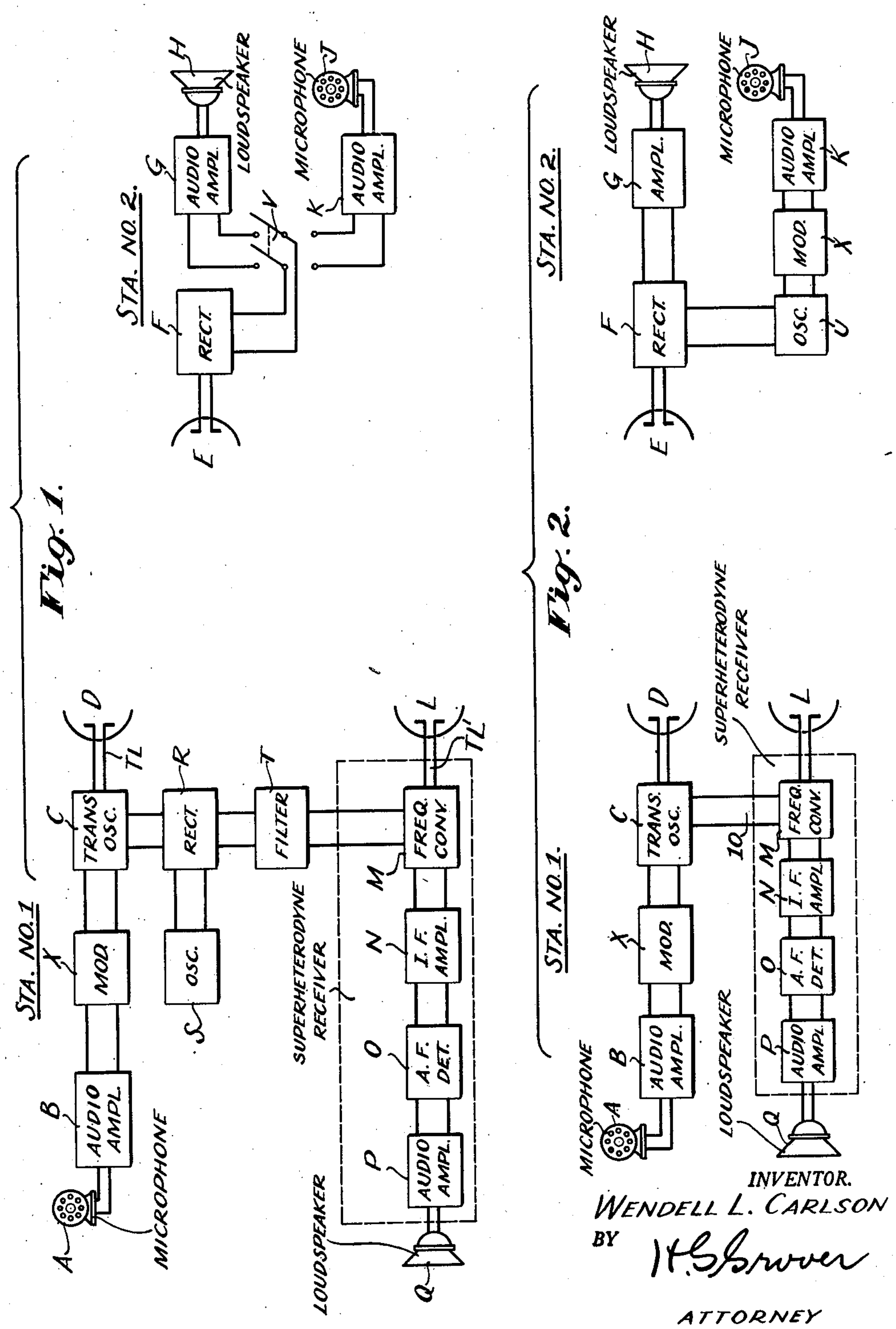
July 5, 1949. W. L. CARLSON 2,475,127

TWO-WAY RADIO COMMUNICATION SYSTEM

Filed March 29, 1945 4 Sheets-Sheet 1



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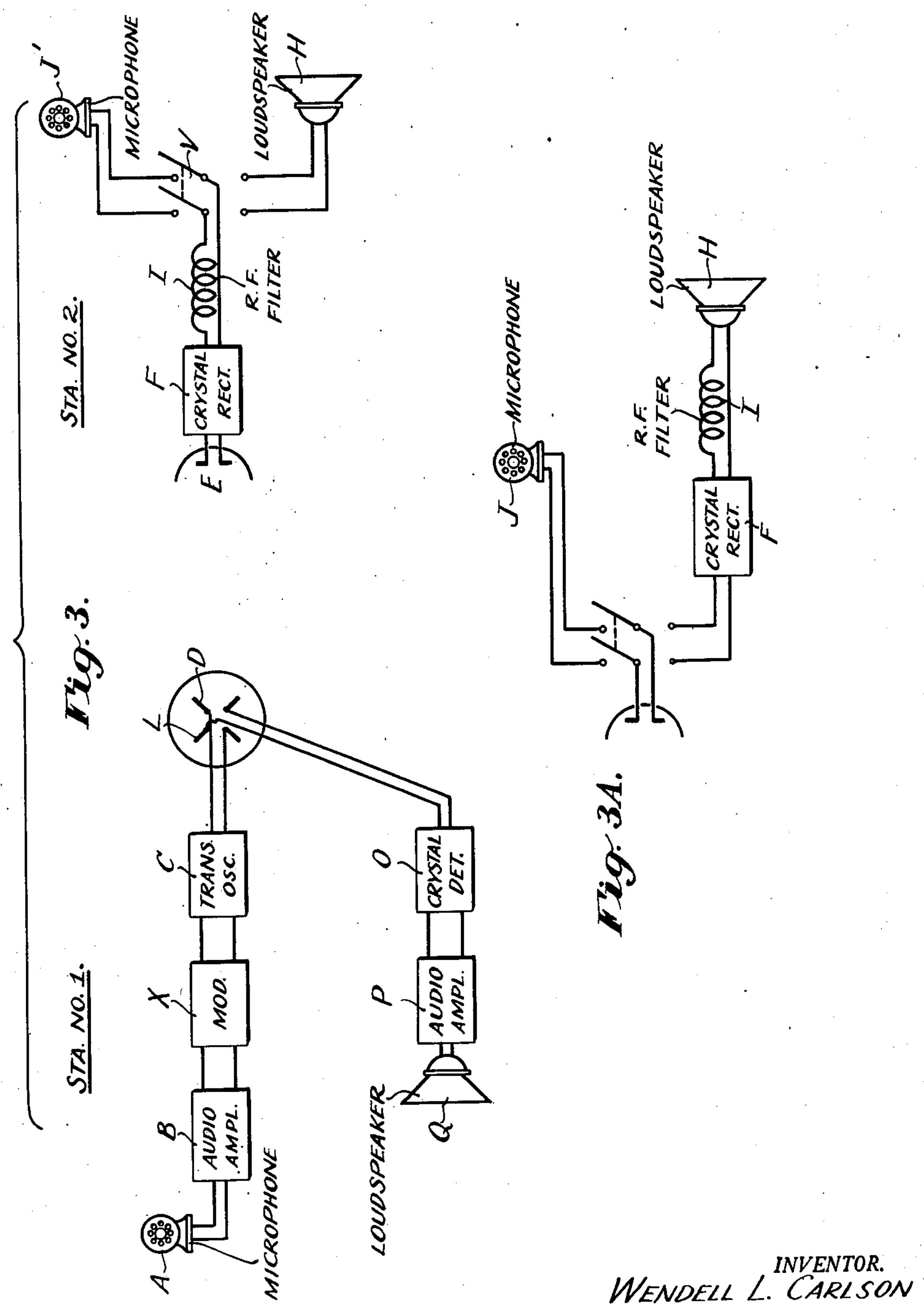
Filed March 29, 1945 4 Sheets-Sheet 2



