G. O. SQUIER.

MULTIPLEX TELEPHONY AND TELEGRAPHY.

APPLICATION FILED NOV. 5, 1910.

980,359. Patented Jan. 3, 1911.

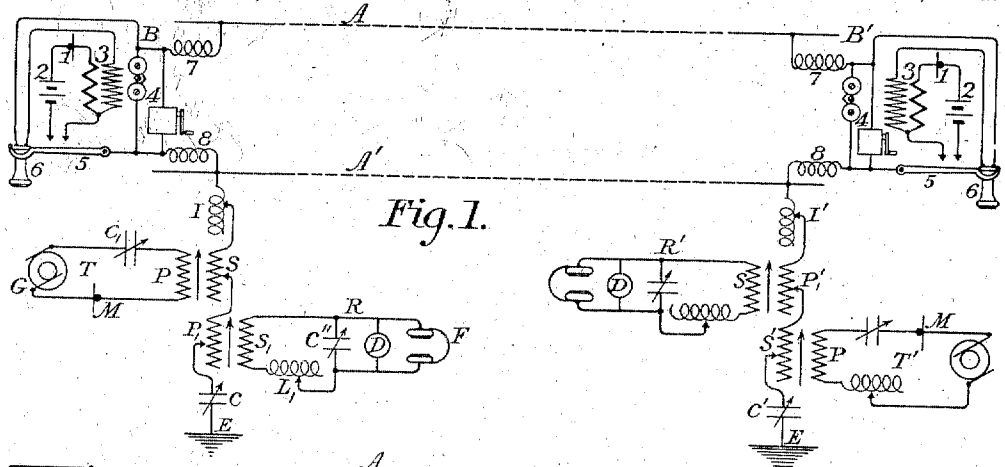


Fig. 1.

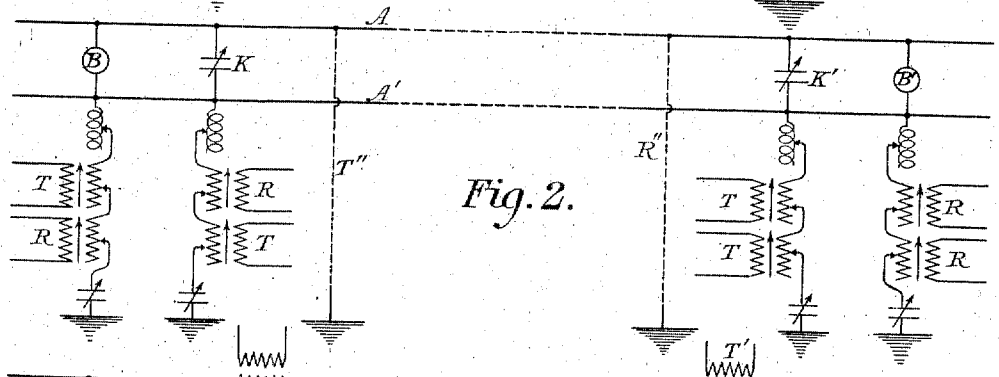


Fig. 2.

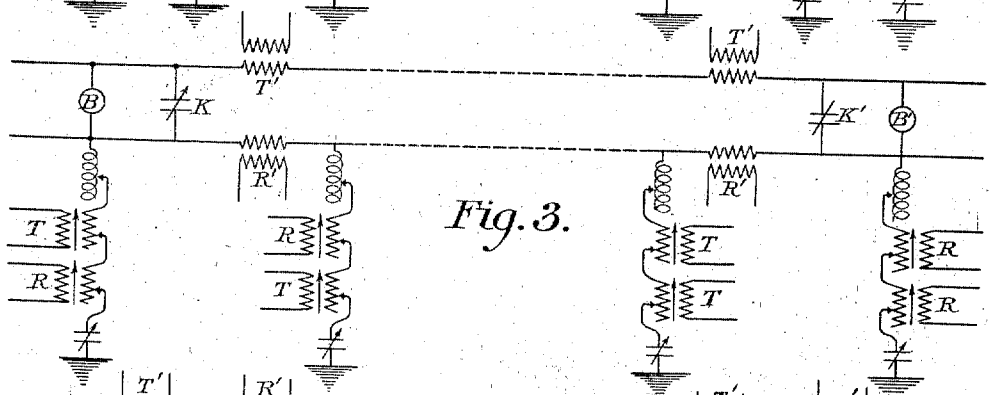


Fig. 3.

