Aug. 28, 1945. V. R. BECK 2,383,462

SPREAD BAND TUNING DEVICE

Original Filed Oct. 10, 1940 2 Sheets-Sheet 1

Fig. 1.

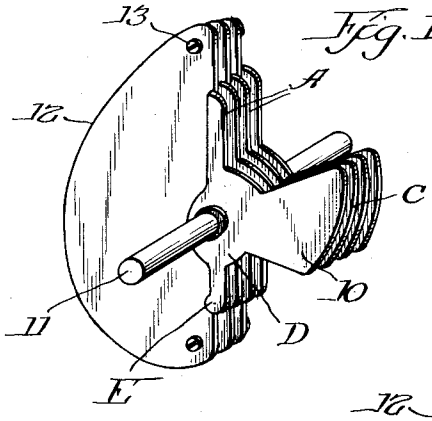


Fig. 2.

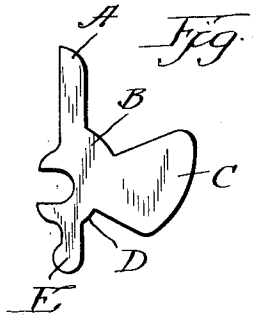


Fig. 3.

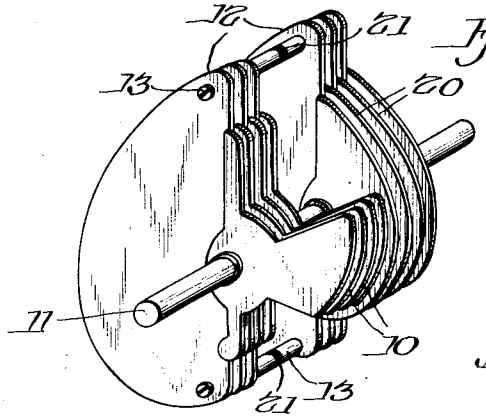


Fig. 4.

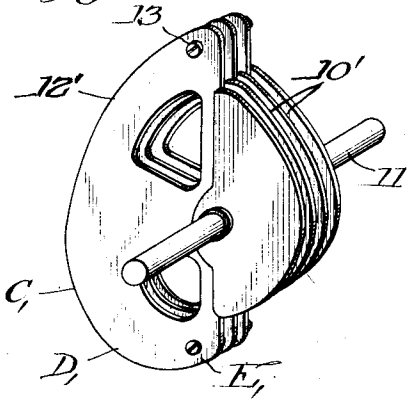


Fig. 5.

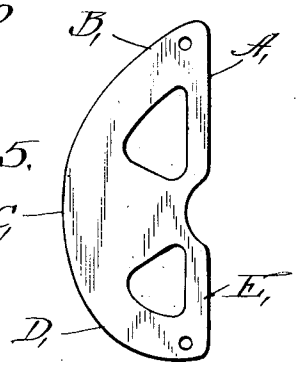


Fig. 6.

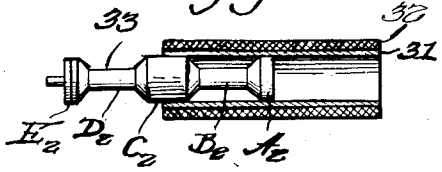
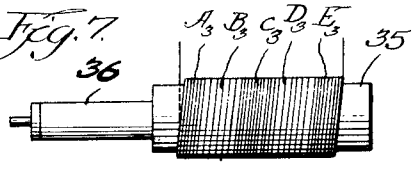


Fig. 7.



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Fig. 8.

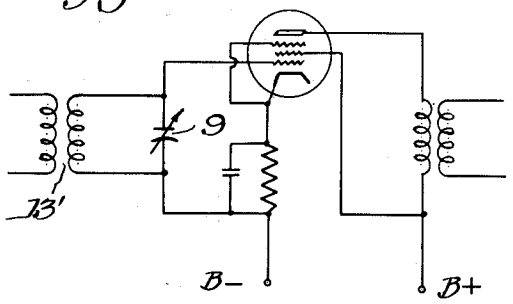


Fig. 9.

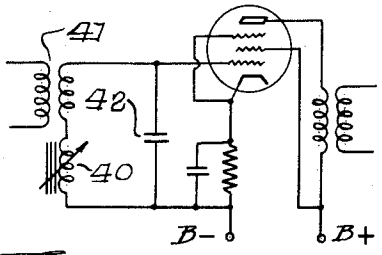


Fig. 10.

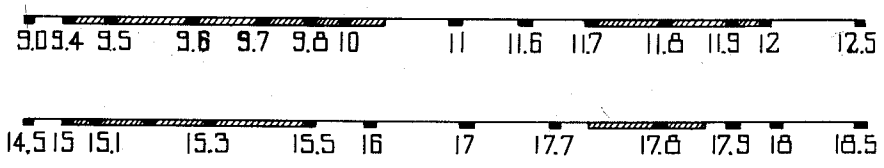


Fig. 11.

