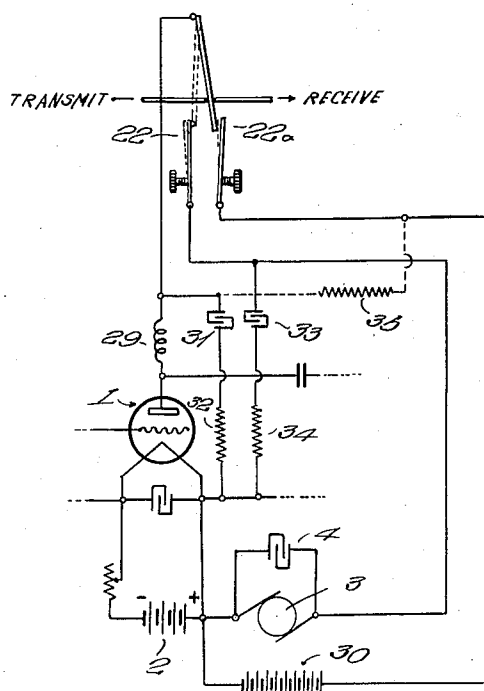
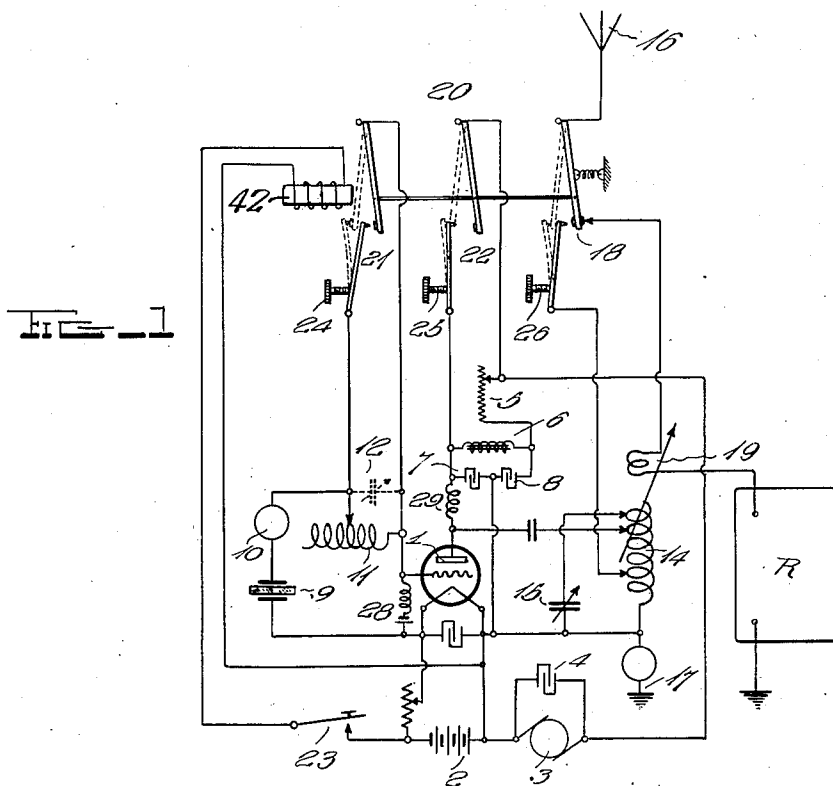


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COMMUNICATION SYSTEM

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COMMUNICATION SYSTEM.

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My invention relates broadly to communication systems and more particularly to a compact arrangement of combined signal transmission and reception apparatus.

5 One of the objects of my invention is to provide a combined continuous wave signal transmission and reception apparatus wherein the keying circuit is arranged to render the receiving apparatus effective intermediate the transmission periods.

10 Another object of my invention is to provide a signal transmission receiving apparatus in which the electron tube oscillator at the transmitter may be utilized as the local
15 generator of oscillations for a heterodyne receiver, the conditions of the oscillator being modified by the actuation of the keying circuit for rendering the oscillator effective by the receiver intermediate the signaling periods.

20 My invention will be more clearly understood by reference to the following specification and the accompanying drawings, in which:

25 Figure 1 illustrates a combined transmission and receiving system employing the principles of my invention, and Fig. 2 represents a modified form of circuit arrangement employed for the oscillator which is alternately used for transmission and receiving
30 purposes under control of the keying circuit.

