Jan. 22, 1929. 1,699,567

R. S. OHL

RADIO SIGNALING SYSTEM

Original Filed Dec. 13, 1924

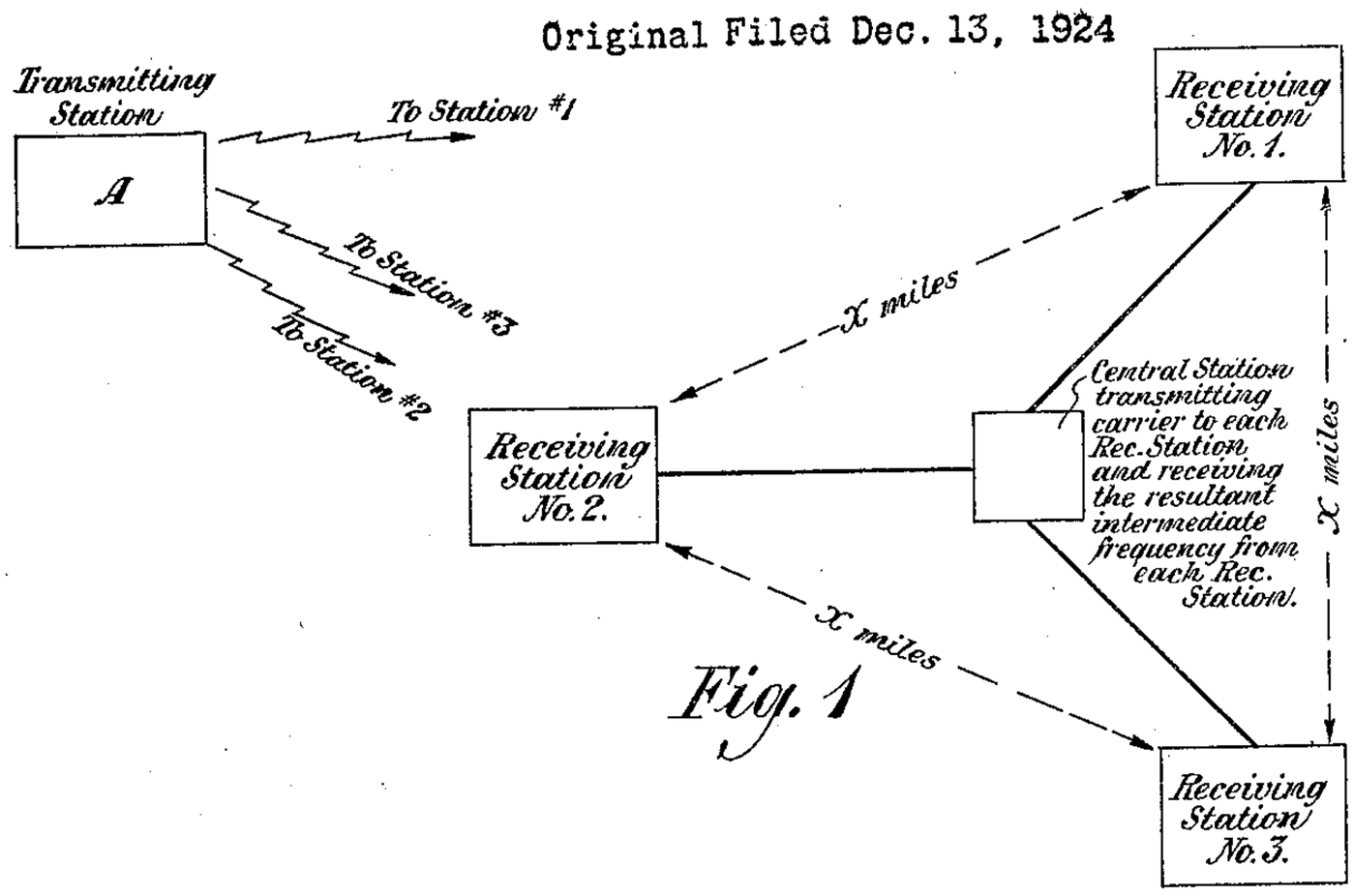

Fig. 1

Fig. 2

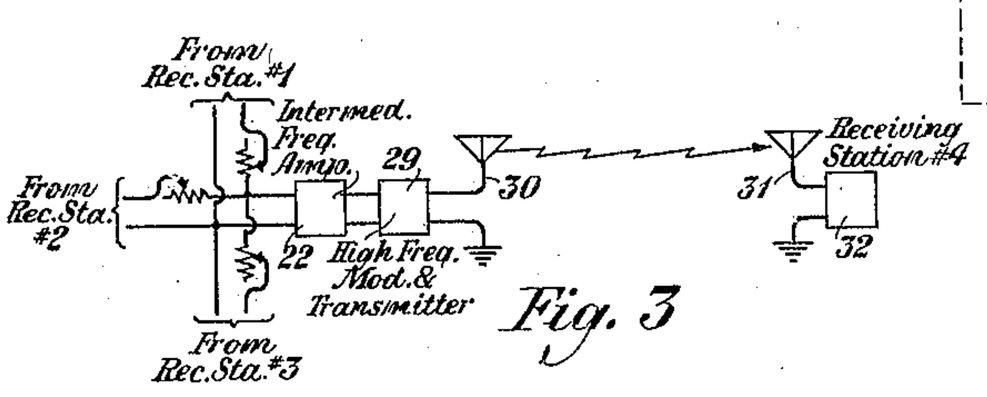

Fig. 3

INVENTOR
R. S. Ohl
BY
ATTORNEY

Patented Jan. 22, 1929. 1,699,567

UNITED STATES PATENT OFFICE.

RUSSELL S. OHL, OF NEW YORK, N. Y., ASSIGNOR TO AMERICAN TELEPHONE AND TELEGRAPH COMPANY, A CORPORATION OF NEW YORK.

RADIO SIGNALING SYSTEM.

Application filed December 13, 1924, Serial No. 755,771. Renewed November 20, 1925.

This invention relates to radio signaling systems and particularly to a system of that type characterized by means for substantially reducing or eliminating the fading effect in the reception of signals.

In the reception of radio signals there is sometimes experienced a gradual falling off in the intensity of the signal, to which has been applied the term "fading". Many theories have been advanced regarding the cause of this defect in the reception of radio signals. One of the theories is that the waves transmitted from a distant station travel to the receiving station by different paths of unequal length and consequently, when these waves reach the antenna at the receiving station they are not in phase. If the waves are sufficiently far out of phase there will be complete neutrallization and as a result the transmitted signal will not be received. On the other hand, if the phase difference between the incoming waves is not sufficiently great as to render neutralization complete, the incoming signal will be reduced in intensity. It has been found that interference and fading effects at radio frequencies are different at receiving stations located an appreciable distance apart each from the other, and also at an appreciable distance from the same transmitting station. These effects are especially noticeable when high frequencies are employed, as for example, of the order of 3,000 kilocycles or higher. I have found that if the receiving stations are at different distances from the same transmitting station the fading effect apparent in the signal received at one station will differ from that at another station. If these radio frequency signals are brought from the receiving stations to a central point and combined it will be found that the mean amplitude of the combined received signals will be more constant than the amplitude of the wave at any station of the group.

One of the objects of my invention consists in the reduction or elimination of the fading effect in the reception of signals by receiving at a plurality of stations the signal transmitted from a common transmitting station and in combining the received signals.

Since it is impracticable to transmit radio frequency signals, particularly of the high value mentioned hereinbefore, I have found that the broad object of the invention may be attained by beating the incoming signaling frequency at each receiving station with a carrier frequency that is the same for all stations, and transmitting the currents of an intermediate frequency from each receiving station to a central station where they may be combined and transmitted to another receiving station or translated in some other manner.