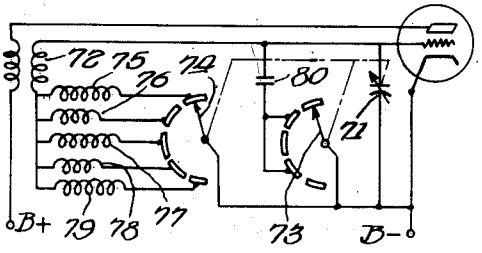


Fig. 13.

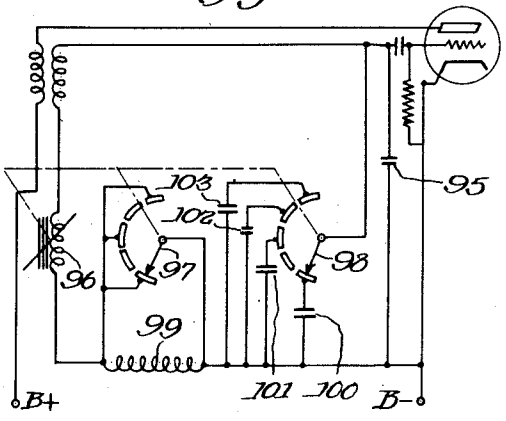
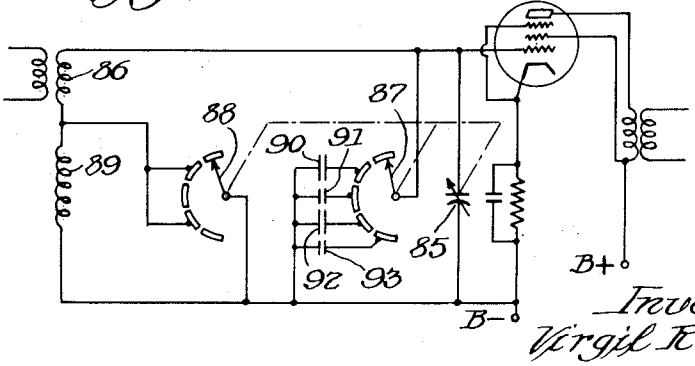


Fig. 12.



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UNITED STATES PATENT OFFICE

2,383,462

SPREAD BAND TUNING DEVICE

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Original application October 10, 1940, Serial No. 360,670. Divided and this application September 19, 1942, Serial No. 458,951

7 Claims. (Cl. 250—40)

This invention relates to spread band tuning circuits and is particularly useful in radio receiving sets, but is applicable to any apparatus employing tuning circuits, such as signal generators, transmitters, etc.

This application is a division of the copending application Serial No. 360,670, filed October 10, 1940, for Spread band tuning device, and assigned to the same assignee as the present application.

It is well known that various portions of the radio spectrum are much more crowded than other portions. For example, in short wave broadcast reception it is found that frequencies, and corresponding portions of the dial, from 9.5 to 9.7 megacycles and from 11.7 to 11.9 megacycles, being respectively the 31 and 25 meter short wave bands, are very crowded, whereas the frequency band from 9.7 to 11.7 megacycles contains very few stations. Likewise, the frequency bands from 15.1 to 15.35 and from 17.75 to 17.85 megacycles, being respectively the 19 and 17 meter short wave bands, are crowded, while the band from 15.35 to 17.75 megacycles contains practically no stations. In conventional receivers wherein modified straight line frequency tuning condensers are ordinarily employed to tune through a relatively wide frequency band, it is found to be almost impossible to tune accurately a station in the crowded portion of the dial, for the reason that a very slight movement of the tuning control results in a considerable change in the capacity of the condenser, and accordingly, in the resonant frequency of the tuned circuit. Thus, a slight rotation of the dial is apt to tune the receiver through the frequencies of a number of stations, resulting in great difficulty in accurately tuning a desired station and eliminating others.

The terms "spectrum" and "bands" are used throughout this specification in their commonly accepted meanings—for example, the radio frequency spectrum includes all of the above mentioned allocated wave bands, i. e.: the 31, 25, 19 and 17 meter bands and the so-called "dead" ranges of frequency similar to the range from 9.7 to 11.7 megacycles and 15.35 to 17.75 megacycles mentioned above. Furthermore, it is understood that the term "broadcast" is used in the manner as defined in present day dictionaries and means any desired radiotelephonic and radio telegraphic transmission of intelligence. Also, the term "switchless" is used to distinguish the present tuning system over the well-known prior art systems employing band switching arrangements for switching tuned circuits in the receiver for reception in two adjacent bands.

It is an object of this invention to provide a new and improved tuning circuit which produces rapid frequency changes in certain frequency ranges and slow frequency changes in other ranges, upon movement of the tuner at a uniform rate throughout its range of adjustment.

It is another object of the invention to provide such a tuning circuit which spreads the scale indications of those portions of the radio spectrum containing large numbers of stations and which condenses the scale indications of those portions which are little used.

A further object of the invention is to provide such a tuning circuit in which the capacitive reactance is so modified locally as to produce desired rapid frequency changes in certain ranges and desired slow changes in other ranges.

