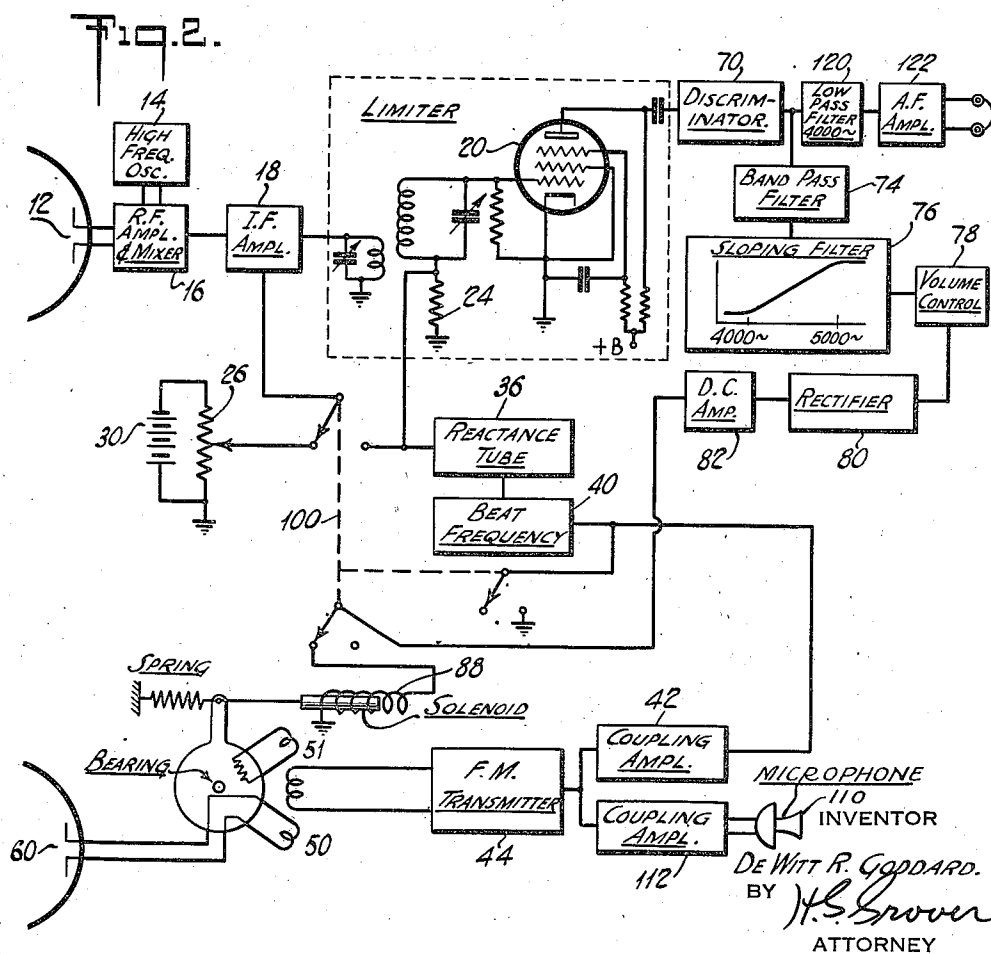
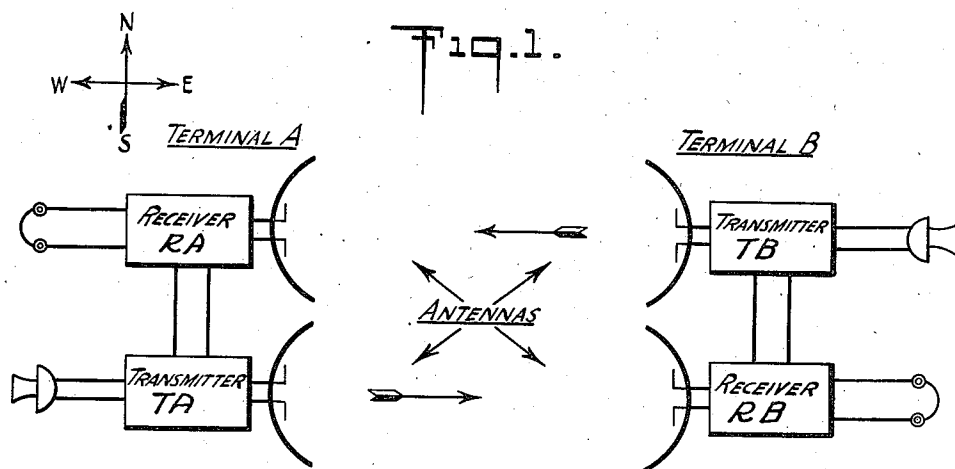


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CONTROLLED CARRIER AMPLITUDE COMMUNICATION SYSTEM

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This application concerns ultra-high frequency signaling systems wherein secrecy of operation is desired.

