

May 24, 1938.

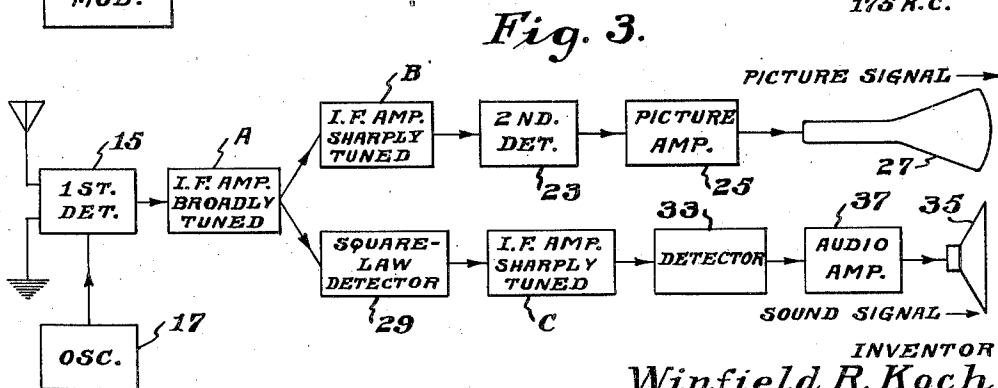
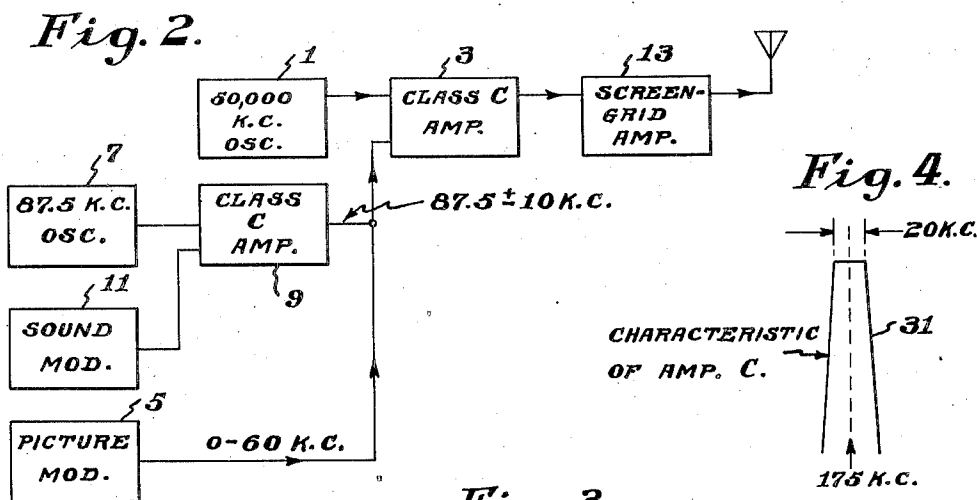
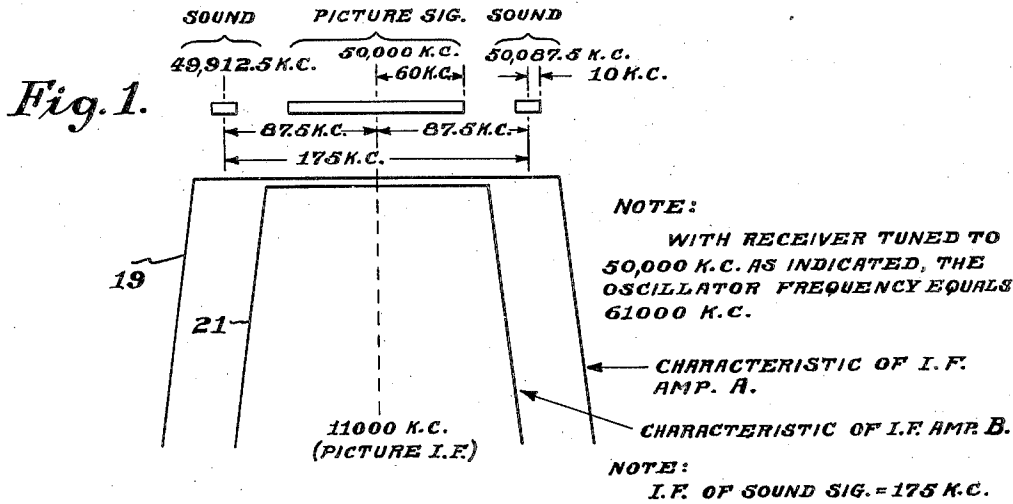
W. R. KOCH

