTEM

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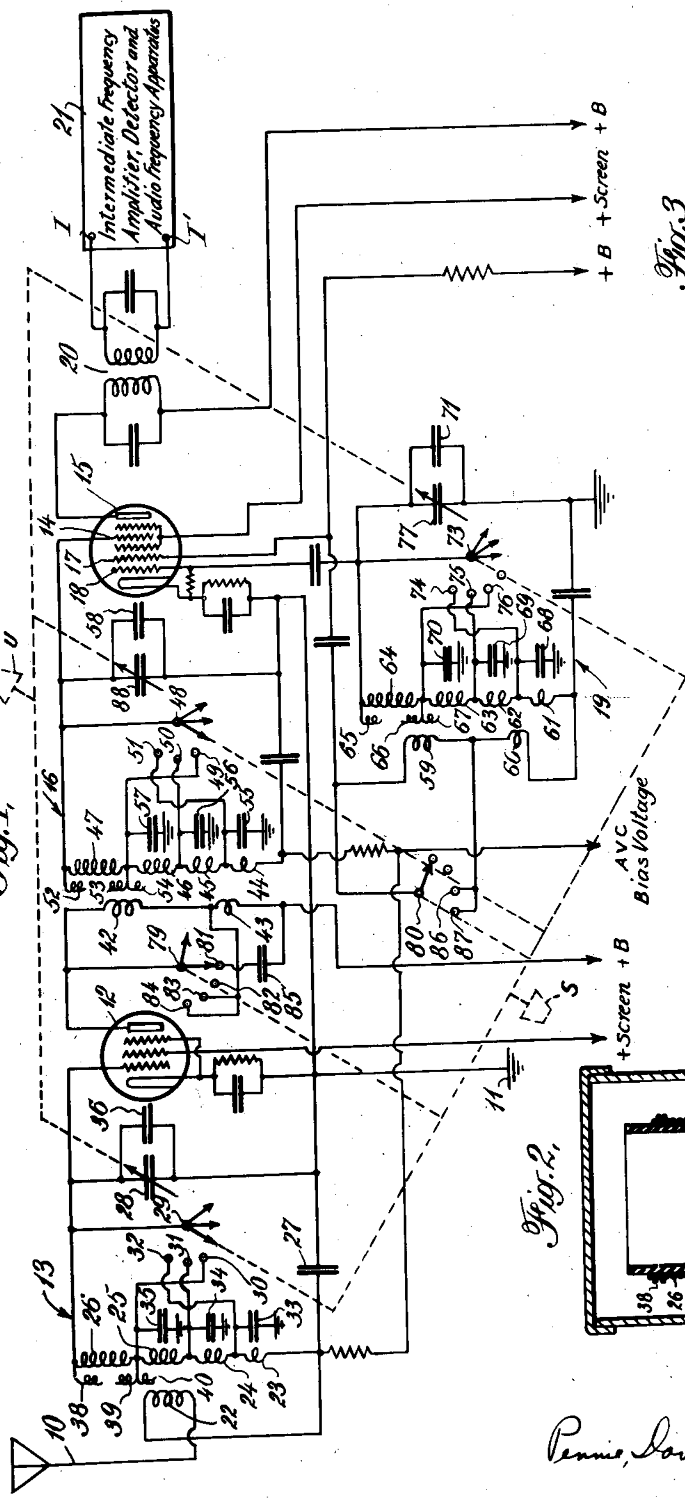

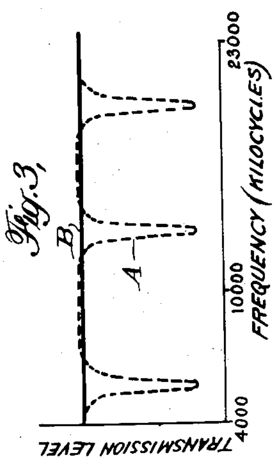

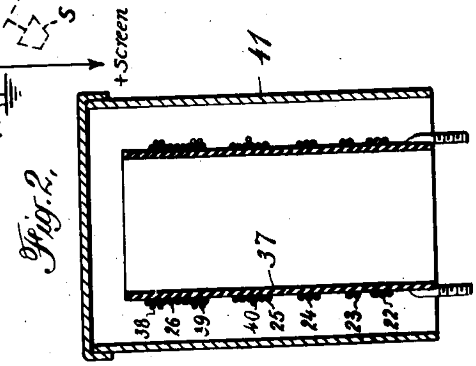

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COUPLING SYSTEM

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18 Claims. (Cl. 250—40)

This invention relates to high frequency coupling systems and more particularly to coupling systems adapted to operate over an unusually wide frequency range or over a plurality of frequency ranges.