In inter-communication between small single tube, piezo electric crystal controlled transmitters, the crystal controlled oscillating tube is difficult to key if tube oscillations
35 cease entirely when the key is up. It is possible and desirable to provide for residual weak oscillations when the key is up, so that oscillations will build up to full strength rapidly and dependably when the key is depressed. Such residual oscillations in the past have been objectionable by their preventing the use of the break-in method for two-way communication on the same frequency, as they have caused so much interference in an adjacent receiver as to blanket
40 reception of a distant signal of same frequency.

My invention makes use of this otherwise objectionable residual oscillation by rendering it suitable as a heterodyne oscillation source for beat note reception, and employs the transmitting crystal to provide crystal controlled reception with freedom from vibration effects and calibration uncertainties,
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and enables reception of strong signals without blocking. It accomplishes these things in the following manner:

(a) It provides the necessary slight frequency shift of the residually sustained oscillations sufficient to cause heterodyne reception at the desired audible beat note of signals being received on the common transmitting frequency.

(b) It provides means for reducing the intensity of oscillations in the transmitting circuit to any desired residual value suitable for heterodyne function.

(c) It eliminates, when the circuit is in residual oscillations, modulation due to any voltage irregularity or ripple peculiar to the plate power source, which may not be objectionable in transmission, but which would interfere with proper heterodyne function.

(d) It provides a suitable adjustable degree of electrical coupling between the receiver and the transmitting circuit while the latter is in residual oscillation and acting as a heterodyne source.

(e) It changes the transmitting circuit from the emitting to the heterodyning condition quickly, thus enabling rapid break-in communication, with a keying contact sequence such as to reduce the possibility of accidental damage to the receiver or any part of the transmitter circuit in normal operation.

It should be noted that the maximum controllable frequency variation of a crystal controlled oscillation circuit, attainable by methods herein described, appears to be a fraction of one per cent, sufficient for satisfactory heterodyne detuning at high communication frequencies.

The circuit arrangement of my invention will be understood by reference to Fig. 1 of the drawings which represents one form of transmitting circuit embodying the principles of my invention. The diagram shows a form of crystal controlled transmitting circuit together with suitable connections to receiver R which may be of any conventional type, but should not be in self-oscillating condition. All keying contacts in the transmitting circuit are shown in the position for reception allowing only residual oscillation. The oscillating tube 1 derives its filament current from a source 2 and its plate voltage from a source 3, shunted by a by-pass condenser 4 if necessary to reduce any voltage
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fluctuations. Residual oscillations of desired strength are maintained by reducing the effective plate voltage through resistor 5; audio frequency modulation due to any voltage ripple is prevented by a suitable filter system such as audio frequency choke coil 6 and by-pass condensers 7 and 8. This choke coil 6 may be of high resistance up to a value where it gives sufficient voltage drop in itself so as to dispense with a separate resistor 5.

The oscillation frequency of the circuit is governed by quartz crystal 9; the radio frequency milliammeter 10 indicates the relative strain on the crystal during transmission and thus insures proper circuit adjustment. The variable inductance coil 11 shunted if desired by variable condenser 12 in the residually oscillating condition provides the slight frequency change desirable for a proper heterodyne note and permits to some extent compensation for a relative frequency change of the incoming signals resulting from temperature changes, etc., at the local or the distant station. The plate circuit of tube 1 connects to oscillation transformer 14 which is properly tuned by variable condenser 15. During transmission, 14 is coupled to the antenna 16 and ground 17 either conductively as shown, or by other suitable means. For receiving purposes the residual oscillation frequency of the circuit is superimposed in a suitable degree and manner upon the incoming signals received on the antenna. This may be effected in a simple manner by the inherent capacity coupling across the open transmitting contact of key 18 and suitable adjustment of the intensity of residual oscillation by resistor 5. I have found of advantage the use of a slight additional variable inductive coupling through coil 19 which may be so rotated that it either suitably reinforces the residual coupling at 18 or by phase opposition reduces it to the desired value, the best coupling value depending upon strength of the incoming signals and other variable conditions.

