Dec. 17, 1935. W. L. CARLSON ET AL 2,024,816

RADIO RECEIVING SYSTEM

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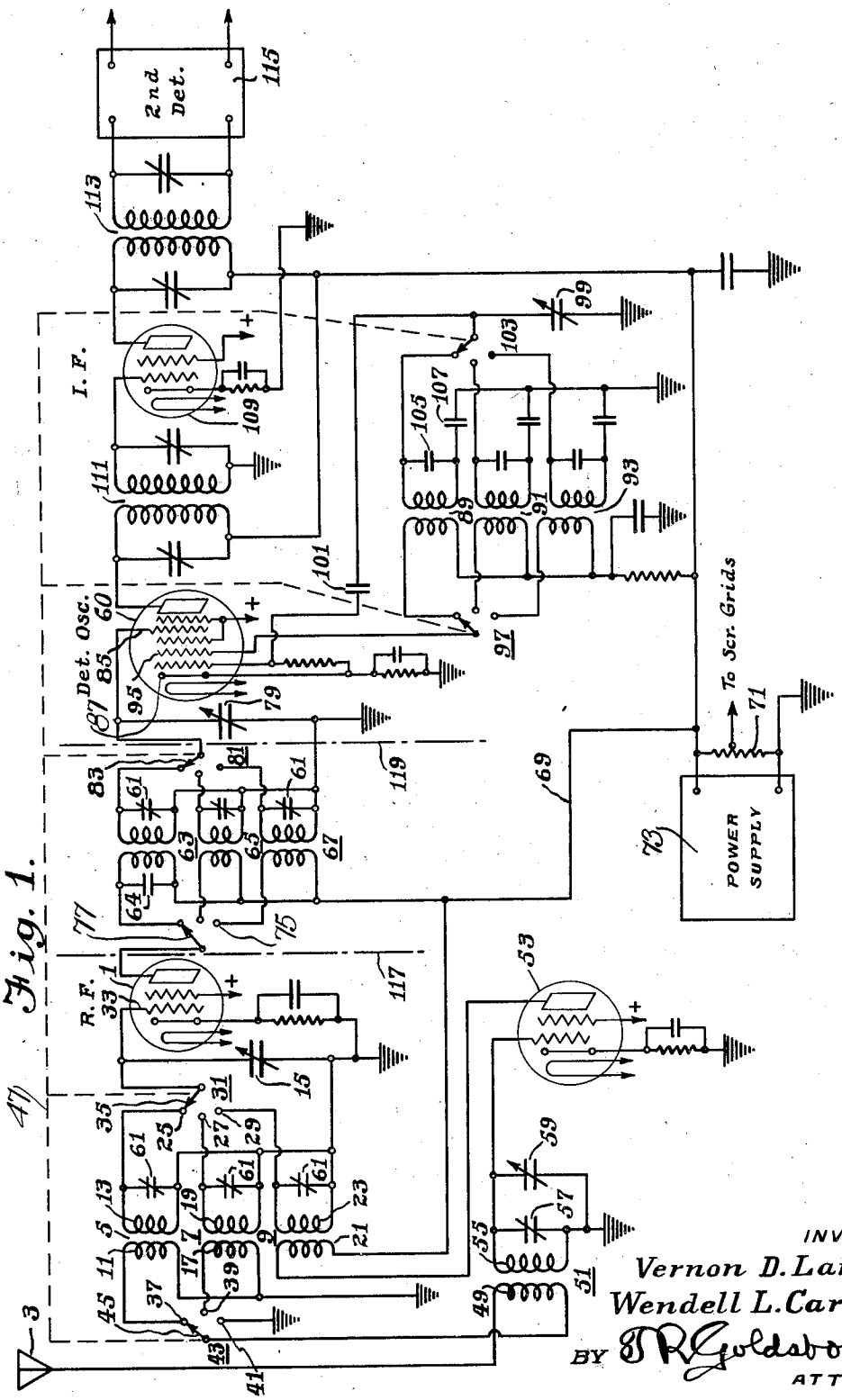


Fig. 1.