An object of this invention is to improve the transmission efficiency and to reduce the effects of local disturbances in high frequency coupling systems operable over wide ranges of frequency. A related object is to improve the operation of coupling systems tunable over the usual radio broadcast range and over another range of frequencies higher than the broadcast range.

Another object is to extend the frequency range and facilitate the tuning of receivers intended to operate over a wide range or a plurality of ranges.

It is the usual practice to construct high frequency coupling systems by shunting an inductance coil with a variable condenser for tuning to the desired frequency. Such a coupling system is ordinarily tunable over a more or less limited range of frequencies, the limits of which are determined by the magnitude of the inductance and by the maximum and minimum capacity values which can be connected across the coil. For example, in the United States, it is customary to tune over the broadcast range of approximately 550–1500 kilocycles by means of a fixed coil of about 250 microhenries inductance shunted by a variable tuning condenser having a maximum capacity increment of about 350 micromicrofarads. The minimum capacity (associated with the coil and condenser) is generally in the neighborhood of 35 micromicrofarads.

It is often required that the tunable coupling system shall tune over other frequency ranges in addition to the usual broadcast range. It is frequently a particular requirement that the system shall tune in one or more frequency ranges higher than the broadcast range, commonly known as short-wave ranges. For this purpose, it is common practice to use one or more coils of different inductance from that of the coil used for tuning in the broadcast range, these additional coils being used for tuning in the additional ranges individually. Such additional coils as are used are often connected in series with the first coil. For tuning in a short wave range, the coil used for the broadcast range, and any coils corresponding to other ranges are ordinarily removed from the circuit by some form of switching arrangement, thereby leaving in the circuit the particular coil corresponding to the desired range. This will be of smaller inductance than the broadcast range coil.

The above form of coupling system has sometimes been found to be attended by undesired effects. Such effects are frequently introduced into a short wave circuit as a result of local parasitic currents generated in the broadcast or other coil. These parasitic or circulating currents are often created in the coil or coils switched out of circuit, by resonance effects involving portions of the coil and stray capacities associated with the coil, including capacities to adjacent surfaces such as a shield. These resonance effects may take the form of standing waves so that substantial coupling to the coil which is in circuit may exist from points of the switched-out coil which have a considerable potential, with reference to the standing waves. These undesired resonance effects are likely to exist at frequencies within a short-wave range, thereby deleteriously affecting the transmission efficiency in that range.

In accordance with this invention, means is provided for reducing the magnitude of the standing waves in a coil or coils switched out of circuit. This means is in the form of a "harness" of open-end turns wrapped around the coil and connected at one or more points thereof, preferably the ends. Such open-end turns connected in this manner act as a capacity shield between the coil and surrounding surfaces such as a can, thus preventing or minimizing currents flowing in series between portions of the coil and such surrounding surface through capacity coupling therebetween.

Such a "harness" also serves to introduce capacity between the ends of the coil and various points thereof, thus effectively short-circuiting these points of the coil in so far as very high frequency currents are concerned. This has the effect of minimizing standing waves which might otherwise occur in parallel circuits formed by parts of the coil and distributed capacity.

An important feature of this invention resides in the novel switching arrangement for switching the coils in or out, in combination with padding condensers. In the switching systems heretofore used for series-connected multi-range coils, the switch is connected to the low potential or ground end of the coil arrangement, and the desired coil or coils are selected by contact with the proper switch point, which is connected to the lower potential end of the coil.

