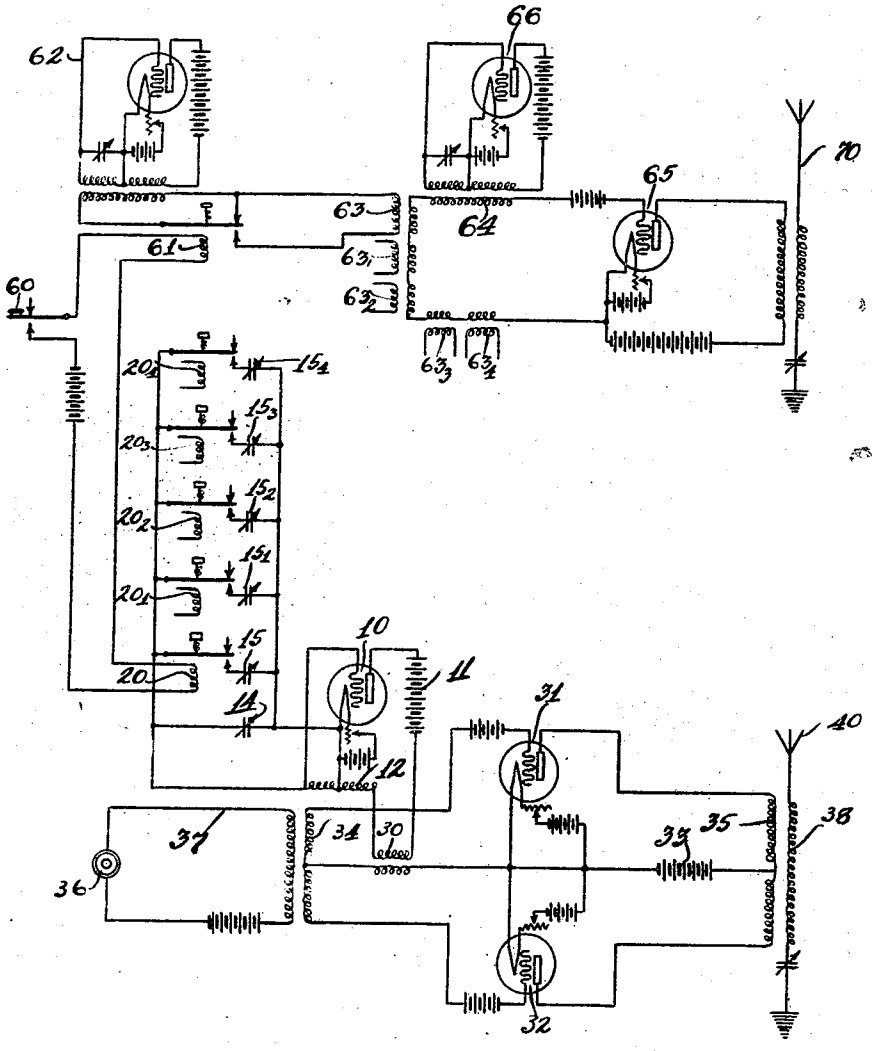
May 10, 1927. 1,628,411

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SYSTEM OF SECRET WIRELESS TELEPHONY