In accordance with the invention the tuning circuit is arranged and constructed so that a single scale encompasses at least two separate crowded portions of the frequency spectrum, and so that these two separate crowded portions are expanded substantially uniformly, the intermediate portion of the frequency spectrum being condensed on the scale.

The features of my invention which I believe to be novel are set forth with particularity in the appended claims. My invention itself, both as to its organization and manner of operation, together with further objects and advantages thereof, may best be understood by reference to the following description taken in connection with the accompanying drawings in which:

Figure 1 is a perspective view of a condenser constructed in accordance with the present invention;

Figure 2 illustrates the shape of a single rotor plate of the condenser of Figure 1;

Figure 3 is a perspective view of two condensers mounted on a single shaft, one being constructed in accordance with my present invention;

Figure 4 is a perspective view of a modified form of condenser similar to that illustrated in Figure 1;

Figure 5 illustrates a single stator plate of the condenser of Figure 4;

Figure 6 is a view, partly in section of a variable inductance analogous to the condenser of Figures 1 and 4;

Figure 7 is a modified form of inductance similar to that shown in Figure 6;

Figure 8 is a schematic diagram of a tuned amplifier circuit including a condenser construct-

ed according to my invention, as illustrated in Figures 1 and 4;

Figure 9 is a schematic diagram of tuned amplifier circuit including a variable inductance such as illustrated in Figures 6 and 7;

Figure 10 illustrates a pair of tuning scales arranged to cooperate with a pointer adjustable simultaneously with the condenser of Figure 8 or the inductance of Figure 9;

Figure 11 is a schematic diagram of a modified form of tuning circuit arranged to produce results as the circuits of Figures 8 and 9; and

Figures 12 and 13 are other modified forms of the circuit of Figure 11.

With reference to Figure 1, the condenser is provided with rotor plates 10 mounted on a shaft 11, the rotor plates being adapted to be rotated into position between stator plates 12 which are secured together by suitable fastening means 13.

The effect of this type of rotor plate can best be described with reference to Figure 2. As the rotor plate is rotated from the position shown in Figure 1 into the space between the stator plates, it is apparent that segment A first enters this space. As the radius and the area of segment A are relatively large, a substantial change is produced in the capacity of the condenser for each increment of rotation. As the segment B begins to enter the space between the stator plates, the amount of change of capacity for a given rotary movement is reduced materially since segment B is of small radius and area, and each increment of rotation introduces only a small additional area. As segment C enters the space between the rotor plates, the capacity of the condenser again changes very rapidly for the same rate of rotation because of the large radius of the segment being introduced. Segment D produces a slow change of capacity at the same rate of rotation for the same reason as segment B. Segment E again produces a rapid change in capacity similar to that of segment A.

This invention is particularly adapted for use in short wave broadcast reception, since it is in the short wave broadcast band that local overcrowding of stations occurs. In a radio receiver designed to receive standard broadcasts, as well as short wave broadcasts, a second condenser, such as a modified straight line frequency condenser may be provided, which cooperates with more or less uniform markings on the standard broadcast scale. These two condensers may be separately provided. However, it has been found advantageous to combine the two condensers into a single unitary structure.

Such a combined unitary structure is illustrated in Figure 3, in which the modified rotor plates 10 and the standard rotor plates 20 are mounted upon the same shaft 11, and are all electrically connected. The stator plates 12 may be divided into two sections between which electrical insulation 21 is provided. That is, two separate condensers may be built together, one serving for the standard broadcast range, and the other for the shortwave range. The rotor plates are usually connected to ground and, therefore, there is no necessity for electrically insulating the two sections of rotor plates of the condenser, although these sections may be insulated if required by the circuit employed. The electrically insulated stator sections of the condenser are connected to a suitable band changing switch (not shown) so that either one may be included in the tuned circuit, depending upon the station which it is desired to receive. As shown in Figure 3, the rotor plates exceed by one the number of stator plates, so that when the rotor plates are in engagement with the stator plates they surround the stator plates. Substantial space is provided between the two stator sections of the condenser, so that the capacity between the two stator sections is minimized.

In Figure 4 a modification of my invention is illustrated in which the rotor plates 10' are solid and in which the stator plates 12' have been perforated to produce the desired effect. The contour of a stator plate is clearly illustrated in Figure 5, wherein segments A_1, B_1, C_1, D_1 and E_1 correspond to segments A, B, C, D and E in Figure 2. It is apparent that the working of this modification is the same as that of Figure 1, the effect being produced by the stator plates as distinguished from the rotor plates.

Figure 6 illustrates a variable inductance of the variable permeability type which may be used to produce an effect similar to that of the variable condensers of Figures 1 and 4. This variable inductance may include an insulating tube 31 about which a coil 32 is wound. The conductors forming the coil are uniformly distributed over the tube 31. A core 33 of low loss magnetic material is arranged to move into and out of the tube 31.

