April 15, 1941. H. RINIA ET AL 2,238,752

RADIO RECEIVER WITH BAND SPREADING

Filed Oct. 14, 1939 3 Sheets-Sheet 1

Fig. 1

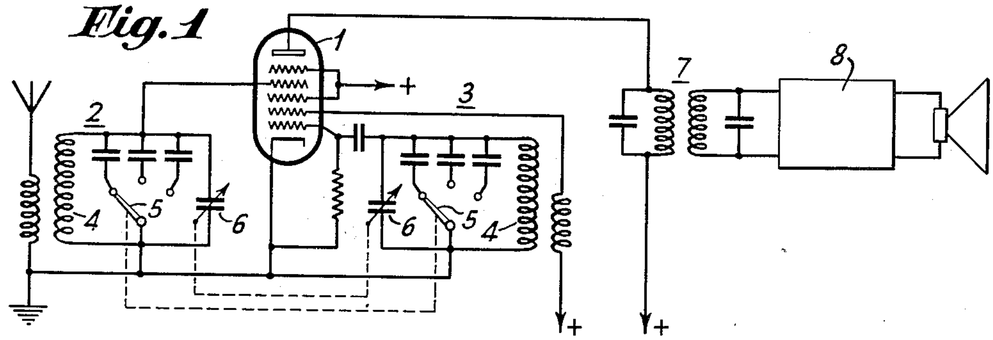

Fig. 2

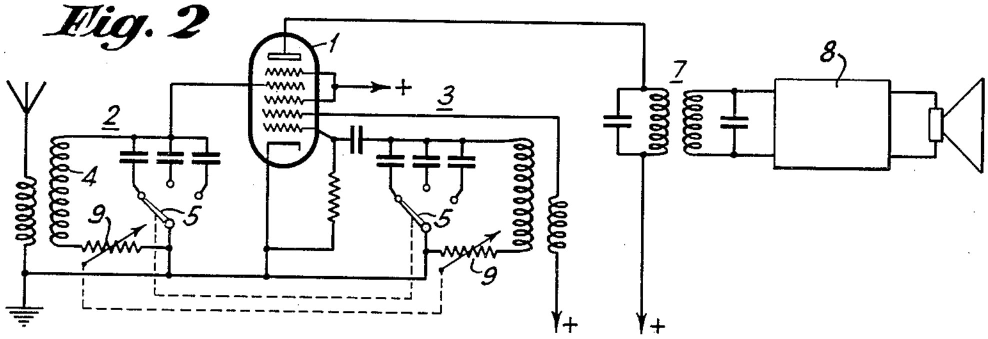

Fig. 3

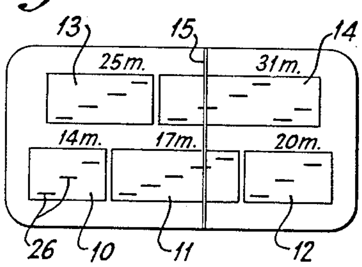

Fig. 4

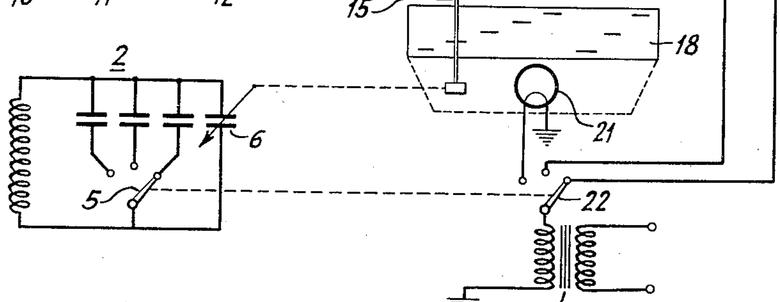