Filed Feb. 1, 1923 2 Sheets-Sheet 1

Fig. 1



Witnesses

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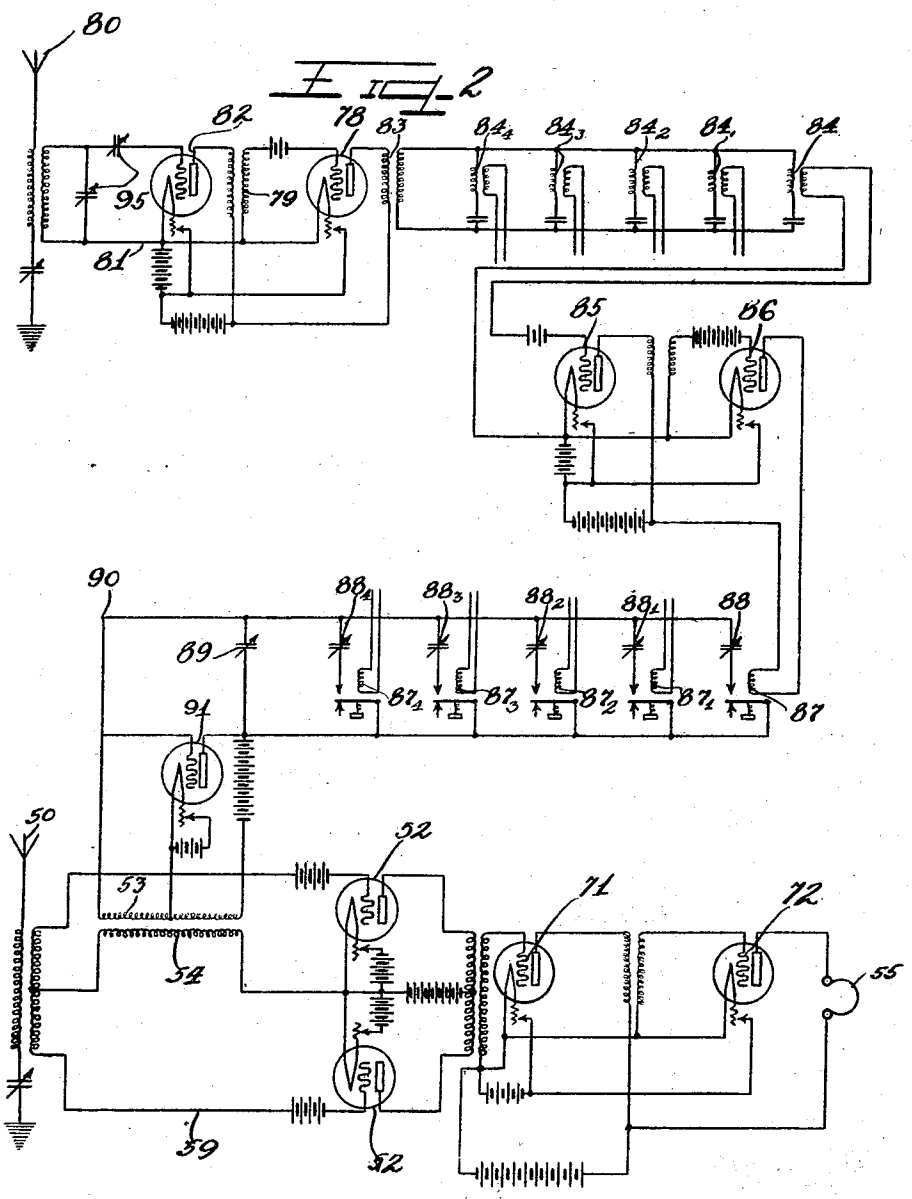
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Fig. 2



Witnesses

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UNITED STATES PATENT OFFICE.

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SYSTEM OF SECRET WIRELESS TELEPHONY.

Application filed February 1, 1923. Serial No. 616,361.

In sending confidential or secret messages by wireless telephone, it is essential or at least highly desirable to make them understandable only to the individual or station for which they are intended. Devices heretofore proposed for this purpose, are not sufficiently secretive, and as a consequence thereof have not proven entirely satisfactory.

It is an object of the present invention to devise a system of sending and receiving apparatus in which messages may be sent by wireless telephony and be heard as understandable speech only at the station where they are intended to be heard. It is recognized that any other station equipped with receiving apparatus exactly like that at the intended receiving station could also hear and understand the message, but this invention contemplates a set of specially designed auxiliary apparatus for each station, so difficult to reproduce by accident that it is unlikely that any station except those intentionally so equipped would get the message.