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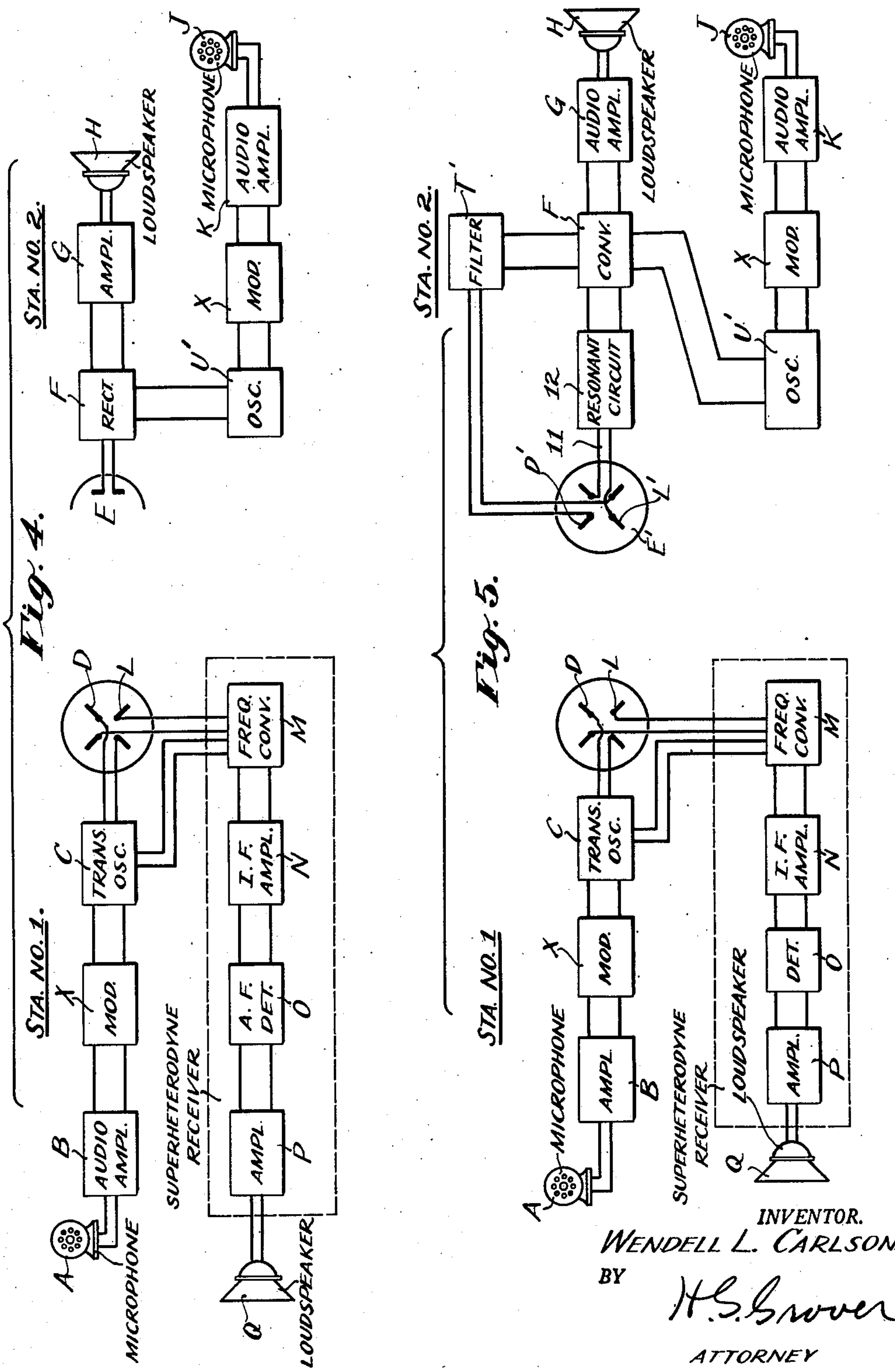