Another object of this invention is to provide a method and means for transferring the received signals from the receiving station to a central station for combining thereat and for subsequent translation.

Other objects of this invention will be apparent from the following description when read in connection with the attached drawing, of which Figure 1 shows schematically the arrangement of the stations illustrating the principle underlying the invention; Fig. 2 shows the circuit arrangements at each station and connecting the various stations; and Fig. 3 is a modification of Fig. 2.

In Fig. 1 the transmitting station A is adapted to transmit signals to be received at each of the receiving stations numbered 1, 2 and 3. The receiving stations may be spaced equally or unequally apart each from the other. For the purpose of illustrating the invention, equality of separation has been assumed which is represented as x miles, where x may, for example, represent 1 to 3. But equality of separation is unnecessary; relatively wide separation is the principal requirement. The receiving stations are so located with respect to the transmitting station A that the distance between the transmitting station and each of the receiving stations are different. Associated with the group of receiving stations is a central station to which the currents of an intermediate frequency are transmitted from each of the receiving stations and combined thereat. Signals transmitted from station A will be received by each of the stations numbered 1, 2 and 3, that is to say, the same signal will be received at each station but the intensity of the signal at each station may vary. For example, if that portion of the wave in traveling from station A toward station No. 1 is subject to any form of interference, the signal received at station No. 1 may fade while signals of normal strength and amplitude will be received at stations 2 and 3. If all of the received signals are combined before re-transmission or subsequent translation of whatever form may be desired, it will be found that the fading effect is substantially reduced.

The manner in which the invention is carried out will be clear by considering Fig. 2. In this figure the transmitting station A comprises an antenna 10, having connected therewith a transmitting circuit 11, which may be of any well known type. The apparatus at each of the receiving stations is similar so that it will be necessary to describe in detail the apparatus at one station only. Thus, at receiving station No. 1 the antenna 12 is intended for the reception of signals transmitted from station A. This antenna is connected with the input side of the signal amplifier 13, which is designed to amplify the high frequencies present in the radio signal. The output side of the amplifier is connected with a modulator 14, the purpose of which is to beat down the incoming radio frequency signal to an intermediate frequency of such value that it may be readily transmitted over a wire line to the central station. The carrier frequency required to beat down the incoming radio frequency signal to the intermediate frequency is provided by a source 15 which is located at the central station. This source, which may be any form of an oscillator, is connected with the antenna 16 by which the oscillations of the beating frequency are transmitted to each of the receiving stations. These beating oscillations are received at each of the receiving stations, for example, at No. 1, by the antenna 17 which is connected with an amplifier 18 by means of which the amplitude of the beating frequency is controlled. The output side of this amplifier is connected with the modulator 14. It will be seen that by receiving the beating oscillations from a common source there can be no difference between the intermediate frequency resulting from modulation of the received signals at each of the receiving stations. The intermediate frequency is amplified by the amplifier 19 and transmitted from station No. 1 over the wire line 20 to the central station. At this station the wire line is connected with other similar wire lines connecting stations 2 and 3 with the central station. A potentiometer 21 is inserted in the wire line 20, and similar potentiometers are inserted in the other wire lines in order to insure substantially equal electrical length of the lines connecting the receiving stations with the central station. The several wire lines are combined and connected with the input side of the intermediate frequency amplifier 22 at the central station, which in turn is connected with the detector 23 for detecting the signal carried by the intermediate frequency, and the output side of this detector is connected with a voice frequency amplifier 24, the output of which is connected by the line 25 with the voice frequency receiving apparatus 26.