The general object of my invention is improved secret signaling.

In order to achieve maximum secrecy on a UHF communications circuit with highly directive antennas I propose to operate with the least amount of radiated power possible consistent with a suitable received signal. In the past it has been customary to radiate a much stronger signal than is necessary. This superabundance of signal is reduced to a reasonable value through the use of AGC circuits at the receiver.

Where a large amount of power is radiated even by a highly directive antenna there is the danger that a receiver, not of the system, outside the direct path of the radiant energy may pick up enough of the radiant energy to reproduce the signal thereby nullifying the secrecy of the system.

A more specific object of this invention is to provide a communication system wherein the radiated signal is at all times maintained just sufficient for good reception at the receiver to which it is directed.

I propose a system in which the receiver of a circuit, instead of controlling the gain of its own amplifying circuits, controls the power being transmitted to it. In this way the receiver operates at maximum gain consistent with a useful signal-to-noise ratio and the power of the transmitter supplying the received signal is so reduced that it just overrides the noise in the receiver.

In describing my invention in detail, reference will be made to the attached drawings wherein Fig. 1 shows schematically and mainly by rectangles a communication system arranged in accordance with my invention; while

Fig. 2 illustrates the essential features of the equipment at one terminal of the system. The other terminal being similar to a large extent has not been shown. In Fig. 2 rectangles are again used to show certain units the details of which per se are not claimed herein.

Referring to Fig. 1, terminal A consists of a receiver RA and a transmitter TA. Terminal B consists of a receiver RB and a transmitter TB. These two terminals are in communication with each other as shown by the arrows. The strength of the signal picked up by RA by suitable means modulates a superaudible tone transmitted by TA. This tone is picked up by RB and by the use of suitable filters is separated from the voice frequencies and fed to transmitter TB. Here,

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through suitable circuits it controls the power being transmitted. In a preferred application the strength of the signal picked up by RA operates through suitable means to control the frequency of the tone transmitted by TA. In a similar fashion receiver RB is able to control the power of transmitter TA. It is of course understood that the transmitters TA and TB do not operate on exactly the same carrier frequency.

Thus I have provided a communication system having a maximum of secrecy because an enemy would have to locate a receiver directly between terminals A and B to obtain a strong enough signal to override the noise in his receiver. If he were located to the right of terminal B or to the left of terminal A, the signal he would receive would be too weak to be useful.

If he were located to the north or south of the straight line between the two terminals his received signal would be too weak to be useful due to the directivity of the antenna system.

Fig. 2 shows mainly by block diagram one possible circuit arrangement for achieving the above result. It makes use of a conventional frequency modulated transmitter and a conventional frequency modulated receiver. This diagram illustrates the equipment required by one of the two terminals shown in Fig. 1. The equipment at the other terminal is the same.

The incoming signal is picked up at the receiver by the parabolic reflector antenna 12 and fed to the receiver which may be conventional to a large extent. The receiver includes a source of oscillations 14, a mixer or converter 16 wherein the oscillations from 14 and picked up signal are beat, one against the other. The selected beat frequency is fed to the I. F. amplifier 18 and thence to a limiter. The limiter tube 20 has in its grid circuit a resistance 24 wherein a potential is developed which depends on the intensity of the signal applied to the limiter input. The grid current of this limiter provides a potential across the resistor 24 which is usually used to bias the intermediate frequency amplifier tube grids so as to provide automatic gain control action. In my system, however, the I. F. amplifier grids may obtain an adjustable bias from a potentiometer 26 across a battery 30 while the potential obtained from the limiter is used to actuate a reactance tube in unit 36 which in turn adjusts the frequency of one of two oscillators in unit 40 so that the frequency of the beat frequency of these two oscillators is controlled in accordance with the intensity of the received signal. The constants of this beat frequency oscillator in 40 are adjusted

so that the beat frequency varies over the range of from say 4000 cycles to 5000 cycles depending on whether a strong or a weak signal is present at the limiter. This control tone is impressed upon a coupling amplifier 42 and then used to modulate the timing of high frequency wave energy in 44. The timing modulated output from 44 is coupled at 50 into the transmitting antenna 60 located in its parabolic reflector.

At the other end of the circuit this tone of variable frequency is filtered off of the received signal and used to adjust the power output of the transmitter sending the signal picked up at 12 which controls the potential across 24 in accordance with its intensity.

The other terminal includes a receiver, limiter, reactance controlled beat generator, timing modulated generator and transmitting means arranged and operating as described above but operating on a different carrier frequency. This being so in order to simplify the description, reference is made again to the receiver of Fig. 2 to disclose how this tone generated in 40 is used to control the amount of signal being sent out by the other transmitter not shown.