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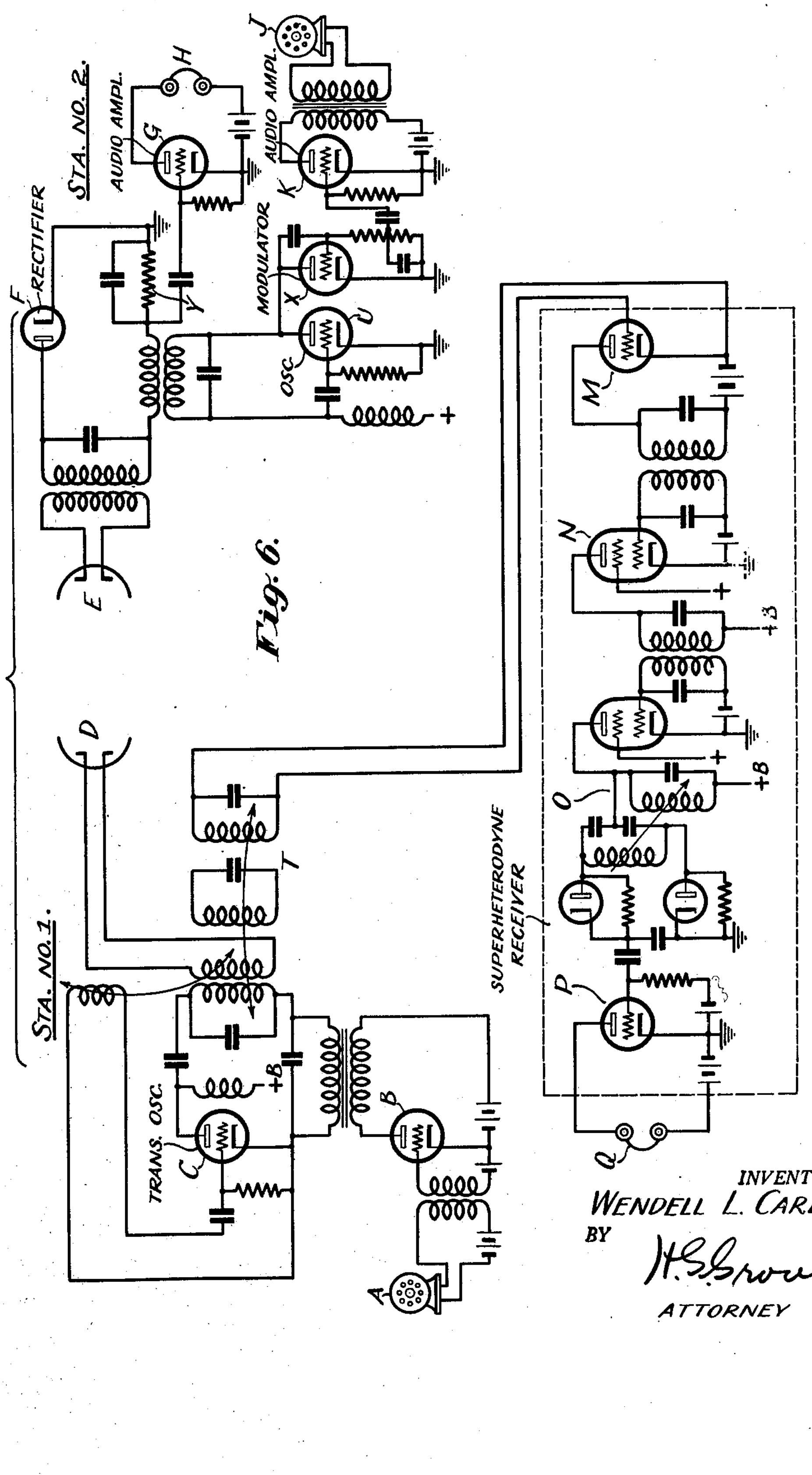
Filed March 29, 1945 4 Sheets-Sheet 4



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UNITED STATES PATENT OFFICE

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TWO-WAY RADIO COMMUNICATION SYSTEM

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Application March 29, 1945, Serial No. 585,482

20 Claims. (Cl. 250—6)

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This invention concerns two-way radio communication systems in which the radio beam from a transmitting station (hereinafter called the "beam originating station") is received at a remotely located radio station, modulated thereat, and then returned or reflected back to the originating station to be received, amplified and demodulated. Both radio stations in the system are provided with highly directional antennas and with modulating and demodulating apparatus to enable two-way communication to be effected between them. The beam originating station is designed to radiate ultra high frequency energy in the range of 1000 to 10,000 megacycles.

In using systems of this type in which the reflected energy sent back from the remote station is utilized as an essential element in reception at the originating station, I have found that so-called "ground clutter" caused by the movement or vibration of undesired reflecting objects (such as the limbs of trees) often seriously interferes with reception at the originating station of the desired reflected wave. This "ground clutter" superimposes low frequency modulations on the reflected wave. This interference is overcome in accordance with a preferred embodiment of the invention by introducing a sub-carrier at the remotely located (wave reflecting) station of a frequency appreciably higher than the relatively low frequency modulations caused by the movement of the undesired reflecting objects.

A more detailed description of the invention follows in conjunction with drawings, in which like parts are designated by like reference characters.

In these drawings:

Fig. 1 shows, in box form, one embodiment of the two-way radio communication system of the invention for use with amplitude modulated waves, in which a superheterodyne receiver is employed at the radio beam originating station.

Figs. 2, 4 and 5 show, in box form preferred embodiments of the invention in which a sub-carrier oscillation is introduced at the radio station which is remotely located relative to the beam originating station.

Figs. 3 and 3*a* illustrate, in box form another embodiment of the invention which differs generally from the other figures of the drawing in using no amplifiers or power supply at the remotely located wave reflecting station.

Fig. 6 schematically shows the circuit diagram of a preferred type of two-way communication system in accordance with the invention in which a sub-carrier is introduced at the radio station

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which is remotely located relative to the beam originating station.

Referring to Fig 1, there is shown a two-way communication system comprising a beam originating station identified as station #1 and a remotely located radio wave reflecting station identified as station #2. Beam originating station #1 is equipped both with transmitting apparatus designed to radiate a wave in the range from 1000 to 10,000 megacycles over a highly directional antenna D and also a superheterodyne receiver designed to receive waves over highly directional antenna L from the remotely located wave reflecting station #2.

Station #1 is provided with a microphone A, an audio amplifier B, a modulator X and a transmitter-oscillator C. The transmitter-oscillator C at the station #1 of the different figures mav be any suitable form of high frequency oscilla- tor capable of generating the desired frequency in the range of 1000 to 10,000 megacycles. Such an oscillator, by way of example, may be a magnetron or a reflex klystron, or a lighthouse triode tube, or any suitable very high frequency oscillator. The output from the transmitter-oscillator C is fed over a transmission line TL, which may be a coaxial line or a wave guide, to the antenna D. Antenna D is shown, by way of example only, as a dipole at the focus of a parabolic reflector. Output from the transmitter-oscillator C is also fed to a rectifier R where this energy combines with oscillations from an auxiliary oscillator S to produce in the output of R a beat frequency which is passed on to the filter T. Filter T selects one side band of a frequency equal to the frequency of the transmitter carrier from C plus or minus the frequency from oscillator S, and passes this selected frequency to the frequency converter M of the superheterodyne receiver at this same station.

By way of example only, the transmitter-oscillator C may generate a carrier of 1500 megacycles while the auxiliary oscillator S may generate oscillations of 100 megacycles. The output from rectifier R will then have two side bands or mean frequencies of 1400 and 1600 megacycles. Filter T is designed to pass either one of these two side bands, usually the lower one of 1400 megacycles. This 1400 megacycle signal from filter T acts as the local oscillator of a conventional superheterodyne receiver consisting of the frequency converter M, the intermediate frequency amplifier N with its frequency selective circuits, the diode audio detector O, the audio amplifier P, and the transducer Q which may consist of a loudspeaker as shown, or suitable headphones. The energy received by the superheterodyne receiver from the remotely located wave reflecting station #2 is collected on directional antenna L, here shown by way of example as a dipole at the focus of the parabolic reflector. The line TL' extending from the antenna L to the frequency converter M may be of the coaxial type or a wave guide. Both antennas D and L are pointed toward the directional antenna E of station #2.