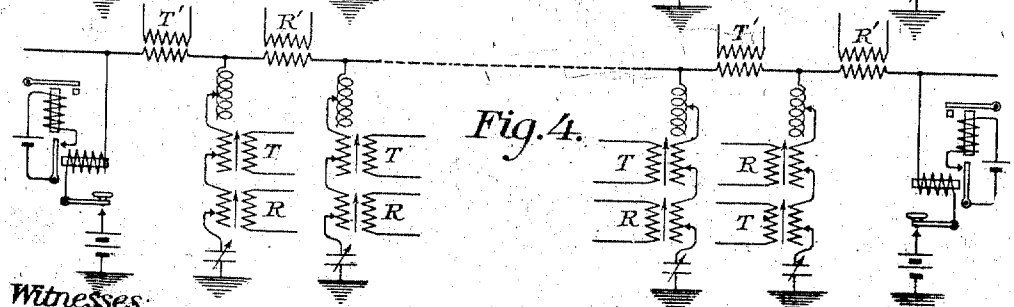


Fig. 4.

Witnesses:
W. Welch
P. J. Ebold.

Inventor
George Owen Squier

# UNITED STATES PATENT OFFICE.

GEORGE OWEN SQUIER, OF THE UNITED STATES ARMY.

## MULTIPLEX TELEPHONY AND TELEGRAPHY.

980,359. Specification of Letters Patent. Patented Jan. 3, 1911

Application filed November 5, 1910. Serial No. 590,804.

(DEDICATED TO THE PUBLIC.)

*To all whom it may concern:*

Be it known that I, GEORGE OWEN SQUIER, major in the Signal Corps, U. S. Army, a citizen of the United States, and residing at Washington, District of Columbia, (whose post-office address is War Department, Washington, District of Columbia,) have invented certain new and useful Improvements in Multiplex Telephony and Telegraphy, of which the following is a specification.

This application is made under the act of March 3, 1883, chapter 143, (U. S. Statute XXII, p. 625,) and the invention herein described and claimed may be used by the Government of the United States or any of its officers or employees in the prosecution of work for the United States or by any person in the United States without the payment of any royalty thereon.

This invention relates to multiplex telephony and telegraphy and has as its object the simultaneous transmission of a plurality of telephonic and telegraphic messages over a single circuit.

A further object of the invention is to make use of grounded or earthed connections in combination with the usual metallic circuit.

A further object is to render such a system as the above silent to external disturbances and in such manner as to eliminate all cross-talk or harmful effects of one message upon another.

A further object is to apply electric waves of such frequencies as to make possible the selection and complete independence of the various messages.

A further object is to superimpose upon a standard battery telephone circuit, as now commercially in use, one or more telephonic and telegraphic circuits without any interference of the various messages.

In accomplishing the above results, use is made of electromagnetic waves, or oscillations, of high frequency, propagated by means of wires, and where use is made in this application of the term high frequency, it is understood to mean any ultra-sound frequency or frequencies above the limit of audition.

Reference is here made to my co-pending applications, Serial Numbers 590,801 and 590,802, filed November 5, 1910, in which I have discussed at length the advantages and limitations of the use of electromagnetic waves of various frequencies in such systems as described there and here. In accomplishing the desired results, I have found it necessary and sufficient to combine the engineering practice of wireless telegraphy and telephony with the engineering practice of wire telegraphy and telephony. I have also found it necessary, in order to obtain satisfactory results, to make use of such detectors as are commonly found in the wireless telegraphic art. Attempts have been made at multiplex telephony, but I have found these inoperative for the reason, among others, that no detector or equivalent device has been used. These detectors are not used because of any greater inherent sensitiveness to electrical energy than resides in the telephone receiver itself, but because the energy being in the form of rapid oscillations cannot affect the telephone or other communicating device. These rapid oscillations can not sensibly affect the telephone, because the diaphragm in its motion must reverse with the reversal of the current and the deflecting impulse if applied directly to the telephone receiver will be first in one direction and then in the other with a frequency so high that the diaphragm cannot sensibly follow or respond. Furthermore, if the diaphragm should respond with this frequency the effect would not be audible. Also in the case of the ordinary telephone, on account of the large self-inductance of the instrument, the high frequency E. M. F. generated by the waves would produce in the telephone receiver only extremely weak currents. I have found it necessary therefore, and consider it an important part of my invention, to make use of some form of integrating detector to transform the rapid oscillations into effects which can be manifested by the indicating instrument.