This invention contemplates the use of a modulator. This is an arrangement of electrical circuits in which the alternating currents of speech frequency and the alternating currents of the frequency chosen for sending re-act upon one another, sending out modulated radiation waves. One of the modulators used in this invention sends out radiation waves of such a character that when combined in the receiving circuit neither the unmodulated sending frequency nor the speech frequency used to produce the modulation will be reproduced in said receiving circuit. The character of the modulated waves which it sends is such, however, that when the unmodulated waves having the sending frequency are added to the other frequencies present in the receiving circuit, the speech frequency will be reproduced therein. Unmodulated waves of the sending frequency, which will, for convenience, be called herein the basic frequency, are not themselves present in the radiations, but in the invention herein presented, such waves are generated in each of two oscillating circuits, one at the sending station and one at the receiving station.

It is an object of this invention to provide means for altering this basic frequency at the sending station, and at the same time altering it at the receiving station so as to keep the basic frequency the same at both stations.

It is a further object of this invention to provide for controlling the oscillating circuit at the receiving station by means of a plurality of tuned circuits. These are selectively energized by means of auxiliary radiations sent from the sending station. The character of these auxiliary radiations is changed by apparatus at the sending station which co-operates with the arrangements for changing the basic frequency there.

It is a further object of this invention to use modulated waves for the auxiliary radiation which controls these tuned circuits. These are of markedly different frequency from the modulated waves first mentioned, and these modulations are produced, not by speech, but by oscillating circuits, which give frequencies corresponding to the several tuned circuits.

This invention thus contemplates the simultaneous sending of two sets of modulated waves of different frequencies, one to carry the speech and one to carry the control of the circuit changing devices.

It is a further object of this invention to produce a system in which a receiving apparatus cannot be built to co-operate with the sending apparatus without knowing the frequencies of a plurality of oscillating circuits.

It is a further object of this invention to produce a system wherein a receiving apparatus cannot be built to co-operate with the sending apparatus without a knowledge of the sequence in which such oscillating circuits are to be used and the times at which changes from one to another are to be made.

It is a further object of this invention to produce a wireless telephony system making use of a basic frequency which changes by arbitrarily chosen amounts at frequent and irregular intervals.

Other and further important objects of this invention will be apparent from the disclosures in the accompanying drawings and in the following specification.

The invention (in a preferred form) is

illustrated in the drawings and hereinafter more fully described.

On the drawings:

Figure 1 is a diagrammatic showing of the circuits employed in the sending station.

Figure 2 is a similar showing of the circuits employed at the receiving station.

As shown on the drawings:

The sending station has a circuit containing an audion 10, a battery 11, an inductance 12, and a set of condensers in parallel. This makes an oscillating circuit whose period determines the basic frequency. This period can be altered by the introduction or removal of one or more of these condensers. One condenser, 14, is permanently connected in the circuit. The other condensers, 15, 15_1, etc.. are controlled by relays 20, 20_1, etc. The full circuit for one only of these relays is drawn, but it is to be understood that each relay has associated with it parts similar to those associated with the relay 20.

The circuit of the oscillator also contains one member of a transformer 30, by means of which the oscillations of this circuit are impressed upon a modulator circuit. The modulator circuit includes two audions, 31 and 32, and a battery 33. At one end of the modulator circuit is a transformer 34, and at the other end a transformer 35. The audions 31 and 32 are symmetrically arranged in this circuit. A single conductor connecting the middle of the transformers 34 and 35 contains the battery 33 and the secondary of the transformer 30. The "A" batteries and the filaments of the audions are also connected to this central conductor so that the whole arrangement is symmetrical, no difference between the distribution of potentials in the two halves of the circuit upon the two sides of the central conductor being possible except by adjustment of the resistances in the filament circuits of the audions. As these adjustments have to do wholly with a non-inductive resistance and as they affect only the temperature of the filaments, they leave the potentials of the whole modulator circuit symmetrical.