Station #2 consists of a highly directional antenna E, here shown by way of example only as a dipole at the focus of the parabolic reflector, which is connected to a rectifier F. Antenna E is pointed toward station #1, as shown. Output from the rectifier F is passed on to a switch V which in one position passes this output to a suitable electro-acoustic transducer such as an amplifier G and thence to a loudspeaker H, and in another position connects the rectifier F to the output circuit of an audio amplifier K whose input circuit is, in turn, connected to an electro-acoustic transducer microphone J. When the blades of switch V are thrown to the upper position, the station #2 receives the ultra high frequency carrier energy radiated from station #1 and passes this energy on to the loudspeaker H. The attendant at station #2 is thus able to listen to the message transmitted from station #1. When the blades of switch V are thrown to the lower position, the attendant at station #2 can by means of microphone J talk or introduce his own local modulation on the energy received by station #2, thus modulating the wave which is received by station #2, and reradiated or reflected back toward station #1.

In the operation of the system of Fig. 1, assuming that station #1 radiates over antenna D a wave of the order of 1500 megacycles, this wave will be received on antenna E of station #2 and reflected back toward station #1 where it will be received on antenna L. The local modulation produced by microphone J at station #2 will be impressed upon the wave reradiated or reflected toward station #1. The 1500 megacycle reflected wave received on antenna I at station #1 will beat with the 1400 megacycle oscillation passed to the frequency converter M from filter T, as a result of which there will be a beat frequency of 100 megacycles passed on to the intermediate amplifier M together with the signal modulation from station #2. This signal modulation from station #2 will be demodulated in detector O of the superheterodyne receiver, amplified at P and heard at loudspeaker Q. Obviously, if the attendants at both stations are talking at the same time, there will be experienced the same type of interference or reaction in Q which is present in an ordinary telephone conversation circuit when two people converse simultaneously. It should be noted that amplitude modulation is employed at both stations of the system of Fig. 1. It should further be noted that the local oscillator S produces oscillations of a frequency equal to the intermediate frequency utilized in a superheterodyne receiver.

Fig. 2 shows a system somewhat similar to Fig. 1, except for the fact that the auxiliary oscillations are now produced at the remotely located station #2 instead of at the beam originating station #1. These auxiliary oscillations were produced in Fig. 1 by oscillator S, whereas in Fig. 2 the auxiliary oscillations are produced at station #2 by oscillator U. The purpose of these auxiliary oscillations in both Figs. 1 and 2 is to

produce energy which can be used in the superheterodyne receiver. The auxiliary oscillations produced by oscillator U at station #2 in Fig. 2 is of substantially lower frequency than the main transmitter oscillations produced by the transmitter-oscillator C and its purpose is to amplitude modulate the main transmitter oscillations at rectifier F so as to derive new high frequencies differing from the main transmitter oscillator frequency by the intermediate frequency. In Fig. 1 the intermediate frequency for the superheterodyne receiver is 100 megacycles, whereas in Fig. 2 the intermediate frequency for the superheterodyne receiver is 1000 kilocycles (one megacycle) which is the frequency of oscillator U at station #2.

Except for the foregoing differences, the operation of the system of Figs. 1 and 2 is substantially the same. The audio amplifier B at station #1 of Fig. 2 modulates through modulator X, the high frequency oscillator C operating at, let us say, 10,000 megacycles. The radiated wave from directional antenna D of station #1 induces a voltage in antenna E at station #2 which is rectified at F and passed on as an audio signal to amplifier G and loudspeaker H. Oscillator U, operating by way of example at 1000 kilocycles, is modulated from modulator X by voice signals from amplifier K and microphone J. The sub-carrier frequency of 1000 kilocycles produced by oscillator U of station #2 amplitude modulates the received 10,000 megacycle carrier collected by antenna E before it is reradiated or reflected to antenna L at station #1. At station #1, the local carrier frequency of 10,000 megacycles from the transmitter oscillator is passed on to the frequency converter M over leads 10, where it combines with the signal received from station #2 in order to produce an intermediate frequency signal of 1000 kilocycles in the output of the frequency converter M. This intermediate frequency of 1000 kilocycles upon which the modulations from station #2 are impressed is amplified by intermediate frequency amplifier N, rectified by audio frequency detector O, and the resulting audio signal is amplified at P and passed on to loudspeaker Q.

An important advantage of the system of Fig. 2 over the system of Fig. 1 lies in the use of the sub-carrier wave introduced by oscillator U at station #2. This sub-carrier, it should be noted, is of a considerably higher frequency than the audio modulation frequency, and also considerably higher in frequency than the low frequency modulations caused by movement or vibration of undesired reflecting objects; so-called "ground clutter," which often seriously interfere with the reception at station #1 of the wave reflected from station #2. This sub-carrier feature at station #2 overcomes this "ground clutter."

Fig. 3 shows an embodiment of a two-way radio communication system of the invention in which the receiver of the beam originating station (to wit, station #1) is not of the superheterodyne type and merely includes a crystal detector followed by an audio amplifier. It should be noted that the transmitting and receiving antennas comprise a pair of dipoles located at right angles to each other at or near the focus of a parabolic reflector. Such a 90° dipole arrangement at station #1 eliminates to a large extent possible feed back from the transmitting aerial D directly into the receiving aerial L at the same location. The reflector in back of the dipoles D and L in Fig. 3 is relatively large, in order to give a power gain for the radiated beam of something of the order of 100. The radiated wave from dipole D is picked up on the remotely located antenna E at the remote wave reflecting station #2. The dipole in the focus of the parabolic reflector at station #2 is located either vertically, as shown, or horizontally, in order to be able to receive some component of the waves radiated from dipole D and to be able to reflect or transmit toward dipole L a wave which will be picked up by the receiving aerial L. It will thus be seen that the dipole of antenna E is rotated 45° with respect to both of the dipoles D and L.

At station #2 in Fig. 3, the antenna E is connected to a silicon crystal detector F from which the rectified voltage is passed through a radio frequency filter I to a switch V. When the blades V are thrown to the lower terminals, the rectified and demodulated wave received by station #2 will be passed on to the loudspeaker or phones H. When the blades of switch V are thrown to the upper terminals, the microphone J' will be connected through the switch to the elements I, F and E, to thereby modulate the amplitude of the collected waves. Microphone J' is of the magnetic type which generates a voltage used to modulate the current at detector F. The radio frequency filter I prevents the radio frequency currents present in the received signal from passing through the filter to either J' or H, depending upon which way the blades of switch V are thrown.