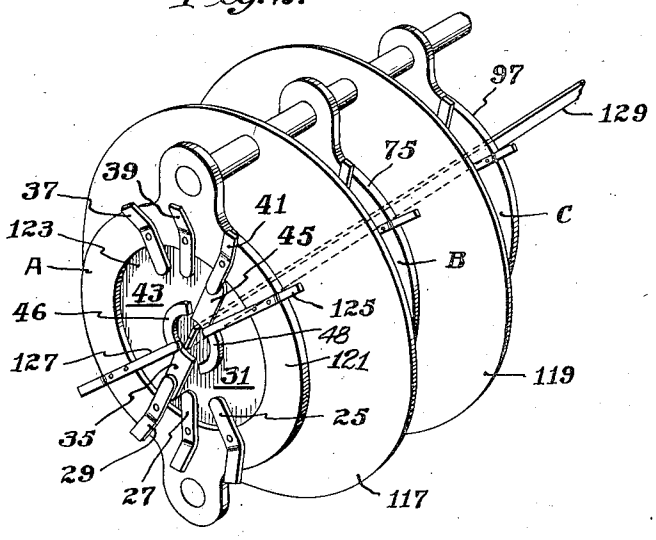
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Fig. 2.



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RADIO RECEIVING SYSTEM

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13 Claims. (Cl. 179—171)

The present invention relates to radio receiving systems and more particularly to radio receiving systems wherein radio signals are selectively receivable through a plurality of differing signal wave or frequency bands.

In receiving systems of the character above described there is a tendency for the amplifier gain to vary from band to band substantially in inverse proportion to the change in frequency from one band to another based upon the mid-band frequency. This does not present any serious problem in design until the frequency range to be covered by the receiver becomes rather wide. It is then found that, in order to obtain sufficient gain in a high frequency band, an additional stage of amplification must be provided which, if conventional receiver design is followed, will make the gain much more at the lower frequencies than is required, and which will increase the cost of the receiver considerably.

It has been found that the tendency for the gain to vary for the different frequency ranges may be reduced to a certain extent by modifying the design of the amplifier coupling means, such as the amplifier coupling transformers for the lower frequency ranges or bands. Modification of the coupling units or transformer design is limited, however, by the preferred and desirable use of a common variable tuning element for each of the wave bands, such as a single gang tuning condenser, while obtaining substantially uniform amplification throughout the different wave bands.

It is an object of the present invention to provide a radio receiving system which may operate to selectively receive radio signals in a plurality of different wave bands or frequency ranges with substantially the same uniform gain for each of said ranges.

It is a further object of the invention to provide switching means and circuits therefor for selecting the various wave or frequency bands to be received.

It is a still further object of the invention to provide amplifier switching circuits adapted for operation in connection with a common unitary gang wave change switch whereby undesirable feed-back coupling between amplifier input and output circuits is prevented without additional shielding in said switch.

In practicing our invention, in one embodiment thereof we utilize a plurality of radio frequency transformers in each radio frequency amplifier stage, and provide an additional radio frequency amplifier stage for one or more of the higher frequency bands. We also provide switching mechanism for connecting the proper transformer into the amplifier circuit for each frequency band, and for completing the extra amplifier connection with the receiver circuit for one or more of the said higher frequency bands. Preferably, we so connect an extra tuned high frequency amplifier or preamplifier that undesired capacity coupling between its input circuit and output, due to capacity coupling between switch elements, is avoided without resorting to additional shielding.

Other objects, features and advantages of our invention will appear from the following description taken in connection with the accompanying drawings in which

Figure 1 is a circuit diagram of a radio receiver constructed in accordance with one embodiment of our invention; and

Fig. 2 is a perspective view of a gang switch used in the receiver shown in Fig. 1.

Referring to Fig. 1, the receiver is preferably of the superheterodyne type comprising a radio frequency amplifier 1 having an input circuit which may be coupled to an antenna 3 through any one of a plurality of transformers 5, 7, and 9.

A transformer is provided for each frequency band that is to be covered, the number of transformers which are employed depending upon the width of the frequency range to be covered by the receiver.

In Fig. 1, the receiver is shown designed for operation over three frequency bands. Transformer 5, having a primary winding 11 and a secondary winding 13, is designed to cover one frequency band in conjunction with the common variable tuning condenser 15. Transformer 7, having a primary winding 17 and a secondary winding 19, is designed to cover a higher frequency band, and transformer 9, having a primary winding 21 and a secondary winding 23, is designed to cover a still higher frequency band. The common tuning condenser 15 is used for tuning each transformer secondary through each band, as will be seen hereinafter.

The lower ends of the secondary windings 13, 19, and 23 are connected to ground and to one terminal of the tuning condenser 15. The upper ends of the secondary windings 13, 19, and 23 are connected to the switch points 25, 27, and 29, respectively, of a switch 31 which forms part of one section of a gang switch. The upper ends of these secondary windings may be selectively connected to the upper terminal of the variable condenser 15 and to the control electrode 33 of the

radio frequency amplifier 1 through a switch arm 35.

