

April 21, 1936.

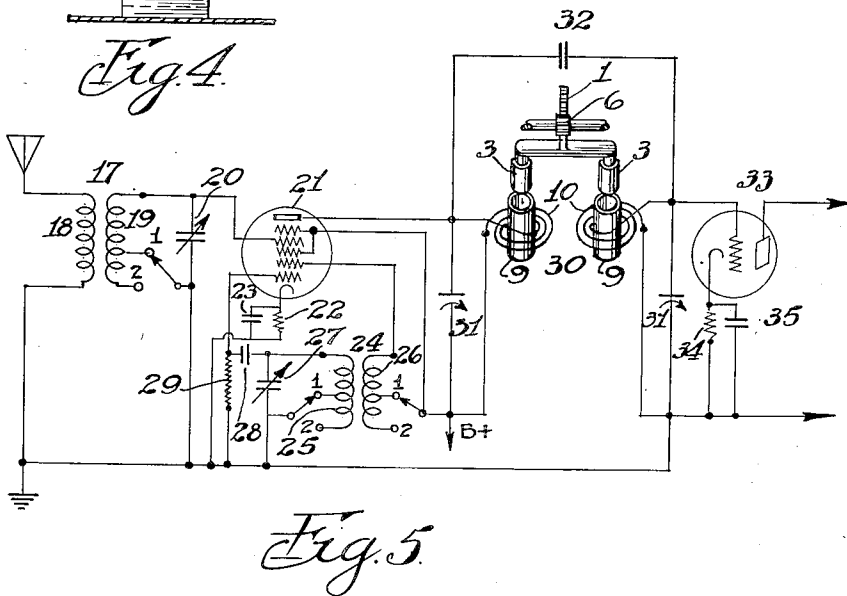
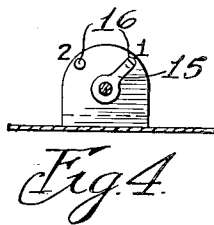
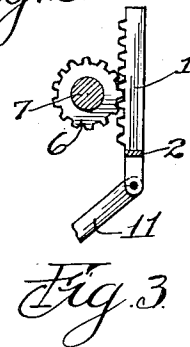
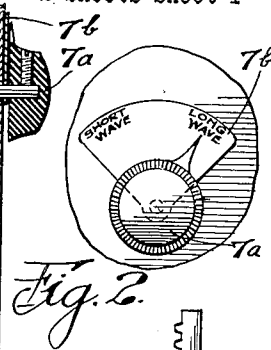
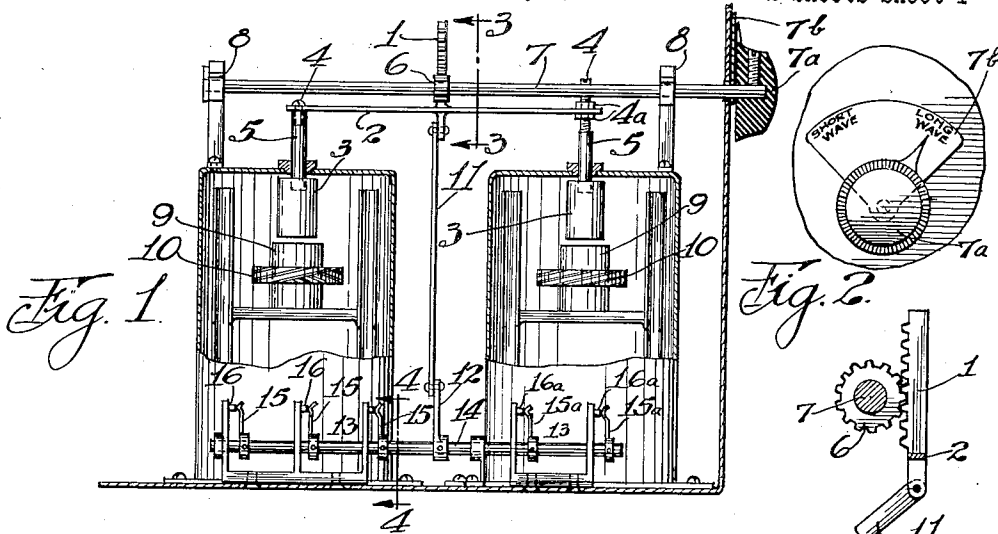
A. CROSSLEY

2,037,883

MULTIPLE BAND RADIO RECEIVER

Filed May 7, 1934

2 Sheets-Sheet 1



INVENTOR,
ALFRED CROSSLEY,

BY
Thomas G. Steward,
ATTORNEY.

April 21, 1936.

A. CROSSLEY

2,037,883

MULTIPLE BAND RADIO RECEIVER

Filed May 7, 1934.

