

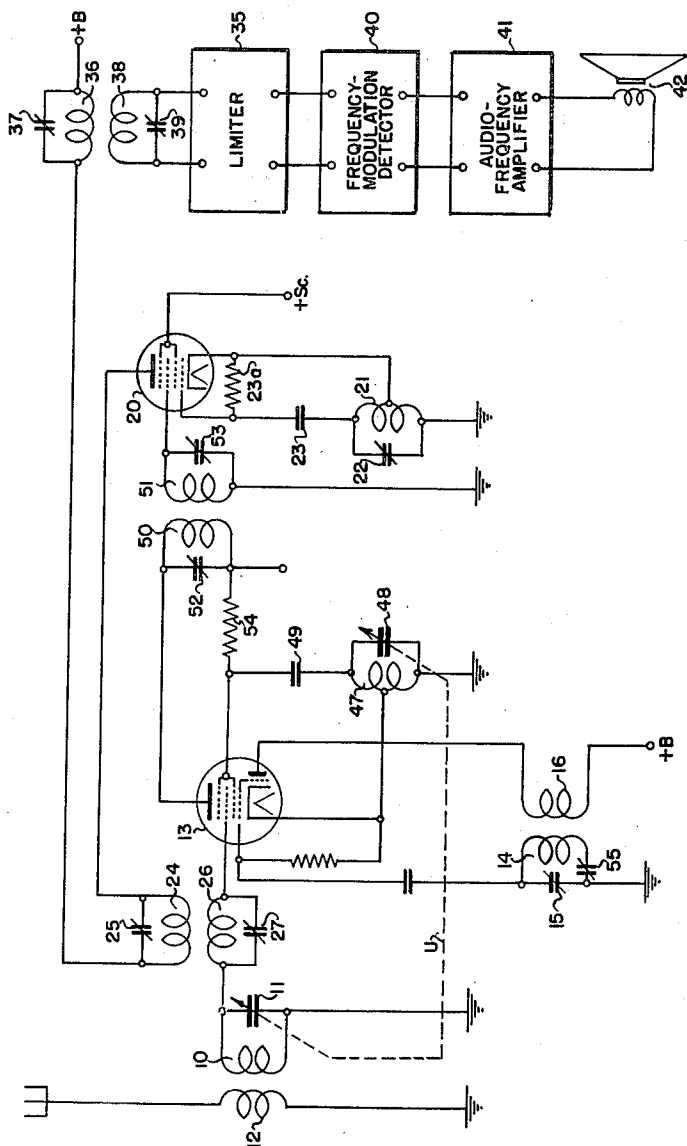
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WAVE-SIGNAL RECEIVER INCLUDING DUPLEX FREQUENCY-CHANGER STAGES

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WAVE-SIGNAL RECEIVER INCLUDING DU-
PLEX FREQUENCY-CHANGER STAGESNelson P. Case, Great Neck, N. Y., assignor to
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This invention relates to wave-signal receivers of the type including one or more reflex signal-translating stages and particularly to such receivers adapted to receive a frequency-modulated carrier signal.

It is frequently desirable to effect a plurality of frequency changes of the signal translated through the carrier-frequency signal-translating channel of a receiver. For instance, in a conventional wave-signal receiver of the double superheterodyne type, two different intermediate-frequency carrier signals are provided by means of two modulators or frequency changers in the signal-translating channel of the receiver. Vacuum-tube repeaters have heretofore commonly been utilized to repeat or to amplify two or more signals of substantially different frequencies. Such devices have been utilized to provide a reflex amplification of a signal in a modulated-carrier signal receiver, thus to minimize the number of tubes required to provide a desired gain. For example, such reflex amplifier stages have been utilized to effect a dual amplification of an audio-frequency signal and a carrier-frequency signal or, in the case of a superheterodyne receiver, to effect an amplification of an intermediate-frequency signal and a radio-frequency signal. It is, however, desirable to provide a receiver including a duplex frequency-changing stage for the reason that the advantages of a multiple superheterodyne receiver are then provided by the use of a fewer number of frequency-changing stages in the receiver. It has heretofore been proposed to effect a reflex amplification in a modulator or frequency-changer stage. However, no prior art modulated-carrier signal receiver has been provided wherein a plurality of frequency changes have been effected in the same signal-translating channel and in the same signal-translating stage.