According to the usual practice, padding condensers are associated with coils which are to be tuned. The use of such padding condensers is made necessary or desirable in order to align accurately the several tunable circuits of the receiver. In the case of multi-frequency range receivers, a separate padding condenser is ordinarily connected either across each of the coils to be connected in the tunable circuit of the coupling system or between ground and the higher potential end of each coil. The net result in the latter case is that all the padding condensers together with capacities in the associated leads are connected effectively across the lowest frequency coil of the coupling system. In the former case, the capacities to ground of the padding condenser plates are connected effectively across the lowest frequency coil. Higher frequency coils have correspondingly smaller capacities connected across them. The size of the padding condensers and associated capacities limits the high frequency end of the range to which a coil can be tuned. This is often undesirable especially in the case of lower frequency ranges, such as the broadcast range, where it is desired that the range be extended as far as possible.

In accordance with an arrangement of this invention, the above-mentioned disadvantage of padding condensers and associated capacities is greatly minimized. In this arrangement, the frequency band changing switch, instead of being at the low-potential side, is connected to the high potential side of the coupling system. Furthermore, the lowest frequency coil is situated at the high potential side, and the highest frequency coil at the low potential, or ground, side of the tunable system, the coils corresponding to frequency ranges between the two extremes being located therebetween. The coils are then switched in circuit by contact with the corresponding switch point.

By reason of the novel switching arrangement, only the padding condensers associated with the particular desired coil and with those of lower frequency are effectively manifested. Although other padding condensers may not actually be switched out of circuit, their presence is rendered negligible because they are across only a small portion of the total desired inductance.

The above and other features are explained and shown in detail in the following description and the accompanying drawing, of which

Fig. 1 illustrates a radio receiver embodying multi-wave band tunable coupling systems according to the invention;

Fig. 2 shows the construction of a transformer adapted to be used in the receiver of Fig. 1; and

Fig. 3 shows graphically how the coupling systems of the invention improve the transmission efficiency.

Fig. 1 shows a superheterodyne type of radio receiver adapted to tune over four frequency ranges. The receiver is provided with a circuit including an antenna 10 and a ground 11 for intercepting signals. A pentode amplifier tube 12 is coupled to the antenna-ground circuit through a coupling system 13 adapted to tune over the four frequency ranges, the input circuit of the tube being a load circuit for the coupling system. The input or signal control grid 14 of a hexode oscillator-modulator tube 15 is coupled to the output of the amplifier tube 12 through another tunable coupling system 16 somewhat similar to coupling system 13. Local oscillations are developed in the oscillator-modulator circuit by means of a feedback system between an anode grid 17 and an inner grid 18 of the tube. This feedback system comprises a tunable frequency-determining circuit 19 connected between the inner grid 18 and ground.

There is produced at the output of the oscillator-modulator the well known product of modulation which is the difference between the signal frequency and the local oscillator frequency. This difference frequency is known as the intermediate frequency of a superheterodyne receiver, and the difference between the local oscillator frequency and the signal carrier frequency is known as the intermediate carrier frequency. For the transmission of signals corresponding to voice and music, the signal carrier frequency has associated with it at least one, and generally two, sidebands of modulation. These sidebands extend several kilocycles on either side of the carrier frequency, so that the signal frequency channel is ordinarily several kilocycles in width. Hence, the intermediate frequency channel is also ordinarily several kilocycles in width; and intermediate frequency selecting circuits are provided to pass such a band width.

There is connected to the output of the oscillator-modulator tube a fixed-tuned coupling system 20 designed to select the intermediate-frequency channel. The output of this coupling system is connected to the input terminals I and I′ of apparatus designated generally by the rectangle 21 as "intermediate frequency amplifier, detector and audio frequency apparatus". This rectangle denotes all the apparatus which ordinarily follows a modulator. This apparatus is not shown or described in detail since it constitutes no part of this invention.

As explained above, the receiver is designed to receive signals in any of four frequency ranges. Four ranges commonly desired are: (1) the broadcast range, which is about 540 to 1550 kilocycles in the United States; (2) a higher frequency range of about 1500 to 4100 kilocycles; (3) the range of 4000 to 10,500 kilocycles; and (4) the range of 10,000 to 23,000 kilocycles. The three latter ranges are commonly referred to as short wave ranges. When these frequency limits are assigned, it is possible to tune to any frequency channel from 540 to 23,000 kilocycles, since the four ranges overlap slightly. For the purpose of this description, the four frequency ranges will be considered as having the above frequency limits, although other frequency limits could as well be used in so far as this invention is concerned. For convenience in this description, the four ranges will be referred to in the above order of increasing frequency as range #1, range #2, range #3, and range #4; range #1 being the broadcast range and range #4 the highest frequency range.