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Fig. 5

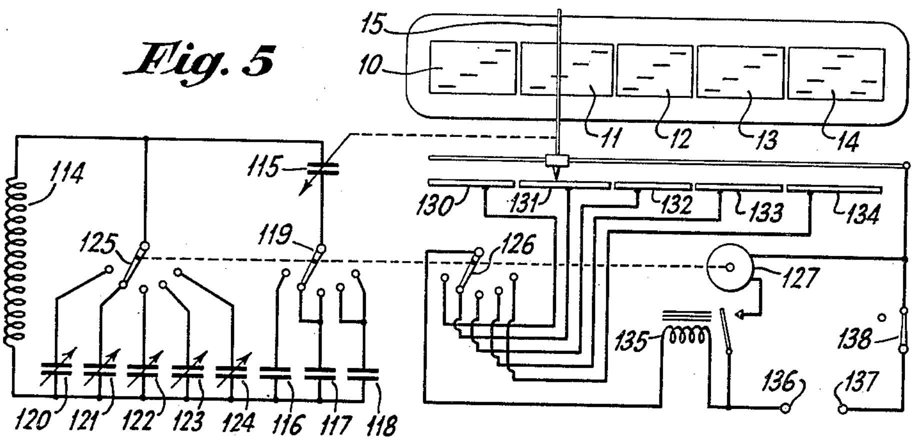

Fig. 6

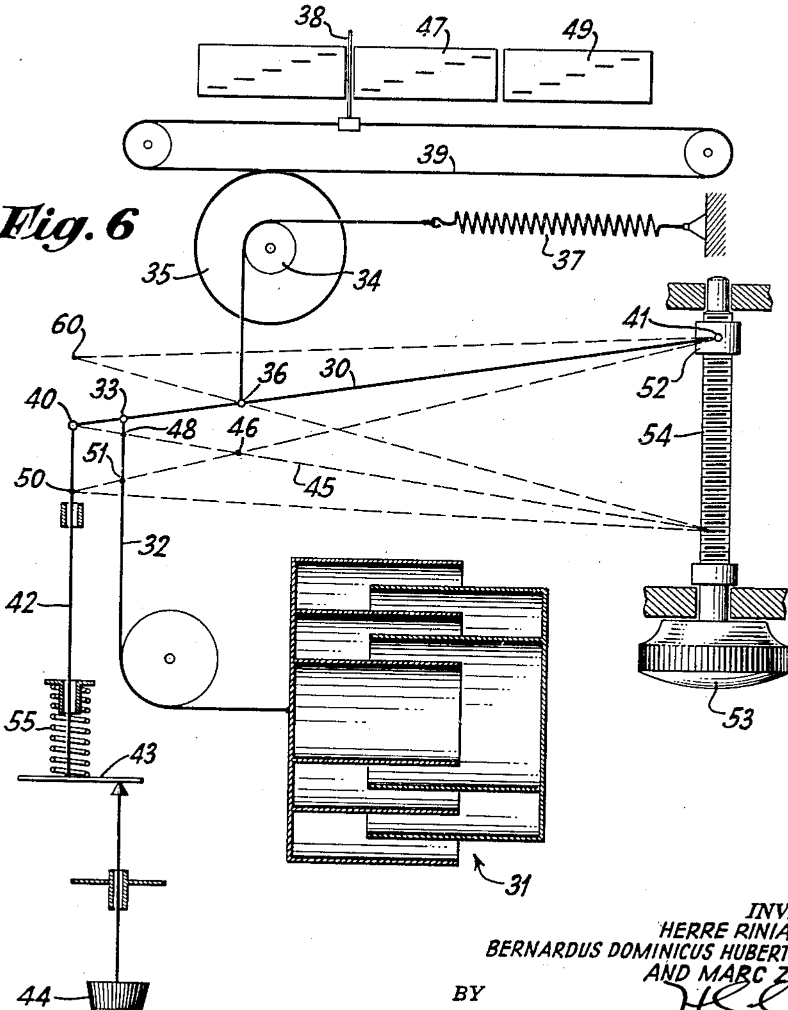

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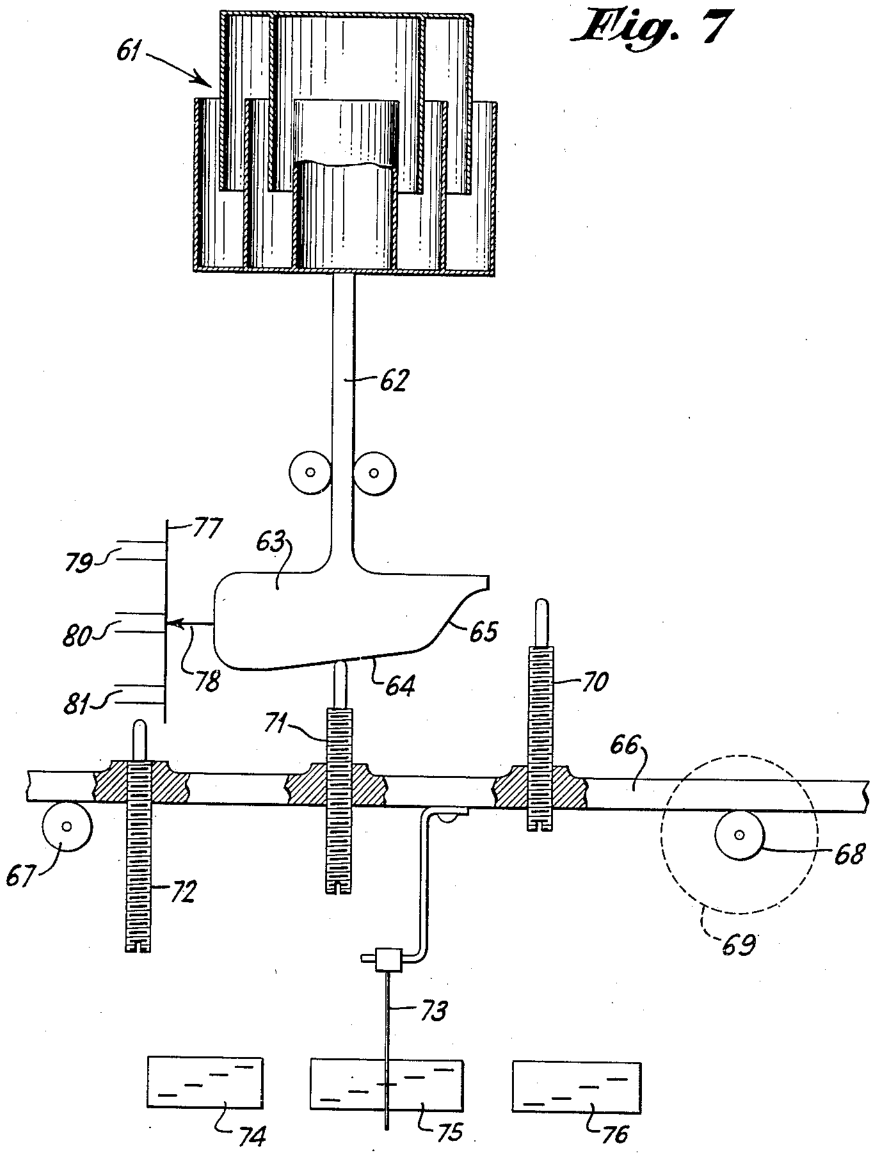
Fig. 7



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RADIO RECEIVER WITH BAND SPREADING

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In the Netherlands February 28, 1939

6 Claims. (Cl. 250—40)

This invention relates to a radio receiver with band spreading for a number of comparatively narrow frequency bands.