2,118,610

SIGNALING SYSTEM

Filed Jan. 29, 1935

2 Sheets-Sheet 1



INVENTOR  
Winfield R. Koch

BY *DR Goldborough*  
ATTORNEY

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2 Sheets-Sheet 2

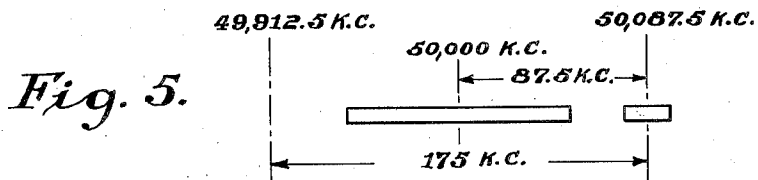
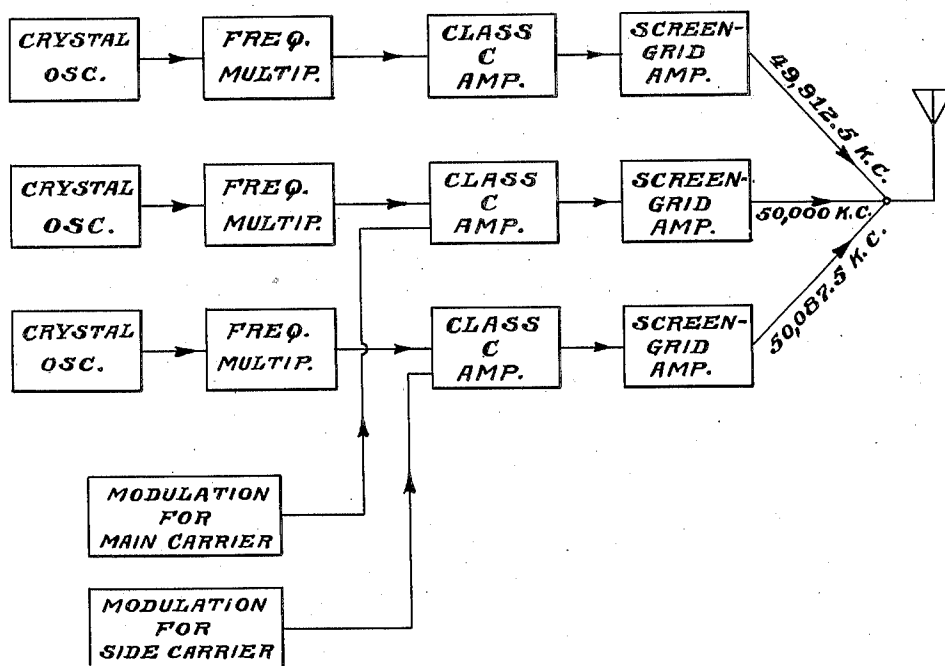


*Fig. 6.*



INVENTOR

Winfield R. Koch

BY *W. R. Goldborough*

ATTORNEY

## UNITED STATES PATENT OFFICE

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## SIGNALING SYSTEM

Winfield R. Koch, Camden, N. J., assignor to  
Radio Corporation of America, a corporation of  
Delaware

Application January 29, 1935, Serial No. 3,919

7 Claims. (Cl. 178—5.6)

My invention relates to signaling systems and particularly to systems in which two signals are to be received simultaneously by a single receiver.

One system of the above-mentioned type is described in Carlson Patent #1,975,056. In the system shown in this patent the two signals modulate two adjacent carrier waves and, at the receiver, the two modulated carriers are heterodyned by means of a common oscillator to two intermediate frequency signals. A defect in such a system is that in the case of television or other high frequency transmission the oscillator at the receiver has a tendency to "drift" in frequency. Consequently, the intermediate frequency channels must be designed to pass a comparatively wide band of frequencies so that the signal will pass through the channel even though the oscillator has "drifted". Because of this, the frequency spacing between the two carriers must be greater than would be required with more sharply selective channels in the receiver.

An object of my invention is to provide a system for the transmission of two signals and for their simultaneous reception on a single receiver in which the above-mentioned defect is substantially avoided.