The signal picked up by the receiver in Fig. 2 contains a tone the frequency of which is between 4000 and 5000 cycles, and which is determined by the strength of the incoming carrier. This tone appears at the output of the limiter and is fed to the discriminator 70 and is filtered off of the voice channel by the band pass filter 74. It passes through a sloping filter in 76, a volume control, i. e., an amplifier of adjustable gain in 78, a rectifier 80 and a direct current amplifier in 82 to energize a solenoid 88. This solenoid is arranged as shown to rotate a frame containing the antenna coupling coils at 50. The frame is on a bearing and is biased by a spring or similar means tending to increase the coupling at 50. The greater the current in the solenoid 88 the more the coupling is opened thereby reducing the antenna power. This rotating frame also contains a second coupling coil 51 feeding a load resistor, the arrangement being such as to increase this coupling as the coupling 50 is reduced to keep the transmitter under approximately constant load regardless of the amount of power fed to the antenna 60.

In operation the switch 100 is first thrown to the right so that the potential drop in resistance 24 is applied to the grids of amplifier tubes in 18 and the system operates in conventional fashion with AGC on the receiver and no tone developed in 40 to act on the transmitter through coupling amplifier 42. Maximum output from the transmitter also occurs since the spring moves the frame to a position whereat there is large coupling at 50. As soon as the two terminals A and B have established contact and the receivers and transmitters have been adjusted for optimum operation transmitter TA and receiver RB at one carrier frequency and transmitter TB and receiver RA at another carrier frequency the switch 100 at both terminals is thrown to the left. The receiver gain control is now adjusted by potentiometer 26 to bring the thermal agitation noise, etc., up until it is just audible. The beat frequency oscillator in 40 is normally adjusted to produce a beat of approximately 4500 cycles and the volume control in 78 following the sloping filter in 76 is adjusted to draw the plunger approximately half way into the solenoid at 88.

The equipment will now operate as described. The signal is impressed by the microphone 110

or similar means on the coupling amplifier 112 and thence to the timing modulator in 44. The signal sent from the other station is fed from the limiter to the discriminator 70 and selected out by the low pass filter in 120 and amplified in 122 and used as desired.

The received signals will remain of constant strength regardless of moderate fading, etc. Should interference occur the gain of the receiver may be reduced through the receiver gain control including battery 30 and potentiometer 26. This will increase the strength of the transmitted signal because the input to the limiter has been increased as has the frequency of the output of the beat frequency oscillator in 40, thereby reducing the interference. Of course, if desired, the switch 100 may be thrown to the right thereby converting the system to conventional full power operation by applying the potential developed in resistance 24 to the gain controlled stages in the receiver and grounding the output of the beat frequency oscillators in 40.

The circuits and apparatus in units 14 and 16 may be of any approved type provided they include means for generating oscillations, amplifying the received wave, mixing the amplified received wave and generated oscillations, selecting the intermediate frequency from the mixer output and supplying the same to an intermediate frequency amplifier of controllable gain.

The limiter including tube 20 likewise may be of any approved type wherein grid limiting takes place and grid current flows which is a measure of carrier input intensity so that a control potential is developed in resistance 24.

The discriminator in 70 may be of any approved type, but preferably is of the type disclosed in the U. S. Patent #2,229,640, dated January 28, 1941, or in Seeley U. S. Patent #2,121,103, dated June 21, 1938, or in Conrad U. S. Patent #2,057,640, dated October 13, 1936.

The low pass filter in 120 and band pass filter in 74 may be of any approved type and such filters are too well known in the prior art to need further discussion here.

The sloping filter in unit 76 which converts the frequency changes on the beat frequency sent out by the other transmitter, as controlled by the other receiver, into corresponding amplitude changes for amplification control in 78 and detection in 80 may be of the type used for frequency discrimination in unit 70, or may be a simple resonant circuit off-tuned to utilize one side of the resonant curve characteristic as used in Conrad U. S. Patent #1,528,047, dated March 3, 1925.

The amplifier of variable gain in 78, the rectifier in 80, and the direct current amplifier in 82 may be conventional and are so well known in the prior art that it is believed a description thereof is unnecessary.

The beat frequency generator in 40 may comprise two sources of oscillations which are beat one against the other to provide the beat output with the frequency of one of the oscillators controlled by a reactance tube modulator in rectangle 36, in accordance with the principle disclosed in Crosby U. S. Patent #2,279,659, dated April 14, 1942. Of course, the reactance tube in 36 or similar means may modulate the frequency of a source of oscillations of superaudible frequency such as, for example, 4500 cycles directly, if desired. It is believed that this system needs no illustration in detail other than as given above.

The amplifiers in 42 and 112 likewise may be conventional and of any approved type, and the

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same will not be described. The timing modulated transmitter in 44 may utilize the principle disclosed in Crosby Patent #2,279,659, dated April 14, 1942.