2 Sheets-Sheet 2

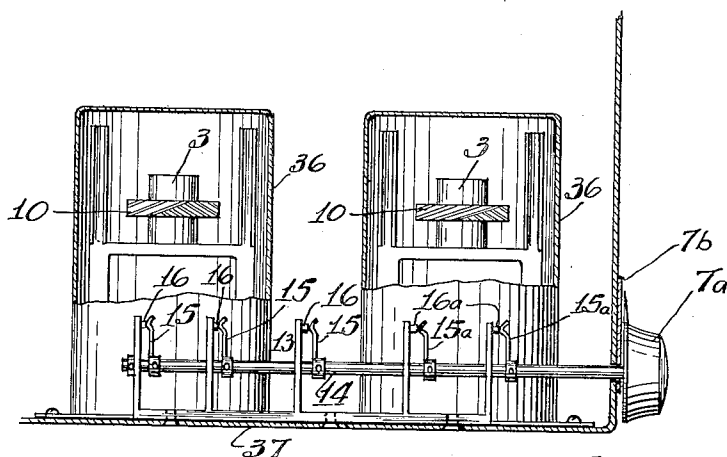


Fig. 6.

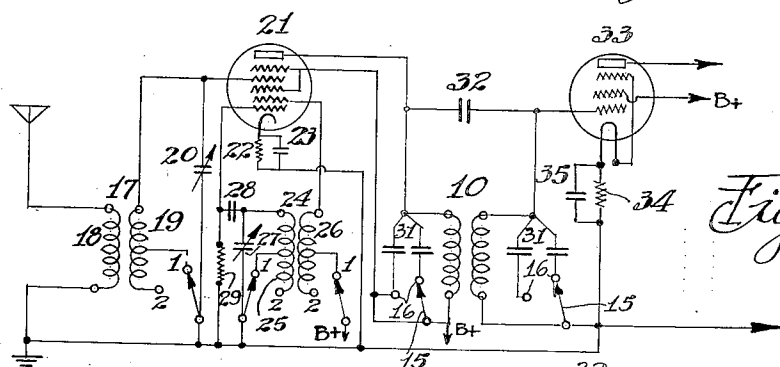


Fig. 7.

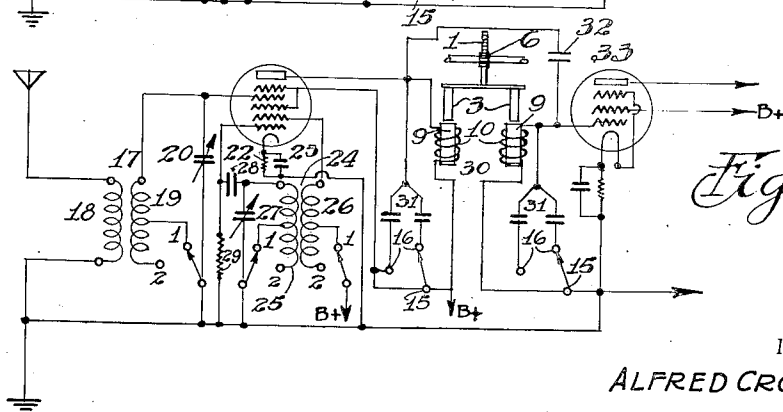


Fig. 8.

INVENTOR,
ALFRED CROSSLEY,

BY

Thomas G. Lewis and
ATTORNEY.

UNITED STATES PATENT OFFICE

2,037,883

MULTIPLE-BAND RADIO RECEIVER

Alfred Crossley, Chicago, Ill., assignor to Johnson Laboratories, Inc., Chicago, Ill., a corporation of Illinois

Application May 7, 1934, Serial No. 724,237

4 Claims. (Cl. 250—20)

This invention relates broadly to improvements in high-frequency amplifying systems, and more particularly to superheterodyne receivers designed to cover a wide band of frequencies. In general, it has been customary to employ only one intermediate frequency for the whole range of signal frequencies, with consequent difficulties from interference in at least a part of the frequency band.

A principal object of this invention is to provide a new type of all-wave superheterodyne receiver which eliminates to a great degree the interference met with in conventional designs. This object is accomplished by using a different intermediate frequency for each range of frequencies covered by the receiver, thereby securing a substantial reduction in undesired responses.

A further object of this invention is to provide mechanical means for changing the intermediate frequency simultaneously with changes in the frequency range which the receiver is adjusted to cover. Thus the intermediate frequency is at all times the most advantageous one for the particular range of frequencies to be covered.

Conventional all-wave radio receivers employ a fixed intermediate frequency usually between 170 and 470 kilocycles. This intermediate frequency produces good discrimination between the desired signal and signals on nearby channels when the receiver is operating in the regular broadcast range of frequencies, namely, from 500 to 1500 kilocycles. It does not, however, afford satisfactory discrimination in the higher frequency ranges, and the discrimination becomes increasingly poor as the signal frequency increases.