The frequencies on which the short wave broadcast transmitters operate are grouped in a number of comparatively narrow frequency bands. There are no important broadcast transmitters in the frequency regions situated between these narrow frequency bands so that these frequency regions are of little importance for a broadcast receiver. There are consequently on the tuning dial large ranges in which there are no broadcasting stations of importance, whilst on the other hand the transmitters are so accumulated within the ranges of the tuning dial that correspond to the comparatively narrow frequency bands that firstly exact adjustment of the receiver is difficult and secondly, due to the fact that the transmitters are situated on the tuning dial in close proximity to each other, the desired transmitter can be found back only with difficulty and mistaking may also readily occur.

This has led to the construction of receivers with so-called band spreading in which it can be ensured by specially proportioning of the tuning means that by successive changes of connections each time one of the comparatively narrow frequency-bands is put on the tuning dial so that a maximum part of the tuning dial is used.

All narrow frequency bands, are, however, not equally wide and, apart from this, the frequency range that can be covered by the complete variation of the tuning members is not constant but, as will be set out more fully, is dependent on the nature and the circuit arrangement of the tuning members and on the value of the mean frequency of the adjusted frequency region with the result that one of the comparatively narrow frequency bands can alone fill the entire tuning dial, whereas the other frequency bands occupy a part only of the tuning dial so that the remaining part of the available space remains unused. In addition, it is not necessary to use the entire width of the tuning dial for tuning in one narrow frequency band since the total width of all the narrow frequency bands is of the same order of magnitude as the width of the intermediate wave-region.

The invention has for its object to provide an improved system for band-spread tuning with the avoidance of the drawbacks advanced hereinbefore of known systems.

The object of the invention is attained by arranging the dial divisions of two or more of the comparatively narrow frequency bands adjacent each other and causing them to be traversed in succession by the same pointer.

According to one embodiment of the invention the movement of the pointer relatively to the tuning dial ensues continuously and synchronously with the movement of one or more tuning members which serve for tuning in the narrow frequency bands, said tuning members being so proportioned that the whole range of variations is necessary for successive tuning in two or more bands and means being provided switching over the circuits in which these tuning members are included for passing over from one frequency band to the other.

As an alternative, the whole or substantially the whole variation of one or more of the tuning members which are already persent in the receiver for tuning within a comparatively wide frequency band may be used for successive tuning in two or more comparatively narrow frequency bands.

In these embodiments the means for switching over the circuits for the passage from one narrow frequency band to another may preferably be operated automatically upon movement of the tuning members which serve for tuning in the narrow frequency bands.

In order that the invention may be clearly understood and readily carried into effect, it will now be described more fully with reference to the accompanying drawings, in which

Fig. 1 shows a receiver circuit with band spreading in which adjustment to a given frequency band is effected by including another fixed condenser in the oscillatory circuits to be tuned for each frequency band, tuning within the frequency band concerned being effected with the aid of variable condensers.

Fig. 2 shows a receiver circuit with band spreading in which band spread tuning is effected with the aid of variable inductances. Similar parts of the circuit arrangements of Fig. 1 and Fig. 2 are designated by like reference numerals.

Fig. 3 shows a tuning dial according to the invention suitable for band spread reception.

Fig. 4 shows a dial indicating device.

Fig. 5 shows a circuit arrangement in conjunction with a tuning dial in which use is made for band spread reception in each oscillatory circuit to be tuned of a tuning condenser which is already present in the receiver and which serves for tuning in comparatively wide frequency-bands, for instance 500 to 1500 kcs./sec.

Figs. 6 and 7 show two mechanical forms of construction according to the invention.

In Fig. 1, 1 designates a mixing valve to which a preselection circuit 2 and an oscillator circuit 3 are connected. Each of these circuits comprises an inductance 4, a number of fixed condensers capable of being connected into circuit in succession by means of a switch 5 and a small variable condenser 6. The switch 5 permits of the receiver being adjusted in succession to different frequency bands, whereas the condensers 6 serve for tuning the receiver in these frequency bands. Instead of using a number of fixed condensers which are connected into circuit in succession by means of a switch use may also be made of a sliding-electrode condenser capable of being adjusted to each frequency band by press-buttons. By the intermediary of a band-pass wave filter 7 tuned to the intermediate frequency, the anode circuit of the mixing valve 1 is connected to the intermediate-frequency amplifier, detector and low-frequency amplifier of the receiver which are schematically represented by 8.

