

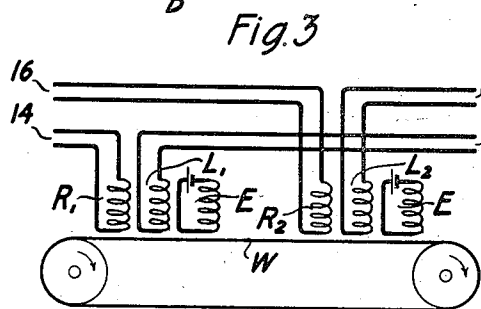
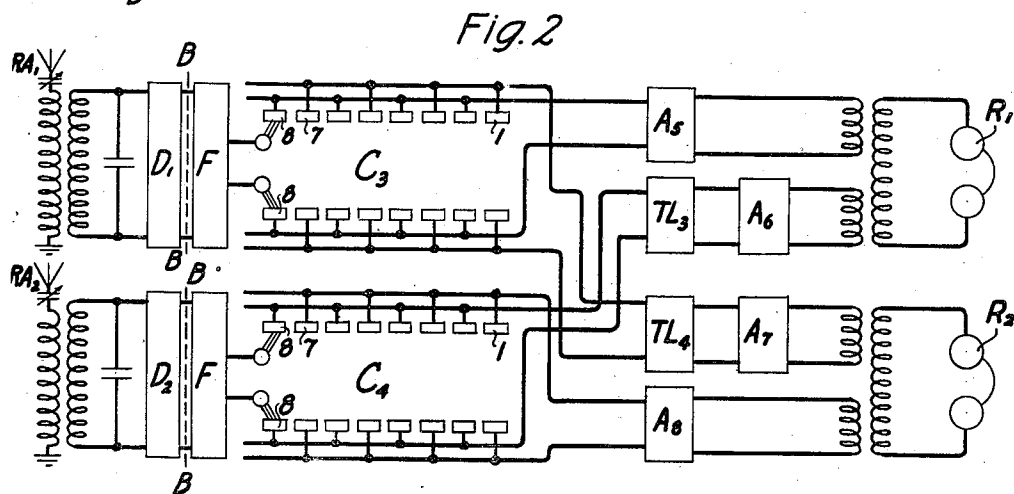
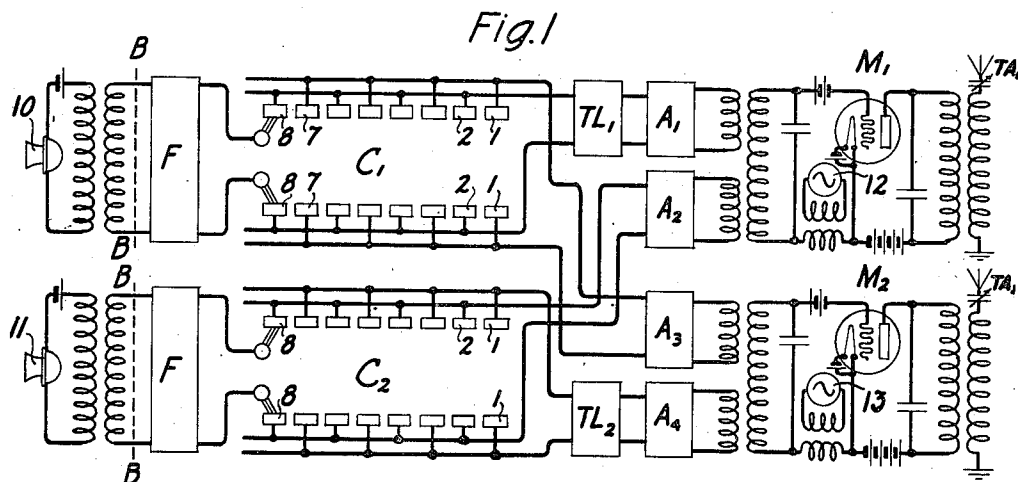
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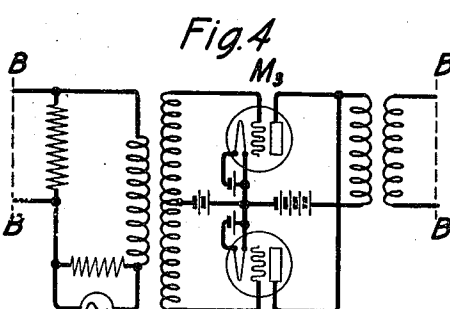
R. C. MATHES

SECRET SIGNALING

Filed August 8, 1923



TIME LAG DEVICE (TL)



SPEECH INVERTER

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UNITED STATES PATENT OFFICE.

