

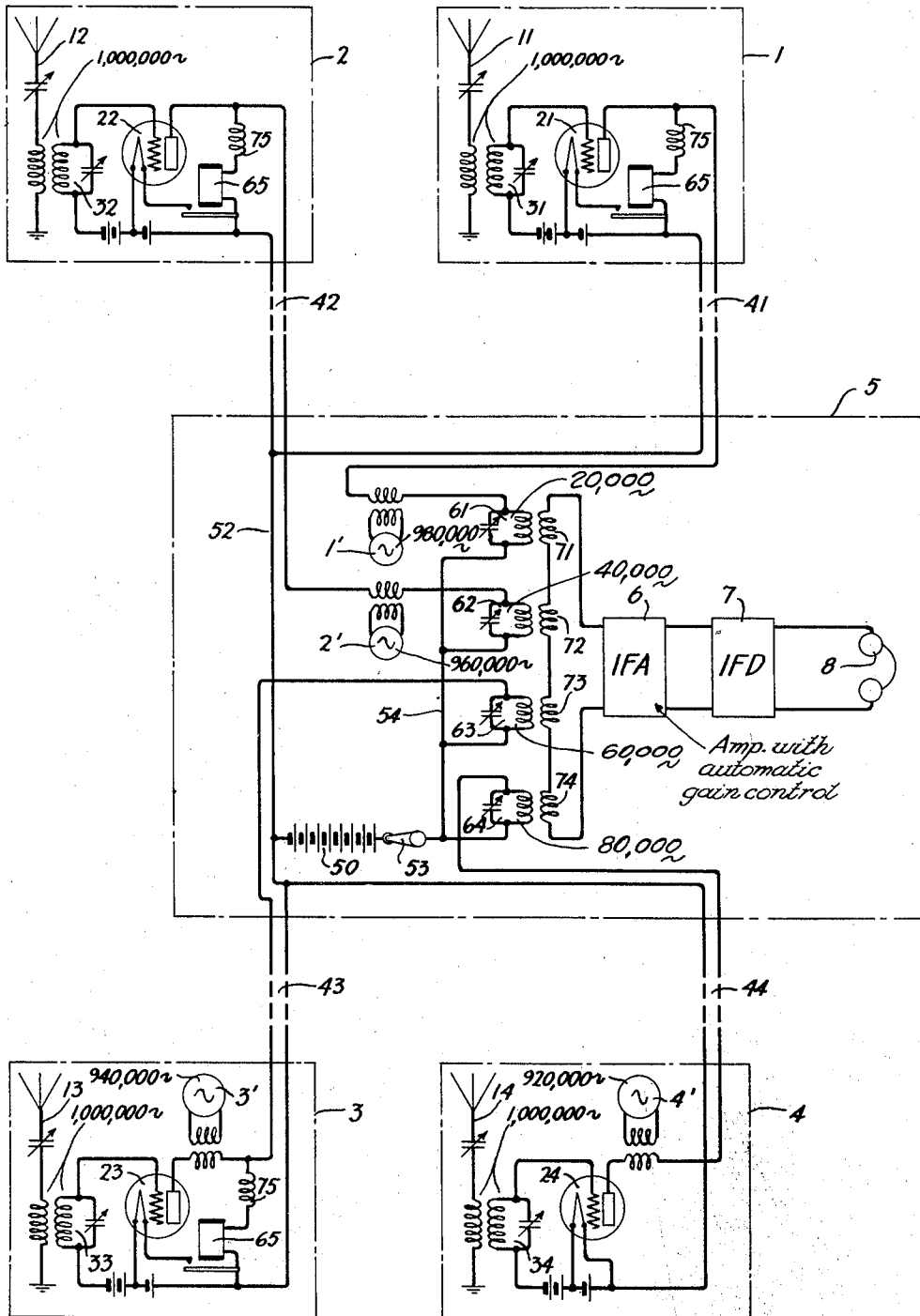
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RADIO RECEIVING SYSTEM

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RADIO RECEIVING SYSTEM

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5 Claims. (Cl. 250—20)

This invention relates to radio signaling systems and aims to efficiently reduce the changes in the intensity of the received signal such as are commonly designated "fading".

5 As an example of applications of the invention there is shown and described hereinafter a radio receiving system in which fading is reduced by receiving the same signal at a plurality of separated radio receiving stations, producing at each
10 a signal modulated wave of intermediate frequency different from the others, conducting these waves, differing from each other in frequency, to a common signal detecting station, and there adding them and detecting the signal component of
15 the resultant wave. By thus combining the effects of the signaling waves arriving at a plurality of stations, a reduction in variation of the intensity of the signal as finally reproduced is achieved in spite of the random nature of the
20 variation of the conditions encountered by the signaling waves in the radio transmission path.

Other objects, features and advantages of the invention will be apparent from the following description and claims.

