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DUPLEX COMMUNICATION SYSTEM

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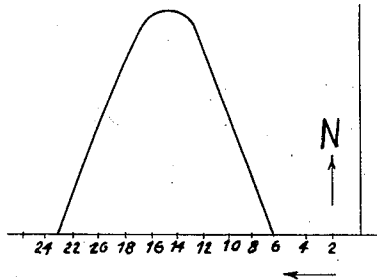


Fig. 1

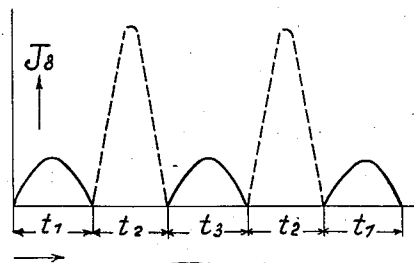


Fig. 4

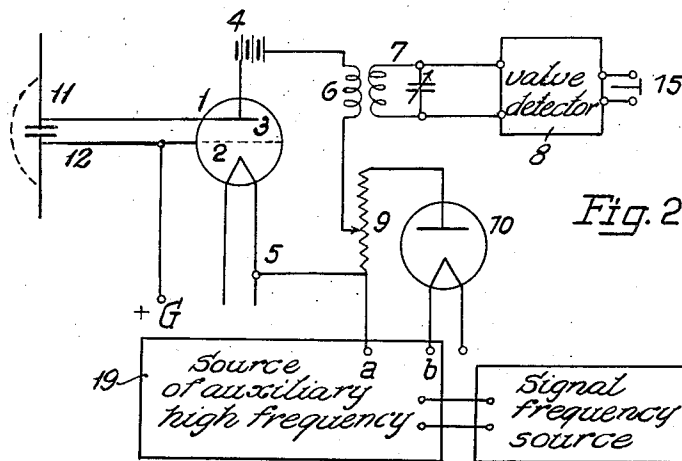


Fig. 2

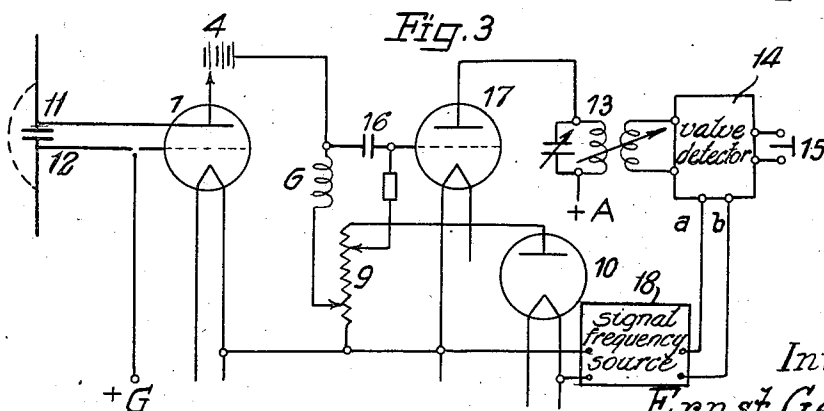


Fig. 3

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DUPLEX COMMUNICATION SYSTEM

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The present invention relates to wireless duplex or two-way communication with ultra-short waves.

It is well known that a thermionic valve, which is connected in a damping field circuit, is not only suitable for generating ultra-short waves but, provided that the working data are differently adjusted, is also capable of receiving ultra-short waves, the circuit being perfectly identical in both cases.

In order to admit of simultaneous transmitting and receiving, according to the present invention, the working voltages, and especially the plate voltage, of the valve connected in a brake field circuit are periodically changed by a control voltage whereby during one half-cycle of the control oscillations, the valve operates as a transmitter and during the other half-cycle it functions as a receiver, the control voltage consuming one half of the cycle during transmitting and the other half during receiving. Instead of one working valve, two working valves may be used and when this is the case one works as receiver, one as transmitter and the function of the auxiliary voltage is the same as outlined above.

In order to produce the control frequency, an oscillation generator of super-audible or high frequency is preferably provided in the communicating stations. Both of the stations may be provided with such a generator, or the generator may be present in only one station. In the first case, where a high frequency generator is provided in each station for the periodic control of the ultra-short wave tube, its frequencies should be so chosen that between them an audible differential sound is produced. This sound occurs in each of the stations and can be used to transmit audible signals as will be described in detail below.