A further object of my invention is to provide an improved receiver for the simultaneous reception of a plurality of signals.

A still further object of my invention is to provide an improved receiver for the simultaneous reception of a plurality of signals in which the receiver may be tuned by a single tuning knob or the like.

In a preferred embodiment of my invention a double modulated carrier wave is transmitted, the carrier being modulated by the first signal, such as a picture signal, and by a second carrier or sub-carrier wave which has previously been modulated by the second signal, such as a sound signal. The receiver is of the superheterodyne type comprising a single local oscillator for selecting the desired transmitting station by the movement of a single tuning knob or the like in the usual manner. The intermediate frequency signal produced by the interaction of the local oscillator and incoming signal is supplied to a comparatively sharply tuned channel which selects the picture signal to the exclusion of the sound signal and to a second channel including a square law detector succeeded by a sharply tuned circuit which selects the intermediate frequency sound signals to the exclusion of other signals. The selected sound signals are

produced in the square law detector by the upper and lower sound side band frequencies which represent the sub-carrier beating together to produce an intermediate frequency carrier equal to the difference between these two frequencies. The sound intermediate frequency is, therefore, independent of any "drifting" in the local oscillator frequency.

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

Figure 1 is a diagram which indicates the frequency spectrum of signals radiated from a transmitter and which also shows certain selectivity characteristics of my receiver,

Fig. 2 is a block diagram exemplifying a transmitter which may be utilized to obtain the frequency spectrum indicated in Figure 1,

Fig. 3 is a block diagram of my improved receiver,

Fig. 4 is a diagram showing the selectivity characteristic of a portion of the receiver shown in Fig. 3,

Fig. 5 is a diagram indicating the frequency spectrum of signals radiated from a transmitter in practicing another embodiment of my invention, and

Fig. 6 is a block diagram exemplifying a transmitter for transmitting signals having the frequency spectrum shown in Fig. 5.

Referring to Fig. 1, certain specific frequency values for the transmitted signals have been assumed in order to make the invention more easily understood. It is assumed that the transmitting station has a carrier frequency of 50,000 k. c. and that this carrier is modulated by a signal, such as a picture signal, having a frequency band width of 60 k. c. Thus the 50,000 k. c. carrier has upper and lower side bands 60 k. c. in width representing picture signals.

The 50,000 k. c. carrier is also modulated by a second signal comprising a carrier wave which has been modulated by a sound signal or the like. For the purpose of explanation it has been assumed that this second carrier wave has a frequency of 87.5 k. c. and that it is modulated by a sound signal having a frequency band width of 10 k. c.

It will be apparent that the sound signal is being transmitted by the method of double modulation. As shown in Fig. 1, the sound modulated 87.5 k. c. carrier appears in the transmitter output as a portion of the upper side band of the 50,000 k. c. carrier and also as a portion of the

lower side band of this carrier. The frequencies have been so selected that there is a certain frequency spacing between the picture signal and the sound signal in each side band of the main carrier. Of course, there is a fixed frequency difference between the sound modulated carrier in the upper side band and the sound modulated carrier in the lower side band. In the particular example being described, this frequency difference is 175 k. c. As will be explained later this frequency is the intermediate frequency employed in the sound channel of the receiver.

Since systems for transmitting double modulated carrier waves are well known, it is thought unnecessary to describe any transmitter in detail. In Fig. 2, however, a transmitter is represented by a block diagram. The main carrier is provided from a suitable oscillator 1 coupled to a class "C" amplifier 3 which functions as a modulator. The picture signal is supplied from a suitable source 5 to the amplifier 3 where it modulates the main carrier wave directly. The sound carrier wave is supplied from a suitable source 7 and supplied to a class "C" amplifier 9 which functions as a modulator. The sound signal is supplied from a source 11 to the amplifier 9 where it modulates the sound carrier. This modulated carrier is then supplied to the first class "C" amplifier 3 to put the sound signal on the main carrier wave by double modulation. The output of the amplifier 3, which has the frequency spectrum indicated in Fig. 1, is supplied to a suitable amplifier 13 and then to an antenna.

It will be understood that a class "C" amplifier is of the well known type commonly referred to in the literature as class "C". Class "C" amplifiers are described in the Proceedings of the I. R. E. for July, 1935, pages 752 to 778, for example.