At station #1, the energy which is reflected or reradiated by the remotely located station #2 is picked up by dipole L and fed to a crystal detector O whose output is coupled to an audio amplifier P and to a loudspeaker or headphones Q.

An advantage of the system of Fig. 3 is that no battery power supply or amplifiers are employed at the remotely located wave reflecting station #2.

As an alternative arrangement for station #2, a carbon microphone might be connected directly in the circuit of the dipole antenna E for modulating the reflected signal, instead of using the magnetic microphone J' in the circuit shown in Fig. 3. Such an alternative arrangement is shown in Fig. 3*a*, in which the carbon microphone is designated J.

Fig. 4 is another modification of the invention, which is substantially identical with the system of Fig. 2 except for the fact that the transmitting and receiving antennas at station #1 comprise a pair of dipoles D and L positioned 90° relative to each other at or near the focus of a large parabolic reflector, in a manner similar to the antenna arrangement of station #1 in Fig. 3. The directional antenna E of station #2 of Fig. 4 comprises a dipole which is either vertical or horizontal so as to be rotated 45° with respect to both of the dipoles at station #1. The system of Fig. 4 functions substantially in the manner as does the system of Fig. 2, except for the improvement in the antenna arrangement which eliminates one parabolic reflector. It should be noted that station #1 of Fig. 4 includes a superheterodyne receiver and that the remotely located station #2 includes an auxiliary oscillator U'. The transmitting oscillator C of station #1 may generate oscillations of the order of 1500 megacycles, while the auxiliary oscillator U' at station #2 may generate oscillations of the order of 100 megacycles, in which case the intermediate frequency energy in the superheterodyne receiver of station #1 will also be 100 megacycles.

Fig. 5 illustrates another modification of the invention in which station #1 is identical in arrangement with station #1 of Fig. 4. Station #2 of Fig. 5 differs from station #2 of any of the other figures generally in these respects: First, the receiving antenna E' comprises a pair of dipoles arranged at 90° with respect to each other, one dipole L', to wit the receiving dipole, being in the same plane as the transmitting dipole D at station #1, while the other dipole D'; to wit the transmitting dipole at station #2, is in the same plane as the receiving dipole L at station #1. The antenna arrangement of both stations in Fig. 5 includes a large reflector behind the dipoles in order to give a power gain for the radiated beam of something in the order of 100. Both of these antenna arrangements are highly directional and pointed toward one another.

In the operation of the system of Fig. 5, let us assume that the transmitter-oscillator C generates a frequency of 1500 megacycles which is modulated by apparatus X by some sort of message impressed on amplifier B by microphone A. The signal wave is radiated from horizontal dipole D and is picked up at station #2 by horizontal dipole L'. From L', the signal is passed over leads 11 to resonant circuit 12, and to converter F, which may consist of any non-linear circuit, such as, for example, a diode or crystal rectifier. The modulation on the signal passed by the rectifier F is then fed to an audio amplifier G whose output is conveyed to a suitable transducer, such as a loudspeaker H or headphones. For modulating the received energy at station #2, there is provided a microphone J which feeds a voice signal to amplifier K causing the modulator X to frequency or amplitude modulate the oscillator U'. Oscillator U' functions to produce a sub-carrier of a frequency of the order of 100 megacycles. This sub-carrier is impressed on the converter F and amplitude modulates the received carrier collected on dipole L' so as to create two side band frequencies, one approximately 100 megacycles above the 1500 megacycles, and the other 100 megacycles below the 1500 megacycles. Box T' is a resonant band pass circuit which selectively passes one side band, let us say 1400 megacycles, from converter F to the vertical antenna D'. This new carrier signal of 1400 megacycles is received at station #1 by the vertical dipole L and passed on to the frequency converter M of the superheterodyne receiver along with some of the 1500 megacycles fed directly to this converter from the transmitter-oscillator C. As a result of this, a 100 megacycle intermediate frequency signal is passed through intermediate frequency amplifier and selective circuits at N and to detecting circuit O. The output from O is an audiofrequency which is amplified by amplifier P and passes on to loudspeaker Q or earphones.

Fig. 6 schematically illustrates an embodiment of the invention which is somewhat like Fig. 2. The same antenna at both the beam originating station #1 and the remote radio station #2 is used for both receiving and transmitting purposes. The conventional circuit symbols are employed in Fig. 6 in place of the block diagram designations of Fig. 2. The radio frequency circuit symbols are those usually associated with low radio frequency systems, but it should be understood that they may refer to resonant cavities or resonant lines when operating at very high frequencies of the order of 1000 to 10,000 megacycles.

Assuming that the transmitter-oscillator C generates oscillations of the order of 1500 megacycles, this oscillator in Fig. 6 is amplitude modulated by voice signals from microphone A operating through amplifier B. The modulated carrier of 1500 megacycles is radiated from highly directional antenna D. At the remote location (to wit, station #2), antenna E intercepts or collects the signal and passes the 1500 megacycle carrier wave on to the diode rectifier F. The resulting rectified audio voltage across resistor Y is impressed on audio amplifier G whose output is coupled to phones H or a suitable loudspeaker. The system so far described is a conventional "one way" amplitude modulated communication system.

The "talk back" feature of Fig. 6 involves microphone J which feeds voice signals to a reactance tube modulator X by way of audio amplifier K. Oscillator U generates oscillations of 100 megacycles for example, and the frequency of this oscillator is modulated by the reactance tube circuit X. The deviation frequency may be, for example, up to 100 kilocycles, depending on the amplitude of the voice modulated signal. The frequency modulated sub-carrier from oscillator U is impressed on the diode rectifier F so as to amplitude modulate the received 1500 megacycle carrier. The high frequency carrier with at least one side band frequency of, let us say 1400 megacycles plus and minus 100 kilocycles, is reflected back and radiated from directive antenna E toward the directive antenna D located at station #1. This reflected signal is picked up by antenna D at station #1 and the 1400 megacycle signal is passed through the selective circuits T to the converter M of the superheterodyne receiver. A small part of the local oscillator voltage from the transmitter-oscillator C also passes through T to the converter M. It should be noted that the selective circuit T comprises a plurality of coupled tuned circuits and this selective system is resonant to 1400 megacycles plus and minus 100 kilocycles and partly attenuates 1500 megacycles so as to avoid overloading the converter M by the transmitter voltage. The side band of 1600 megacycles plus and minus 100 kilocycles is not utilized and therefore is substantially attenuated by circuit T. The output of converter M of the superheterodyne receiver is a 100 megacycle intermediate frequency carrier which is frequency modulated with voice from the remotely located microphone J. This signal passes through a conventional frequency modulation discriminator circuit O which converts the intermediate frequency carrier to an audio signal which is amplified by amplifier P and passed on to phones or speaker Q.