Of course, various means may be used to control the power output of the transmitter, such as changing the plate voltage, inserting attenuation in the antenna transmission line, opening and closing shutters across the mouth of the parabolic reflector, etc. In the case of an amplitude modulated system even the depth of modulation may be varied.

It is to be understood that this describes just one of many possible systems that will permit the transmitter power to be automatically varied to permit the minimum signal consistent with good communication to be present at the receiver.

This system can also be adapted to effect economy in transmitter power consumption as at all times a minimum of power is required for communication and waste or excess is eliminated.

I claim:

1. In a signalling system, a signal transmitter and a receiver for the transmitted signal, and means for controlling the strength of the transmitted signal energy in accordance with the strength of the signal energy at the receiver including means in said receiver for producing a potential depending upon the strength of the received signal energy, an oscillation generator controlled as to frequency of operation by said produced potential, means at the transmitter for producing a control potential which varies with variations in the frequency of the produced oscillations, and control means at said transmitter responsive to said last mentioned potential for controlling the strength of the transmitted signal energy.

2. In a signalling system, two terminals each including a signal transmitter and a signal receiver, means at each receiver for producing a potential which is representative of the strength of the signal received at the other receiver, and a control circuit at each transmitter responsive to changes in the produced potential for controlling the strength of the transmitted signal energy to thereby automatically hold the transmitted energy at a value sufficient for good reception at the receiver.

3. A communication system having at least two terminal stations each including a signal modulated transmitter and a receiver, a control circuit coupling the receiver to the transmitter for controlling the power transmitted in accordance with modulations on the energy received at the receiver, and a coupling between said transmitter and said receiver for modulating the transmitted energy in accordance with the intensity of the signal at the receiver.

4. A communication system having at least two terminal stations each including a signal modulated transmitter and a receiver, a control circuit coupling the receiver to the transmitter for controlling the power transmitted in accordance with modulations on the energy received at the receiver, a source of oscillations, a coupling between said source of oscillations and said receiver for modulating the oscillations in accordance with the strength of the signal at the receiver, and connections between said oscillator and said transmitter for modulating the transmitted energy in accordance with said modulated oscillations.

5. In a signalling system, a signal transmitter and a receiver for the transmitted signal, and

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means for controlling the strength of the transmitted signal energy in accordance with the strength of the received signal energy including a rectifier at said receiver for producing current a characteristic of which depends upon the strength of the received signal energy, a second transmitter modulated by said current, and a second receiver including a rectifier associated with said first transmitter and responsive to the modulations on said second transmitter for controlling the strength of the signal sent out by said first transmitter.

6. A signalling system comprising at least two terminals, each including a receiver and a transmitter with the transmitter at one terminal and the receiver at the other terminal operating on one frequency and the transmitter at the other terminal and the receiver at said one terminal operating on another frequency, means for controlling the strength of transmission from the transmitters at the receivers therefor including, a rectifier at each receiver for producing a potential depending upon the strength of the received signal, a control circuit between the transmitter and receiver at each terminal for modulating a characteristic of the wave transmitted by each transmitter in accordance with the potential produced by the receiver at that terminal, and means at each receiver responsive to the modulations on the wave sent out by the transmitter at the other terminal for controlling the intensity of the signal sent out by the transmitter at the receiver terminal.

7. A signalling system comprising at least two terminals, each including a receiver and a transmitter with the transmitter at one station sending signals to the receiver at the other station and the transmitter at the other station sending signals to the receiver at said one station and means for controlling the strength of transmission of the respective transmitters at each receiver including means at each terminal for producing oscillatory energy the frequency of which depends on the strength of the received signal, means at each terminal for modulating the amplitude of the transmitted wave in accordance with the produced oscillatory energy, means at each terminal for rectifying the received wave energy to recover said oscillations, a frequency discriminator at each terminal excited by the recovered oscillations for producing current the intensity of which varies as the frequency of the oscillations vary, and means at each terminal for controlling the intensity of the transmitted energy by the produced currents.

8. A signalling system comprising at least two terminals, each including a receiver and a transmitter with the transmitter at one station sending signals to the receiver at the other station and the transmitter at the other station sending signals to the receiver at said one station and means for controlling the strength of transmission of the respective transmitters at each receiver including a rectifier at each receiver excited by wave energy transmitted from the other terminal for producing a potential depending upon the strength of the received signal, a source of oscillations of variable frequency at each terminal, a modulator coupled therewith and controlled by the produced potential for controlling the frequency of the oscillations generated, connections from said source of oscillations to the transmitter at each terminal for modulating a characteristic of the transmitted wave by the

oscillations of controlled frequency, a frequency responsive circuit and detector at each terminal responsive to the oscillations transmitted as modulation on the wave energy from the transmitter at the other terminal for producing current the intensity of which depends on the frequency of the said oscillations, and apparatus at each terminal controlled by said current for controlling the intensity of the wave energy transmitted.

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