Telegraphic keying is effected by a multiple contactor switch system 20 having mechanically connected contact arms 21, 22 and 18. This device may be directly hand operated or may be operated by a relay through electromagnet 42 and hand key 23 as shown. Contact 21 short circuits the detuning circuit rendering it ineffective when in the transmitting position. Contact 22 applies full plate voltage to the oscillator tube 1 by short circuiting the voltage-reducing resistor 5 and the filter inductance 6 when in the transmitting position. 18 switches the common antenna 16 from the receiver R to the transmitter. It is desirable, for the protection of the circuit that when the key is closed, contact 22 should close after contacts 21 and 18 and, inversely, be the first one to open as the key is released.

This is accomplished by proper adjustment of the spring contacts and clearances by means of the screw means shown at 24, 25 and 26. Fig. 1 shows adjustment for a closing sequence 21, 18, 22 and an opening sequence in reverse order. Thus the detuning is made ineffective by 21 before application of full transmitting voltage through 22 and remains so until the plate voltage has again been reduced to residual oscillation value by opening of 22; this prevents injurious overloading of the quartz crystal 9 due to any regeneration inherent in the detuning method. The connection of the antenna 16 to the transmitter through contact 18, before 22 applies full voltage and inversely the opening of 18 subsequent to that of 22 likewise prevents possible damage to the crystal 1 from momentary oscillation at full power without the output load. 21 and 18 may make simultaneous contact for transmission, but in view of the desirable clearance of contact due to the radio frequency voltage involved, 18 can be adjusted to make transmitting contact after 21 as shown, or its lever arm may be lengthened to provide greater travel.

The variation of oscillation frequency of the crystal controlled circuit, for purposes of my diagram by means of detuning inductance 11 and optional condenser 12, may be accomplished in a variety of ways which may be classified as follows:

(a) Variation of the grid or crystal circuit reactance at 11, 12 or 28.

(b) Variation of the plate circuit reactance by changing 14, 15 or 29.

(c) By introducing a variable degree of electrostatic or electromagnetic coupling between the crystal, or grid and plate circuit of the tube 1.

(d) By changing the effective reactance of a secondary circuit coupled to either the grid circuit or plate circuit or both.

(e) By resistance variation in any of the above mentioned circuits.

Fig. 2, shows a modification of the plate supply circuit of Fig. 1, which employs a battery 30 or well filtered, separate source of reduced plate voltage for residual oscillations and heterodyne purposes. This arrangement is particularly adapted to cases where a transmitting plate supply source 3 is employed having high inherent or intentional modulation such as rectified A. C., that would be unsuitable for a heterodyne power source without use of an expensive filter system, or where the voltage delivered by source 3 fluctuates. Relay arm 22 through a back contact 22^a connects the plate of tube 1 to this battery during heterodyne reception, and switches therefrom to the high voltage source 3 while the key is depressed during transmission. Condenser 31 is used to store up sufficient energy to serve as power source to maintain oscillations during the transfer

period of 22 and in connection with resistance 32 absorbs the initial voltage surges during transmission. Condenser 33 and resistor 34 reduce sparking at the transmitting contact of 22. A connection through suitable resistor 35 may be employed, if desired, for the purpose of maintaining the charge of battery 30 by momentary charging during transmission.

While the principles of my invention have been described only in their application to a single tube transmitter, they are also applicable to larger sets employing a crystal controlled oscillator with one or more stages of output amplification. While in such transmitters balancing methods are generally employed to prevent or neutralize direct coupling between successive circuits, it is usually impossible to completely shield or neutralize the master oscillator from an adjacent receiver to prevent interference with reception on the same frequency. By applying my method of detuning to the master oscillator and suitable coupling its oscillations to the receiver when the key is up, intercommunication on the same frequency is facilitated.

The special advantages gained by my system as herein described are:

(a) It permits intercommunication by the break-in method with undamped waves between crystal controlled transmitters, with receivers in close proximity, all operating at the same frequency or in harmonic relationship.

(b) It provides the advantages of crystal controlled transmission and reception without requiring the use of separate crystals for reception purposes.

(c) It provides selection of optimum receiving conditions by variation of strength of the heterodyne by adjusting the intensity of the residual oscillation of the transmitter or by variable coupling of the receiver thereto.