The configuration of the core is such as to produce the desired result, such as that produced by the condensers of Figures 1 and 4. The large section A_2 at the end of the core 33 produces a rapid change in inductance when inserted in the tube 31 and accordingly a large change of frequency. As section B_2 enters the tube 31, the rate of change of frequency is lower, since the cross-sectional area of the core is smaller. Section C_2, which is of large cross-section, produces a rapid change of frequency. Section D_2, like section B_2, produces a slow change of frequency because of its small cross-section. Section E_2 of large cross-section, like section C_2, produces a rapid change of frequency. It is apparent that by suitably adjusting the cross-sectional areas of the sections referred to, this variable inductance of Figure 6 may be made to produce the same effect as the previously described variable condensers of Figures 1 and 4.

Figure 7 illustrates a variable inductance having a uniform core 36 arranged to move into and out of a non-uniformly wound inductance coil. The inductance illustrated is designed to produce a result similar to the result produced by the reactances illustrated in Figures 1, 4 and 6. It includes a tube 35 about which a conductor may be wound in sections, each section having the requisite number of turns to produce the desired rate of change of frequency for that section. Sections A_3, C_3 and E_3 are closely wound and contain many turns per unit length. Sections B_3 and D_3 contain a few turns per unit length. It is evident that as a uniform core 36 enters the tube 35, there is produced in sequence a rapid change, a slow change, a rapid change, a slow change, and a rapid change of inductance, and therefore of frequency.

While the condensers of the present invention as illustrated in Figures 1 and 4, have been described as being constructed with either the stator plates or the rotor plates modified to expand certain portions of the spectrum while compressing other portions, it is apparent that the same result can be produced by partially modifying both the stator plates and the rotor plates, so that the modified portions of both plates cooperate to produce the desired result. Similarly the inductances illustrated in Figures 7 and 8 achieve the desired result in the one case by reason of a modified core shape and in the other case by rea-

son of modified winding distribution. It is apparent that the desired results according to the invention may be produced by making both core shape and winding distribution non-uniform so as to produce the same result described as produced by the non-uniformity of either one of these constructional features of the inductance.

In Figure 8, the condenser 9 is connected in shunt to an inductance 13', illustrated as a transformer, and is a condenser such as that illustrated in Figure 1 or 4. The condenser 9 and inductance 13' form a tuned input circuit for a stage of tuned amplification, in which the tuned frequency may be adjusted according to my invention.

In Figure 9 there is shown a similar tuned amplifier in which the tuned input circuit includes an inductance 40, such as the inductances illustrated in Figures 6 and 7. This inductance 40 is connected in series with an inductance 41 which is illustrated as an input transformer, and a fixed condenser 42 is connected in shunt to the series combination of inductances 40 and 41.

In Figure 10 there is illustrated a pair of scales suitable for cooperation with a pointer attached to the movable element of the inductance 40 of Figure 9, or the condenser 9 of Figure 8. The upper of the two scales of Figure 10 shows that the portion of the frequency range from 9.5 to 9.7 megacycles has been spread out considerably to take care of the large number of stations in that area. Likewise, from 11.7 to 11.9 megacycles there are many stations, and this portion of the scale has also been spread out considerably. The portion from 9.7 to 11.7, which contains few stations, has been crowded together. This upper scale of Figure 10 shows that the two standard short wave bands from 9.5 to 9.7 megacycles, and from 11.7 to 11.9 megacycles have been spread substantially uniformly and equally. Each of these two short wave bands covers 200 kilocycles, and each is spread for substantially the same linear distance along the scale. The segments B and D of the adjustable reactance in the tuning circuit are so formed as to produce this substantially uniform spread in each of the two separated spread band portions.

Comparing the shape of the condenser rotor plate illustrated in Figure 2 with the lower scale of Figure 10, it is evident that segment A produces a rapid change in frequency from 18.5 to 17.85 megacycles. This insures complete coverage of the upper end of the range. When segment B is rotated into the space between the stator plates, the slow change of capacity and of frequency corresponds to the large distance on the scale between 17.85 and 17.75 megacycles. Then, as segment C enters between the stator plates, the rapid change in capacity produces a large change in frequency corresponding to the relatively short distance along the lower scale from 17.75 to 15.35 megacycles. As segment D enters between the stator plates, its slow change of capacity corresponds to the long part of the scale between 15.35 and 15.1 megacycles. Segment E produces a rapid change of capacity from 15.1 to 14.5 megacycles so as to insure complete coverage of the lower end of the range.

In the previous paragraph the condenser has been described as covering the range from 14.5 to 18.5 megacycles. This condenser is also used to cover the range from 9 to 12.5 megacycles, by changing the inductance with which it is connected in shunt so as to make the tuned circuit resonant within the range 9.0 to 12.5 megacycles. That is, two inductances are used, one being connected in shunt with the condenser for the high frequency range and the other for the low frequency range. The circuit is switched from one inductance to the other depending upon which wave band it is desired to tune.