As noted previously, the four frequency ranges are too widespread to permit tuning by means of a single coil and condenser. Hence, the tunable circuits of the receiver are each provided with four coils, one for use in each range.

Referring to coupling system 13, there is provided a primary coil 22 electromagnetically coupled to four secondary coils 23, 24, 25 and 26, and a coupling capacity 27 common to both the primary and the secondary circuits. The four secondaries are connected in series between the low potential, or ground, side of the system and the high potential side of the system which is connected to the input electrode of tube 12. The four series-connected secondaries have connected across them a variable tuning condenser 28. A rotary switch 29 having three switch arms is connected to the high potential end of coil 26 and the three arms are adapted to make contact progressively with the contact points 30, 31 and 32, which are connected at the junctions of coils 25—26, 24—25, and 23—24, respectively.

The lower secondary coil 23 at the low potential side of the tunable system is wound to a relatively very small inductance required to be tuned over range #4. The next secondary coil 24 is of somewhat larger inductance and is proportioned so that it, together with coil 23, is adapted to be tuned by condenser 28 over range #3. Coil 25 is wound to the proper inductance so that it, together with coils 23 and 24, is conveniently tunable over range #2. The upper coil 26 at the high potential side of the tunable system is the largest of the four coils and is proportioned to be tuned, together with coils 23, 24 and 25, by condenser 28 over the broadcast range #1.

When it is desired to tune to a signal channel within range #4, the switch 29 is rotated so that the three switch arms make contact respectively with points 30, 31 and 32, thereby short-circuiting and effectively removing from circuit the three coils 24, 25 and 26. In this position of the switch, the only coil remaining effectively in the tunable circuit across the tuning condenser 28 is the highest frequency coil 23.

When it is desired to tune in range #3, the switch 29 is rotated one notch counterclockwise from the above position so that the two switch arms at the left contact respectively with points 30 and 31, thereby short-circuiting and effectively removing from circuit only the two upper coils 25 and 26. This places across tuning condenser 28 the two series coils 23 and 24, the latter of which is considerably larger than the former.

To tune to a frequency channel in range #2, the switch 29 is rotated counterclockwise another notch so that the switch arm at the left makes contact with point 30. In this position, coil 26 is the only one effectively removed from circuit. Since coil 25 is considerably larger than either of coils 23 and 24, it is the principal one of these three coils.

Tuning over range #1 is permitted by a further counterclockwise rotation of the switch to the position illustrated in the drawing, so that points 30, 31 and 32 are all open. Under this condition, coil 26 is of predominating effect.

Individual padding condensers 33, 34, 35 and 36 are associated with coils 23, 24, 25 and 26, respectively. Each padding condenser is connected between ground and the higher potential end of the respective associated coil. These padding condensers are adjusted to produce proper alignment of all the tunable circuits of the receiver and also to adjust properly the frequency ranges of tuning.

It is noted that when the switch is adjusted for range #4, all the padding condensers are connected across the coil 23. When the switch is rotated counterclockwise one notch to the position for range #3, condenser 33 is effectively removed from circuit because this condenser is connected only across coil 23 which is a small part of the total inductance of coils 23 and 24 in series. Thus, one less padding condenser is effectively present for each succeeding lower frequency range. Finally, when adjusted for the broadcast range #1, condenser 36 is the only effective padding condenser because all the other padding condensers appear across coils of small inductance as compared with that of the coil 26.

This arrangement of the switch, coils and padding condensers whereby smaller minimum capacities are connected across the lower frequency coils possesses the advantage of extending the broadcast range, and possibly range #2, beyond the upper limits which they would otherwise have. This advantage is important, for if more padding and distributed capacity were connected across the lower frequency coils than across the higher frequency coils, range #4 would be extended instead of the broadcast range, and adjacent signal channels in range #4 would be very crowded. The present arrangement, on the other hand, provides the more convenient spacing of signal channels on the tuning dial, in all ranges. A related advantage is that it becomes possible to tune over the entire broadcast band in one range, with a tuning condenser of convenient capacity.