The lower ends of the primary windings 11, 17, and 21 are connected to ground, while their upper ends are connected to the switch points 37, 39, and 41 of a switch 43 which forms a second part of a section of the above-mentioned gang switch. These primary windings may be selectively connected to the antenna 3 through a switch arm 45 which is operated simultaneously with the switch arm 35 through a uni-control connection indicated by the dotted line 47.

In accordance with our invention, and for reasons which will be explained hereinafter, the switch arm 45 is not connected directly to the antenna 3, but, instead, is connected to the antenna through the primary winding 49 of a transformer 51, included in the input circuit of a second radio frequency amplifier 53.

As previously mentioned, it is comparatively difficult to obtain sufficient gain in a receiver in the high frequency band. Therefore, in accordance with one feature of our invention, means is provided for connecting the second amplifier 53 in cascade with the radio frequency amplifier 1 when the receiver is set for operation on the highest frequency band.

The coupling of the output circuit of the amplifier 53 to the input circuit of the radio frequency amplifier 1 is provided through the transformer 9, the primary winding 21 of which is included in the plate circuit of the amplifier 53.

In the input circuit of the amplifier 53, the secondary winding 55 of the transformer 51 is provided with the usual trimmer condenser 57 and with a tuning condenser 59 which last condenser may be varied simultaneously with the tuning condenser 15 through a suitable common control connection.

The lower contact point 41 of the switch 43 is connected to ground whereby the primary winding 49 is connected directly between the antenna 3 and ground when the receiver is set for reception on the high frequency band.

It will be noted that the amplifier 53 is ineffective when operating over the two lower frequency bands since the secondary winding 23 of the transformer 9 is not connected to the input of the radio frequency amplifier 1. Although the primary winding 49 is connected in series with the primary windings 11 and 17 of the transformers 5 and 7 when operating over the two lower frequency bands, this does not produce any detrimental effect since the inductance of the primary winding 49 is comparatively low.

When the receiver is set for operation on the highest frequency band, the switch arm 45 is grounded through contact point 41 and the other switch arm 35 connects the secondary winding 23 to the input circuit of the radio frequency amplifier 1, whereby the two amplifiers 1 and 53 are connected in cascade.

Attention is called to the fact that since the switch arm 41 is grounded when the amplifiers 1 and 53 are in cascade, there is no possibility of regeneration due to capacity coupling between the two switches or switch sections of the same gang. It should be noted that if a conventional switching arrangement were employed, the switch arm 45 and lower contact point 41 would be connected to the high potential end of a primary winding and undesirable regeneration would result.

The radio frequency amplifier 1 is provided with an output circuit which is coupled to the input circuit of a first detector 61 through one of a plurality of radio frequency transformers 63, 65, and 67. The lower ends of the primary windings of these transformers are connected through a conductor 69 to a positive point on the voltage divider 71 of a power supply 73. The upper ends of these primary windings are connected to the switch points of a switch 75, whereby they may be selectively connected to the anode of the radio frequency amplifier 1 through a switch arm 77.

The lower ends of the secondary windings of transformers 63, 65, and 67 are connected to ground and to the lower terminal of a variable tuning condenser 79. The upper ends of these secondary windings are connected to the switch points of a switch 81, whereby they may be selectively connected through a switch arm 83 to the upper terminal of the tuning condenser 79 and to the control grid 85 of the first detector 60.

The secondary windings of the transformers 63, 65, and 67 as well as the secondary windings of the transformers 5, 7, and 9, are shunted by the usual trimmer condensers, indicated at 61, for the tuning condensers 79 and 15. The primary winding of transformer 63 is shunted by a condenser 64 for lowering the gain of the receiver when set at the low frequency band so that the gain will be the same at all three frequency bands.

The vacuum tube elements of the superheterodyne oscillator are included in the same evacuated envelope with the tube elements of the first detector 61, the oscillator and first detector having a common cathode 87. Coupling between the oscillator and the first detector 61 is provided by having the oscillator elements and the detector elements in a common electron stream.

The oscillator is of the type in which the plate circuit is coupled to the grid circuit through a transformer and in which the frequency is determined by the tuning of the grid circuit. In the receiver illustrated, a separate feed-back transformer is provided for each frequency band to be covered by the receiver, these transformers being identified by the reference numerals 89, 91, and 93. Thus, for the lowest frequency band, the primary of the transformer 89 is connected in series with the power supply and the plate 95 of the oscillator by means of a switch 97, and the secondary of the transformer 89 is connected to a tuning condenser 99 and to the grid circuit of the oscillator through a coupling condenser 101 by means of a switch 103.