Simple calculation shows that the frequency range which is traversed during the complete variation of the condensers 6 is approximately proportional to the third power of the mean frequency to which the oscillatory circuit is tuned so that, if all the frequency bands are assumed to be equally wide, traversing a frequency band having a high mean frequency involves a substantially smaller variation of the condensers 6 than traversing a frequency band having a low mean frequency. Since the pointer of the tuning dial is mechanically coupled to these condensers in such manner that the whole dial is traversed during a complete variation of these condensers the frequency band having a high mean frequency will occupy a much smaller part of the tuning dial with this band spread circuit arrangement than the frequency band having a low mean frequency.

Referring to Fig. 2 where tuning is effected to the center of the frequency bands, in a manner similar to that of the circuit arrangement of Fig. 1, whereas tuning within the frequency bands is effected by the variation of variable inductances 9 included in the circuits 2 and 3, a calculation similar to the previous one shows that the frequency range which is traversed during the complete variation of the inductances 9 is approximately proportional to the mean frequency to which the oscillatory circuits are tuned by means of the fixed condensers and the switch 5. In this case also with the same assumption of equally wide frequency bands, traversing a frequency band having a high mean frequency involves a smaller variation of the inductances 9 than traversing a frequency band having a low mean frequency, although in this band spread arrangement the differences are not so great as in the previous one.

Since, moreover, the comparatively narrow frequency bands are in fact not equally wide, the drawback of the inefficiently filled tuning dial is also experienced in the last-described form of construction.

According to the invention this may be obviated in the manner already referred to in the opening part.

Fig. 3, which shows a band spread tuning dial according to the invention, serves to illustrate this principle.

In Fig. 3, 10, 11, 12, 13 and 14 designate respectively parts of a tuning dial which serve for tuning in the 14 meter, 17 meter, 20 meter, 25 meter and 31 meter bands in view of which the 14 meter, 17 meter and 20 meter bands are continuous, as are the 25 meter and the 31 meter bands. Tuning to the stations indicated by the portions 26 may be effected with the aid of a pointer 15. Intermediate the two extreme positions of the pointer 15 is the whole range of the tuning dial and also the whole variation of the tuning means that serve for band spread tuning. Now, part of this whole variation is used for tuning in the 25 meter band 13 and the remaining part for tuning in the 31 meter band 14. The whole variation is also used for tuning in the 14 meter, the 17 meter and the 20 meter bands jointly. When the pointer passes from the dial part 13 to the dial part 14 the tuning means of the 25 meter band have to be changed-over or adjusted from the 25 meter band to the 31 meter band. When this is not effected frequencies are received which are located outside the 25 meter band. Changing-over or adjustment to a further frequency band may be effected, for example, by means of a switch which can be operated by hand or upon movement of the tuning condensers. In the case of Fig. 3 where two groups of frequency bands are located above each other on the tuning dial the limits of the bands do not occur at the same position of the tuning condensers so that automatic band-change becomes very involved. If the band-change is effected by hand an indicating device must be provided to indicate to which frequency band the receiver is adjusted. This indicating device may be constituted, for example, by a number of small dial-illuminating lamps each of which is capable of illuminating a part of the tuning dial which is associated with a given frequency band, said lamps being connected into circuit alternately and synchronously with the band-changing device, such as the switch 5 of Figs. 1 and 2 or the push-buttons, already mentioned in the description thereof, for adjustment to the desired frequency band.