This application is closely related to my three co-pending applications, Serial Numbers 590,801, 590,802, and 590,803, filed November 5, 1910. In each of these, use is

Samsung Ex. 1018, Page 2 of 6

made of high frequency waves as a vehicle for the telephone or telegraph messages which are impressed upon the same line as carries the telephonic currents from an ordinary local battery telephone set.

In my co-pending application, Serial Number 590,803, I have shown a specific manner of connecting a plurality of high frequency circuits in parallel between the ordinary battery line and the earth. In this application I shall describe a manner of connecting a plurality of such high frequency circuits in series relation, making use of the telephone circuit and ground connections.

In the drawings forming a part of this specification, several modifications for circuit connections are shown, and in said drawings, Figure 1 illustrates a circuit in which a plurality of transmitting or receiving circuits is connected in series in a circuit between the earth and the ordinary telephone line. Figs. 2, 3 and 4 illustrate a modification of Fig. 1.

Referring to these figures in detail, Fig. 1 shows a common metallic circuit A—A′ for ordinary telephony, across which are bridged the telephone sets B B′. These telephone sets include the usual apparatus in present use in local battery circuits, there being shown a transmitter 1 of any suitable form such as a microphone transmitter with its local battery 2 and the primary of the transformer 3. Also there are shown connected in the usual way the ringing circuit 4, the switchhook 5 and the receiver 6. The secondary of the transformer 3 is bridged directly across the line when the receiver is off the hook. The invention is not in any way connected with the details of this telephone connection, any of the usual circuits being suitable, and the one described being given merely as an illustration. Connected to the line wire A′, at or near its connection to the telephone set B, I have shown a circuit connection to the earth at E, this circuit including the variable inductance I, the secondary coil S, the primary coil $P_1$ and the variable condenser C, these all being connected directly in series. Inductively connected to the secondary S is a primary coil P which is in circuit with the high frequency generator G, this circuit also including a variable condenser $C_1$ and a microphone M. Inductively connected to the primary $P_1$ is a secondary coil $S_1$, including in its circuit a variable condenser C″ and a variable inductance L′. Shunted around the condenser is the detector D, and operatively associated with the detector D is the telephone set F, with a battery if desired. At or near the station B′ is a similar earth connection, including the inductance I′, the primary $P_1'$, the secondary S′ and the condenser C′, these being all variable and connected in series in the same manner as shown at the station B. Inductively connected to the primary $P_1'$ is a receiver circuit R′, similar in every respect to the receiver R at the station B. Inductively connected to the secondary S′ is a transmitter circuit T′, similar in every respect to the transmitter circuit T at the station B. The receiver R′ is tuned to the frequency of the oscillations given off by the transmitter T and the receiver circuit R is tuned to the frequency developed by the transmitter T′, these frequencies being sufficiently different to afford effective, selective tuning. The tuning elements throughout the circuit which comprise the various condensers and inductances are all variable in order to permit of ready and effective tuning of each and any circuit. The high frequency transformers are all so constructed as to give variable coupling, either by sliding the one coil within the other, or having one coil swing within the other, or by any other suitable method well known in the wireless art.

The operation of the system is as follows: Ordinary telephonic communications may be carried on between the stations B and B′ by the telephone sets. Simultaneously therewith high frequency oscillations may be impressed on the line A′ by the transmitter circuits T and T′; both of these operating at the same time, if desired. These high frequency oscillations are modified in accordance with speech by the microphone M, and oscillations transmitted by T are picked up by the receiver R′ and are rectified or transformed by the detector D in such a way as to give a reproduction of speech in the telephone F, all of these being well known in the art. So also oscillations modified by the microphone M at the transmitter circuit T′ will be translated into speech at the station R. All of these messages may exist on the same line at the same time without any cross-talk or interference whatsoever. If desired, one or more of the microphones M may be replaced by suitable telegraphic keys in order that communication by telegraphy may be carried on. Obviously this change will not affect the principle of the operation in any way whatsoever. The telegraphic signals may be produced by the ordinary key placed directly in the generator circuit or by such an arrangement as is shown in Fig. 3 of my co-pending application, Serial Number 590,801. It is to be noted in this circuit that I have connected a metallic circuit to earth at both ends, and I have done this without experiencing any difficulty in consequence of external disturbances. I am able to accomplish this by means of the condensers C and C′, which, in addition to acting as