It is an object of the invention, therefore, to provide an improved modulated-carrier signal receiver adapted to effect a plurality of frequency changes of a received signal in the same signal-translating stage.

In accordance with the invention, a modulated-carrier signal receiver comprises a carrier-signal frequency-converting stage, including one or more input circuits and a given number of output circuits, means for selecting and applying a desired received carrier signal to one of the input circuits of the stage, and means for applying to one of the input circuits of the stage oscillations of a frequency having a predetermined relation to that of the selected signal for hetero-

dyning with the selected signal. There is also provided means for deriving from the heterodyne components so produced an intermediate-frequency carrier signal together with means for feeding back the intermediate-frequency carrier signal to one of the input circuits of the stage and for producing in one of the output circuits of the stage another intermediate-frequency carrier signal. Means are further provided for translating and reproducing the above-mentioned other intermediate-frequency carrier signal.

For a better understanding of the invention, together with other and further objects thereof, reference is had to the following description taken in connection with the accompanying drawing and its scope will be pointed out in the appended claims.

The single figure of the drawing illustrates a frequency-modulation carrier-signal receiver of the multiple superheterodyne type incorporating duplex frequency-changer stages in accordance with the invention.

In general, the receiver represented in the drawing comprises a tunable radio-frequency selector circuit including an inductance 10 and a tuning condenser 11 coupled to an inductance 12 of an antenna-ground circuit and to a carrier-frequency signal-translating or frequency-converting stage comprising a multielectrode tube 13. Tube 13 is of the duplex oscillator-mixer type and the signal input to the receiver is applied to the third grid or outer control electrode of the mixer section of the tube. The carrier-frequency signal-translating stage also includes therein a means for applying to one of the input circuits of the stage or for developing in the stage oscillations of a predetermined frequency having a predetermined relation to that of the selected carrier frequency for heterodyning with the selected signal. This means is shown as comprising an oscillator circuit associated with tube 13 and includes a frequency-determining circuit comprising an inductance 47 and a tuning condenser 48, which is uncontrolled with condenser 11, as indicated by the dotted line U, for tuning the receiver. A suitable feed-back circuit for producing sustained oscillations in frequency-determining circuit 47, 48 is provided by the screen grid and the cathode of tube 13. The direct current required by the screen grid is obtained through a resistor 54, while the carrier-signal path for this element includes the isolating condenser 49 and the tuned circuit 47, 48. The cathode of tube 13 is connected to a tap on inductance 47.

The first intermediate-frequency signal produced by tube 13 in the output circuit thereof is applied through a suitable selector including a double-tuned transformer 50, 52 and 51, 53 to the third grid or outer control electrode of a second frequency-changer tube 20. The second frequency-changer stage includes means for applying thereto or developing therein oscillations of a predetermined frequency for heterodyning with the first intermediate-frequency signal supplied thereto through selector 50, 52 and 51, 53. This means comprises an oscillator section in tube 20 having a fixed frequency-determining circuit including an inductance 21 and an adjustably-fixed condenser 22 and having a feed-back circuit thereof provided by the connection of the cathode of tube 20 to a tap on inductance 21, the oscillator voltage across the circuit 21, 22 being applied to the first grid or inner control electrode of tube 20 by means of a coupling condenser 23.

A second intermediate-frequency signal is developed by the heterodyning of the oscillations supplied by the oscillator section of tube 20 and the first intermediate-frequency signal supplied through selector circuit 50, 52 and 51, 53. This second intermediate-frequency signal is fed back to tube 13 for a further change in frequency through a selective circuit in the anode of tube 20 which includes an inductance 24 tuned by condenser 25 and inductively coupled to an inductance 26 in the circuit of the outer control electrode of tube 13, inductance 26 being tuned by a condenser 27.

In order to effect the second frequency change in tube 13, a separate source of fixed-frequency oscillations is provided. This source comprises an oscillator section within tube 13 including a frequency-determining circuit comprising an inductance 14 and adjustably-fixed condensers 15 and 55. A suitable feed-back circuit for developing sustained oscillations in the circuit 14, 15, 55 is provided by connecting the anode of the oscillator section of tube 13 to feedback winding 16 inductively coupled to inductance 14.

The third intermediate-frequency signal so produced from the heterodyne components of the signals just mentioned is translated to tube 20 for a further frequency change through selector circuit 50, 52 and 51, 53. Transformer 50, 51 is tuned by condensers 52, 53 to a frequency approximately mid way between the carrier frequencies of the two intermediate-frequency signal outputs of tube 13. Transformer 50, 51 is over-coupled to provide resonant peaks substantially at the carrier frequencies of each of the intermediate-frequency signals to be coupled between tubes 13 and 20.