Fig. 4 shows such an indicating device in conjunction with the oscillatory circuit 3 of Fig. 1. A switch 5 permits of the oscillatory circuit 2 being tuned to three different frequency bands. These frequency bands correspond to the dial parts 16, 17 and 18 of the tuning dial. Tuning within these frequency bands is effected by means of a variable condenser 6 which is mechanically coupled to the pointer 15 of the tuning dial. Upon a complete variation of the condenser 6 the pointer 15 traverses the whole tuning dial. The dial parts 16, 17 and 18 are illuminated respectively by small dial-illuminating lamps 19, 20 and 21 which are connected to a winding of the mains transformer 23 through a switch 22. The switch 22 is mechanically coupled to the frequency band switch 5. In the position shown of the switches the dial part 16 alone is illuminated. When tuning within the frequency-band that corresponds to this dial part a part only of the variation of the condenser 6 is used. As soon as the pointer 15 leaves the illuminated dial part 16 changing-over to the frequency-band that corresponds to the dial part 17 has to be effected, the lamp 19 being cut out of circuit and the lamp 20 connected into circuit. The remaining part of the variation of the condenser 6 then serves for tuning within this frequency-band.

Fig. 5 shows a circuit arrangement of an oscillatory circuit suitable for band spreading in conjunction with a band spread tuning dial, the dial parts that serve for tuning within the frequency bands being all in a line. In this circuit arrangement the whole or substantially the whole variation of one or more of the tuning members which are already present in the receiver for tuning within a comparatively wide frequency-band is used for tuning in succession in two or more comparatively narrow frequency-bands, the means for switching the circuits when passing from one narrow frequency-band to another being automatically operated upon movement of the tuning members that serve for tuning in the narrow frequency bands.

The oscillatory circuit shown in Fig. 5 includes an inductance 114, a variable tuning condenser 115 which is also used in tuning in a comparatively wide frequency-band, some fixed condensers 116, 117, 118, which can alternately be connected in series with the condenser 115 by means of a switch 119 and some variable condensers 120, 121, 122, 123, 124 which, by means of a switch 125, can alternately be connected in parallel with the series combination of the condenser 115 and one of the fixed condensers. In this form of construction the two switches 119 and 125 are mechanically coupled to one another and to an auxiliary switch 126. The switches possess five positions which correspond to the five comparatively narrow frequency-bands and the five dial parts into which the tuning dial is divided. In each of these positions one of the condensers 116, 117, 118 and one of the condensers 120, 121, 122, 123, 124 is connected into circuit. The last mentioned variable condensers permit of the oscillatory circuit being tuned to the mean frequency of each of the frequency-bands. The condensers 116, 117, 118 alternately govern the capacity-variation of the condenser 115 connected in series with one of these condensers. It is found that there is no need to connect another series condenser into circuit for each frequency band. This form of construction offers the great advantage that separate tuning means for band-spreading reception are not present but that the tuning condensers already present in the receiver may serve for this purpose so that the dial driving mechanism may remain unchanged. When the pointer 15 passes from one dial part to another a band-change must be effected since otherwise tuning will be effected outside the frequency-band to which the receiver is intended to be tuned; in other words, reception will be had in a frequency range other than in the range covered by the dial part with which the pointer cooperates. In the embodiment of the invention shown in Fig. 5 this band-change is effected automatically. For this purpose the mechanically coupled switches 119 and 125 are driven by a device 127 which may comprise, for example, a motor or a step magnet. The tuning dial is provided with a number of conductive strips 130, 131, 132, 133, 134 which correspond in length to the successive dial parts 10, 11, 12, 13, 14 and which are connected respectively to the contacts of the auxiliary switch 126. Each of the frequency-bands corresponds to a different position of the switches 119, 125 and 126, to one of the strips 130 to 134 and one of the dial parts 10 to 14. The pointer 15 is alternately in contact with one of the strips 130 to 134 and in the position, shown in the drawings, of the switches and of the pointer it closes a circuit in which a relay 135 is included. This relay receives current from a source of current (not shown) which is connected between the terminals 136 and 137 and in this state it interrupts the energizing circuit for the device 127. When the pointer 15 leaves the dial part 11 and makes contact with the strip 132 the relay 135 becomes inoperative so that the device 127 starts to drive the switches. As soon as the arm of the switch 126 reaches the contact which corresponds to the strip 132 the relay 135 is energized so that the device 127 is cut out of circuit.