Samsung Ex. 1018, Page 3 of 6

tuning elements, also act as a check to any earth disturbances in the vicinity. This is possible only because the condensers C and C′ here used are of very small electrical dimensions, being measured in some thousandths of a microfarad, whereas the condensers now in ordinary use in telephone practice have a capacity measured in microfarads. Such large condensers offer very small impedance to the passage of external disturbances of such frequencies as are within the audible limit, but with my very small condensers and sharp tuning in the ground circuit to a frequency entirely above audition, these low frequency audible disturbances are entirely shut out, giving me what I choose to call a "silent ground connection". In view of the fact that heretofore single line telephone circuits which include a ground return, or a 2-wire telephone circuit which is grounded at either end, are subject to many and strange noises, the causes of which are not entirely understood, I consider that my present invention, whereby I am enabled to use a ground connection on a single telephone circuit with no such disturbances, a very important and essential part of my invention. I have found the above circuits entirely successful on a standard telephone line circuit consisting of a pair of twisted copper conductors, paper insulated, which pair constitutes but one out of a large number inclosed in a lead sheath used in ordinary city traffic. This lead sheath surrounding the pair of wires brings the earth connection very close indeed to the line circuit all along its length, but in spite of this, my selective circuits are so effective as to give no trace whatsoever of any cross-talk or influence due to external disturbances. It is apparent that any number of transmitter or receiver circuits may be connected in series in addition to the two shown in Fig. 1.

Fig. 2 shows a modification of Fig. 1, in which a plurality of earth branches are connected in parallel, each single branch connected to earth being similar in every respect to the earth branches shown in Fig. 1, and each including two or more circuits which may be transmitter or receiver circuits, these circuits being indicated only diagrammatically and designated by the reference characters T and R throughout. The connections of the battery sets B and B′ are shown only diagrammatically, it being understood that the connections are similar to those shown in Fig. 1. Each transmitter has a different frequency always being of ultra-sound frequency, and each transmitter has a corresponding receiver circuit at the other end of the line tuned to its frequency. I may also use condensers K and K′ bridged across the lines A A′ which serve the purpose of placing the two lines A and A′ in parallel for the high frequency currents. This capacity, however, is made so small as to give practically insuperable impedance to the telephone currents of ordinary frequencies as given by the telephone sets B and B′. It is also obvious, as shown in Fig. 2, that high frequency currents may be connected to the line wire A as shown at T″ and R″, these circuits having connected in them a plurality of transmitter or receiver circuits in any suitable arrangement.

Fig. 3 shows a further modification, which is a combination of the systems shown in Figs. 1 and 2 and the systems shown in my co-pending application, Serial Number 590,802. In this figure, a plurality of branches connected to the earth is shown, each circuit including a plurality of transmitter or receiver circuits, as shown in Fig. 2. In addition to this high frequency transmitter circuits are inductively connected by means of transformers connected directly in the line circuit in series with the battery sets B and B′ in the manner described in my co-pending application, Serial Number 590,802, cited above. In this case, the condensers K and K′ are necessary in order to give a free path for the high frequency oscillations of the series connected transmitter and receiver sets T′ and R′.

Fig. 4 shows a further modification in which the battery sets B and B′ and one of the line wires such as A, are entirely eliminated, in which case I have multiplex telephony by a single wire using earth return. As is apparent from this Fig. 4, I have shown a plurality of ground branches, each including a plurality of telephone or receiver sets, each transmitter having a different frequency and having a receiver set at the other end of the line tuned to its periodicity. Also in series with the line, I have connected other transmitter and receiver sets, as shown diagrammatically at T′ and R′. In this case I am able to carry on multiplex telephony by the single wire connected to earth at various points without any cross-talk or disturbances from external causes, and I consider this an essential part of my invention. In connection with Fig. 4, I have shown means whereby Morse telegraphy may be carried on in the usual way and this without any cross interference of the messages. In case way stations are used on the line, each of such stations will be shunted by a small condenser or a condenser and inductance tuned to the frequency of the high frequency oscillations. Thus it is apparent that my invention may be superimposed directly on the present Morse telegraph systems. Other forms of

Samsung Ex. 1018, Page 4 of 6

high frequency transmitter and receiver circuits may be used in place of those shown, and various suitable modifications are shown and described in detail in my co-pending application, Serial Number 590,801 cited above.