If only one of the stations is provided with such a source of control frequency, the alternating control current in the other station can be produced by amplifying the control frequency of the first station which may be detected as the modulation of the ultra-high frequency received from the second station; this amplified frequency serves for the periodic control or switching over of the ultra-short wave tube. The modulation frequencies which permit the transmission of signals are preferably superimposed on the alternating control current. In each of the stations the ultra-high frequency received is rectified to give the control frequency of the sending station, and when this is rectified the true modulation frequency is obtained. If each of the stations uses a high frequency generator, the differential

tone of which is audible, signals from one station can be transmitted to the other without any modulation of the control frequencies. If the control frequency of the first station is transmitted for instance in Morse code, sound-frequency signs of the same code are received in the other station.

If both stations operate with the same control frequency or if one of the stations uses an amplified control frequency received from the other station, interference between the local and remote control frequencies may be avoided by synchronization of the frequencies and by shifting the phase of the local and remote frequencies through 180°.

Finally, it is of advantage to block the receiver-amplifier during the transmitting half-cycle of the control oscillations, preferably by periodically displacing the grid-potentials of one or more amplifying valves in the frequency of the control voltage, or more especially by using the half-cycle control oscillations for the ultra-short waves valves simultaneously for blocking the amplifier.

Fig. 1 shows the relation between the ultra-high frequency energy N and the plate or brake-field electrode potential EB ;

Fig. 2 is an exemplary embodiment of the invention;

Fig. 3 is another exemplary embodiment of the invention wherein the switching or commutating oscillations are synchronized with the modulated oscillations received; and

Fig. 4 shows the time sequence of the receiving and sending periods.

Fig. 1 shows schematically a characteristic oscillation curve of an ultra-short wave valve arranged in a brake field circuit. It shows the relation between the ultra-high frequency oscillation energy N and the voltage EB of the brake-field electrode (plate electrode) with a grid voltage of for example 200 volts. The valve operates as a transmitter in the region of $EB = -7$ volts to $EB = -23$ volts whereas with a potential of about $EB = -4$ v. to -8 v. on the brake-field electrode it is adapted to operate as a receiver. Now if an alternating voltage is superimposed on the normal voltage of the brake-field electrode, which amounts to say $EB = -7$ volts, ultra-high frequency oscillations will be generated in the valve during each negative half-cycle of this alternating voltage. When the plate or brake-field electrode potential EB is varied between the values -7 v. and -15 v., the tube having the characteristic illustrated in Fig. 1, produces ultra-high fre-

quency oscillations and if this brake-field potential is periodically varied between these or intermediate voltage values the tube periodically generates ultra-high frequency oscillations.

5 During the positive half-cycle of the control oscillations the valve will function as a receiver. However, seeing that the range of voltage in which good reception is obtained is not so great as the range of voltage in which the tube can
10 operate as a transmitter, it is of advantage to suppress entirely the positive half-cycle, so that during this time the brake-field electrode possesses the normal voltage most suitable for reception, viz. about -7 volts.

15 The frequency of the control oscillations lies preferably outside the range of audibility. Otherwise, the control oscillations which may cause interference during the reception of telephony, may be filtered out by known means.

20 Fig. 2 shows an example of the invention. The ultra-short wave valve 1 is arranged in Barkhausen-Kurz connection or a brake field circuit. A high positive D. C. voltage + G of say 200
25 volts is applied to the grid 2 whilst the brake-field electrode 3 is impressed with a smaller positive or negative direct voltage of say -7 volts which is taken from the battery 4. Inserted in the circuit between the brake-field electrode 3 and the cathode 5 is the transformer coil 6, which
30 is coupled to the oscillatory circuit 7 of the high frequency receiver 8. The positive half-cycle of the auxiliary alternating voltage supplied to the terminals a and b is blocked by the valve 10.