The primary of the transformer 34 is a circuit 37 containing a telephone transmitter 36. The electric currents of the speech frequency which are set up in this circuit 37 affect the two halves of the modulator circuit oppositely so that their frequency produces its effect in the resultant character of the output of the modulator. This output is delivered to the secondary 38 of the transformer 35 and so received on the aerial 40.

It is a well-known principle of modulator circuits containing audions that in general the sum, the difference, and the octaves of the several impressed frequencies as well as the impressed frequencies themselves will appear in the output. Because of the symmetrical arrangement of the circuit with respect to the transformer 30, the basic frequency of the oscillating circuit will not appear in the antenna 40. If s be the speech frequency and b be the basic frequency, the modulator circuit will impress upon the antenna 40 the following frequencies: s, $b+s$, $b-s$, $2s$ and $2b$. The frequencies s, and $2s$, are so low that the amount of energy radiated by the antenna at these frequencies will not be sufficient to need consideration. The amplitude of the vibrations of frequency $2b$ is so small that no result which need be considered is produced by them.

The antenna 50 in Fig. 2 receives therefore impulses of the frequency $b+s$ and $b-s$. The transformer 51 delivers this energy to the receiving circuit 59 which contains a symmetrical pair of audions 52, and preferably the usual regenerative and amplifying connections and a telephone receiver 55. Each audion 52 has its grid maintained at the proper voltage with respect to the filament, so that it acts as a modulator and will have in its output current, oscillation frequencies which are the sums and the differences of the frequencies of the alternating voltages impressed on its input. This output, therefore, if it were not for arrangements explained below, would contain only the frequencies $b+s$, $b-s$, $2b$ and $2s$. The first three of these are of radio frequency and will not be transmitted by the low frequency transformers to the amplifiers and in fact, even though they were, they would not be audible in the receivers 55. The currents of frequency 2s would produce sounds which would be wholly unintelligible, because they are not of the same frequency as the spoken message.

A circuit containing the primary of a transformer 53, whose secondary 54 is in the receiving circuit just described, impresses, by means which will be described below, strong alternating voltages of the frequency b upon the receiving circuit. The secondary 54 is in the middle wire of the symmetrical circuit 59. Consequently currents of the frequency b will not appear in the output of this circuit but this does not prevent the alternating voltages of frequency b from combining with the other frequencies present in the circuit 59. These voltages of frequency b are so large in comparison with those whose frequencies have just been discussed, that the interaction of them with those of frequencies $b+s$ and $b-s$ eclipses all others in effect in the output. These interactions have, however, in each case the frequency s, so that the result of the action of the transformer 53 upon the receiving circuit is to cause alternating currents of the frequency answering to the transmitter 36 to appear in the telephone receiver 55,

although waves of this frequency are not, to any great extent, present in the radiated energy. The symmetrical character of the circuit 59 also prevents the transformer 53—54 from causing currents of frequency *b* in the antenna 50.

The circuit 90 containing the primary of the transformer 53 is controlled indirectly by the mechanism controlling the relays 20, 20_1, etc., Fig. 1. When the key 60 is closed to energize the relay 20, the relay 61 is also energized, which results in causing the oscillating circuit 62 to deliver energy to the transformer 63. This transformer impresses its energy upon a circuit containing the transformer 64, and the audion 65. The transformer 64 is energized by an oscillating circuit including the audion 66. The result of this combination is to cause the circuit including the transformers 63 and 64 and the audion 65 to act as a modulator. The alternating currents delivered to the antenna 70 consequently contain not only the frequency of the oscillating circuit 66—64 but also the frequencies that result from interaction between the oscillations from the two transformers 63 and 64.

Any radio frequency may be chosen for the oscillating circuit but the period of the oscillating circuit 62 must be below the period of the circuit 66—64. Preferably periods near, if not in speech frequency range, are chosen for each of the circuits corresponding to the circuit 62.