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SECRET SIGNALING.

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To all whom it may concern:

Be it known that I, ROBERT C. MATHES, a citizen of the United States of America, residing at New York, in the county of Bronx and State of New York, have invented certain new and useful Improvements in Secret Signaling, of which the following is a full, clear, concise, and exact description.

The present invention relates to the transmission of signaling or other waves, and has particularly to do with obtaining secrecy in such transmission.

It is an object of the invention to transmit with secrecy signals or other waves of any desired frequency or other characteristic.

A further object of the invention is to enable multiplex transmission with secrecy in a simple and effective manner.

It has been proposed to divide a message wave into its frequency components and to transmit different portions of the wave so divided over different transmission paths, such as different lines or different carrier or radio channels. To receive the message, the separately transmitted fragments are separately received, or separately detected in the case of carrier or radio transmission, and are recombined to make up the message waves.

According to the present invention, the message wave is divided as to time rather than as to frequency, and the successive portions of the waves so divided are sent in rotation over different paths (lines, carrier or radio channels, etc.) Since at least two paths are required, the system lends itself readily to multiplex transmission. Different messages are divided into successive time-divisions and the successive fragments of different messages are sent in succession over the channels so that each channel is used practically continuously for message-transmission. This not only increases the efficiency of the system over what it would be if two paths were used exclusively for transmitting only one message, but it also makes the system still more secret since the currents which would be received by anyone attempting to intercept the message would be so much the more confusing from having been produced from two different messages.

Briefly and specifically described, the invention may employ commutators for divid-

ing the speech or other waves into successive fragments. In the case of a single message, the message variations produced during the time that one commutator segment is in circuit may pass directly into the first transmission path. The message variations produced during the time that the next commutator segment is in circuit could be arranged to pass immediately into the second path, but it is preferred to supply these variations to a storage device in order to introduce a delay into the transmission of these variations equal to the time of transit of a commutator segment. With this delay introduced, the variations produced during the transit of the second segment, as described, pass into the second transmission path simultaneously with the production and transmission into the first path of variations occurring during transit of the next or third segment. With this arrangement, there are periods of no transmission over either of the two paths (assuming only two paths) and these periods alternate with periods during which successive portions of a message are simultaneously sent over both paths.

This manner of transmitting the message portions will prevent a listener from receiving an understandable message by receiving simultaneously from both transmission paths, as by tapping two physical lines or using sufficiently broad tuning to intercept the waves from two carrier channels.

The periods of no transmission of one message may be utilized in an entirely analogous manner for transmitting a second message. Due, however, to the fact that successive portions of each message are simultaneously sent over different paths, the system does not depend for secrecy upon the continuous transmission of two messages, but is secret when only one message is being sent.

To receive the message according to the invention, the portions sent over the separate paths are separately received and commutated to deliver to each receiver the components of the message intended for that respective receiver, sufficient delay being introduced into the proper portions to make them follow the other portions in their effect upon the receiver.

While electrical filters may be used in practicing the invention, they are not essen-

tial and the invention provides a system which is highly secret and which can be constructed and used by persons having no knowledge of the principles of frequency selection.

The various objects and features of the invention will be clear from the following detailed description of a typical application of the invention to a radio telephone system as shown in the accompanying drawing.

In the drawing:

Fig. 1 is a schematic representation of a transmitting terminal employing the invention;

Fig. 2 is a similar representation of the corresponding receiving terminal;

Fig. 3 shows a form of time lag device that may be used with the invention; and

Fig. 4 shows a frequency-inverting circuit that may be employed in conjunction with the system when desired.