In order to overcome this undesirable condition and to provide more nearly uniform discrimination over the whole frequency band covered by the receiver, means are provided to change the intermediate frequency to a desirable value for each range of frequencies, and this change is arranged to be made simultaneously with a change in the position of the frequency-range selector of the receiver. This selector usually consists of several ganged switches which alter the characteristics of the radio-frequency, first-detector, and oscillator tuned circuits, respectively.

For a complete understanding of the invention, the following description should be read in connection with the accompanying drawings, in which—

Figure 1 is a cross-sectional side elevation of one desirable embodiment of the invention;

Figure 2 is a front elevation of a manual control device which may be used in conjunction with the invention;

Figure 3 shows in detail the rack and pinion gear mechanism shown in Figure 1;

Figure 4 shows in detail one type of switch which may be employed in the embodiment of the invention shown in Figure 1;

Figure 5 is a wiring diagram showing how the embodiment of Figure 1, or a similar embodiment, is to be connected;

Figure 6 shows a cross-sectional view of another embodiment of the invention;

Figure 7 is a wiring diagram covering components shown in Figure 6; and

Figure 8 is a wiring diagram showing a composite arrangement of parts obtained from Figures 1 and 6.

Referring to Figure 1, a rack 1 is associated with a cross member 2, which has secured to its ends ferro-magnetic cores 3. These cores are attached to member 2 by means of set screws 4 and insulating rods 5. In order that these parts of the receiver may occupy proper relative positions, at least one of said cores should be adjustable in position relatively to the member 2, and secured in that position by lock nuts 4a, or by any other suitable means. The rack 1 is moved up and down by a pinion 6, which is mounted on a shaft 7, said shaft having an actuating knob 7a and being supported by suitable bearings 8. The device includes movable ferro-magnetic cores 3 and insulating tubes 9 which have secured to them coils 10. The insertion of the ferro-magnetic cores into the coils increases the inductance of the coils, and thus tunes the circuit to a lower frequency. When the core is removed from the coil, the circuit will be tuned to a higher frequency. Ordinary iron cores would have excessive losses at the frequencies described in this application, and hence it is necessary to employ special cores composed of finely-divided and individually-insulated iron particles, compressed with a suitable binding material. Cores of this type, suitable for use at high frequencies, are disclosed in British Patents Nos. 366,475 and 403,368, and have recently been described in numerous publications in the United States and abroad. If desired, the cores may be shaped to produce a desired variation in tuning with axial movement.

A rod 11 connects the cross member 2 with a crank 12, which, in turn, is connected with switching mechanisms 13 by an insulating shaft 14. Each switch includes a suitable switch arm

13 and plural contacts 16. Tied in with the shaft 14 are two additional switches, as shown, having contacts 16a and switch arms 15a. These switches are referred to later on as applied to the functioning of the arrangement shown in Figure 8.

An alternate, and from the manufacturing viewpoint, a more economical form of the invention may be produced by eliminating shaft 7, pinion 6 and rack 1, and extending shaft 14 through the front panel to receive knob 7a, as shown in Figure 6. In this modification, the cross member 2 could be actuated as shown in Figure 1, or by a rack and pinion, the latter being mounted on the shaft 14, and the rack replacing the connecting rod 11.

Figure 2 shows a front view of the knob 7a and the escutcheon 7b, which may be suitably lettered and attached by rivets or any other suitable means to the front panel of the receiver. Although only two ranges are shown, it is within the scope of this invention to provide for a greater number of ranges.

Figure 5 shows connections which may be used in a desirable embodiment of the invention. The antenna coupler 17 includes the conventional primary 18 and a tapped secondary 19. The secondary is tuned by a variable condenser 20. Alternatively, the secondary may be a part of a transformer in which the tuning is accomplished by the movement of an iron core, and the condenser may be non-variable. This tuning system is included in the control-grid or input circuit of a pentagrid converter tube 21. The cathode circuit of the tube 21 includes a biasing resistor 22, which is shunted by a by-pass condenser 23. There is also associated with the tube 21 an oscillating circuit which includes a coupling unit 24 having a grid coil 25 and a plate coil 26. Both of these coils are tapped in order to provide the required inductance for each frequency range. Although only two taps per coil are shown, it is within the scope of this invention to utilize a larger number of taps on each coil, or; alternatively, to use a plurality of coils of various inductance values and having common ground terminals, the switches being arranged to select the high-potential terminal of the desired coil.