When a high frequency wave modulated by a signal is transmitted from station A, corresponding high frequency oscillations will be set up in the receiving antennæ, such as 12, at each of the receiving stations. The amplitude of the received oscillations at each station may, of course, vary, for reasons set forth hereinbefore. These high frequency oscillations will be beaten down to an intermediate frequency by the carrier frequency transmitted from the source 15 at the central station to each of the receiving stations. The resultant intermediate frequency, when amplified, will be transmitted over the wire lines such as 20, 27 and 28 to the central station where they will be combined and amplified. The signal superimposed upon this intermediate frequency will be detected by the device 23 and the resultant signaling frequency, which may be within the voice range, will be amplified and transmitted over the wire line 25 to the receiving apparatus 26, which may be located any distance from the central station.

The arrangement shown in Fig. 3 provides for the transmission of the signal from the central station to another receiving station by means of a radio link in place of the wire line 25, shown in Fig. 2. If it is found desirable, after combining the intermediate frequencies from the receiving stations Nos. 1, 2 and 3, to transmit by a radio circuit to the distant receiving station, the combined currents of intermediate frequency may be amplified by the amplifier 22 and impressed upon a high frequency modulator and transmitter 29, which is connected with the antenna 30. At the receiving station the incoming high frequency signal would be received by the antenna 31 and detected by the apparatus 32. If, however, the distance between the antenna 30 and the receiving station 4 were so great or the conditions were such as to produce interference and fading effect at station No. 4, it might be found desirable to replace station No. 4 with a group system such as is represented by stations 1 to 3 inclusive and the central station, as shown on Fig. 2.

The reason for beating down to an intermediate frequency carrying the signal instead of detecting the signal directly and transmitting it over the wire line from the receiving station to the central station is as follows: If the signals were reduced to speech frequencies at the receiving stations of the group and transmitted over the wire line to the central station, the detected speech frequencies would include the lower fading frequencies and these would not neutralize each other but would pass into the common circuit at the central station as the summation of the amplitude of the voice frequencies coming from the separate receiving stations. On the other hand, when modulated intermediate frequencies are combined at the central station and then detected together, the changes in amplitude from the different stations of the modu-

lated wave will tend to neutralize to a certain extent before being demodulated.

Although this invention has been disclosed as embodied in a particular form it is obvious that it is capable of embodiment in other and different forms without departing from the spirit and scope of the appended claims.

What is claimed is:

1. In a radio signaling system the combination with a transmitting station of a plurality of receiving stations, a central station having means to transmit a beating carrier frequency to each of the said receiving stations, each receiving station having an antenna to receive the high frequency signaling currents from the said transmitting station, an antenna to receive the beating carrier frequency from the central station, and a detector having its input connected with both antennæ to beat the received signaling current to an intermediate frequency, means connecting each of said receiving stations with the said central station for transmitting to the latter the currents of the intermediate frequency, and means to combine at the said central station all of the received currents of intermediate frequency.

2. In a radio signaling system, the combination with a transmitting station of a plurality of receiving stations each having an antenna to receive the signal waves from the said transmitting station and an antenna to receive beating oscillations and a detector having its input connected with both of said antennæ, a source of beating oscillations common to all receiving stations to supply oscillations of the same frequency to beat the received signal waves at all receiving stations to the same intermediate frequency, and a central station connected with the detectors of all of said receiving stations to combine the intermediate frequency waves from all of the stations, and means to detect the signal superimposed upon the said intermediate frequency.

3. In a radio signaling system, the combination with a transmitting station of a plurality of receiving stations each having an antenna to receive the signal waves from the said transmitting station, an antenna to receive beating oscillations, means to separately control the amplitudes of the received signal and beating oscillations, and a detector having its input effectively connected with both of said antennæ, a source of beating oscillations common to all receiving stations to supply oscillations of the same frequency to beat the received signal waves at all receiving stations to the same intermediate frequency, and a central station connected with the detectors of all the said receiving stations to combine the intermediate frequency waves from all of the stations, and means to detect the signal superimposed upon the said intermediate frequency.

In testimony whereof, I have signed my name to this specification this 11th day of December, 1924.

RUSSELL S. OHL.