35 The alternating currents which have been amplified and rectified in the high frequency receiver 3 are conducted to the telephone 15. The grid 2 and the brake-field electrode 3 are connected through the ultra-high frequency double
40 conductor 12 to the antenna 11 which serves both for transmitting and for receiving. The control oscillations are supplied from the binding posts a and b of the oscillation generator 19. For this purpose, these binding posts are connected to the
45 resistance 9 and valve 10 connected in series. The binding post a of the source of control current is also connected to the filament 5 of the tube 1, and the variable contact of resistance 9 is connected through coupling coil 6 and battery 4 to the plate or brake-field electrode 3.

50 The operation of this arrangement is as follows: The grid 2 of the ultra-short wave tube carries a high positive current. The plate or brake-field electrode is provided with such direct
55 current from the battery 4 that the ultra-short wave tube 1 can act either as a receiver or transmitter. When alternating currents are impressed on the binding posts a and b, a rectified current is caused to flow in resistance 9. The variable
60 contact of resistance 9, connected to the plate or brake-field electrode, is maintained at a negative potential with respect to the cathode, and if this potential is sufficiently negative, no current will flow through the vacuum tube from the
65 resistance 9. During the positive portion of the alternating control current cycle the voltage of the plate or brake-field electrode 3 therefore remains substantially constant, at or near the potential of the battery 4 and the tube can act as a receiver of ultra-high frequency signals.

70 The sending station is provided in the same manner with a source of alternating current for periodic control. The ultra-high frequency signals which are modulated by the frequency of the control frequency are received by the antenna 11 and amplified and rectified in the ultra-

high frequency tube. The control frequency of the sending station is therefore effective in the plate or brake-field electrode circuit and in the coil 6. This control frequency is received by the
5 oscillation circuit 7 and supplied to the amplifier 8. If the control oscillation of the communicating station is first modulated by signal or voice frequencies, these frequencies can be rectified or detected at the end of the amplification
10 step and made audible in the telephone 15.

The transmission of low frequency signals from one station to the other can be performed very simply by modulating the alternating control
15 frequency current, supplied by the source 19 which is either very high or super-audible frequency by the signal or voice frequencies.

To avoid disturbances in the receiving circuits of the unit 8 by the oscillation produced by the control frequency generator 19, the frequency of the generator is made different from that of the
20 sending station so that little or no energy from the generator 19 is selected by the oscillation circuit 7. The control oscillation of the receiving station can also be separated from the amplifier 8 by additional filter circuits connected between
25 the oscillation circuit 7 and the amplifier 8. If the high frequency control oscillations of the two stations are so chosen that an audible sound occurs from their super-imposition, this sound can be used for transmission of signals. The amplifier 8 then receives an unmodulated high frequency, that is, oscillations from its own control generator, and a second unmodulated high frequency from the sending station through the
30 ultra-high frequency tube 1. If the control frequency of the communication station is now interrupted by low frequency keying of the transmitted frequency in accordance with the Morse code, corresponding low frequency signals will be received in the telephone 15.

Fig. 3 shows an example of the invention in which the control oscillations are synchronized with the received modulation oscillations. The circuit of the ultra-short wave valve 1 corresponds with that of Fig. 2. The ultra-short
40 waves generated by the distant communicating station, are so modulated by a high-frequency control oscillation, as described above, that ultra-short waves are only radiated during the time
45 t_1 of a half-cycle of the control oscillation. The modulation oscillations arising in the coil 6, of Fig. 3, of the receiving station and having been produced by rectifying the ultra-short waves by the ultra-short wave valve 1, have somewhat the shape of the heavily drawn curves in Fig. 4.
50 These modulation oscillations are passed through the condenser 16 to the grid of the amplifying valve 17, and energize the oscillatory circuit 13, which is tuned to the fundamental frequency of these oscillations, whereupon they are finally
55 further amplified by the high frequency receiver 14, rectified, and made audible in the telephone 15. The unrectified high-frequency oscillations of modulation frequency arising in the amplifier 14 are also led over the conductor a-b to the
60 valve 10, which only passes the negative half-wave of these oscillations, the phase relations being so adjusted by suitable choice of the coupling elements in the amplifier 14, that the negative half-cycle just falls in the periods t_2
65 (see Fig. 4) during which no reception takes place. The voltage is so set on the potentiometer 9, that the valve 1 functions as a transmitter during the time t_2 of the negative half-cycle, for example by arranging that the characteristic 75

curve in Fig. 1 is impressed by half the amount, that is, in the region from $EB = -7$ v. to -15 v. This gives rise to a brake field electrode current I_B , whose course is denoted in Fig. 4 by the dotted curves. A modulator 18 is connected in the conductor a, b which leads from the high frequency amplifier 14 to the resistance 9 and tube 10. By means of this modulator the control frequency which serves for the periodic control of the ultra-short wave tube, supplied through the amplifier 14, can be modulated by voice or signal frequencies.