Associated with each of the relays 20, 20_1, etc., is a circuit similar to the circuit 62, and each of these must have a different frequency. Moreover, these differences must be large enough for the selective apparatus described below to discriminate between currents of the several frequencies. The several transformers 63_1, 63_2, etc. in the circuit 64—65, are similar to the transformer 63, and are related to the relays 20_1, 20_2, etc., in the same way as the transformer 63 is related to the relay 20.

Thus, by manipulating the several keys corresponding to the key 60, the energy delivered by the antenna 70 may be made to have the frequency of the circuit 66—64 modified by a selected one of the circuits corresponding to the circuit 62. It is, of course, obvious that the modulation of the output of the circuit 66—64 may be effected by two or more of the transformers 63, 63_1, etc., simultaneously. With five keys similar to the key 60, and the corresponding circuits similar to 62, it is possible to get thirty-two different modulations of the output delivered to the antenna 70.

The antenna 80, Fig. 2, receives energy delivered from the antenna 70, and the circuit 81, including the audion 82, and the amplifying connections, will cause the several frequencies received by the antenna 80 to interact in the way already described. It is not necessary to impress an extra alternating voltage upon the circuit 81 as the transformer 54 did upon the circuit 59 because the modulator circuit 64—65 is not symmetrical.

The frequency of the circuit 66—64 as well as its interaction frequencies with the frequencies of the circuits 62, 62_1 (not shown), etc. are present in the radiation from the antenna 70 and are received in the circuit 81. The audion 82 acts as a detector or modulator, and interaction frequencies are produced between all the frequencies impressed on it and will appear in the output current. Because of the frequencies impressed, among the most prominent of these frequencies appearing in the output circuit will be the relatively low frequencies from the oscillators 62, 62_1 (not shown), etc., depending on the arrangement of the relays 20, 20_1, etc. The transformer 79 is a low frequency transformer (as distinguished from a radio frequency transformer) and the low frequency currents are amplified by the audion 78 and are impressed on the several tuned circuits 84, 84_1, etc., which are arranged in parallel. The tuning of these circuits is such that one is resonant to the oscillations sent out by oscillator 62 when relay 20 is energized, another to those sent out by oscillator 62_1 when relay 20_1 is energized, and so on, there being one of these tuned circuits for each of the combinations of relay and oscillator.

Each of these tuned circuits is connected, preferably by induction, to a similar set of apparatus, although on the drawing only the circuit 84 has this apparatus shown in full. The apparatus includes an amplifier 85 and a rectifier 86, which are shown as being of the audion type although any types of amplifier and rectifier may be used. Beyond the rectifier the circuit includes a relay 87, and similar relays 87_1, 87_2, etc., are shown, which correspond to the several tuned circuits 84_1, 84_2, etc. The relay 87, when it is energized, puts the condenser 88 into the circuit 90 containing the primary 53 and the audion 91. When the condenser 88 is in the circuit 90, the natural period of vibration of this circuit is equal to that of the circuit 10—30 when it contains the condenser 15. In the same way, the condenser 88_1 answers to the condenser 15_1, 88_2 to the condenser 15_2, and so on. The condenser 89 corresponds to the condenser 14, and is permanently in the circuit 90.

It will thus be evident that by manipulating the keys 60 the periods of the circuits 10—30 and 90 are changed, but in each change the periods of the two circuits continue to be alike, and for the reasons above explained, the voltages impressed upon the receiving circuit by the transformer

53 are in each case of the exact frequency needed to cause the telephone 55 to reproduce the speech spoken into the transmitter 36.