25 The single figure of the drawing is a circuit diagram of a form of the invention.

Each of the specific frequency values mentioned hereinafter is merely an example of various values which may be employed in a system of
30 the type shown.

In the drawing separated radio receiving sets or stations 1, 2, 3 and 4 have their antennae circuits tuned to 1,000,000 cycles per second. These sets have random distribution within a short distance of a common signal receiving station 5 which, for convenience, may be called a central receiving station. Since fading may be materially different at points as near together as 400 feet, the distance between sets 1, 2, 3 and 4 may be of
40 the order of 400 feet. A beating or combining frequency is supplied to each of these sets in a manner described hereinafter for stepping the frequency of the incoming signal down to an intermediate frequency. The beating frequency and
45 therefore the intermediate frequency is different for each set. The intermediate frequency waves are conducted from each set to the central station and there added, for example, in the input circuit of an electric space discharge intermediate frequency amplifier 6, and the signal component of the resultant wave is detected, for example, in an electric space discharge detector 7. This signal component may then actuate a signal indicating device, as for example, a telephone
50 receiver 8, to reproduce the desired signal.

To produce the intermediate frequencies, separate oscillators 1', 2', 3' and 4' may be used. The oscillators may be located at the receiving sets to which they are individual, or they may be located at the central station. The oscillators 3' and 4' for the sets 3 and 4, respectively, are shown at those respective sets.

The receiving sets 1, 2, 3 and 4 are shown as comprising antennae 11, 12, 13 and 14, respectively, and electric space discharge detectors 21, 22, 23 and 24 respectively. The input circuits of the receiving sets 1, 2, 3 and 4 include tuning circuits 31, 32, 33 and 34, respectively, each tuned to 1,000,000 cycles per second. The beating frequencies are impressed on the plates of the distributed first detectors. The beating oscillators 1' and 2', which are at the central station, supply the beating frequencies for the sets 1 and 2 over the plate circuit conductors which transmit the intermediate frequencies from those sets to the central station. Paths 41, 42, 43 and 44 transmit the intermediate frequencies from stations 1, 2, 3 and 4, respectively, to the central station 5. The frequencies of oscillators 1', 2', 3' and 4' may be 980,000, 960,000, 940,000 and 920,000 cycles per second, respectively. Consequently, the intermediate frequency delivered by detectors 21, 22, 23 and 24 are 20,000, 40,000, 60,000 and 80,000 cycles per second, respectively.

The D. C. plate currents for all of the detectors 21, 22, 23 and 24 are supplied from a plate battery 50. The intermediate frequency wave from detector 21 is transmitted to the input circuit of amplifier 6 over a circuit extending from the filament of detector 21 through left-hand conductor 41, conductor 52, battery 50, a switch 53, conductor 54, a circuit 61 tuned to the carrier frequency, secondary winding of the output coil of oscillator 1', and right-hand conductor 41, to the plate of detector 21. The beating frequency from oscillator 1' and the D. C. plate current for detector 21 pass through this same circuit, it being noted, however, that in the tuned circuit 61 the condenser shunts the beating frequency around the inductance coil of the tuned circuit so that substantially no beating frequency is transferred from the tuned circuit to the input circuit of the amplifier 6. The tuned circuit 61 is an intermediate frequency filter, and its inductance coil is inductively related to a coil 71 in the input circuit of amplifier 6, so that the intermediate frequency filter 61 passes the intermediate frequency to the input circuit of amplifier 6 while preventing the beating frequency and the frequency of
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1,000,000 cycles received by antenna 11 from passing into the input circuit of amplifier 6.

Tuned circuit or intermediate frequency filter 62, and coil 72 function in connection with detector 22 in the manner in which tuned circuit 61 and coil 71 have just been described as functioning in connection with detector 21. Also, tuned circuit 63 and coil 73 function similarly in connection with detector 23, and tuned circuit 64 and coil 74 function similarly in connection with detector 24. With this explanation the circuits for supplying direct currents and beating frequencies to the plates of detectors 22, 23 and 24 will be apparent from the description above of the circuit for supplying D. C. and beating frequency to the plate of detector 21.

At stations 1, 2 and 3, relay 65 closes the filament heating circuit of the detectors when the plate battery switch 53 at station 5 is closed. Relay 65 is connected in series with a choke coil 75 across the plate and filament of the detector and is energized over the circuit which supplies D. C. E. M. F. across the plate and filament of the detector. The coil 75 is a choke for the intermediate frequency delivered by the detector, and at stations 1 and 2 is also a choke for the beating frequency delivered to the detector.

No relay is shown in receiving set 4 for closing the detector filament heating circuit. If desired the filament heating circuit of that detector may be controlled in the way described above for controlling the filament heating circuit at stations 1, 2 and 3.

