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METHOD OF MAINTAINING SECRECY IN THE TRANSMISSION OF WIRELESS TELE GRAPHIC MESSAGES

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This invention relates to a method of maintaining secrecy in the transmission of wireless telegraphic messages and to transmitting and receiving apparatus to be used in connection therewith.

The known methods of maintaining secrecy operate, in most cases, with codes or cryptograms and with a periodically modified transmission frequency, which is received by means of a receiving apparatus, the tuning of which is modified in synchronism, or a so-called beam transmitter is employed. These methods, however, do not guarantee the desired security against interception of the messages because a code can always be deciphered after reception and, in all circumstances a varying transmission wave can be picked up by a receiver sensitive to a broad wave band; whilst beam transmitters transmit energy, not only in the desired direction, but also, in a sector which, although narrow, is outside this direction, and furthermore, in a few secondary directions.

These difficulties are overcome by the present invention because the special method adopted is non-rigid, that is to say, its secret variables can be modified during the transmission, so that even when the principle of the method is known, great difficulties arise in attempts to intercept the messages in practice, the number of possible variations being practically unlimited.

The essential feature of the invention resides in the fact that messages are transmitted by means of a group of frequencies (working frequencies) known to the sender and receiver alone, and alternated at will during transmission of the messages. For example, five frequencies may be used, care being taken at the transmitting station that the signals—i. e. the dots and dashes of the Morse or any other alphabet—are transmitted by these frequencies alternately. The alternation may take place, both during the transmission of the signals and between the signals, and be effected either mechanically or in any convenient manner by hand. The term "alternation" implies, not merely that all the frequencies of the selected group may be switched on in any convenient serial order, but also that one or more of said frequenci may be left entirely out of use for a conside able time.

The working frequencies employed fo transmitting the signals may be of such per odicity that they are sent out either direct, o as modulations of one or more higher fr quencies. There are also intermediate form in which the two methods may be employe in combination.

If high-frequency transmission be en ployed, a series of working waves is used, i any convenient serial order. In a metho of this kind, secrecy is ensured by reason o the fact that an unauthorized receiver wh at first, is tuned in to only a single frequenc length, picks up only disconnected portion of the message. If he knows or discove that a plurality of high-frequency waves being used in sending, such waves have first t be identified and the receiving apparatus wi then have to be reconstructed so that the po tions transmitted on these waves can be co veyed to the same reproducing device (such a telephone) where, taken together, they for the complete message.

Before this has been done, however, th sending device—by reason of its non-rigi character, which largely contributes to th maintenance of secrecy—has already lon had the opportunity by selecting another fr quency, of again nullifying the partial su cess attained by the intercepter. Moreover the sender and receiver come to the nece sary understanding beforehand, and desig their apparatus accordingly, this change o frequencies can be effected after a precedin warning signal, frequently and rapidly, s that the interception of the secret messag becomes practically impossible.

Another possibility consists in that the si nals may be produced by means of low-fr quency oscillations superimposed, by modul tion, on a carrier wave. In this case, to it will be very difficult to pick up the massa in the absence of knowledge of the group o frequencies employed. This difficulty can, o course, be increased, on the part of the sende by changing over, wholly or in part, to a other group from time to time. The grou

low-frequency oscillations can be superimsed on one or more carrier waves. If now, ese carrier waves be alternated during the ansmission (i. e. during or between the sigls), a combination of the two aforesaid posibilities can be obtained, by means of which e secrecy can be increased still further. It self evident that this combination can also effected in such a way that the one portion the carrier waves transmits the signals as termediate modulations, whereas the other rtion is simply interrupted in rhythm with e signals or is modified in intensity. The nes at which the change in the carrier waves effected is now also entirely a matter of conanience.

In all the solutions described, the tracing the key to the secret by any unauthorized rson is prevented by making it difficult for n to ascertain the scope of the group of rking frequencies employed. This can be ne, for example by alternating only three equencies at first out of a group, of, say e, frequencies whilst the transmission with ur and five frequencies is not resorted to til later. Moreover, although the group ected may contain, for example, seven freencies, the sender may transmit, in all ses, with only three frequencies, and may ry the trio within the group at convenace. Even the listener-in who has recogzed the method is deceived in this case, cause he receives the impression that the mber of frequencies in the group is three, d that a new group is employed by the ader every time.

According to the invention, the maintenance of secrecy is still further increased by oducing one or more what may be called en-circuit frequencies or spacing frequens, between the signals, and also varying d frequencies at will. Because the reiver for which the message is intended does t pick up these open-circuit frequencies, the ader is free to choose their periodicity and rial order at will. The unauthorized lisner-in, however, who, in addition to the g. 5) working frequencies, detects a ses of other frequencies, will have to astain clearly, in the first place, which of e frequencies represent the secret message d which must be disregarded.

In practice, such difficulties will thereby ise that a correct reception of the message unauthorized persons may be considered possible.