A switch 138 operated by the wavelength switch ensures that the above-described device can operate in the case of band-spreading reception only.

Fig. 6 shows an embodiment of the invention in which for the purpose of obtaining band-spreading use is solely made of a mechanical construction. This mechanical construction constitutes a connection between the tuning means, the operating knobs and the pointer drive of the tuning dial and comprises a lever 30 whose two ends can be shifted.

Intermediate these two ends the driving mechanism of the pointer and of the tuning means are arranged at properly chosen points. In Fig. 6 the tuning means are represented by a sliding-electrode condenser 31 which, by means of a cord 32, is connected to the lever 30 at the piont 33. The lever 30 and the sliding-electrode condenser 31 may also be gauged or interconnected by a connecting rod. The drive for the pointer comprises two drums 34 and 35 mounted on one shaft in view of which the smallest 34 has running over it a cord which on the one hand is coupled to the lever 30 at the point 36 and on the other hand is kept stressed by a spring 37. The pointer 38 is moved by a cord 39 running over the drum 35. The lever 30 has two ends 40 and 41. The end 40 is fixed to a rod 42 which is provided with a plate 43 acted upon by a number of push-buttons. One of these push-buttons is designated 44 in Fig. 6. Upon depression of a push-button the plate 43 and the rod 42 are shifted against the action of a spring 55. The lever pivots at the end 41 which, prior to operating the push-buttons, is moved into a predetermined position. During this rotation both the sliding-electrode condenser 31 and the tuning pointer 38 are driven. The receiver can be tuned in this manner to a number of pre-selected stations situated, for example, in the medium wave band.

The end 41 is coupled to a nut 52 which, by means of a screw 54 driven by a tuning knob 45, can be pushed forward and backward.

For reception with band spreading the band concerned is selected by moving the end 40 of the lever 30 into one of the positions 40, 50 or 60 by means of one of the push-buttons. Subsequently, tuning in the band concerned can be effected by rotating the tuning knob 53. If, for example, the end of the lever 30 has been moved into the position 40 by means of the push-button 44, the lever 30 can occupy all positions between the position 30 and the position 45, the end 40 remaining in place and the end 41 moving along the screw 54. During this period the point 36 on the lever 30 where the pointer drive is secured is shifted to the point 46 and the pointer 38 passes over the middlemost band-spreading dial 47. The point 33 on the lever 30 to which the drive of the sliding-electrode condenser 31 is connected is shifted to the point 48. When the tuning knob 53 is then turned back entirely and the end 40 of the lever 30 is moved into the position 50 by means of another push button (not shown), the point 36 on the lever takes up the place of the point 46 so that the end of the band-spreading dial 47 corresponds with the beginning of the band-spreading dial 49. A proper choice of the point 36 on the lever 30 therefore permits of causing the band-spreading dials 47 and 49 to be continuous. Upon rotation of the tuning knob 53 the continuous band-spreading dial 49 is traversed in this position 50 of the end 40. During the movement of the end 40 into position 50 the sliding-electrode condenser 31 jumps, however, over to another value, as is apparent from the situation of the points 33, 48 and 51.

This construction ensures that the band-spreading dials are continuous, as is by no means the case with the capacity ranges within which the sliding-electrode condenser is altered during the tuning operation within the bands, since these capacity ranges are spaced apart similarly to the manner in which the bands in which band-spreading is used are spaced apart in the frequency spectrum. By choosing the point 33 on the lever 30 it is possible to select the ratio between the width of the band and the spacing between two bands. The relative positions of the points 49, 50 and 60 can be established in accordance with the ratios of the mutual distances between the bands, whereas the choice of the point 36 on the lever 30 permits of rendering the tuning dials continuous as far as possible.

Fig. 7 shows a further mechanical construction for obtaining band-spreading.