The ordinary receiving station cannot receive signals sent out through the transmitter 36, because it is not equipped with any means for producing the basic frequency which must be added to the receiving frequencies in order to obtain intelligible sounds. If an attempt is made to build a receiving station which can eavesdrop, it would be necessary to provide means for producing oscillations of the frequency produced by the circuit 90, and to provide means for changing this frequency in the same manner as is done by the introduction of the condensers 88, 88_1, etc., into the circuit 90, and to provide means for making these changes of frequency in the same way and at the same times as is done in the circuit 90. This would require an exact duplication of the elements of circuit 90, together with the condensers 88, 88_1, etc., and the tuned circuits 84, 84_1, etc., and the equivalent of the rest of the apparatus shown in Fig. 2. Changes can be made in these circuit elements at any time by agreement between the sending and receiving stations so as to make duplication by a third party as a result of experiment, still more difficult.

The several condensers 15, 15_1, etc., have been shown on the drawing as adjustable, and the corresponding condensers 88, 88_1, etc., in Fig. 2 have also been shown as adjustable, but it is to be understood that these condensers are not to be changed except after interchange of information between the sending and the receving station, and then they are to be changed only in such a way that the corresponding condensers produce like frequencies in their several circuits, and the same is true of condensers 14 and 89. The condenser in the circuit 62 has been shown as adjustable, while the condensers in the several circuits 84, 84_1, etc., have been shown as non-adjustable. The adjustment in the circuit 62 would be used only to perfect the tuning. While the condensers in the circuits 84, 84_1, etc., might be made adjustable to accommodate the receiving station to different sending stations, it is believed that better results would be obtained by making a different set of tuned circuits for each sending station with which this receiving station is expected to correspond, and changing from one to another set by mere switching and not by tuning.

Numerous variations of the arrangement of the circuits will occur to those who are skilled in the art, and numerous changes in details of the apparatus come within the scope of this invention. It is therefore to be understood that I do not wish to limit the patent to be granted otherwise than is necessitated by the prior art.

I claim as my invention:

1. A system for secret wireless communication comprising means at one station for sending radiation waves of a plurality of frequencies symmetrically differing from a basic frequency, a circuit at another station, means for receiving said waves and impressing electrical oscillations of the resulting frequencies on the circuit, auxiliary wave sending means at the first station, and means at the second station controlled by said auxiliary sending means for impressing electrical oscillations of said basic frequency on said circuit, the oscillations of said auxiliary sending means being unrelated in any frequency sense to the oscillations of said basic frequency.

2. In a wireless communication system, means at a sending station for generating electrical oscillations of a basic frequency, means for modifying said oscillations and sending radiation waves of frequencies differing symmetrically therefrom, a circuit at a receiving station, means for receiving said waves and impressing electrical oscillations of said frequencies on said circuit, means controlled at said sending station and associated with said receiving means for generating and impressing electrical oscillations of said basic frequency on said circuit, means for sending waves of an auxiliary frequency, and separate from said basic frequency waves, said auxiliary frequency being unrelated in any frequency sense to said basic frequency, and means controlled by said auxiliary frequency waves for controlling the last named generator of electrical oscillations of basic frequency.

3. In a wireless communication system, an electrical oscillating circuit of basic frequency, a modulator circuit having means for producing electric current of speech frequency and producing modulated frequencies differing from said basic frequency by said speech frequency, a radiating circuit sending out only said modulated frequencies, a receiving circuit an electrical oscillating circuit having said basic frequency and impressing oscillations of said basic frequency on said receiving circuit, means associated with said first named oscillating circuit for altering said basic frequency, and for controlling a means associated with said second named basic frequency circuit for correspondingly altering the frequency of the second named circuit to maintain it like that in said first named oscillating circuit, and a receiving circuit whose output will contain the combinations of said modulated frequencies with the basic frequency produced by the oscillating circuit.

4. In a wireless communication system, a

sending circuit, a receiving circuit, an electrical oscillating circuit associated with the sending circuit, means for altering the constants of said oscillating circuit, a sending device associated with said altering means whereby radiation waves changing to correspond to each alteration are sent out, an electrical oscillating circuit associated with said receiving circuit, means for altering the constants of said last named oscillating circuit to produce the same changes in its period as the first named altering means produce in the first named oscillating circuit, a receiving device controlling said second named altering means, said receiving device being responsive to the said changes in radiation waves whereby the period of said two oscillating circuits are kept alike.