In each frequency band the oscillator frequency may be varied by means of the variable tuning condenser 99 which is preferably operated simultaneously with the other variable tuning condensers through any suitable common control such as the usual gang tuning control. The secondary winding of the transformer 89 is provided with a trimmer condenser 105 and with a series tracking condenser 107 in accordance with well known practice. The secondary winding of transformers 91 and 93 are similarly provided with trimmer condensers and series tracking condensers.

The intermediate frequency output of the first detector is fed to an intermediate frequency amplifier 109 through an intermediate frequency transformer 111. The output of the intermediate frequency amplifier 109 is fed through another intermediate frequency transformer 113 to the second detector 115.

While any suitable form of switch may be employed in practicing our invention, in order to make the disclosure complete we have illustrated one preferred form of switch in Fig. 2.

The switch comprises a plurality of switch units A, B, and C, the units being shielded from each other by means of electrostatic shields 117 and 119. In Fig. 1, the shields are indicated by the broken lines 117 and 119.

The switch units are identical in construction. Referring to switch unit A, the unit connected to transformers 5, 7 and 9 in Fig. 1, it comprises a ring 121 of insulating material upon which are supported the switch contact points 37, 39, and 41 of the switch 43 and the contact points 25, 27, and 29 of the switch 31. A disc 123 of insulating material is rotatably mounted within the ring 121 for carrying the switch arms 45 and 35. The switch arms 45 and 35 are provided with contact segments 46 and 48 for brushes 125 and 127, respectively, mounted upon the ring 121.

The rotatable discs and switch arms of the switch units A, B, and C may be rotated simultaneously by means of a common control which comprises a flat bar 129 extending through a slot in the center of the rotatable discs.

It will be seen that in the preferred switch construction shown in Fig. 2, the primary and secondary switches are combined in one switch unit, thereby simplifying the switch construction and rendering it more compact. However, the two switches of each unit cannot readily be shielded from each other. Regeneration due to the resulting capacity coupling is prevented, however, by employing the circuit shown in Fig. 1 and, as a result, we avoid the necessity for shielding in each switch unit and the added cost in a multiple unit switch.

In addition to a simplified switching means and with an amplifier gain which is made substantially the same for all frequency bands, it will be seen that we have also provided a receiver in which the cost of radio frequency transformers is reduced to a minimum, since the extra amplifier is included in the circuit only for the frequency band requiring it. If the receiver is designed to cover five frequency bands, for example, the expense of four transformers is avoided by utilizing our invention instead of following conventional design.

Various modifications may be made in our invention without departing from the spirit and scope thereof, and we desire, therefore, that only such limitations shall be placed thereon as are necessitated by the prior art and are imposed by the appended claims.

We claim as our invention:

1. A radio receiver comprising a signal selecting circuit tunable through a predetermined frequency range, a radio frequency amplifier, means for changing to a second such range the frequency range through which said selecting circuit is tunable, and means for connecting said amplifier in cascade relation with said selecting circuit in response to changing said frequency range from said first range to the second range.

2. A radio receiver comprising a radio frequency amplifier having an input circuit tunable through a predetermined frequency range, a second radio frequency amplifier, means for changing the frequency range of said input circuit, and means for connecting said second amplifier in cascade with said first amplifier in response to changing said frequency range from one range to a higher frequency range.

3. A radio receiver comprising an amplifier having a tunable input circuit, a plurality of transformers having primary windings and secondary windings, switching means for selectively connecting each of said transformers with said input circuit whereby the tuning range of said input circuit may be changed, a second amplifier having an input circuit which includes a radio frequency transformer having a primary winding and a secondary winding, switching means for selectively connecting the primary winding of said radio frequency transformer in series with the primary winding of one of said other transformers for operating within a certain frequency range, and means including said two switching means for connecting said two amplifiers in cascade in response to changing from one tuning range to a higher frequency tuning range.

4. A radio receiver comprising an amplifier having a signal input circuit including a transformer having a primary and a secondary, a radio frequency amplifier having an input circuit and an output circuit, said last-named input circuit including a second transformer having a primary and a secondary, a source of signal energy, means for selectively connecting said transformer primaries in series with said source, and means for selectively connecting the primary of the second transformer only in series with said source and for coupling said output circuit to said first-named input circuit.