The grid coil 25 is tuned by a variable condenser 27, but, alternatively, might be tuned by a moving iron core, the condenser being non-variable. The high-potential terminal of the condenser 27 is connected to the oscillator-grid of tube 21 through a stopping condenser 28. A gridleak resistor 29 is connected between the oscillator-grid and the ground. The output of the pentagrid converter is connected to the input terminals of transformer 30, the construction of which is identical with that shown in Figure 1, in that the coils 10 have adjustable ferro-magnetic cores 3. The coils 10 are tuned by means of adjustable condensers 31, and their high-potential ends are coupled electro-statically by means of a condenser 32. The output of the transformer 30 is fed to the amplifier tube 33, which is biased by means of a resistor 34 in its cathode circuit, the resistor 34 being shunted by a by-pass condenser 35 for high-frequency currents. In the embodiments shown, the cores 3 are of relatively small dimensions, and the coils are of the types commonly used in the intermediate-frequency amplifiers of superheterodyne receivers. It will be understood that the coils themselves are designed to give the desired high in-

intermediate frequency for the upper tuning range, and that when the cores are inserted into the coils, the effective inductance of the coil is increased, thus tuning the intermediate-frequency amplifier to the lower frequency suitable for the lower tuning range. Cores of the type shown in Figure 1 will have an effective permeability of the order of 4, and will thus produce a lower intermediate frequency approximating half of the upper intermediate frequency.

In cases where it is desired to produce a greater change in the inductance and in the frequency, the coil and the core may be differently designed to produce a greater effective permeability. Coil and core combinations of this type have been described in the British patents above referred to, and in other recent publications. Alternatively, as shown in Figure 7, the condensers 31 may have two or more sections, and may be connected to the gang switch in such a way that the intermediate frequency is changed by changing the capacity in the circuit, as well as the inductance.

Figure 6 is similar in some respects to Figure 1, with exception of the elimination of the mechanical movement of the iron cores 3, and the addition of two switches employed primarily for changing the capacity across the coils 10. In this figure, the coils 10 are mounted on a bakelite frame and may have an iron core 3. The coils 10 are shielded one from the other by metal shields 36 which are mounted on the base 37. The switching mechanism 13 is similar to that shown in Figure 1, with the exception of the extension of the shaft 14 to the front of the panel and the securing of the knob 7a to this shaft. The escutcheon 7b is also included in this figure.

Figure 7 schematically shows the electrical connections used in conjunction with the device shown in Figure 6. In this figure, the input system up to the plate of the pentagrid converter 21, is identical with that of Figure 5. The plate circuit of the pentagrid converter tube 21, comprises an inductance 10 associated with which are two condensers 31, 31, and a switching means 15, 16, for connecting either condenser across the coil 10. Capacitively coupled to this resonant plate circuit is a second circuit having like inductance and condensers with the above mentioned switching system. This latter circuit is connected to the grid and cathode of the amplifier tube 33. In this figure, the change of capacity from one value to another permits tuning to resonance for the desired intermediate frequency.

Figure 8 is identical with Figure 7, with the exception of the tuning components of the intermediate frequency amplifier. In this figure, condensers 31 are switched in or out simultaneously with the movement of iron core 3 in and out of the influence of coils 10. In such a resonant system, a great variation in resonant-frequency conditions is obtainable, it being possible to reduce capacity simultaneously with reduction in inductance. When inductance is increased, the capacity can likewise be increased. With such an arrangement, maximum frequency variation can be obtained, and, at the same time, the desired L over C ratio can be kept substantially constant.

Although this specification discloses the use of iron-core intermediate-frequency transformers, it is entirely possible to obtain fair results if air-core coils are used.

Having thus described my invention, what I claim is:

1. A high-frequency receiving system, including adjustable means for receiving plural bands of frequencies, adjustable means for producing a different beat frequency for each of said bands of frequencies, an amplifier for amplifying said beat frequencies, said amplifier including inductors, ferro-magnetic cores movable relatively to said inductors to resonate said amplifier to each of said beat frequencies, and means for simultaneously selecting a desired one of said frequency bands and for moving said cores to the corresponding position.

2. A high-frequency signaling system having signal-frequency circuits tunable over at least two ranges of signal frequencies, an oscillator circuit tunable to produce at least two different beat frequencies with said signal frequencies, a modulator in which said beat frequencies are produced, an amplifier coupled to said modulator for amplifying said beat frequencies, said amplifier including inductors, range-changing switches for

changing the tuning range of said signal-frequency circuits and said oscillator circuit, and ferro-magnetic cores movable relatively to said inductors for changing the resonant frequency of said amplifier, said switches and said cores being actuated by a single control.

3. A high-frequency signaling system according to claim 2, in which the range-changing switches are of the rotary type, and in which the movable ferro-magnetic cores are actuated by a crank on the switch shaft, through a link member connecting said crank to a cross member supporting said cores.

4. A high-frequency signaling system according to claim 2, in which the range-changing switches are of the rotary type, the movable ferro-magnetic cores being actuated by means of a rack and pinion, said pinion being mounted on the switch shaft, said rack being attached to a cross member supporting said cores.

ALFRED CROSSLEY.