Fig. 2 shows the physical construction of a transformer comprising the five coils 22 to 26, adapted for use in the coupling system 13 of Fig. 1. The transformer comprises a cylindrical form 37 of a suitable insulating material. The primary coil 22 is helically wound around one end of the cylindrical form, and the four secondary coils 23 to 26 are also helically wound around the form at spaced intervals from the primary coil in the order of increasing inductance. All the coils of the transformer are coaxial so that magnetic coupling exists between the primary coil and each of the secondaries. There is also incidental to this construction a certain amount of magnetic coupling, and some capacitive coupling, between the several secondary coils.

An important feature of the transformer is the application to the two larger secondary coils 25 and 26 of a "coil harness". This coil harness as applied to coil 26 comprises a few turns of wire 38 wound over the upper portion of coil 26 and another few turns of wire 39 wound over the lower portion of coil 26. One end of the turns 38 is connected to the upper end of coil 26 and one end of turns 39 is connected to the lower end of coil 26, the remaining ends of the harness turns being left open. The electrical connection of this harness is shown in Fig. 1.

A somewhat similar harness is associated with coil 25. It has been found that a single turn of wire 40 looped around coil 25 at the appropriate position and having one end connected to the upper end of coil 25 is adequate for this harness, although more turns may be used if necessary or desired.

The function of this coil harness arrangement will be described in detail later.

For the purpose of preventing extraneous couplings between the transformer and other portions of the radio receiver, the transformer is enclosed in a shielding can 41 of a good electrically conducting material.

The following constructional dimensions and coil winding data have been found satisfactory for the above described transformer:

	Inches
Length of form 37	4⅝
Diameter of form 37	1
Inside diameter of shielding can	2

Coil	Turns	Wire (B. & S. gauge)	Winding
22	3⅝	#38 sse	Close.
23	4	#18 e	16 t. p. i.
24	12¾	#22 e	24 t. p. i.
25	36⅞	#28 e	52 t. p. i.
26	157	#31 e	88 t. p. i.
38	4	#30 dsc	16 t. p. i. starting ⅝" from top of 26.
39	4	#30 dsc	5 t. p. i. starting from bottom of 26.
40	1	#30 dsc	3 t. p. i. starting at top of 25.

It should be understood that the above transformer specifications refer only to a specific transformer construction found suitable for a particular purpose. Great latitude in the coil construction, number of turns, and coil harness arrangement may be secured without departing from the scope of the invention.

It is found that a transformer constructed as described above is, in the absence of the coil harness, often characterized by transmission deficiencies, generally occurring in ranges #3 and #4. These deficiencies are found to be due to resonance effects in the form of standing waves in a coil, or coils, which are short-circuited or effectively removed from circuit. The short-circuited or removed coil which produces most of these deleterious effects is usually the largest coil, that is, the range #1 coil, although the range #2 coil may also contribute to the effects.

The cause of these standing waves is the presence of capacities distributed across portions of the short-circuited coil winding, and capacities between the winding and adjacent grounded objects, notably the shield. In consequence, parasitic resonant currents due to standing waves are created in the short-circuited coil, or coils. There are usually present standing waves of a length corresponding to one or more frequencies within ranges #3 and/or #4. These local resonance effects are introduced into the higher frequency coils of ranges #3 and #4 through the conductive and magnetic coupling which exists between the several secondary coils and also through any capacity coupling which may be present. At whatever frequency such a parasitic resonance occurs, a reduction of transmission level, or gain, is experienced in the higher frequency ranges. The selectivity is also greatly decreased, that is, the band width of whatever signal channel exists at or near such a parasitic resonance in one of the higher frequency ranges, is undesirably broadened.

The effect of the local resonances on the transmission level is illustrated by curve A of Fig. 3, in which the transmission level is plotted against frequencies of the higher frequency ranges. Curve A shows three dips within these ranges, two of the dips being in range #4 and the other dip in range #3. This is a typical effect experienced in transformers of the type described, in the absence of the "coil harness".

