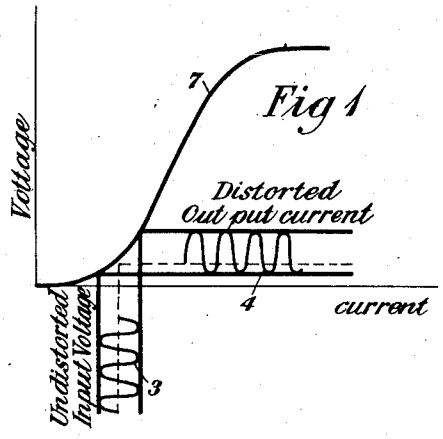
June 28, 1927. 1,633,625

L. ESPENSCHIED

SECRECY SYSTEM

Original Filed March 5, 1921



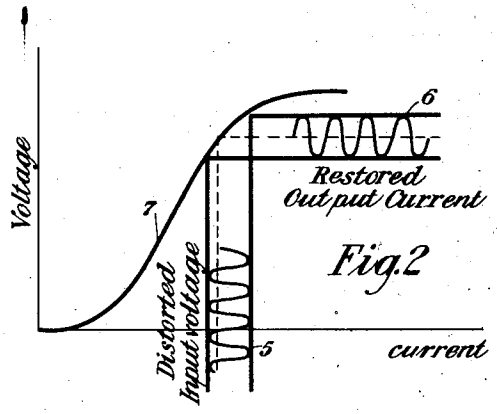


Fig. 3.

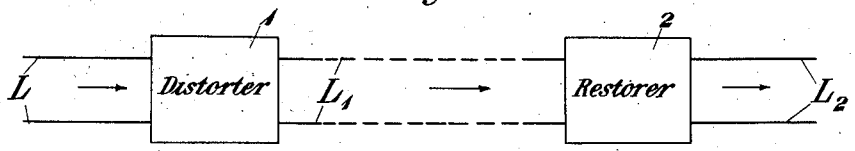
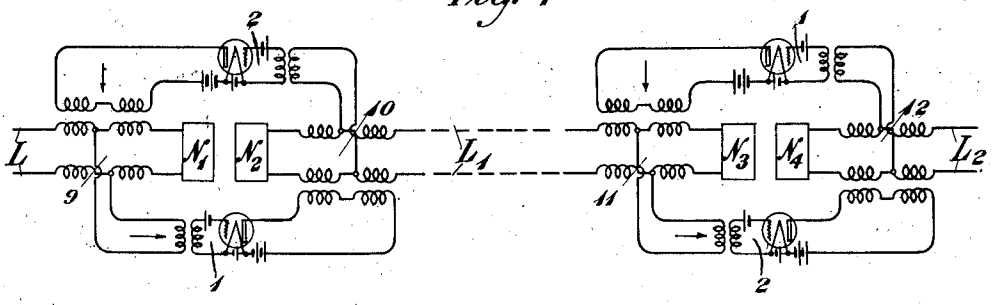


Fig. 4



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By his Attorney

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UNITED STATES PATENT OFFICE.

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SECRECY SYSTEM.

Application filed March 5, 1921, Serial No. 449,879. Renewed October 9, 1925.

This invention relates to transmission systems and more particularly to a method of and means for providing secrecy in the transmission of messages over such systems.

In general it is the object of the invention to provide a system of communication over which messages, such for example as telephonic messages, may be transmitted in such a manner that it will be practically impossible for unauthorized persons who might have access to the medium through or over which the messages are transmitted to obtain the information contained therein. It is furthermore a feature of the arrangements of the invention that they are applicable both to systems of communication employing metallic conductors as the medium of transmission and to radio systems. Other objects and features of the invention will appear more fully from the detailed description hereinafter given.

In the arrangements of this invention the message currents are rendered unintelligible at the sending station by distortion and are transmitted in such unintelligible form to the receiving station. At the receiving station the incoming distorted message currents are given a compensating or restoring distortion and thus restored to intelligible form. The original distortion and restoring distortion may be accomplished by any suitable electrical device which has a nonlinear operating curve. Such a device, for purposes of illustration, might be the well known vacuum tube amplifier. The distorting device at the sending station will be adjusted to operate on a portion of its operating curve which has a non-linear characteristic, thereby distorting and rendering the message currents unintelligible. The device at the receiving station will be adjusted to operate on a portion of its operating curve which is complementary to the portion of the curve selected for the operation of the distorting device at the sending station. In this manner the message currents may be restored to an intelligible form at the receiving station.

The invention may be more fully understood from the following description when read in connection with the accompanying drawing, in the Figures 1, 2, 3 and 4 of which are illustrated the arrangements thereof. Figs. 1 and 2 are graphical illustrations of the operating characteristics of the distorting and redistorting devices respectively. In Fig. 3 are shown schematically the arrangements of the invention as applied to a one-way two wire line, while in Fig. 4 is illustrated how the arrangements might be embodied in a two-way circuit. Similar reference characters have been utilized to denote like parts in all of the figures of the drawing.