Complete coverage of the range from 9 to 18.5 megacycles can also be accomplished by a single condenser without a change of inductance by forming a condenser plate so as to give rapid coverage of the ranges 9.0 to 9.5, 9.7 to 11.7, 11.9 to 15.1, 15.35 to 17.75, and 17.85 to 18.5 megacycles; and to give slow coverage of the ranges between 9.5 and 9.7, 11.7 and 11.9, 15.1 and 15.35, and 17.75 and 17.85 megacycles. That is to say, condensers in accordance with the present invention can be employed wherever it is desired to extend substantially uniformly selected portions of a tuning range while compressing intermediate portions of the range.

In the previously described circuits the desired results have been produced by forming one or more elements of the adjustable tuning reactance so as to give the desired non-uniform frequency change. In Figures 11, 12 and 13, similar results are produced by introducing into, or removing from, the tuning circuit one or more reactances separate from the variable tuning reactance. This is brought about by switch means operated in unison with the tuning reactance and arranged to control the connection of additional inductance or capacity to the circuit such as to vary the rate of tuning in the various sections of the radio frequency spectrum in the desired manner while maintaining a continuous change of frequency across the entire range.

In Figure 11 there is illustrated a tuning circuit having a variable capacity 71 and a fixed inductance 72. Operatively connected to the variable condenser 71 are switches 73 and 74. The switch 73 is adapted to introduce additional capacity into the circuit while switch 74 is arranged to introduce additional inductance to the circuit. When the condenser 71 is adjusted to minimum capacity to tune the circuit to high frequencies in the desired range, switch 74 connects inductance 75 in series with inductance 72 across condenser 71, the only capacity in circuit. Since condenser 71 is the only capacity in the tuning circuit, a change in its capacity produces a relatively rapid change of frequency.

At a desired point in the adjustment of condenser 71, as its capacity is increasing, switch 74 removes inductance 75 from the circuit and introduces another inductance 76, which is a smaller inductance. Simultaneously, switch 73 introduces condenser 80 into the circuit in shunt to the condenser 71. The condenser 80 and the inductance 76 are selected to be of such appropriate values that there is no change in the product of inductance and capacity, and therefore no change in frequency, as the switches 73 and 74 move from one contact to the next. Thus, the frequency immediately before the change is the same as the frequency immediately following the change.

With the additional capacity 80 in the circuit in shunt to capacity 71, further adjustment of condenser 71 to increase its capacity results in a slower change of frequency because of the reduced rate of change of the overall to capacity. This effect is used to spread out a desired portion of the spectrum, as from 17.85 to 17.75 megacycles. At the end of that portion of the spectrum, as condenser 71 is being adjusted in the di-

rection of still greater capacity, switches 73 and 74 move to the next contact, thereby introducing inductance 77 into the circuit and removing condenser 80 therefrom. The inductance 77 is of suitable value to maintain the product of inductance and capacity constant, and therefore to keep the frequency the same as it was immediately before condenser 80 was removed from the circuit. The inductance 77 is larger than the inductance 76, as is necessary because the condenser 80 has been removed from the circuit. With inductance 77 in the circuit, and condenser 80 out of the circuit, the change of frequency is rapid, since a change in the capacity of condenser 71 now produces an equal change in the overall capacity of the tuning circuit. The part of the frequency spectrum covered by the tuning circuit with inductance 77 in the circuit and condenser 80 out may, for example, be used to cover a little used portion of the spectrum rapidly, as from 17.75 to 15.35 megacycles.

When condenser 71 is increased in capacity until the tuning circuit is tuned to the lowest frequency in this little used range of the spectrum, switch 74 disconnects inductance 77 from the circuit and introduces inductance 78, and simultaneously switch 73 reconnects condenser 80 in the circuit. The inductance 78 is of the value necessary so that these switching operations produce no change in frequency of the tuning circuit. The inductance 78 is smaller than the inductance 77 to compensate for the introduction of condenser 80 in the circuit. Adjustment of the condenser 71 with these connections results in a slow change of frequency for the same reason as when the inductance 76 and condenser 80 were in circuit. The portion of the frequency spectrum covered by adjustment of the condenser 71 under these conditions may correspond, for example, to that portion between 15.35 and 15.1 megacycles.

At the end of that portion of the frequency spectrum, switch 74 removes inductance 78 from circuit and introduces inductance 79 into the circuit, while switch 73 removes condenser 80 from the circuit. This switching operation is also carried out without any change of frequency because the inductance 79 is made of proper value. Further increase of capacity of condenser 71 produces a rapid change in frequency.

It is evident from the above description that the circuit of Figure 11 produces in sequence a rapid change, a slow change, a rapid change, a slow change, and a rapid change of frequency, with uniform change in capacity of the variable condenser 71. It is evident that the shape of the plates of condenser 71 may be modified to produce the substantially uniform frequency change over the two short wave bands on each of the scales illustrated in Figure 10. If desired, separate fixed condensers for each of the five tuning ranges, corresponding to each of the inductances 75 to 79 may be employed instead of a single condenser 80.