To avoid the above harmful effects, there is provided the above-described coil harness composed of an open-end turn or turns connected to the end or ends of the coil or coils in which the parasitic resonances are created. This coil harness acts as a capacity shield between the turns of secondary coils 25 and 26 and the grounded shielding can 41 or other surfaces. The flow of parasitic series currents through parts of the coil to the can through capacity therebetween is therefore greatly reduced. The coil harness also has the effect of introducing capacity from the end or ends of the coil to various points thereof, thereby effectively short-circuiting such points to the coil ends at very high frequencies so that standing waves in parallel circuits formed by parts of the coil and the distributed coil capacity, are broken up.

The coil harness may be applied to any coil which creates disturbances and may consist of any number of open-end, or dead-end, turns from one to a considerable number.

As a result of minimizing the undesired standing waves, the transmission characteristic of the tunable coupling system changes from the form of curve A to a form more like that of curve B in Fig. 3.

Coupling system 16 includes a transformer and switching arrangement very similar to that of coupling system 13. The principal differences are that the transformer of system 16 comprises two primary coils 42 and 43 instead of the single primary coil 22 of coupling system 13. Primary coil 42 is of larger inductance than primary coil 43 and serves to transmit most of the energy in ranges #1 and #2; whereas coil 43 serves to transfer the energy in ranges #3 and #4. The secondary coils 44, 45, 46 and 47 are respectively the coils for ranges #4, #3, #2, and #1; and these coils are tuned by variable condenser 88.

It will generally be found desirable in constructing a transformer for use in coupling system 16 to place the primary coils inside the cylindrical form, instead of outside as in Fig. 2. In that case, primary coil 42 will best be located approximately between coils 46 and 47, and coil 43 will be most effective when located between coils 44 and 45.

The rotary short-circuiting switch 48 is adapted to make contact with switch points 49, 50 and 51 in a manner similar to that of switch 29, points 49, 50 and 51 being for the purpose of respectively short-circuiting coils 47, 46 and 45. The coil harness turns 52 and 53 are applied to coil 47 in the same manner decribed in connection with coil 26; and the harness turn 54 is applied to coil 46 in the manner described in connection with coil 25. Padding condensers 55, 56, 57 and 58 are associated respectively with coils 44, 45, 46 and 47 in the same manner that condensers 33 to 36 are associated with coils 23 to 26 in coupling system 13.

The frequency-determining circuit 19 of the oscillatory system associated with tube 15 includes a transformer arranged similar to that in coupling system 16. The transformer comprises the two series-connected coils 59 and 60 and the four series-connected coils 61, 62, 63 and 64, these latter four coils being those for ranges #4, #3, #2, and #1, respectively. Coil 59 is a primary coil electromagnetically coupled to coils 63 and 64; and coil 60 is a primary coil related to coils 61 and 62; coil harness turns 65 and 66 are associated with coil 64, and the harness turn 67 is associated with coil 63, as in the case of coupling systems 13 and 16. Condensers 68, 69, 70 and 71 are padding condensers for coils 61, 62, 63 and 64, respectively.

The three arms of the short-circuiting switch 73 are adapted to make contact with any one, two or three contact points 74, 75 and 76. Contact with points 76, 75 and 74 short-circuits coils 64, 63 and 62, respectively.

Variable condenser 77 is the adjustable frequency-determining element of the oscillator circuit. This condenser is so related to variable condensers 28 and 88 as to maintain the fixed frequency difference at the output of the oscillator-modulator tube, that is, a constant intermediate carrier frequency.

In addition to the above-described switching arrangements, there are provided two additional switches 79 and 80. There are associated with switch 79 four switch points 81, 82, 83 and 84, the latter three points corresponding to points 49, 50 and 51, of switch 48.

Switch 79 is provided with two switch arms instead of three, these two arms being spaced to correspond with the extreme arms of switches 29, 48 and 73. When adjusted for range #4, then, the two arms of switch 79 contact respectively with points 84 and 82. In this position, the lower frequency primary coil 42 is short-circuited.

When the switch is rotated counterclockwise one notch to the position for range #3, contact is made with points 83 and 81. This also short-circuits primary coil 42 and at the same time connects a condenser 85 across the primary 43. The purpose of this condenser is to reduce the resonant frequency of the primary circuit to a frequency somewhat below range #3, since this condition is desired for uniformity of transmission over the range. (When adjusted for range #4, the distributed capacity of coil 43 plus the output capacity of tube 12 is sufficient to make the primary circuit resonant below this highest frequency range).