As has been pointed out the vacuum tube amplifier is an electrical device having a non-linear operating characteristic suitable for the arrangements of this invention. In Figs. 1 and 2 there is illustrated graphically the curve 7, which is the operating curve of the vacuum tube, or more specifically the input-voltage output-current curve. It will be seen that this curve has non-linear characteristics near the lower and upper parts of the curve and substantially linear characteristics near the central portion of the curve illustrated. Accordingly the distorting tube at the sending station will be adjusted to operate on a non-linear portion of the curve such as the lower portion. The effect of this will be seen from a comparison of the wave forms 3 and 4. As the message current, especially in the case of telephone currents, is composed of a plurality of frequencies and is of a complex form, the invention is illustrated by taking a wave form representing one of these component frequencies and accordingly the wave forms 3 and 4 are of simple rather than complex formation. The wave form 3 represents the input voltage of the original and undistorted message current. It will be seen from the dotted line that it is composed of variations of equal amplitude, when in its original and undistorted form. The wave form 4 will represent the output current which will result under these conditions due to the non-linear operating characteristic at which the tube is adjusted to function. It will now be seen from the dotted line that the wave form 4 is composed

of variations of unequal amplitude, or in other words has assumed a distorted form. Accordingly the voltages of the original message currents, when applied to the tube, will result in an output current which will be sufficiently distorted to be rendered unintelligible.

The tube at the receiving station will be adjusted to function on a non-linear portion of the operating curve, such as the upper portion of the curve, which is complementary to the portion of the curve on which the tube at the sending station functions. The result will then be as illustrated by the wave forms 5 and 6. The wave form 5 shows the applied input voltage from the current of the wave form 4, which as has been pointed out is in distorted and unintelligible form. The wave form 6 will represent the output current which will result under these conditions due to the non-linear operating characteristic at which the tube is adjusted to function. It will be seen that the wave form 6 is composed of variations of equal amplitude and is similar to wave form 3. In other words the distortion, as shown by wave forms 4 and 5, will be removed and the message current restored to its original and intelligible form.

In Fig. 3 the arrangements of the invention are shown in a one-way transmission line. In this arrangement the original message currents are transmitted over a section L of the transmission line to the distorting device 1, by which they are rendered unintelligible. The message in unintelligible formation will then be transmitted to the receiving station over a channel, such as L_1. It is pointed out that the channel L_1 might be a wire line or the messages might be transmitted to the receiving station by wireless methods and apparatus if desired. At the receiving station the messages in unintelligible formation would be transmitted through the restoring device 2 and thus restored to intelligible formation and thence transmitted over section L_2 of the line to any suitable receiving apparatus. The distorter 1 at the sending station would operate in accordance with the graphical representations of Fig. 1 and the restorer 2 would operate in accordance with the graphical representations of Fig. 2. It is pointed out that the devices 1 and 2 are not limited to vacuum tube amplifiers, but may be any suitable electrical devices which have non-linear operating characteristics.

In Fig. 4 the arrangements of the invention are shown in a two-way transmission line. At each station in this type of line there would be provided the hybrid windings 9 and 10 and the balancing networks N_1 and N_2, and the hybrid windings, such as 11 and 12, and the networks, such as N_3 and N_4. At each station there would be provided the distorters, such as 1, and the restorers or redistorting devices, such as 2, connected substantially as shown. It is obvious that the arrangements of the invention are applicable to many types of circuits other than those illustrated. Accordingly, while the arrangements have been illustrated as embodied in certain specific arrangements which are deemed desirable, it is understood that they are capable of embodiment in many and widely varied forms without departing from the spirit of the invention as defined in the appended claims.

What is claimed is:

1. The method of providing secrecy in a system of communication which consists in translating original message currents into a current wave whose elements bear a non-linear relation to the corresponding elements of the original message currents, transmitting the translated wave to a receiving station, and subjecting the received wave at said station to a non-linear translation complementary to the translation at the sending station whereby the message currents will be restored to original formation.

2. A transmission system including a sending station and a receiving station, a transmitting channel at said sending station, a device in said transmitting channel having a voltage-current operating curve portions of which are non-linear, said device being adjusted to operate on one of the non-linear portions of said curve to distort said message currents in the same frequency range as the original message currents, means for transmitting said message currents to said receiving station in said distorted condition, a receiving channel at said receiving station, a device in said receiving channel having a voltage-current operating curve similar to the operating curve of said device at said sending station, said device at said receiving station being adjusted to operate on a non-linear portion of its curve which is complementary to the portion of the curve on which said device at said sending station operates to remove the distortion from said received message currents to render them intelligible.

3. A transmission system including a sending station and a receiving station, a transmitting channel at said sending station, a vacuum bulb device in said transmitting channel having an input-voltage output-current curve portions of which have non-linear characteristics, said vacuum bulb being adjusted to operate on one of the non-linear portions of said curve to distort the message currents in the same frequency range as the original message currents, means for transmitting said distorted message currents to said receiving station, a receiving channel at said receiving station, a vacuum bulb de-

vice in said receiving channel having an input-voltage output-current curve similar to the curve of said device at said sending station, said device at said receiving station being adjusted to operate on a non-linear portion of its curve which is complementary to the portion of the curve on which said device at said sending station operates to remove the distortion from said received message currents to render them intelligible.

In testimony whereof, I have signed my name to this specification this 2nd day of March, 1921.

LLOYD ESPENSCHIED.