The locally produced control oscillations which are displaced in phase by 180° with respect to the received modulation oscillations, are prevented from influencing the amplifying valve 17 by arranging that the grid potential of this valve is made so intensely negative by the control oscillations during the times t_2 , that an automatic blocking takes place. This negative blocking voltage can also be tapped off from the potentiometer 9.

If the arrangement according to Fig. 3 is not to be employed at first as a receiver as described but as a transmitter, that is, as the calling station, the control oscillations are produced initially in the amplifier 14, for example, by a sufficiently high degree of back coupling. As soon as communication has been established with the opposite station, so that ultra-short waves are periodically transmitted from the latter also, the back coupling in the amplifier 14 is made looser, so that the control oscillations are no longer generated by self-energization, but by amplification of the received modulation oscillations.

Instead of one single ultra-short wave valve, two of them may be used and during one-half cycle of the control oscillations the first valve acts as a transmitter and during the other half-cycle, the second valve acts as a receiver. In all the cases described it is possible to use one common reflector for the transmitting and receiving valves.

The above arrangement may be used with advantage for measuring distance by the method, already known per se, in which a wave group is transmitted and then received by an opposite station whence it is retransmitted. The distance between the stations may be determined from the time difference between the transmitted and returning groups of waves. In the arrangement according to Fig. 1 for instance, a group of ultra-short waves is transmitted after an accurately ascertainable time, when the valve 1 has received the incoming wave group.

I claim:

1. An apparatus for duplex wireless signalling with ultra-short waves, comprising a vacuum tube having grid, cathode and plate electrodes, means for impressing a positive potential on the grid electrode with respect to the cathode, means for impressing a varying negative potential on said plate electrode, said last means including means to impress on said plate electrode a constant negative potential and means to superimpose on said constant negative potential a variable potential which is at least in part negative, whereby the potential of said plate electrode varies between more and less negative values, the more negative value being more negative than said constant negative potential, means for generating ultra-high frequency oscillations with said vacuum tube when said potential has said more negative value, means for modulating and transmitting said generated oscillations, and

means for receiving signalling energy when said plate electrode potential has said less negative value.

2. An apparatus for duplex wireless signalling with ultra-short waves, comprising a vacuum tube having grid, cathode and plate electrodes, means for impressing a positive potential on the grid electrode with respect to the cathode, means for impressing a varying negative potential on said plate electrode, said last means including means to impress on said plate electrode a constant negative potential, means for generating a periodically pulsating negative potential, and means to superimpose said pulsating negative potential on said constant negative potential, whereby the potential of said plate electrode varies between more and less negative values, the more negative value being more negative than said constant negative potential, means for generating ultra-high frequency oscillations with said vacuum tube when said potential has said more negative value, means for modulating and transmitting said generated oscillations, and means for receiving signalling energy when said plate electrode potential has said less negative value, a source of alternating current, circuits connected thereto, means for amplifying said received signalling energy and impressing a portion of the amplified signalling energy on said circuits for controlling the operation thereof, and means for detecting and reproducing said received signalling energy.

3. An apparatus for duplex wireless communication with ultra-short waves, comprising a vacuum tube in brake-field-circuit connection which serves both for transmitting and receiving of ultra-short waves, said tube having a brake-field-electrode, a source of alternating current supply, means for rectifying the alternating current from said source, means controlled by said rectified current to produce a pulsating negative potential, means for impressing the pulsating negative potential on the brake-field-electrode of said tube, whereby the brake-field-electrode becomes more negative during alternate half periods of the alternating current for causing said tube to function as an oscillation generator during said half periods, and means for receiving signals during the intervals between said half periods.