The next counterclockwise movement of switch 79 brings the switch to the position of range #2. This position disconnects condenser 85 and causes primary coil 42 to be placed in series with coil 43; and since coil 43 is of small inductance as compared with coil 42, this latter coil predominates. The distributed capacity of coil 42 plus the output capacity of tube 12 is sufficient to resonate the primary circuit at a frequency somewhat below range #2.

For tuning in range #1, the switch is again rotated counterclockwise so that the left-hand arm contacts point 81. This causes condenser 85 to be connected across both primary coils, which reduces the primary resonant frequency below the broadcast range #1.

Switch 80 is a simple rotary switch having only one switch arm. Switch points 86 and 87 corresponding to ranges #3 and #4, respectively, serve to short-circuit the larger primary coil 59 when the receiver is adjusted for these higher frequency ranges #3 and #4.

To facilitate switching from one frequency range to another, there is provided a mechanical control device represented by the lines connecting the device S for simultaneously operating all of the switches 29, 48, 73, 79 and 80. The device S will usually be in the form of a knob so arranged that all of the coils are switched for ranges #1, #2, #3 or #4, as desired.

A second mechanical control device U is provided to tune simultaneously all the variable condensers 28, 88 and 77.

Other elements such as resistors and by-passing condensers are employed where they serve to improve the general operation of the receiver.

The connection labeled "AVC bias voltage" at the input grid circuits of tubes 12 and 15, indicates a means for applying an automatic volume control biasing voltage to these grids. Such a biasing voltage, which is well known in the art, is a uni-directional voltage which varies substantially as the received signal strength. Such an automatic biasing voltage maintains the output of the receiver substantially uniform in spite of changes in received signal intensity, or of transmission efficiency within the receiver itself.

The sources of operating voltage for the vacuum tube electrodes and for heating the cathodes are not shown because their application is well understood in the art, and constitutes no part of this invention.

I claim:

1. A high frequency coupling system adapted to operate over a plurality of frequency ranges, comprising a transformer having at least two secondary coils of different inductance adapted to be coupled to a load circuit, a switch for effectively removing one of said secondary coils from said load circuit, and an open end shielding winding around one of said coils, said winding having a point thereof conductively connected to a point of said latter coil.

2. A high frequency coupling system adapted to operate over a plurality of different frequency ranges, comprising a transformer having at least two secondary coils with coupling therebetween, a variable condenser for tuning said secondary coils, a switch for effectively removing one of said secondary coils from the circuit of said variable condenser, and an open end winding wound over, and connected to, said removable coil for reducing local disturbances originating in said removable coil.

3. A tunable high frequency system comprising a plurality of coils, a variable tuning condenser connected in circuit with said coils, switching means for removing from circuit at least one of said coils to shift the frequency range over which said variable condenser tunes, and an open end winding wound over, and connected to a point of, said latter coil for minimizing local resonances in said removed coil.

4. A tunable high frequency system comprising a plurality of co-axial coils, a variable condenser for tuning said coils, switching means for effectively removing from circuit or inserting at least one of said coils, and a coil harness wound over and connected to said latter coil for minimizing parasitic resonances in said removed coil.

5. A high frequency coupling system comprising at least one primary coil and at least two secondary coils electromagnetically related to said primary coil, said secondary coils being wound on the same form within a grounded shield, a variable condenser for tuning said secondary coils, switching means for effectively removing at least one of said secondary coils from the circuit of said variable condenser to shift the frequency range over which said coupling system tunes, and an open-end winding wound over, and connected to a point of said removable secondary coil for minimizing local resonances in said latter coil when it is removed from circuit.

6. A high frequency coupling system adapted to operate over a plurality of frequency ranges, comprising, a transformer having a plurality of series-connected secondary coils coupled to at least one primary coil, means for short-circuiting one of said secondary coils, and a coil harness wound over and connected to said latter secondary coil for minimizing resonances therein when said latter coil is short-circuited.