(d) Beat note reception of relatively high powered continuous wave signals at close range is made possible without blocking of the receiver, since a crystal controlled and relatively powerful heterodyne source is used.

The signal transmission and receiving apparatus of my invention has been found to be extremely practical in operation and while I have described the invention in connection with a short distant communication system, it will be understood that embodiment of my invention disclosed herein is merely illustrative of my invention and that modifications in the circuit arrangement of the communication system may be made without departing from the spirit of my invention within the scope of the appended claims.

What I claim as new and desire to secure by Letters Patent of the United States is as follows:

1. A signal transmission and receiving system comprising an antenna ground circuit, radio receiving apparatus, radio transmission apparatus including an electron tube oscillator and a piezo electric crystal control circuit connected with said electron tube oscillator, a switching system comprising a plurality of sections, keying means for controlling the operation of said switching system, one section of said switching system being arranged to detune said piezo electric crystal control circuit, another section of said switching system being arranged to modify the amplitude of oscillations sustained by said oscillator, and another section of said switching system being arranged to control the connections between said antenna ground circuit, said radio receiving apparatus and said radio transmission apparatus.

2. A signal transmission and receiving system comprising an antenna ground circuit, signal receiving apparatus, signal transmission apparatus, switching means for alternately establishing connection between said antenna ground circuit and said signal receiving and transmission apparatus, said transmission apparatus including an electron tube oscillator, a piezo electric crystal system capable of generating oscillations sustained by said piezo electric crystal system, and separate switching means simultaneously operative with the actuation of said first mentioned switching means for detuning said piezo electric crystal system and modifying the amplitude of oscillations developed by said electron tube oscillator in accordance with telegraphic signals.

3. In a signal transmission and receiving system an antenna ground circuit, a continuous wave signal receiving apparatus, signal transmission apparatus including an electron tube oscillator, a piezo electric crystal control circuit connected with said electron tube oscillator whereby oscillations of a frequency determined by said piezo electric crystal control circuit may be sustained by said electron tube oscillator, said receiving apparatus being selectively tuned to a frequency remote from the frequency of said electron tube oscillator, and switching means including a plurality of separate sections, one section of said switching means being arranged to effect a detuning of said piezo electric crystal control circuit, another section of said switching means being arranged to modify the amplitude of the oscillations sustained by said electron tube oscillator, and another section of said switching means being arranged to transfer connections from said antenna ground circuit to said signal receiving apparatus and to said signal transmission apparatus, said electron tube oscillator being adjusted to sustain oscillations controlled by the detuned condition of said piezo electric crystal control circuit for im-

pressing local oscillations upon said signal receiving apparatus at a frequency adjacent the incoming signaling frequency.

4. A signal transmission and reception
5 system comprising an antenna ground circuit, a signal receiving circuit, a radio transmitter including a piezo electric crystal control circuit and an electron tube oscillator
10 for sustaining oscillations at the frequency of said piezo electric crystal control circuit, a coupling between said electron tube oscillator and said signal receiving circuit, switching means constituted by a plurality of independent sections, a keying circuit for
15 simultaneously controlling the movement of said independent sections, the first of said sections being arranged to effect a detuning of said piezo electric crystal control circuit, the second of said sections being arranged to
20 effect a modification of the amplitude of the oscillations developed by said electron tube oscillator, and a third section being arranged to transfer connections from said antenna ground circuit to said radio transmitter or
25 receiving circuit, said second mentioned sec-

tion operating to restore the amplitude of the oscillations of said electron tube oscillator to a normal condition subsequent to the closing of said first and third mentioned switching sections.

5. A transmission and receiving system
30 comprising a continuous wave receiving apparatus, an antenna ground circuit, a signal transmission apparatus including a piezo electric crystal control circuit, an electron
35 tube oscillator and a pair of independent output circuits, switching means for transferring connections between said antenna ground circuit and said signal transmission and receiving system, and means simultane-
40 ously actuated in accordance with the operation of said switching means for rendering one of said output circuits ineffective for changing the operating condition of said electron tube oscillator for effectively impress-
45 ing local oscillations upon said receiving apparatus intermediate the signal transmission periods.

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