4. An apparatus for duplex wireless communication with ultra-short waves, comprising a vacuum tube in brake-field-circuit connection which serves both for transmitting and receiving of ultra-short waves, said tube having a brake-field-electrode, a source of alternating current supply, means for rectifying the alternating current from said source, means controlled by said rectified current to produce a pulsating negative potential, means for impressing the pulsating negative potential on the brake-field-electrode of said tube, whereby the brake-field-electrode becomes more negative during alternate half periods of the alternating current for causing said tube to function as an oscillation generator during said half periods, means for receiving signals during the intervals between said half periods, and means for amplifying and detecting said received signals.

5. An apparatus for duplex wireless signalling with ultra-short waves, comprising a vacuum tube having grid, cathode and plate electrodes, means for impressing a positive potential on the grid electrode with respect to the cathode, means for impressing a varying negative potential on

said plate electrode, said last means including means to impress on said plate electrode a constant negative potential and means to superimpose on said constant negative potential a potential which varies through a predetermined cycle and which is at least in part negative, whereby the potential of said plate electrode varies between more and less negative values, the more negative value being more negative than said constant negative potential, means for generating oscillations with said vacuum tube throughout substantially half said predetermined cycle when said potential has said more negative value, means for modulating and transmitting said generated oscillations and means for receiving signalling energy throughout the remainder of said cycle when said plate electrode potential has said less negative value.

6. An apparatus for duplex wireless communication with ultra-short waves, comprising a vacuum tube in brake-field-circuit connection which serves both for transmitting and receiving of ultra-short waves, a source of current supply connected to said tube to supply to the brake-field-electrode of said tube a direct current of such value that the tube when in brake-field-circuit connection can receive ultra-short wave oscillations, a resistance in the brake-field-electrode circuit of said tube, a source of control frequency, a vacuum tube connected to said source and to said resistance, whereby during one half period of said source of control frequency, said brake-field-electrode may be so negatively charged that the short wave tube operates as transmitter.

7. An apparatus for duplex wireless signalling with ultra-short waves, comprising a vacuum tube having grid, cathode and plate electrodes, means for impressing a positive potential on the grid electrode with respect to the cathode, means for impressing on said plate electrode a negative potential which varies at a super-audio frequency, said last means including means to impress on said plate electrode a constant negative potential and means to superimpose on said constant negative potential a variable potential which is at least in part negative, whereby the potential of said plate electrode varies between more and less negative values, the more negative value being more negative than said constant negative potential, means for generating ultra-high frequency oscillations with said vacuum tube when said potential has said more negative value, means for modulating and

transmitting said generated oscillations, and means for receiving signalling energy when said plate electrode potential has said less negative value.

8. An apparatus for duplex wireless signalling with ultra-short waves, comprising a vacuum tube having grid, cathode and plate electrodes, means for impressing a positive potential on the grid electrode with respect to the cathode, means for impressing on said plate electrode a negative potential which varies at a super-audio frequency, said last means including means to impress on said plate electrode a constant negative potential and means to superimpose on said constant negative potential a potential which varies through a predetermined cycle and which is at least in part negative, whereby the potential of said plate electrode varies between more and less negative values, the more negative value being more negative than said constant negative potential, means for generating oscillations with said vacuum tube throughout substantially half said predetermined cycle when said potential has said more negative value, means for modulating and transmitting said generated oscillations and means for receiving signalling energy throughout the remainder of said cycle when said plate electrode potential has said less negative value.

9. An apparatus for duplex wireless communication with ultra-short waves, comprising a vacuum tube in brake-field-circuit connection which serves both for transmitting and receiving of ultra-short waves, said vacuum tube having a brake-field-electrode, a source of super-audio frequency alternating current supply circuits connected thereto, means for rectifying the alternating current from said source, means controlled by said rectified current to produce a pulsating negative potential, means for impressing the pulsating negative potential on the brake-field-electrode of said tube, whereby the brake-field-electrode becomes more negative during alternate half periods of the alternating current for causing said tube to function as an oscillation generator during said half periods, means for receiving signals during the intervals between said half periods, means for amplifying said received signals, means for impressing a portion of said received signals on said circuits for controlling the operation thereof, and means for detecting and reproducing said received signals.

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