5. An apparatus for sending signals comprising an electrical oscillating circuit, a plurality of devices for altering the period of said circuit, means associated with said devices for sending controlling waves of a plurality of characters, one character for each of said devices.

6. An apparatus for wireless communication, an electrical oscillating circuit, a plurality of devices for altering the period of said circuit, means associated with said devices for sending controlling waves of a plurality of characters, one character for each of said devices, a receiving circuit, means for impressing electrical oscillations thereon, a plurality of means for altering the period of said oscillations, and means responsive to said controlling waves, one to each character thereof, for controlling said last named period altering means.

7. In a wireless communication system, a sending device, a receiving device, adjustable basic frequency means at the receiving device to condition it to respond to the sending device, adjustable basic frequency means at the sending device to alter the quality of its output, and means for simultaneously altering the condition of the receiving device to maintain it ready to respond to the sending device, said last mentioned means comprising an auxiliary sending device of a frequency separate from that of the basic frequency.

8. In a wireless communication system, a high frequency electrical circuit, a low frequency electrical circuit, a modulator circuit receiving vibrations from each of said circuits, said modulator circuit being electrically symmetrically arranged with respect to the high frequency circuit whereby the modulator circuit will have vibrations of said low frequency and of interaction frequencies only, a radiating circuit supplied thereby, whereby the radiating current will emit radiation waves of said interaction frequencies only, a receiving circuit for said radiated waves, means for impressing voltages of high frequency upon said receiving circuit producing therein vibrations of frequencies resulting from interaction between said radiated waves and said impressed voltages, and an auxiliary sending means having a frequency unrelated to said high frequency or said interaction frequencies.

9. In a signalling system, the combination of means at a transmitting station for supplying a carrier wave, means for varying the frequency of said wave by irregular steps, means for modulating the frequency of said wave in accordance with a signal, means for suppressing the unmodulated portion of said wave, means for receiving the modulated portion of said wave, means for separately transmitting any combination of a plurality of control frequency waves said means also determining the frequency of the carrier wave, means for receiving said control frequency waves, means at the receiving station for converting said control frequency waves to waves of carrier frequency and means at the receiving station for combining the waves of carrier frequency with said modulated waves to reproduce said signal.

10. In a signalling system, the combination of means at a transmitting station for supplying a carrier wave, means for modulating the frequency of said wave in accordance with a signal, means for suppressing the unmodulated portion of said wave, means for receiving the modulated portion of said wave, means for separately transmitting any combination of plurality of control frequency waves said means also determining the frequency of the carrier waves, means at the receiving station for converting said control frequency waves to waves of carrier frequency and means at the receiving station for combining the waves of carrier frequency with said modulated waves to reproduce said signal.

11. In a wireless signalling transmission system, the combination of means at a transmitting station for supplying a carrier wave, means for varying the frequency of said wave and simultaneously transmitting a separate frequency wave, means for modulating said carrier wave in accordance with a signal, means for suppressing the unmodulated portion of said wave, and means at a receiving station and controlled by said separate frequency wave for combining the wave of carrier frequency with the modulated wave to reproduce said signal.

12. The method of electrical signalling which comprises selectively altering by increments of predetermined amounts the carrier frequency of a modulated transmitting system, the transmission of only the modulated frequencies, and automatically altering the receiving circuit corresponding to the alteration of the carrier frequency to maintain said circuit in adjustment to re-

ceive and react on said modulated frequencies to reproduce the original modulated frequencies.

13. The method of electrical signalling which consists in selectively altering by predetermined increments the carrier frequency of the transmitting circuit and altering the period of a receiving circuit by non-predetermined combinations of predetermined increments.

In testimony whereof I have hereunto subscribed my name.

FREDERICK W. KRANZ.