In the operation of the system, for example in receiving radio telephone signals transmitted to the antennae 11, 12, 13 and 14 as a carrier wave modulated by signal waves of frequencies in the audible frequency range, the modulated carrier wave, received from each antenna circuit by the high frequency detector, modulates or is modulated by oscillations supplied to the plate or output circuit of the detector by the beating oscillator. At each receiving set, one of the modulation products, the so-called intermediate frequency is a signal modulated carrier wave of a frequency equal to the difference between the carrier frequency and the oscillator frequency. This different frequency will ordinarily be small compared to the carrier frequency received by the antenna. The intermediate frequency in the output circuit of each high frequency detector is transmitted over the wire conductors to the station 5 where it passes the intermediate frequency filter for that frequency and reaches the input circuit of the intermediate frequency amplifier 6. In the input circuit of the intermediate frequency amplifier, which may be, for example of the electric space discharge tube type, the waves of different intermediate frequencies are added. The resultant wave after amplification by the amplifier, is transmitted from the output of the amplifier to the input of the detector 7, which detects the signal component of the amplifying wave as the audible frequency signal wave, so that it is audible in the telephone 8. Any desired number of radio receiving sets such as 1, 2, 3 and 4 may be employed to feed station 5. Although the same signal will be received at each of the radio receiving stations, the field intensity at any of these stations may vary relatively to the field intensity at others of these stations. For example, the signal received at station 1 may fade while signals of normal strength are received at stations 2, 3 and 4. In that case, if the received signals from all four

stations are combined the fading effect in the resultant wave will be substantially less than in the signaling wave received by station 1.

If desired, the intermediate frequency amplifier may include automatic gain control means, such means being known in the art, as for example in U. S. Patent 1,675,848, issued July 3, 1928, to H. T. Früs.

Use of a single detector for detecting the intermediate frequency wave from all of the receiving stations is facilitated by employing different intermediate frequencies. This will be seen from the following considerations. If the signaling waves arriving at two of the radio receiving stations are modulated by the same beating frequency, the resulting intermediate frequency waves will follow their respective incoming waves in amplitude and phase. If these intermediate frequencies are added they will produce a single wave of the same frequency which will fade and have the same phase relations as would a wave secured by adding the two carriers arriving at the two stations. There would be two waves but only a single frequency to detect and due to mutual interference or beating between the two waves a fading effect would be introduced. However, by producing waves of different intermediate frequencies at the two stations, the waves will not combine in the intermediate frequency amplifier to produce a single resulting wave of low or audible variation but will be separately propagated through the amplifier 6 and the wave of greater intensity will be effective in the detector 7 and serve to operate the automatic gain control, if used. As both intermediate frequencies carry the same signal, the detector 7 will respond to the stronger of the two or to both if they are of nearly equal amplitude. As the instants at which the wave arriving at two or more stations are both zero, or unusable on account of weakness, will be few compared to the number of instants that this condition obtains at a single station, and as the second detector 7 is always operating on the strongest wave arriving, the resulting signal to be heard at 8 will fade out very seldom as compared with the number of times it would fade out if only one receiving station were used, or if only one intermediate frequency were transmitted from several stations.

What is claimed is:

1. A multiple station radio receiving system comprising a plurality of separated radio receiving stations, antenna means at each separated station for intercepting a signal modulated wave of high frequency, means at each of said separated stations for producing from said signal modulated waves of high frequency signal modulated waves of intermediate frequency which are of different frequency at the respective stations, a single amplifier for said signal modulated waves of intermediate frequency, and means whereby the gain of said amplifier is automatically controlled by the wave of greatest intensity.
2. A multiple station radio receiving system comprising a plurality of separated radio receiving stations, antenna means at each separated station for intercepting a signal modulated wave of high frequency, a plurality of frequency changing means adapted to change the respective received waves to frequencies that are distinct from each other, a single amplifier for the changed frequency waves, and means whereby the gain of the amplifier is automatically controlled by the wave of greatest intensity.

3. In a signaling system subject to variable

transmission conditions, a plurality of receivers each receiving the same signal and so related to each other that the received signals vary differently at the several receivers with variations in transmission conditions, means for changing the carrier frequencies of the respective received signals to values which are distinct from each other, a signal circuit common to said frequency changing means, and means responsive to the amplitude of the outputs of said receivers for automatically controlling the gain of said signal circuit.

4. A plurality of separated radio receiving stations each including means for receiving a wave having different intensities at the respective stations, a plurality of frequency changing means adapted to change the respective received waves to frequencies that are distinct from each other and an amplifier common to said respective frequency changing means, said amplifier including an automatic gain control device effective to maintain a substantially constant output over a wide range of intensities of received waves.

5. In a signaling system subject to variable transmission conditions, a plurality of receivers each receiving the same signal and so related to each other that the received signals vary differently at the several receivers with variations in transmission conditions, frequency changing means at each station adapted to change the received waves to frequencies that are distinct from one another, an amplifier common to said frequency changing means and means for automatically controlling the gain of said amplifier to render the combined output thereof substantially free from variations.

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