In Figure 12 is illustrated a circuit which produces an effect similar to that of the circuit of Figure 11. This circuit includes a variable condenser 85, a fixed inductance 86, and a fixed inductance 89. Connected to operate in unison with the condenser 85 are switches 87 and 88. At the high frequency end of the scale, inductances 86 and 89 and the variable condenser 85 are inserted. Adjustment of condenser 85 under such condition produces a relatively rapid change of frequency. At a desired frequency switch 87 introduces condenser 90 into circuit and switch 88 short circuits inductance 89, so as to remove it from the circuit. Inductance 89 and condenser 90 are of suitable values so that the frequency immediately preceding the switching operation is the same as that immediately following the the switching operation.

After condenser 90 is inserted and inductance 89 is removed, the rate of change of frequency with change in capacity of the variable condenser 85 is materially reduced. At the end of the desired spread band portion, switch 87 removes condenser 90 from the circuit and substitutes condenser 91, a smaller condenser. Simultaneously switch 88 removes the short circuit from the inductance 89, so that it is again effective in the circuit. Condenser 91 is of suitable value so that the switching operation is effected without a change of frequency to which the circuit is tuned. After this switching operation the rate of change of frequency with change of capacity of the adjustable condenser 85 is rapid.

As the capacity of condenser 85 is further increased, switch 87 removes condenser 91 from the circuit and substitutes condenser 92, a larger condenser, in place thereof. Switch 88 again removes inductance 89 from the circuit by short circuiting it. Condenser 92 is of suitable value to maintain the frequency the same before and after the switching operation. After this switching operation the rate of change of frequency is again slow over a desired range, after which switch 87 removes condenser 92 from the circuit and introduces condenser 93, a smaller condenser than 92. Simultaneously, switch 88 removes the short circuit from inductance 89 so that it is again effective in the circuit. Condenser 93 is of suitable value to maintain the frequency the same before and after the switching operation. Thereupon further increase of capacity of the condenser 85 produces a rapid change of frequency. It is thus evident that this circuit also produces in sequence a rapid change, a slow change, a rapid change, a slow change, and a rapid change of frequency.

In Figure 13 there is illustrated a circuit arranged to produce the same effect and including a variable inductance such as those illustrated in Figures 6 and 7. This circuit includes a fixed condenser 95 and a variable inductance 96. Operatively connected to the inductance 96 for movement in unison therewith are switches 97 and 98. At the high frequency end of the portion of the spectrum covered by the tuning circuit, inductance 96 and condensers 95 and 100 are inserted. With these connections a small change in inductance produces a large change in frequency. At a desired frequency, switch 98 removes condenser 100 from the circuit and at the same time switch 97 places the additional inductance 99 in circuit in series with inductance 96. Inductance 99 and condenser 100 are of suitable values so that the frequency with which the tuning circuit is resonant is the same before and after the switching operation.

With the added inductance 99 in circuit, change of frequency upon change in the inductance 96 is slow so as to spread the frequencies of a desired portion of the spectrum. At the end of that band over which frequencies are so spread, switch 97 again removes inductance 99 from the circuit by short circuiting and switch 98 places a relatively large condenser 101 in circuit, the condenser 101 having a value such that a frequency

change is not produced by the switching operation.

Further adjustment of inductance 96 produces a rapid change in frequency with such switching connections. As the inductance further increases, switch 98 removes condenser 101 from circuit and substitutes therefor a smaller condenser 102, while switch 97 simultaneously reinserts inductance 99 in the circuit. Condenser 102 is of suitable value to maintain the frequency the same before and after the switching operation. This change in the circuit spreads another portion of the band, so that further increase of the inductance 96 produces a relatively slow change of frequency.

Upon still further increase in inductance 96, switch 97 removes the inductance 99 from circuit by short circuiting it, and switch 98 removes condenser 102 from circuit and substitutes a larger condenser 103 in its place. Again, there is no change of frequency before and after the switching operation. After this circuit change, change of inductance 96 produces a rapid change of frequency. It is evident that this circuit produces much the same effect as the circuits of Figures 11 and 12.

The circuits of Figures 11 through 13 are particularly suited for producing the results illustrated on the two scales of Figure 10. As pointed out previously, the spread-out portions of each of these scales are spread substantially uniformly and equally, the intermediate portions on each scale being compressed. It is evident that these circuits may be employed without band switching to produce over one scale all of the changes in tuning rate illustrated in Figure 10 on two scales by merely providing the requisite number of elements to cover the entire range.

In the drawings only those elements of tuning circuits necessary to produce an operative circuit have been disclosed. It is evident that additional refinements in turning circuits may be employed in conjunction with the present invention without departing from the spirit thereof. The switches employed in the various circuits of Figures 11, 12 and 13 may be mounted upon the same shaft or other movable member used to tune the variable tuning member, and may be of the snap-action type. However, these switches may be separate from the tuning member and may be operated therefrom by any suitable means such as gears, belt chain drives, etc.

While I have shown and described particular embodiments of my invention, it will be obvious to those skilled in the art that changes and modifications may be made without departing from my invention in its broader aspects, and I, therefore aim in the appended claims to cover all such changes and modifications as fall within the true spirit and scope of my invention.