An advantage of Fig. 6, in addition to those obtained by using the sub-carrier modulator feature at the remote station #2, lies in the use of the same antenna at station #1 for both transmitting and receiving without employing balanced circuits to prevent the transmitter from overloading the receiver. Wide band frequency modulation, which appears possible only with a sub-carrier, may be necessary for many applications to improve the signal-to-noise ratio. Complete avoidance of ground clutter and overload of the receiver at station #1 also results from employing a sub-carrier modulation at station #2.

It should be noted that in Figs. 2, 4, 5 and 6 there is generated a new carrier at the remote station #2 by the reaction of the received carrier with the local oscillations produced at station #2. This new generated carrier is relied upon to produce the beat frequencies at the superheterodyne receiver of station #1. Although the carrier received at station #2 is also reradiated back toward station #1, it serves no useful purpose.

The system of the invention has numerous applications. For example, a number of small reflector units of the type shown for station #2 equipped with studio microphones could be employed for spot pick-up at conventions, football games, etc., in which case station #1 would be a central control point which would directively radiate a beam from a very high frequency transmitter carrier to the desired remote reflector unit. This can be done by orienting the antenna at station #1 to any one of several of the small reflector units, thus eliminating the old problem of using microphone cables for ordinary studio pick-ups and avoiding interference from several remote units transmitting simultaneously. For short distances, no power supply would be employed at the microphone unit at station #2. Other applications to which this system may prove practical are: Two-way communication for large construction projects, fire fighting, transportation centers, railroads, harbor traffic, ship to small boats and tow planes to gliders. In all of these applications, station #1 may be a central control point with a movable directive antenna so as to enable its use with any one of several remotely located wave reflecting or reradiating stations of the type identified above as station #2.

The system of the invention most generally used may employ amplitude modulation at station #1 because the signals received at station #2 will generally be very strong and there will be no need for employing frequency modulation in order to improve the signal-to-noise ratio of the signals received at station #2. In such a system, modulator X at station #1 should be an amplitude modulator. As for station #2, the modulator X thereat can be either an amplitude or a frequency modulation type of modulator depending upon the type of modulation effected at station #2. If the modulator X at station #2 is of the frequency modulation type, then, of course, the superheterodyne receiver at station #1 should have a suitable discriminator circuit following the intermediate frequency amplifier.

What is claimed is:

1. A two-way radio communication system comprising first and second radio stations spaced apart from each other, said first station comprising a beam originating station, said second station comprising a wave reflecting station, each of said stations having highly directional wave radiating structures pointed toward each other, a very high frequency transmitter-oscillator at said first station, means at said first station for modulating said oscillator in accordance with the intelligence to the transmitted over its associated wave radiating structure, a superheterodyne receiver at said first station and including a frequency converter and an intermediate frequency amplifier, a circuit at said first station coupling a portion of the output from said transmitter oscillator to the frequency converter of said superheterodyne receiver, a non-heterodyning receiver at said second station composed substantially solely of a rectifier coupled to the wave radiating structure thereat for directly reproducing the original modulations impressed by said first station on the wave transmitted toward said

second station, an audio amplifier and an electro-acoustic transducer, there also being a source of signal modulation at said second station, and an auxiliary source of oscillations at one of said stations producing oscillations of a frequency which is of substantially lower frequency than that of the transmitter-oscillator and which beats with the energy of said transmitter-oscillator in said frequency converter so as to cause the production of an intermediate frequency wave in the output of said frequency converter, whereby the energy sent back from said second station to said first station is utilized as an essential element in reception at said first or originating station.

2. A two-way radio communication system comprising first and second radio stations spaced apart from each other, each of said stations having highly directional wave radiating structures pointed toward each other, a very high frequency transmitter-oscillator at said first station, means at said first station for modulating said oscillator in accordance with the intelligence to be transmitted over its associated wave radiating structure, a superheterodyne receiver at said first station including a frequency converter, a circuit at said first station coupling a portion of the output from said transmitter-oscillator to the frequency converter of said superheterodyne receiver, a receiver at said second station comprising a wave demodulating circuit coupled to the wave radiating structure thereat for reproducing the original modulations impressed by said first station on the wave transmitted toward said second station, said receiver having apparatus excited by the received waves for detecting at the received frequency, a source of oscillations at said second station in circuit with the receiver thereat for converting the frequency of the carrier wave received at said second station to a carrier wave of a different frequency to be reradiated back toward said first station, and a source of signal modulation at said second station for modulating the energy of said source of oscillations.

3. A two-way radio communication system comprising first and second radio stations spaced apart from each other, each of said stations having highly directional wave radiating structures pointed toward each other, a very high frequency transmitter-oscillator at said first station, means at said first station for modulating said oscillator in accordance with the intelligence to be transmitted over its associated wave radiating structure, a superheterodyne receiver at said first station having a frequency converter and an intermediate frequency amplifier, a circuit at said first station coupling a portion of the output from said transmitter-oscillator to the frequency converter of said superheterodyne receiver, a receiver at said second station comprising a wave demodulating circuit coupled to the wave radiating structure thereat and having apparatus for directly reproducing from the received carrier the original modulations impressed by said first station on the wave transmitted toward said second station, a source of oscillations at said second station in circuit with the receiver thereat for converting the frequency of the carrier wave received at said second station to a carrier wave of a different frequency to be reradiated back toward said first station, said source of oscillations at said second station having a frequency substantially lower than the frequency of the transmitter-oscillator at said first station and equal to the mid-frequency to be passed by the intermediate frequency circuit of said superheterodyne receiver at said first station, and a source of signal modulation of said second station for modulating the energy of said source of oscillations.