5. A radio receiver comprising an amplifier having an input circuit, said input circuit including a plurality of transformers having primary windings and secondary windings, a variable tuning condenser in said input circuit, switching means for selectively connecting said secondary windings across said tuning condenser, a second amplifier having an input circuit and an output circuit, said last-named input circuit including a transformer having a primary winding and a secondary winding, an antenna connected to one end of said last-named primary winding, and switching means connected to the other end of said last-named primary winding, said last-named switching means being so connected as to connect said last-named primary winding selectively either in series with certain of said first-named primary windings or between said antenna and ground, the output circuit of said second amplifier being permanently connected to one of said first-named primary windings, said two switching means being so actuated through a uni-control that said two amplifiers are connected in cascade when said last-named primary winding is connected between antenna and ground.

6. Radio apparatus comprising an antenna, an amplifier having an input circuit, a plurality of transformers, each transformer having a primary and a secondary, means for selectively connecting said transformers to said input circuit, said means including a switch for selectively connecting said primaries to said antenna and a second switch for selectively connecting said secondaries to said amplifier input circuit, said two switches having switch points and switch arms all of which lie adjacent to and are unshielded from each other, a second amplifier having an input circuit which includes a transformer having a primary, means including said first switch for connecting said last-named primary in series with a primary of one of said first transformers in response to connecting said one transformer to the input circuit of said first amplifier, and means for connecting said last-named primary between said antenna and ground and for connecting said two amplifiers in cascade in response to connecting another of said first transformers to the input circuit of said first amplifier.

7. In a radio system, an antenna, an amplifier having an input circuit and an output circuit, a plurality of output transformers, a switch for selectively connecting said transformers to said output circuit, said switch being one unit of a gang switch, a plurality of input transformers, each input transformer having a primary and a secondary, a second switch for selectively connecting said transformers to said input circuit, said second switch being another unit of said gang switch, means for shielding said two switch units, a second amplifier having an input circuit which includes a transformer having a primary, means for connecting said last-named primary in series with a primary of one of said input transformers in response to connecting said one transformer to the input circuit of said first amplifier, and means for connecting said last-named primary between said antenna and ground and for connecting said two amplifiers in cascade in response to connecting another of said first transformers to the input circuit of said first amplifier.

8. In a radio receiving system, the combination with an amplifier having a signal input circuit comprising band selecting tuning means, of a high frequency amplifier in circuit with a band selecting element of said input circuit, a signal supply circuit connected with said high frequency amplifier, and selector switching means for completing said signal supply circuit through certain of the wave band coupling elements of the input circuit.

9. In a radio receiving system, the combination with a plurality of selectable signal input coupling transformers, of a high frequency amplifier having an output circuit connected with a primary of one of said input transformers, a signal input transformer for said amplifier having a primary winding, a circuit connected with said last named primary winding for supplying signals thereto, and selector switching means for completing said circuit to ground and to at least one other of said first named transformer primary windings.

10. In a radio receiving system comprising a high frequency amplifier and selectable input and output coupling transformer means therefor, switching means for selecting the desired coupling transformers, and means connected with one of said transformers for attenuating signals in one signal wave band, and means connected with another of said transformers for amplifying signals in another wave band.

11. In a radio receiving system comprising a high frequency amplifier and selectable input and output coupling transformer means therefor, of means connected with one of said transformers for attenuating signals in one signal wave band, and means connected with another of said transformers for amplifying signals in another wave band, said last named means comprising a second high frequency amplifier having an output circuit connected with the primary winding of said last named transformer, an input transformer for said last named amplifier, a signal supply circuit, and selector switching means for said first named transformers for completing said supply circuit through said last named transformer and said first named transformers and through said last named transformer to the exclusion of said first named transformers.

12. In a radio receiving system, the combination with a selective wave band amplifier comprising a plurality of tunable amplifier coupling devices and common tuning means therefor, of means for attenuating signals in one of said wave bands, and means for amplifying signals in another of said wave bands, said last named means including a high frequency amplifier having an input circuit comprising a transformer having a primary winding and a secondary winding, and means for grounding one end of said primary winding when said amplifier is in operation to amplify signals.

13. In a radio receiving system comprising a high frequency amplifier having an input circuit, a plurality of transformers, each having a secondary and a primary, a common tuning condenser for said secondaries, means for selectively connecting said secondaries to said tuning condenser, a second amplifier having an input circuit and an output circuit, said output circuit being permanently connected to one of said primaries, and means for selectively connecting the input circuit of said second amplifier either to one of said other primaries or to ground.

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