I claim:

1. In a radio receiver for receiving signals at any frequency within a large portion of the radio frequency spectrum having a plurality of separated allocated bands in each of which there are a relatively large number of broadcast signals differing in frequency by relatively small amounts, each pair of adjacent allocated bands being separated by a relatively large contiguous so-called "dead" range of frequencies within which range there are a relatively few broadcast signals differing in frequency by relatively large amounts, the combination of a switchless tuning circuit having a fixed inductance and a variable capacitance, said capacitance having two relatively movable members, one of which is a movable tuning element continuously adjustable for varying the capacitance of said circuit to tune said circuit continuously within said portion of the spectrum to any desired frequency within said bands and so-called "dead" range, and a control element for continuously moving said tuning element through a first series of positions and through intermediate positions to and through a second series of positions, within which first and second series of positions said circuit is tuned to desired frequencies within two of said separated allocated bands, said intermediate positions corresponding to resonant frequencies within the intervening so-called "dead" range, at least one of said relatively movable members being shaped to vary relatively rapidly the resonant frequency of said circuit within said intervening so-called "dead" range for a given rate of displacement of said tuning element through said intermediate positions and being shaped to vary the resonant frequency of said circuit within one of said two separated bands at a substantially lower rate for the same rate of displacement of said tuning element through said first series of positions and at substantially the same rate within the other of said two separated bands through said second series of positions.

2. In a radio receiver for receiving signals at any frequency within a large portion of the radio frequency spectrum having a plurality of separated allocated bands in each of which there are a relatively large number of broadcast signals differing in frequency by relatively small amounts, each pair of adjacent allocated bands being separated by a relatively large contiguous so-called "dead" range of frequencies within which range there are a relatively few broadcast signals differing in frequency by relatively large amounts, the combination of a switchless tuning circuit having a fixed inductance and a variable capacitance, said capacitance having two relatively movable members, one of which is a rotatably movable tuning element continuously adjustable for varying the capacitance of said circuit to tune said circuit continuously within said portion of the spectrum to any desired frequency within said bands and so-called "dead" range, and a control element for continuously and rotatively moving said tuning element through a first series of positions and through intermediate positions to and through a second series of positions, within which first and second series of positions said circuit is tuned to desired frequencies within two of said separated allocated bands, said intermediate positions corresponding to resonant frequencies within the intervening so-called "dead" range, at least one of said relatively movable members being shaped to vary relatively rapidly the resonant frequency of said circuit within said intervening so-called "dead" range for a given rate of displacement of said tuning element through said intermediate positions and being shaped to vary the resonant frequency of said circuit within one of said two separated bands at a substantially lower rate for the same rate of displacement of said tuning element through said first series of positions and at substantially the same rate within the other of said two separated bands through said second series of positions.

3. In a radio receiver for receiving signals at any frequency within a large portion of the radio frequency spectrum having a plurality of sepa-

rated allocated bands in each of which there are a relatively large number of broadcast signals differing in frequency by relatively small amounts, each pair of adjacent allocated bands being separated by a relatively large contiguous so-called "dead" range of frequencies within which range there are a relatively few broadcast signals differing in frequency by relatively large amounts, the combination of a switchless tuning circuit having a fixed inductance and a variable capacitance, said capacitance having two relatively movable members, one of which is a movable tuning element continuously adjustable for varying the capacitance of said circuit to tune said circuit continuously within said portion of the spectrum to any desired frequency within said bands and so-called "dead" range, movement of said movable tuning element producing substantially no change in the magnitude of said inductive reactance, said movement of said movable tuning element changing the resonant frequency of the tuned circuit solely by producing capacitance changes in said variable capacitance, and a control element for continuously moving said tuning element through a first series of positions and through intermediate positions to and through a second series of positions, within which first and second series of positions said circuit is tuned to desired frequencies within two of said separated allocated bands, said intermediate positions corresponding to resonant frequencies within the intervening so-called "dead" range, at least one of said relatively movable members being shaped to vary relatively rapidly the resonant frequency of said circuit within said intervening so-called "dead" range for a given rate of displacement of said tuning element through said intermediate positions and being shaped to vary the resonant frequency of said circuit within one of said two separated bands at a substantially lower rate for the same rate of displacement of said tuning element through said first series of positions and at substantially the same rate within the other of said two separated bands through said second series of positions.

4. In a radio receiver for receiving signals at any frequency within a large portion of the radio frequency spectrum having a plurality of separated allocated bands in each of which there are a relatively large number of broadcast signals differing in frequency by relatively small amounts, each pair of adjacent allocated bands being separated by a relatively large contiguous so-called "dead" range of frequencies within which range there are a relatively few broadcast signals differing in frequency by relatively large amounts, the combination of a switchless tuning circuit having a fixed inductance and a variable capacitance, said capacitance having two relatively movable members, one of which is a movable tuning element continuously adjustable for varying the capacitance of said circuit to tune said circuit continuously within said portion of the spectrum to any desired frequency within said bands and so-called "dead" range, and a control element for continuously moving said tuning element through a first series of positions and through intermediate positions to and through a second series of positions, within which first and second positions said circuit is tuned to desired frequencies within two of said separated allocated bands, said intermediate positions corresponding to resonant frequencies within the intervening so-called "dead" range, at least one of said relatively movable members having two portions of relatively small area separated by a portion of relatively large area, said member being shaped to vary relatively rapidly the resonant frequency of said circuit within said intervening so-called "dead" range for a given rate of displacement of said tuning element through said intermediate positions and being shaped to vary the resonant frequency of said circuit within one of said two separated bands at a substantially lower rate for the same rate of displacement of said tuning element through said first series of positions and at substantially the same rate within the other of said two separated bands through said second series of positions, said portions of relatively small area corresponding to said separated bands.