7. A tunable high frequency system adapted to operate over a plurality of different frequency ranges, comprising two series-connected coils having incidental coupling therebetween, a switch for short-circuiting a first of said coils, and an open-end winding wound over, and connected to a point of, said first coil for minimizing local resonances in said first coil when it is short-circuited, and thereby minimizing disturbances in the second coil.

8. A tunable high frequency system comprising a plurality of coils, a variable tuning condenser connected effectively across said coils, switching means for short-circuiting a first of said coils to shift the frequency range over which said variable condenser tunes, and an open-end winding wound over, and connected to a point of said first coil for minimizing local resonances therein and thereby preventing said local resonances from creating disturbances in a second of said coils.

9. A radio-frequency coupling system comprising a plurality of coils connected in series and

a variable condenser in shunt with said series-arranged coils, a first of said coils being adapted to be tuned by said condenser over a high frequency range and a second of said coils being adapted to be tuned by said condenser over a lower frequency range, a switch connected across said second coil which when open permits tuning over said lower frequency range and when closed permits tuning over said high frequency range, and an open-end winding wound over, and connected to a point of, said second coil for minimizing in said first coil resonance effects which originate in said second coil when said switch is closed.

10. A high frequency tunable system adapted to operate over a plurality of different frequency ranges, comprising at least two series-connected coils having incidental coupling therebetween, a switch for short-circuiting a first of said coils, and a winding wound over, and having one end thereof connected to one end of, said first coil, and a second winding wound over, and having one end thereof connected to the other end of, said first coil, the remaining ends of said windings being open.

11. A high frequency coupling system adapted to operate over a plurality of frequency ranges comprising a plurality of serially connected inductance coils one end of the series being effectively grounded, a tuning condenser, a padding condenser permanently connected in circuit with each of certain of said coils, and circuit connecting means including a switch for effectively including a selected coil or coils across said tuning condenser and for minimizing the lower limit of capacity in circuit with a coil operating at a lower of said frequency ranges.

12. A high frequency coupling system adapted to operate over a plurality of frequency ranges comprising a plurality of inductance coils and a tuning condenser, a padding condenser in circuit with each of certain of said coils, and means for effectively including a selected coil or coils across said tuning condenser and for minimizing the lower limit of capacity in circuit with a coil operating at a lower of said frequency ranges comprising connections for including said coils in a series circuit across said tuning condenser with the coils from the high potential end of the series to the low potential end thereof proportioned for operation at successively higher frequencies, and switch means for selectively short-circuiting one or more of said coils.

13. A high frequency tunable coupling system adapted to operate over a plurality of frequency ranges, comprising a plurality of coils of different inductance arranged in series and connected effectively in shunt with a variable tuning condenser, the coil having the largest inductance being located at the high potential end of said series arrangement and the coil having the smallest inductance being located at the low potential end of said series arrangement, padding condensers connected from said low potential end of said series to the high potential end of each of one or more of said coils, and a switch having an arm connected to said high potential end of said series arrangement and adapted to make contact with switch points which short-circuit at least some of said coils, whereby the lower limit of capacity in circuit with a coil operating at a lower of said frequency ranges is minimized.

14. A high frequency tunable coupling system adapted to operate over a plurality of frequency ranges, comprising a plurality of coils of different inductance effectively connected in series between ground and a higher potential terminal, said coils progressively increasing in inductance from ground to said higher potential terminal, padding condensers connected between ground and one or more of the junctions between said coils, and a switch connected to said higher potential terminal adapted to make contact with switch points connected to said junctions, whereby the lower limit of capacity in circuit with a coil operating at a lower of said frequency ranges is minimized.

15. A system according to claim 14 in which said switch is constructed selectively to connect directly together a plurality of said switch points.

16. A system according to claim 14 in which said switch has a switch arm corresponding to each switch point so that any desired number of said switch points may be connected together.

17. A high frequency transformer comprising a primary coil and a plurality of secondary coils, at least one of said secondary coils having a shield comprising open-end turns wound over it and conductively connected to said latter secondary coil.

18. A high frequency transformer comprising a primary coil and a plurality of secondary coils of different inductance, at least two of said secondary coils being wound on a cylindrical form, the larger of said latter two coils having wound over it a shielding coil of open-end turns for conductive connection to said larger coil.

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