A fourth intermediate-frequency signal is thus developed by the heterodyne components of the third intermediate-frequency signal translated by selector 50, 52 and 51, 53 and the source of oscillations provided by the oscillator section of vacuum tube 20. This fourth intermediate-frequency signal is applied to the input circuit of a limiter 35 through a selective circuit in the anode circuit of vacuum tube 20 including an inductance 36 tuned by a condenser 37 and inductively coupled to an inductance 38, tuned by condenser 39. The fourth intermediate-frequency signal supplied to limiter 35 is therein limited to a substantially constant amplitude to eliminate amplitude-modulation components and is supplied to a frequency-modulation detector 40 wherein the modulation components of the

received signal are derived. The audio-frequency components are further amplified by an amplifier 41 and reproduced by a sound reproducer 42. While it is not intended to limit the circuit of the drawing to any specific circuit constants, there follows a set of circuit values which have been found satisfactory for use in a frequency-modulation receiver:

Tube 13-----	Type 6K8
Tube 20-----	Type 6SA7
10 R. F. Selector circuit 10, 11-----	Tunable over the range from 42-50 megacycles
Oscillator frequency-determining circuit 47, 48---	Tunable over the range from 33-41 megacycles
15 Second I. F. Transformer 24, 26-----	Tuned to the frequency of 6.7 megacycles
Oscillator frequency-determining circuit 14, 15, 55	Tuned to the frequency of 1.6 megacycles
20 First and third I. F. Transformer 50, 51-----	Tuned to a frequency of 6.8 megacycles and over-coupled to provide resonance peaks at 9 megacycles and 5.1 megacycles
Oscillator frequency-determining circuit 21, 22---	Tuned to a frequency of 2.3 megacycles
25 Fourth I. F. transformer 36, 38-----	Tuned to a frequency of 2.8 megacycles

In considering the operation of the circuit of the drawing, it will be seen that a desired received signal within the frequency range from 39 to 45 megacycles is selected by circuit 10, 11 and is heterodyned in tube 13 with oscillations developed by the tunable oscillator associated with frequency-determining circuit 47, 48 to develop a first intermediate-frequency signal having a carrier frequency of 9 megacycles, which is translated through transformer 50, 51 to tube 20. This first intermediate-frequency signal is heterodyned in tube 20 with the oscillations generated by the oscillator section of this tube to develop a second intermediate-frequency signal having a carrier frequency of 6.7 megacycles which, in turn, is fed back through transformer 24, 26 to tube 13. This second intermediate-frequency signal is heterodyned in tube 13 with the oscillations generated in the oscillator section of the tube connected to frequency-determining circuit 14, 15, 55 to develop a third intermediate-frequency signal having a carrier frequency of 5.1 megacycles which, in turn, is translated through transformer 50, 51 to tube 20. This third intermediate-frequency signal is heterodyned in tube 20 with the oscillations generated by the oscillator section of this tube to develop a fourth intermediate-frequency signal having a carrier frequency of 2.8 megacycles which is translated through transformer 36, 38 to limiter 35 and the succeeding stages of the receiver for reproduction in a manner well understood in the art.

It will thus be seen that means are provided for driving from the heterodyne components produced in the output circuit of tube 13 an intermediate-frequency signal which is fed back to tube 13 for a further frequency change, thereby to produce in the output circuit of tube 13 another intermediate-frequency signal. This feed-back signal is derived indirectly through the succeeding frequency changer 20. Similarly there is derived from the heterodyne components of tube 20 an intermediate frequency signal which is subjected to a later frequency change in tube 20; that is, the signal reflexed to tube 20 for a further frequency change is indirectly derived from heterodyne components of tube 20 through the frequency changer 13.

While there have been described what are at present considered to be the preferred embodiments of this invention, it will be obvious to those skilled in the art that various changes and modifications may be made therein without departing from the invention, and it is, therefore, aimed in the appended claims to cover all such changes and modifications as fall within the true spirit and scope of the invention.