A sliding-electrode condenser 61 is connected to a shoe 63 by means of a rod 62. This shoe comprises a feeble incline 64 and a steep incline 65. A rod 66 is arranged below the shoe 63 so as to be adapted to slide. This rod 66 rests on two small rollers 67 and 68 and can be displaced by means of a tuning knob 69. The rod 66 has arranged in it a number of adjusting screws 70, 71 and 72 corresponding respectively with the frequency bands in which band-spreading is employed. The rod 66 also carries a pointer 73 which, upon the rod 66 being displaced by means of the knob 69, passes over a number of substantially continuous tuning dials 74, 75 and 76 corresponding with the said frequency bands. The shoe 63 is forced by a spring (not shown), by means of one of its inclines, against one of the adjusting screws 70, 71 or 72, according to the position of the rod 66.

Upon rotation of the tuning knob 69 the rod 66 is displaced, so that the adjusting screw 71, which is shown engaging the feeble incline 64 of the shoe 63, slides along this incline and thus enables the sliding-electrode condenser 61 to move a short distance. If the rod 66 is displaced to the right, the adjusting screw 71 passes from the feeble incline 64 over to the steep incline 65 of the shoe 63 so that the sliding-electrode condenser 61 slides quickly until the feeble incline 64 engages the adjusting screw 72. Upon further displacement of the rod 66 the sliding-electrode condenser 61 slides slowly again. The pointer 73 is so adjusted relatively to the tuning dials that slow movement of the sliding-electrode condenser occurs when the pointer 73 is over one of the tuning dials, whereas rapid movement occurs when the pointer 73 is intermediate the tuning dials.

The spacings between the tuning dials depend on the steepness of the incline 65; 77 and 78 designate schematically the normal tuning dials and the associated pointer. The bands in which band spreading is employed are designated by 79, 80 and 81. The pointer 78 moves slowly through these bands but rapidly through the intermediate parts of the tuning dial. Each of the adjusting screws 70, 71 and 72 is adjustable, so that each of the tuning dials 74, 75 and 76 can be rated separately.

What we claim is:

1. A radio receiver comprising at least one tunable circuit and means for tuning said circuit over a wide frequency range, said range including a plurality of comparatively narrow frequency bands, means constructed and arranged to effect band spreading of said tunable circuit for said narrow frequency bands, a separate band spread scale for each of said narrow frequency bands, and a common indicator pointer under the control of said tuning means adapted to successively traverse said band spread scales.

2. A radio receiver as defined in claim 1, wherein the pointer moves synchronously with the movement of the tuning means, said tuning means being so proportioned that the whole range of variations is necessary for the successive tuning in of two or more bands, and means under the control of the pointer for conditioning the circuit to respond to appropriate frequency band.

3. A radio receiver as defined in claim 1, wherein substantially the whole variation of the tuning means utilized for tuning through a comparatively wide frequency band is used for the successive tuning in of two or more comparatively narrow frequency bands.

4. A radio receiver as defined in claim 1, wherein the band spread means for switching the tunable circuit from one narrow frequency band to another are operated automatically upon movement of the tuning means which serves for tuning in said narrow frequency bands.

5. A radio receiver comprising at least one tunable circuit and means for tuning said circuit over a wide frequency range, band spread means for converting said tunable circuit to respond respectively to a plurality of comparatively narrow frequency bands within said range, a plurality of aligned band spread scales, one for each of said narrow frequency bands, and a common indicator pointer under the control of said tuning means adapted to successively traverse said band spread scales.

6. A radio receiver as defined in claim 5, wherein the band spread means comprises a plurality of condensers and switch means for selectively connecting one of said condensers in series and another in shunt to said tuning means, there being as many switch positions as there are band spread scales, means for operating the band spread switch means, and means under control of the indicator pointer for energizing said operating means whereby the tunable circuit is automatically conditioned for reception in the frequency band corresponding to the scale with which the indicator pointer is in cooperative relation.

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