Referring first to Fig. 1, speech currents representing two separate conversations are produced as a result of speaking into the respective microphones 10 and 11. For convenience, the message transmitted from the microphone 10 will be referred to as the first message and that transmitted from microphone 11 will be referred to as the second message. Filters F, F are shown for confining the frequencies to a convenient range, such as 200 to 2200 cycles, for example, in the case of speech. These filters are not essential but are shown since it may at times be convenient to use them. These filters may be constructed in accordance with the principles disclosed in the U. S. patent to Campbell 1,227,113, May 22, 1917.

The speech currents from the microphone 10 are applied to the commutator C_1 . This and the other commutator shown will be considered to be moving to the right in the drawing. That is, the segments pass to the right across the stationary brushes connected to the respective filter. The segments for each commutator are numbered 1 to 8 respectively, although it will be obvious to employ any number of segments as may be found convenient.

The even numbered contacts of commutator C_1 are connected to the time lag device TL_1 which is associated with the amplifier A_1 and the transmitting modulator M_1 , to be referred to later. The odd numbered segments of commutator C_1 are connected directly to the modulating circuit M_2 through the amplifier A_2 . Conversely, the even numbered segments of commutator C_2 are connected to the modulator M_1 through the amplifier A_2 and the odd numbered segments are connected to the time lag device TL_2 associated with the modulator circuit M_2 through the amplifier A_4 .

The modulator circuit M_1 is of the usual

and well-known type of vacuum tube modulator having its grid or input circuit supplied with the signaling currents from the amplifiers A_1 and A_2 and with a radio frequency wave from the source 12. This source 12 may be a machine generator or a vacuum tube oscillator of the type shown in the United States patent to Hartley 1,356,763, October 26, 1920. The outer or plate circuit of the modulator is connected to the transmitting antenna TA_1 .

The modulator M_2 may be identical with the modulator M_1 except that the generator 13 supplies a wave of a different frequency and the antenna TA_2 is arranged to transmit the modulated wave of correspondingly different frequency.

The time lag devices TL_1 , TL_2 , etc. may each be of the type shown in Fig. 3 in which the telegraph wire W is moved at a uniform speed beneath the recording coils R_1 , R_2 and the listening coils L_1 , L_2 . Message currents applied to the circuit 14 act through the coil R_1 to impress magnetic variations on the wire W , and after a time interval depending upon the speed of movement of the wire and the distance between the coils R_1 and L_1 , the message variations are reproduced in the listening coil L_1 and pass into the outgoing circuit 15. In a similar manner, a second message incoming on the line 16 is recorded on the wire W and after a predetermined time interval is retransmitted into the outgoing circuit 17. The coils E , E are erasing coils.

The operation of the circuit of Fig. 1 is as follows: With the parts in the position shown in the drawing, currents representing the first message, that is, from the microphone 10, are applied to even numbered segments 8, 8 of commutator C_1 so that as long as the brushes are in contact with these segments, the speech variations of the first message are applied to the time lag device TL_1 . Currents representing the second message are also applied to the even numbered segments 8, 8 of commutator C_2 and during the time that the brushes are in contact with these segments, these message variations are transmitted directly to the modulating circuit M_1 , where they modulate the carrier or radio frequency wave and are transmitted to the distant station.

As soon as the brushes of both commutators advance to engagement with an odd numbered segment, the first message is applied directly to the modulating circuit M_2 and is transmitted. Simultaneously with this transmission, the portion of the first message which has been recorded on the time lag device TL_1 is applied to the modulating circuit M_1 and is therefore transmitted. This time relation is obtained by adjusting the amount of time lag of the device TL_1 to equal the time of transit of one of the

commutator segments across the brushes. When the brushes, therefore, are in contact with odd numbered segments, successive portions of the first message are simultaneously sent over the respective transmitting channels. During this time, the second message is applied to the time lag device TL_2 so that this message is not immediately transmitted.

In a corresponding manner, when the brushes again reach even numbered contacts, the first message is stored in the delay device TL_1 and the successive portions of the second message are simultaneously transmitted over both channels, one portion being sent directly through amplifier A_2 and modulator M_1 , and the other portion coming from the delay device TL_2 and being applied to the modulator M_2 .

The amplifiers A_1 , A_2 , etc. serve the additional purpose of preventing reaction of the currents applied to the respective modulators upon the commutating and time lag devices, these amplifiers being of the well-known three-electrode vacuum tube type which are to a high degree unilaterally conducting.