What is claimed is:

1. A modulated-carrier signal receiver comprising, a carrier-signal frequency-converting stage including one or more input circuits and a given number of output circuits, means for selecting and applying a desired received carrier signal to one of said input circuits, means for applying to one of said input circuits oscillations of a frequency having a predetermined relation to that of said selected signal for heterodyning with said selected signal, means for deriving from the heterodyne components so produced in one of said output circuits an intermediate-frequency carrier signal, means for feeding back said intermediate-frequency carrier signal to one of said input circuits and for producing in one of said output circuits another intermediate-frequency carrier signal, and means for translating and reproducing said other intermediate-frequency carrier signal.

2. A modulated-carrier signal receiver comprising, a carrier-signal frequency-converting stage including one or more input circuits and a given number of output circuits, means for selecting and applying a desired received signal to one of said input circuits, means for applying to one of said input circuits oscillations of a frequency having a predetermined relation to that of said selected signal for heterodyning with said selected signal, means for deriving from the heterodyne components so produced in one of said output circuits an intermediate-frequency carrier signal, means for feeding back said intermediate-frequency carrier signal to one of said input circuits, means for applying oscillations of a predetermined frequency to one of said input circuits for heterodyning with said feed-back signal to produce in one of said output circuits another intermediate-frequency carrier signal, and means for translating and reproducing said other intermediate-frequency carrier signal.

3. A modulated-carrier signal receiver comprising, a carrier-signal frequency-converting stage including one or more input circuits and a given number of output circuits, means for selecting and applying a desired received signal to one of said input circuits, means for applying to one of said input circuits oscillations of a frequency having a predetermined relation to that of said selected signal for heterodyning with said selected signal to provide a first intermediate-frequency carrier signal, a second carrier-signal frequency-converting stage having one or more input circuits and an output circuit, means for applying oscillations of a predetermined frequency to one of said input circuits of said second stage for heterodyning with said first intermediate-frequency carrier signal to provide a second inter-

mediate-frequency carrier signal in said output circuit of said second stage, means for feeding back said second intermediate-frequency carrier signal to one of said input circuits of said first-mentioned stage and for producing in one of said output circuits of said first-mentioned stage a third intermediate-frequency carrier signal, and means for translating and reproducing said third intermediate-frequency carrier signal.

4. A modulated-carrier signal receiver comprising, a first carrier-signal frequency-converting stage including one or more input circuits and a given number of output circuits, means for selecting and applying a desired received signal to one of said input circuits, means for applying to one of said input circuits oscillations of a frequency having a predetermined relation to that of said selected signal for heterodyning with said selected signal, a second carrier-signal frequency-converting stage having one or more input circuits and an output circuit, means for applying said first intermediate-frequency carrier signal to one of said input circuits of said second stage, means for applying oscillations of a predetermined frequency to one of said input circuits of said second stage for heterodyning with said first intermediate-frequency carrier signal to produce a second intermediate-frequency carrier signal in said output circuit of said second stage, means for feeding back said second intermediate-frequency carrier signal to one of said input circuits of said first stage, a separate source of oscillations of a predetermined frequency, means for applying said last-mentioned oscillations to said first stage for heterodyning with one of said input circuits of said feed-back signal to produce in one of said output circuits of said first stage another intermediate-frequency carrier signal, and means for translating and reproducing said other intermediate-frequency carrier signal.

5. A modulated-carrier signal receiver comprising, a carrier-signal frequency-converting stage including one or more input circuits and a given number of output circuits, means for selecting and applying a desired received signal to one of said input circuits, means for applying to one of said input circuits oscillations of a frequency having a predetermined relation to that of said selected signal for heterodyning with said selected signal, means including a double-tuned over-coupled transformer for selecting from the heterodyne components so produced a first intermediate-frequency carrier signal, means responsive to said intermediate-frequency carrier signal for feeding energy back to one of said input circuits of said stage and for producing in one of said output circuits another intermediate-frequency carrier signal, means including said transformer for selectively translating said other intermediate-frequency carrier signal, said transformer being tuned between the carrier frequencies of said one and said other intermediate-frequency signals and having resonance peaks substantially coinciding with said carrier frequencies, and means for translating and reproducing said other intermediate-frequency carrier signal.

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CERTIFICATE OF CORRECTION.

Patent No. 2,251,397.

August 5, 1941.

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It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 3, second column, lines 35 and 36, claim 4, strike out "one of said input circuits of" and insert the same after "to" in line 34, same claim; and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 18th day of November, A. D. 1941.

(Seal)

Henry Van Arsdale,
Acting Commissioner of Patents.