Referring to Fig. 3, there is represented one embodiment of my receiver which comprises a first detector 15 and the usual local oscillator 17 employed for superheterodyne receivers. All tuning of the receiver is accomplished by the operation of a single tuning knob or other control for varying the local oscillator frequency in the usual manner. The incoming signal beats with the oscillator output to produce an intermediate frequency which has the same frequency spectrum shown in Fig. 1, the only difference being that instead of a 50,000 k. c. carrier there is now an intermediate frequency carrier which, for the purpose of explanation, will be assumed to be 11,000 k. c. If the oscillator is operated at a higher frequency than the frequency of the incoming signals, the frequency of the oscillator output is 61,000 k. c. when receiving signals from the transmitter having the 50,000 k. c. carrier.

The intermediate frequency amplifier indicated at "A" is tuned broadly enough to pass the complete side bands of the intermediate frequency carrier. This selectivity characteristic is represented by the curve 19 in Fig. 1. It will be understood that the amplifier A functions as a band pass filter for the purpose of providing adjacent channel selectivity.

The output of the amplifier A is supplied to a picture signal channel and to a sound channel. In the picture channel an intermediate frequency amplifier B is provided which is tuned sharply enough to permit only the main carrier and picture side bands to pass. The selectivity of the amplifier B is indicated by the curve 21 in Fig. 1. The output of amplifier B is applied to a second detector 23 which demodulates the 11,000 k. c. intermediate frequency carrier whereby the pic-

ture signals appear in the detector output. They are then supplied through a picture frequency amplifier 25 to a cathode ray tube 27 or other suitable device for reproducing the picture.

In the sound channel, a square law detector 29 is provided. The entire frequency spectrum is supplied to the square law detector whereby sum and difference frequencies appear in the detector output. The detector output includes a modulated intermediate frequency carrier which is produced by the 50,087.5 k. c. modulated carrier of the upper side band beating with the 49,912.5 k. c. modulated carrier in the lower side band. The frequency difference between these two carriers, of course, is 175 k. c. and this 175 k. c. intermediate frequency carrier has the sound signals appearing thereon as upper and lower side bands.

The output of the square law detector is supplied to an intermediate frequency amplifier C which is tuned sharply enough to select the sound modulated 175 k. c. carrier to the exclusion of all other frequencies. The selectivity characteristic of amplifier C is indicated by the curve 31 in Fig. 4. The output of the amplifier C is supplied to a detector 33 which demodulates the 175 k. c. carrier and supplies audio frequency signals to a translating device such as a loudspeaker 35 through an audio frequency amplifier 37.

It will be evident that the selectivity characteristic of the amplifier C need not be widened in order to allow for frequency drift of the local oscillator 17 since the intermediate frequency sound carrier will always be 175 k. c. regardless of the local oscillator frequency. In addition to permitting the transmission of the picture and sound signals on a channel of minimum frequency width, a sharply selective amplifier "C" excludes the maximum amount of static or other noise.

It will be clear to those skilled in the art that various types of detectors may be utilized as the detector 29 in the sound channel in order to obtain an intermediate frequency carrier having a frequency equal to the difference between the frequencies of the sound signals in the upper and lower side bands. For example, the usual grid-condenser grid-leak detection, which is referred to as grid detection, may be employed, or plate detection may be employed if preferred.

In the picture channel, the amplifier or filter circuit B may be omitted providing the detector 23 is a linear detector since the output of a detector of this type includes only the desired signal and undesired signals of a higher frequency whereby all undesired signals may be filtered out in the amplifier 25.

In some cases it may be preferred to use my improved receiver in a system where double modulation is not employed. For example, my receiver may be used in combination with a transmitter which radiates signals having the frequency spectrum shown in Fig. 5. It will be noted that this frequency spectrum is the same as the one shown in Fig. 1 except that in the lower side band the 49,912.5 k. c. carrier is unmodulated. There is a certain advantage in utilizing a frequency spectrum of this character since there are no sound signals in the lower side band to beat with sound signals in the upper side band (which would result in a certain amount of distortion). It may be noted, however, that the distortion due to this cause in the system first described would not be objectionable in most cases.