4. A two-way radio communication system comprising first and second radio stations spaced apart from each other, a very high frequency transmitter-oscillator generating oscillations of the order of 1000 to 10,000 megacycles located at said first station, means at said first station for modulating said oscillator in accordance with the intelligence to be transmitted, a superheterodyne receiver at said first station having a frequency converter and an intermediate frequency amplifier, a circuit at said first station coupling a portion of the output from said transmitter-oscillator to the frequency converter of said superheterodyne receiver, a wave radiating structure in circuit with the output of said transmitter-oscillator, an energy collecting structure in circuit with the input of said superheterodyne receiver, both of said structures being directional in character, a directional wave radiating structure at said second station pointed toward said first station, a receiver including a demodulating circuit at said second station coupled to the wave radiating structure of said second station, said demodulating circuit including a rectifier for directly reproducing from the received carrier the original modulations impressed by said first station, a source of signal modulation at said second station, and an auxiliary source of oscillations at one of said stations producing oscillations of a frequency which is of substantially lower frequency than that of the transmitter-oscillator and which beats with the energy of said transmitter-oscillator in said frequency converter so as to cause the production of an intermediate frequency wave in the output of said frequency converter.

5. A two-way radio communication system comprising first and second radio stations spaced apart from each other, a very high frequency transmitter-oscillator generating oscillations of the order of 1000 to 10,000 megacycles located at said first station, means at said first station for modulating said oscillator in accordance with the intelligence to be transmitted, a superheterodyne receiver at said first station having a frequency converter and an intermediate frequency circuit, a circuit at said first station coupling a portion of the output from said transmitter-oscillator to the frequency converter of said superheterodyne receiver, a wave radiating structure in circuit with the output of said transmitter-oscillator, an energy collecting structure in circuit with the input of said superheterodyne receiver, both of said structures being directional in character, a directional wave radiating structure at said second station pointed toward said first station, a receiver including a demodulating circuit at said second station for directly reproducing from the received carrier the original modulations impressed by said first station, a source of oscillations at said second station in circuit with the receiver thereat for converting the frequency of the carrier wave received at said second station to a carrier wave of a different frequency to be reradiated back toward said first station, said source of oscillations at said second station having a frequency substantially lower than the frequency of the transmitter-oscillator at said first station and equal to the mid-frequency to be passed by the intermediate frequency circuit of said superheterodyne receiver at said first station, and a source of signal modulation at said second station for modulating the energy of said source of oscillations.

6. A two-way radio communication system in accordance with claim 5, characterized in this that the wave radiating structure and the energy collecting structure at said first station comprise dipoles arranged at 90° relative to each other and located in front of a common reflector.

7. A two-way radio communication system in accordance with claim 5, characterized in this that the wave radiating structure and the energy collecting structure at said first station comprise dipoles arranged at 90° relative to each other and located in front of a common reflector, said directional wave radiating structure at said second station comprising a dipole arranged at an angle of 45° relative to the structures at said first station, said radiating structure at said second station being positioned in front of a reflector.

8. A two-way radio communication system comprising first and second radio stations spaced from each other, a very high frequency transmitter-oscillator generating oscillations of the order of 1000 to 10,000 megacycles, means at said first station for modulating said oscillator in accordance with the intelligence to be transmitted, a receiver at said first station, a wave radiating structure coupled to the output of said transmitter-oscillator, an energy collector structure coupled to the input of said receiver, both of said structures having highly directive patterns, a directional receiving and wave radiating structure at said second station pointed toward said first station, a demodulating circuit at said second station for directly reproducing from the received carrier the original modulations impressed by said first station, a pair of electro-acoustic transducers at said second station, one of said transducers comprising a microphone, and a switch for alternatively connecting said transducers to the receiving and wave radiating structure at said second station.

9. A two-way radio communication system comprising first and second radio stations spaced from each other, a very high frequency transmitter-oscillator generating oscillations of the order of 1000 to 10,000 megacycles, means at said first station for modulating said oscillator in accordance with the intelligence to be transmitted, a superheterodyne receiver at said first station having a frequency converter, a local oscillator at said first station producing oscillations of a frequency substantially lower than the frequency of said transmitter-oscillator and which beat with a portion of the output of said transmitter-oscillator, means including a frequency selective circuit for supplying selected beat frequency waves to the frequency converter of said super heterodyne receiver, a wave radiating structure coupled to the output of said transmitter-oscillator, an energy collector structure coupled to the input of said receiver, both of said structures having highly directive patterns, a directional receiving and wave radiating structure at said second station pointed toward said first station, a demodulating circuit at said second station for directly reproducing from the received carrier the original modulations impressed by said first station, a pair of electro-acoustic transducers at said second station, one of said transducers comprising a microphone, and a switch for alternatively connecting said transducers to the receiving and wave radiating structure at said second station.

10. A two-way radio communication system comprising first and second radio stations spaced from each other, a very high frequency transmitter-oscillator generating oscillations of the order of 1000 to 10,000 megacycles, means at said first station for modulating said oscillator in accordance with the intelligence to be transmitted, a receiver at said first station, a wave radiating structure coupled to the output of said transmitter-oscillator, an energy collector structure coupled to the input of said receiver, both of said structures having highly directive patterns, a directional receiving and wave radiating structure at said second station pointed toward said first station, a demodulating circuit including a rectifier at said second station, the waves collected by said directional receiving structure at said second station being adapted to pass through said rectifier, a pair of electro-acoustic transducers at said second station, one of said transducers comprising a microphone, and switching means for alternatively connecting said transducers to the receiving and wave radiating structure at said second station.

11. A two-way frequency modulation radio communication system comprising first and second radio stations spaced apart from each other, each of said stations having highly directional wave radiating structures pointed toward each other, a very high frequency transmitter-oscillator at said first station, means at said first station for modulating said oscillator in accordance with the intelligence to be transmitted over its associated wave radiating structure, a frequency modulation superheterodyne receiver at said first station including a frequency converter, a circuit at said first station coupling a portion of the output from said transmitter-oscillator to the frequency converter of said superheterodyne receiver, a receiver at said second station, a source of oscillations at said second station in circuit with the receiver thereat for converting the frequency of the carrier wave received at said second station to a carrier wave of a different frequency to be reradiated back toward said first station, a reactance tube modulator at said second station for modulating the frequency of said source of oscillations, and a source of signal modulation comprising a microphone coupled to said reactance tube modulator.

12. A radio communication system comprising first and second spaced radio stations, said first station having a transmitter and a superheterodyne receiver, said superheterodyne receiver including a frequency converter and an intermediate frequency amplifier, means for transmitting a modulated radio carrier from said transmitter to the second station, means for directly feeding said superheterodyne receiver with a portion of said carrier produced at said first station, a non-heterodyne receiver at said second station for directly reproducing from the received carrier the original modulations impressed by said first station, means at said second station for modulating the received carrier by a sub-carrier, said second station also having means for radiating back toward said first station at least one of the side band frequencies resulting from the modulation of the received carrier by the sub-carrier, said superheterodyne receiver having circuits for receiving the side band frequency radiated from the second station and for beating the same with a portion of the original carrier produced at the first station in order to produce an intermediate frequency in said superheterodyne receiver.