If an unauthorized person attempts to intercept the message by tuning a receiving set to the wave from only one of the transmitting antennae, the attempt will be unsuccessful since a single channel carries only fragments of each message wave and these fragments may readily be made too small to be understandable. Tuning the receiver to receive both transmitted waves simultaneously will yield equally confusing components regardless of whether one or both messages are being transmitted at any instant. During pauses in one of the conversations, there will be alternate transmission of energy and no energy in rapid succession due to the other message. As pointed out above, during the transmission periods successive portions of the same message are simultaneously sent so that even though they both are received they will not combine in the proper manner to increase the intelligibility of the received currents.

The messages are received according to the invention and are rendered intelligible by means of the circuits shown in Fig. 2. The receiving antennae RA_1 and RA_2 are tuned respectively to the waves transmitted from the antennae TA_1 and TA_2 . The radio waves are detected at D_1 and D_2 by any suitable type of detector, such as the three-electrode vacuum tube detector. The separately received and detected waves are, if desired, passed through the filters F , F which are identical with the corresponding filters of Fig. 1 and are applied to the brushes of the corresponding commutators C_3 and C_4 . These commutators are identical with the commutators C_1 and C_2 and are

controlled in any suitable manner to run in approximate synchronism with the commutators at the transmitting station. This may be accomplished by using constant speed motors to drive the commutators at the respective stations and in either manually or automatically controlling the commutators at one station, preferably the receiving station, to give the maximum clearness to the received signal.

Currents representing the portion of the first message that was stored in the time lag device TL_1 are, during the time when the brushes are in contact with an even numbered segment, applied directly through the unilateral device A_3 to the receivers R_1 . Currents corresponding to the portion of the first message which were transmitted directly to the amplifier A_3 from the commutator C_1 are during the corresponding interval applied at the receiving station to the time lag device TL_3 . This time lag device is adjusted in the same manner as the device TL_1 to introduce a delay in the message currents equal to the time of transit of a commutator segment across the brushes. Accordingly, when the portion of the message transmitted through amplifier A_3 directly to the receiver R_1 terminates, the succeeding portion of the message stored in the device TL_3 begins to be impressed on the receiver R_1 so that the currents representing the first message are continuously impressed on the receiver R_1 .

In an entirely similar manner, the commutators C_3 and C_4 cooperate with the time lag device TL_4 to impress currents representing the second message continuously upon the receiver R_2 .

Various changes and refinements may be made in the system, to suit requirements. For example, instead of using simple modulators and detectors, as has been described, the well-known carrier-suppression modulators and detectors (U. S. patent to Carson 1,343,306, June 15, 1920) may be used and either the transmitting and receiving antennae may be tuned to confine the transmitted components to a single side band, or a successive modulation system, such as is shown in U. S. patent to Osborne 1,361,488, December 7, 1920, may be employed to obtain a single side band for transmission.

Instead of transmitting two separate carrier waves and relying on frequency selectivity between the radio frequencies to separate the respective messages at the receiver, the messages may modulate two intermediate frequencies of the same carrier wave and the frequency selection may be made after detection of the received wave as is shown, for example, in British Patent 132,562.

Instead of using radiated waves for transmission of the respective message variations, the carrier waves may be applied to a line

or, if desired, the two or more transmission paths may be separate physical line circuits.

As a further modification to increase the degree of secrecy, the frequency inverting circuit of Fig. 4 may be inserted in the circuit at both the transmitting and receiving stations. The circuit of Fig. 4 may be inserted at each of the points B, B by merely opening the circuit at each of these points in Figs. 1 and 2 and connecting the left-hand terminals of Fig. 4 to the left-hand side of the severed circuit and the right-hand side of Fig. 4 to the right-hand side of the severed circuit in each of these figures.