A transmitting station for providing signals having the frequency spectrum shown in Fig. 5

is indicated by the block diagram in Fig. 6. It will be noted, in effect, there are three transmitters although, preferably, they all radiate their signal from the same antenna. Each transmitter unit preferably comprises a crystal controlled oscillator, a frequency multiplier, a class "C" amplifier and a screen grid amplifier. In the first transmitter unit, the unmodulated 49,912.5 k. c. carrier is supplied to the antenna. In the second transmitter unit, the 50,000 k. c. carrier is modulated by the picture signal or other signal to be put on the main carrier wave. In the third transmitter unit, the 50,087.5 k. c. carrier is modulated by the second signal, which may be a sound signal as previously described.

It will be apparent that the two carriers which beat together in the receiver to provide the 175 k. c. carrier in the sound channel will maintain a substantially constant frequency spacing since the oscillators are crystal controlled. At the receiver, of course, the local superheterodyne oscillator can not be crystal controlled to prevent frequency drifting, since this oscillator must be variable in order to tune the receiver.

From the foregoing description it will be seen that I have provided a receiver for the simultaneous reception of two signals which has a single tuning control and in which the sound channel may be made very selective.

It will be understood that various other modifications may be made in my invention without departing from the spirit and scope thereof and I desire, therefore, that only such limitations shall be placed thereon as are necessitated by the prior art and are set forth in the appended claims.

I claim as my invention:

1. In a receiver for the simultaneous reception of a plurality of signals, means including a local oscillator for converting the incoming signals to intermediate frequency signals, an intermediate frequency filter circuit for providing adjacent channel selectivity, said filter circuit being connected to supply said intermediate frequency signals to a plurality of signal channels, one of said channels including a detector of the type in which, when two signals are impressed upon its input circuit, its output includes a signal having a frequency equal to the frequency difference of said two signals, a filter means having a comparatively narrow pass range, and a second detector in the order named, the connecting means between said filter circuit and said first-named detector having a pass range wide enough to pass the entire band width of said intermediate frequency signals.

2. A receiver according to claim 1 characterized in that another of said signal channels includes a filter means and a detector in the order named, said filter means having a pass range which is narrower than that of the first filter and which is wider than that of the filter means in said one channel.

3. A receiver for the reception of a carrier modulated by one signal having a certain band width and by a second carrier which has been modulated by a second signal, the frequency of said second carrier having a numerical value

which is greater than the width of a side band of said one signal, said receiver comprising means including a local oscillator for converting an incoming signal to an intermediate frequency signal, a single intermediate frequency filter means for providing adjacent channel selectivity, and a plurality of signal channels having input circuits coupled to said filter means, one of said channels including means for deriving solely from said intermediate frequency signal a carrier modulated by said second signal which carrier has a frequency equal to twice said numerical value.

4. A receiver according to claim 3 characterized in that said last means comprises a detector of the square law type.

5. A receiver for the reception of signals in a frequency spectrum comprising a carrier wave modulated by a signal having a certain band width whereby said carrier wave has a side band region representing said signal, a second carrier wave modulated by a second signal and located adjacent to and on one side of said side band region, and a heterodyning carrier wave located adjacent to and on the other side of said side band region, said receiver comprising means including a local tunable oscillator for converting an incoming signal to an intermediate frequency signal including a second signal intermediate frequency carrier derived from said second carrier and a heterodyning intermediate frequency carrier derived from said heterodyning carrier, an intermediate frequency filter circuit for providing adjacent channel selectivity, a signal channel having an input circuit coupled to said filter circuit, said channel including means for mixing said second signal intermediate frequency carrier with said heterodyning intermediate carrier and deriving therefrom a carrier modulated by said second signal which has a frequency equal to the frequency difference of said second carrier wave and said heterodyning carrier wave.

6. A receiver according to claim 5 characterized in that said last means comprises a detector of the square law type, and further characterized in that said detector is followed by filter means for passing only said last modulated carrier and by another detector.

7. In a communication system for the simultaneous transmission and reception of picture and sound signals, a transmitting station comprising means for transmitting a carrier wave which is modulated by said picture signal and also by a sub-carrier wave which is modulated by said sound signal, said sub-carrier wave having a frequency higher than the highest frequency in said picture signals, a receiver comprising a first detector and a local tunable oscillator for converting said carrier wave to an intermediate frequency signal which includes said sub-carrier wave as upper and lower side-band components, a sound channel including a detector and means for beating said components in said detector to produce a carrier equal to the frequency difference of said components which is modulated by said sound signals, and means for demodulating said last carrier.

WINFIELD R. KOCH.