13. In a two-way radio communication system having a beam originating station with receiving apparatus thereat and a remote wave reflecting

station, the method of operation which includes producing oscillations at said originating station, modulating said oscillations with the signal to be transmitted, directively transmitting the resultant wave to said remote wave reflecting station, beating said oscillations at said originating station with other oscillations to produce a wave of a different frequency and feeding said wave of different frequency to the receiving apparatus at said orginating station, receiving said transmitted resultant wave at said remote wave reflecting station, reproducing the original modulations at said remote station directly from the received wave, and directively reflecting back from said remote station toward said originating station the wave received by said remote station, receiving said reflected wave at said originating station and beating it with said first wave of different frequency.

14. In a two-way radio communication system having a beam originating station with receiving apparatus thereat and a remote wave reflecting station, the method of operation which includes producing oscillations at said originating station, modulating said oscillations with the signal to be transmitted, directively transmitting the resultant wave to said remote wave reflecting station, beating said oscillations at said originating station with other oscillations to produce a wave of a different frequency and feeding said wave of different frequency to the receiving apparatus at said originating station, receiving said transmitted resultant wave at said remote wave reflecting station, reproducing the original modulations at said remote station directly from the received wave, impressing modulation at said remote station upon the wave received from said originating station, and directively reflecting back from remote station toward said originating station the wave received by said remote station as modulated by the impressed modulation, receiving said reflected modulated wave at said originating station and beating it with said first wave of different frequency to produce an intermediate frequency wave, and detecting at said originating station said intermedate frequency wave.

15. In a two-way radio communication system having a beam originating station with receiving apparatus thereat and a remote wave reflecting station, the method of operation which includes producing oscillations at said originating station, modulating said oscillations with the signal to be transmitted, directively transmitting the resultant wave to said remote wave reflecting station, directly feeding the receiving apparatus at said originating station with a portion of the produced oscillations, receiving said transmitted resultant wave at said remote wave reflecting energy, reproducing the original modulations at said remote station directly from the received wave, converting said received wave at said remote station to a wave of different frequency and modulating said wave of different frequency with a signal at said remote station, directively radiating back toward the originating station from said remote station said last modulated wave, receiving said last wave at said originating station and beating it with the oscillations directly fed to the receiver at said originating station to produce waves of intermediate frequency and detecting said waves of intermediate frequency at said originating station.

16. A two-way frequency modulation radio communication system comprising first and second radio stations spaced apart from each other, each of said stations having highly directional wave radiating structures pointed toward each other, a very high frequency transmitter-oscillator at said first station, means at said first station for modulating said oscillator in accordance with the intelligence to be transmitted over its associated wave radiating structure, a superheterodyne receiver at said first station including a frequency converter, a circuit at said first station coupling a portion of the output from said transmitter-oscillator to the frequency converter of said superheterodyne receiver, a non-heterodyning receiver at said second station for directly reproducing from the received carrier the modulations impressed thereon by said first station, a source of oscillations at said second station in circuit with the receiver thereat for converting the frequency of the carrier wave received at said second station to a carrier wave of a different frequency to be reradiated back toward said first station, a reactance tube modulator at said second station for modulating the frequency of said source of oscillations, and a source of signal modulation comprising a microphone coupled to said reactance tube modulator.

17. A two-way frequency modulation radio communication system comprising first and second radio stations spaced apart from each other, each of said stations having highly directional wave radiating structures pointed toward each other, a very high frequency transmitter-oscillator at said first station, means at said first station for modulating said oscillator in accordance with the intelligence to be transmitted over its associated wave radiating structure, a superheterodyne receiver at said first station including a frequency converter, a frequency selective circuit at said first station coupling a portion of the output from said transmitter-oscillator to the frequency converter of said superheterodyne receiver, a non-heterodyning receiver at said second station for directly reproducing from the received carrier the modulations impressed thereon by said first station, a source of oscillations at said second station in circuit with the receiver thereat for converting the frequency of the carrier wave received at said second station to a carrier wave of different frequency to be reradiated back toward said first station, a reactance tube modulator at said second station for modulating the frequency of said source of oscillations, and a source of signal modulation comprising a microphone coupled to said reactance tube modulator.

18. A two-way radio communication system comprising first and second radio stations spaced apart from each other, each of said stations having highly directional wave radiating structures pointed toward each other, a very high frequency transmitter-oscillator at said first station, means at said first station for modulating said oscillator in accordance with the intelligence to be transmitted over its associated wave radiating structure, a superheterodyne receiver at said first station including a frequency converter, a frequency selective circuit at said first station coupling a portion of the output from said transmitter-oscillator to the frequency converter of said superheterodyne receiver, a non-heterodyning receiver at said second station for directly reproducing from the received carrier the modulations impressed thereon by said first station, a source of oscillations at said second station in circuit with the receiver thereat for converting the frequency of the carrier wave received at

said second station to a carrier wave of different frequency to be reradiated back toward said first station, a vacuum tube modulator at said second station for modulating said source of oscillations, and a source of signal modulation comprising a microphone coupled to said vacuum tube modulator.

19. In a two-way radio communication system having a beam originating station with receiving appartus thereat and a remote wave reflecting station, means for producing oscillations at said originating station, means for modulating said oscillations with the signal to be transmitted, means for directively transmitting the resultant wave to said remote wave reflecting station, means for beating said oscillations at said originating station with other oscillations to produce a wave of a different frequency and feeding said wave of different frequency to the receiving apparatus at said originating station, means for receiving said transmitted resultant wave at said remote wave reflecting station, means for reproducing the original modulations at said remote station directly from the received wave, and means for directively reflecting back from said remote station toward said originating station the wave received by said remote station, means for receiving said reflected wave at said originating station and means for beating it with said first wave of different frequency.

20. In a two-way radio communication system having a beam originating station with receiving apparatus thereat and a remote wave reflecting station, means for producing oscillations at said originating station, means for modulating said oscillations with the signal to be transmitted, means for directively transmitting the resultant wave to said remote wave reflecting station, means for directly feeding the receiving apparatus at said originating station with a portion of the produced oscillations, means for receiving said transmitted resultant wave at said remote wave reflecting energy, means for reproducing the original modulations at said remote station directly from the received wave, means for converting said received wave at said remote station to a wave of different frequency and modulating said wave of different frequency with a signal at said remote station, means for directively radiating back toward the originating station from said remote station said last modulated wave, means for receiving said last wave at said originating station and beating it with the oscillations directly fed to the receiver at said originating station to produce waves of intermediate frequency, and means for detecting said waves of intermediate frequency at said originating station.

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