The speech inverting circuit of Fig. 4 comprises an inverting modulator M_3 of the type shown in U. S. patent to Hartley 1,419,562, June 13, 1922, to the input or grid circuits of which may be applied speech currents together with a wave from the source 18 of continuous waves having a frequency near the upper limit of essential speech frequencies, for example, 2400 cycles. The inverting action of this circuit when used in connection with the systems of Figs. 1 and 2 may be explained more clearly by the following numerical example: Assuming that the continuous wave from source 18 has a frequency of 2400 cycles, the incoming speech waves from the respective microphones 10, 11 of Fig. 1 or from the detectors D_1 , D_2 of Fig. 2, received by the speech inverter may comprise a component of 200 cycles which modulates the 2400 cycle wave to produce an upper side band component of 2600 cycles and a lower side band component of 2200 cycles. Assuming that the filters F transmit only frequencies from 200 to 2200 cycles, the 2600 cycle component will be suppressed and only the 2200 cycle component will be transmitted. Similarly, an incoming component having a frequency of 2200 cycles will be transmitted as a component of only 200 cycles. The frequency order of the components is therefore reversed in passing through the circuit of Fig. 4.

It is found that inverted speech frequencies thus produced are practically incapable of being understood so that if they are employed the commutators may be run much more slowly without permitting any intelligible fragments to be transmitted, and the secrecy of the system may be markedly increased.

While the system has been described in connection with speech transmission it is applicable to the transmission of waves or currents of any desired character, such as telegraph currents and the like.

I claim:

1. The method of wave transmission comprising separating the waves into successive

portions and simultaneously transmitting the successive portions over different respective transmission paths.

2. The method of wave transmission comprising separating the waves into successive portions of equal duration and simultaneously transmitting the successive portions over different respective transmission paths.

3. The method of secret transmission of a message comprising producing current variations corresponding to the message variations, mechanically dividing the current variations into successive portions occurring in time, and simultaneously transmitting over a plurality of distinct paths successive portions of the current variations.

4. The method of secret transmission of a message comprising producing current variations representing the message, switching successively produced portions of the current variations into different circuits and simultaneously transmitting over a plurality of transmission paths variations corresponding to the variations switched into the respective circuits.

5. The method of secret transmission of a message comprising commutating the message wave to direct successive portions of the wave into different circuits and simultaneously transmitting said wave portions over a plurality of transmission paths.

6. The method of secret transmission of a message comprising arbitrarily dividing the message wave into portions of equal time periods, transmitting alternate portions of the waves directly to a transmission channel and transmitting the remaining portions to a different transmission channel after a delay equal to one of said periods.

7. The method of secret multiplex transmission comprising transmitting successive portions of one message over respective transmission paths simultaneously, and thereafter transmitting successive portions of another message over the same respective paths simultaneously.

8. The method of secret multiplex transmission comprising producing separate message waves, introducing a time lag into the transmission of certain portions of each message wave, transmitting in turn another portion of each message over one transmission path and transmitting over a different path simultaneously the delayed portion of the same message.

9. The method of secret signaling comprising inverting the frequency order of the message waves and simultaneously transmitting over different transmission paths successive portions of the inverted frequency waves.

10. The method of receiving successive portions of message waves simultaneously sent over different paths comprising impressing certain of the received wave por-

tions directly upon a receiver and impressing other received portions upon the same receiver after a time lag sufficient to bring the different portions into non-overlapping relation in the proper order to reproduce the message intelligibly.

11. The method of secret telephony comprising dividing speech waves on a time basis, simultaneously transmitting successively produced speech components over different transmission paths, and at a receiving point producing successively occurring speech components from the simultaneously received components.

12. In a secret signaling system, a plurality of transmission paths, means to produce signal variations to be transmitted, means to divide said variations into successive portions, a distributor for directing successive portions of said variations to different ones of said transmission paths, and a time lag device connected between said distributor and one of said paths to cause the portions of the signal variations transmitted over the path to overlap in time the portions transmitted over another path.

13. In a secret signaling system, means to

produce signaling current variations, means to divide said variations into successively occurring portions, and means to transmit successively portions of said variations simultaneously over different transmission paths.

14. In a secret signaling system a plurality of transmission paths, means to produce message currents, and means including a distributor and a storage element for simultaneously impressing on said paths successively produced message current components.

15. In a secret multiplex signaling system, a plurality of transmission paths, means to produce current variations representing different messages, and means including distributors and time-lag devices for simultaneously impressing on said paths successively produced current components of one message, and impressing on said paths alternately with said simultaneously impressed components, successively produced components of the other message.

In witness whereof, I hereunto subscribe my name this 2 day of August, A. D. 1923.

ROBERT C. MATHES.