Although several modifications have been described in detail in this specification, it is obvious that many changes may be made without departing from the spirit of the invention, and I therefore do not wish to be limited to the exact connections shown, but

What I claim as my invention is the following:

1. In a silent earthed multiplex telephone and telegraph system, a line wire; a plurality of earth circuits extending from said line; a plurality of transmitter or receiver circuits associated in series relation in each of said earth circuits, each transmitter circuit impressing different but ultra-sound frequencies on the line, each receiver circuit being tuned to the frequency of one transmitter.

2. In a silent earthed multiplex telephone and telegraph system, a line wire; a plurality of earth circuits extending from said line; a plurality of transmitter or receiver circuits associated in series relation in each of said earth circuits, a plurality of transmitter and receiver circuits associated in series in the line, each transmitter impressing different but ultra-sound frequencies on the line, and each receiver being tuned to the frequency of one of the transmitters.

3. In a multiplex telephone and telegraph system, a line wire; low frequency signaling apparatus connected to the line, a plurality of ground circuits extending from said line, a plurality of transmitter or receiver circuits associated in series relation in each earth connection, each transmitter circuit impressing different but ultra-sound frequencies on the line, each receiver circuit being tuned to the frequency of one transmitter.

4. In a multiplex telephone and telegraph system, a pair of line wires; low frequency signaling apparatus associated therewith; a plurality of earth connections placed between each line and the earth, a plurality of high frequency signaling circuits associated in series in each earth connection, each transmitter circuit developing oscillations of different but ultra-sound frequency and each receiver tuned to one transmitter circuit.

5. In a multiplex telephone and telegraph system, a pair of line wires; low frequency signaling apparatus bridged across said lines; a plurality of earth connections placed between each line and the earth, a plurality of high frequency signaling circuits associated in series in each earth connection, each transmitter circuit developing oscillations of different but ultra-sound frequency, each receiver circuit being tuned to one transmitter circuit and containing a detector for high frequency oscillations and a telephone receiver operatively associated with said detector.

6. In a multiplex telephone and telegraph system, a pair of line wires, battery telephone sets bridged across said line wires, a plurality of earth connections placed between each line and the earth, a plurality of high frequency signaling circuits associated in series in each earth connection, each transmitter circuit developing oscillations of different frequency, each receiver circuit being tuned to one transmitter circuit and containing a detector for high frequency oscillations and a telephone receiver operatively associated with said detector.

7. In a multiplex telephone and telegraph system, a pair of line wires, battery telephone sets bridged across said line wires, a plurality of earth connections placed between each line and the earth and containing a variable condenser and a variable inductance, a plurality of high frequency signaling circuits inductively associated in series in each connection, each transmitter circuit containing a generator of high frequency oscillations, a variable condenser and inductance for tuning said circuits and a telephone transmitter for modifying said oscillations, each receiver circuit being tuned to one of the transmitter circuits and containing a detector of high frequency oscillations and a telephone operatively connected therewith.

8. In a multiplex telephone and telegraph system, a pair of line wires; battery telephone sets bridged across said line wires; a plurality of earth connections placed between each line and earth and containing a variable inductance, and variable condenser; a plurality of high frequency signaling circuits inductively associated in series in each earth connection a plurality of signaling circuits connected inductively in series in the lines, each transmitter circuit developing oscillations of different ultra-sound frequencies and containing a microphone transmitter for modifying the oscillations in accordance with speech, each receiver circuit containing a variable inductance and a variable capacity, and tuned to the frequency of one transmitter circuit, a detector in shunt to the condenser of the receiver circuit and a telephone operatively connected therewith.

9. In a multiplex telephone and telegraph system, a pair of line wires; battery telephone sets bridged across said line wires; a condenser of small capacity parallel to each of the battery telephone sets; a plurality of earth connections placed between each line and earth and containing a variable inductance and a variable capacity, a

Samsung Ex. 1018, Page 5 of 6

plurality of high frequency signaling circuits inductively associated in series in each earth connection; a plurality of signaling circuits connected inductively in series in the lines, each transmitter circuit developing electric waves of different ultra-sound frequencies and containing a microphone transmitter for modifying the oscillations in accordance with speech; each receiver circuit containing a variable inductance and a variable capacity and tuned to the frequency of one transmitter circuit, a detector in shunt to the condenser of the receiver circuit and a telephone operatively connected therewith.

GEORGE OWEN SQUIER.

Witnesses:
P. I. WOLD,
E. R. CRAM.

Samsung Ex. 1018, Page 6 of 6