5. In a radio receiver for receiving signals at any frequency within a large portion of the radio frequency spectrum having a plurality of separated allocated bands in each of which there are a relatively large number of broadcast signals differing in frequency by relatively small amounts, each pair of adjacent allocated bands being separated by a relatively large contiguous so-called "dead" range of frequencies within which range there are a relatively few broadcast signals differing in frequency by relatively large amounts, the combination of a switchless tuning circuit having a fixed inductance and a variable capacitance, said capacitance having two relatively movable members, one of which is a movable tuning element continuously adjustable for varying the capacitance of said circuit to tune said circuit continuously within said portion of the spectrum to any desired frequency within said bands and so-called "dead" range, and a control element for continuously moving said tuning element through a first series of positions and through intermediate positions to and through a second series of positions, within which first and second series of positions said circuit is tuned to desired frequencies within two of said separated allocated bands, said intermediate positions corresponding to resonant frequencies within the intervening so-called "dead" range, at least one of said relatively movable members having a pair of cutout portions, said member being shaped to vary relatively rapidly the resonant frequency of said circuit within said intervening so-called "dead" range for a given rate of displacement of said tuning element through said intermediate positions and being shaped to vary the resonant frequency of said circuit within one of said two separated bands at a substantially lower rate for the same rate of displacement of said tuning element through said first series of positions and at substantially the same rate within the other of said two separated bands through said second series of positions, said cutout portions corresponding to said two separated bands.

6. In a radio receiver for receiving signals at any frequency within a large portion of the radio frequency spectrum having a plurality of separated allocated bands in each of which there are a relatively large number of broadcast signals differing in frequency by relatively small amounts, each pair of adjacent allocated bands being separated by a relatively large contiguous so-called "dead" range of frequencies within which range there are a relatively few broadcast signals differing in frequency by relatively large amounts, the combination of a switchless tuning circuit having fixed inductance and a variable capacitance, said capacitance having at least one fixed plate and at least one plate spaced therefrom and parallel

thereto and rotatably mounted for relative movement with respect to the fixed plate, the overlap area being dependent upon the location of said movable plate relative to said fixed plate, the amount of said capacitance depending upon the amount of said overlap area, the position of said rotatably mounted plate relative to said fixed plate being continuously adjustable for varying the capacitance of said circuit to tune said circuit continuously within said portion of the spectrum to any desired frequency within said bands and so-called "dead" range without substantial change in the quality factor of the circuit, and a control element for continuously and rotatively moving said rotatably mounted plate through a first series of positions relative to said fixed plate and through intermediate positions to and through a second series of positions, within which first and second series of positions said circuit is tuned to desired frequencies within two of said separated allocated bands, said intermediate positions corresponding to resonant frequencies within the intervening so-called "dead" range, said fixed and movable plates being so shaped that the derivative of their overlap area-location function has a relatively large magnitude through said intermediate positions and relatively small magnitudes through said first and second series of positions.

7. In a radio receiver for receiving signals at any frequency within a large portion of the radio frequency spectrum having a plurality of separated allocated bands in each of which there are a relatively large number of broadcast signals differing in frequency by relatively small amounts, each pair of adjacent allocated bands being separated by a relatively large contiguous so-called "dead" range of frequencies within which range there are a relatively few broadcast signals differing in frequency by relatively large amounts, the combination of a switchless tuning circuit having at least two units presenting impedance to the flow of current, one of said two units having primarily inductance and the other having primarily capacitance, at least one of said two units having two relatively movable members, one of which is a movable tuning element continuously adjustable for varying the inductance-capacitance product of said circuit to tune said circuit continuously within said portion of the spectrum to any desired frequency within said bands and so-called "dead" range without substantial change in the quality factor of the circuit, and a control element affixed to said tuning element for continuously moving said tuning element through a first series of positions and through intermediate positions to and through a second series of positions, within which first and second series of positions said circuit is tuned to desired frequencies within two of said separated allocated bands, said intermediate positions corresponding to resonant frequencies within the intervening so-called "dead" range, at least one of said relatively movable members being shaped to vary relatively rapidly the resonant frequency of said circuit within said intervening so-called "dead" range for a given rate of displacement of said tuning element through said intermediate positions and being shaped to vary the resonant frequency of said circuit within said two separated bands at substantially lower rates for the same rate of displacement of said tuning element.

VIRGIL R. BECK.