The attempts of an unauthorized receiver find out the secret may be nullified at any oment, by the sender passing over to aner group of working frequencies, in the anner described above, or by wholly or parlly alternating the working frequencies d open-circuit frequencies (transmitting e message by means of what were origilly the open-circuit frequencies, and interposing what were originally the working frequencies.

It is also possible to hamper the solving of the secret by interrupting the open-circuit frequencies at will thus giving them the character of working frequencies. For instance, a dash can be transformed into one or more dots by suitable interruption.

It will be evident that the frequencies, to which, the term open-circuit frequencies has been applied above, by reason of their being transmitted between the actual signals, can also be produced concurrently with the signals, in which case they also assist in increasing the secrecy. They do not disturb the receiver for whom they are intended, since he does not pick up these open-circuit frequencies. In addition to the working frequencies, these open-circuit frequencies may also be of low or high periodicity. These two methods can also be combined, for example by alternating open-circuit frequencies of high and low periodicity, or the transmission by means of working frequencies of low periodicity, may be improved by the employment of open-circuit frequencies of high periodicity or vice versa.

The secrecy obtained by the employment of this invention is so complete that it is unnecessary to employ codes or cryptograms in transmitting the letters or numerals of which the message is composed and this not only facilitates reception by the receiver, but also prevents mistakes, which are more difficult to clear up, in the case of cryptograms than in that of ordinary script.

As a matter of principle, the variation of the working frequencies, can, as already mentioned, be effected at any moment both during and between the signals, and the variations of the open-circuit frequency can be effected at any time.

The variation of the working frequencies during the signals can be visualized by assuming, for example, that the switch mechanism for the working frequencies (e. g. that for several tuned circuits) and the sending key are connected in series. In such event, the switch mechanism—actuated by any convenient means—varies the working frequencies in any convenient serial order, only such frequencies being sent out as occur during the closing of the key. If open-circuit frequencies be employed in addition, another switch mechanism in series with the key may be allotted to said frequencies, so that such frequencies may be transmitted when the circuit for the switch mechanism of the working frequencies is broken.

Such a variation of frequencies can, of course be effected not only in principle but also as regards its practical embodiment, in various ways, according to the disposition of the senders' control, the connection of the tuned circuits, the position of the key, &c.

If the change in the working frequencies is not to take place during the transmission of the signals, the action of the corresponding switch mechanism must be independent of the manipulation of the key; that is, it must not operate unless the key is opened.

In the case of simple sending arrangements, a circuit arrangement has been found highly advantageous in which, every time the sending key is depressed, a certain working frequency is switched on which, if desired, is replaced by any convenient open-circuit frequency on the key being released. This solution represents a special modification of the method in which the switching over of the working frequencies is effected between the signals. The practical design will be explained later.

The transmitting apparatus employed for carrying out the new method is designed, according to the invention, so as to be capable of generating a number of frequencies which can be alternated at will during the sending of the message. This may be effected by providing a tuned circuit of which the constants (such as self-induction, capacity, or both) are influenced by means of a switch; or several circuits may be provided, which can be switched on and off alternatively as a whole. According to the fundamental arrangement of the generator connection (one or more stages), such a circuit arrangement (i. e. a reversible, or several complete oscillation circuits) will be repeated once or several times in such a way that, in all circumstances the corresponding members will be influenced simultaneously. The manner in which the oscillations themselves are produced (the actual generator connection) is immaterial to the principle of the invention and the present state of the art offers numerous arrangements suitable for this purpose.

A suitable circuit arrangement, which has proved perfectly reliable in practice, and also combines great simplicity with ease in manipulation, can be obtained by controlling a differential relay by means of the sending key, so as to effect the progressive switching-on, by stages, of one or more disc switches in the tuned oscillation circuits, which effect the necesary switching operations simultaneously. This ensures, in all circumtances, the certainty that, on the key being depressed, or released, the wave required for the next period (working- or open-circuit period) will be switched on. The closing of the contacts on the disc switches determines the serial order of the waves produced and the serial order can be altered by employing interchangeable discs.

One form of the invention will be described with reference to the accompanying drawing which is a diagram of the aforesaid circuit arrangement. The signals are sent out directly, as high frequency oscillations, by means of a group of six working frequencies and six open-circuit frequencies are employed between the working frequencies.

The circuit arrangement consists of a transmitting valve Z, the anode circuit of which is tuned and is directly connected with the aerial A.

The anode current is supplied through a choke coil P to the anode circuit which consists of a coil L and three condensers k^1, k^2, and k^3 and an unlimited number of different wave lengths can be generated by the aid of these condensers and the tappings 13—18 of the coil L. The action of the generator is maintained by means of a coil R, which is connected with the grid of the valve and is magnetically coupled with the anode coil L.

In telegraphing, the sender Z is in continuous operation, and the alternation of the working and open-circuit waves is effected by controlling the sending key S, the open-circuit contact 20 of which is connected with the winding w' and the working contact 21 with the winding w^2. These windings influence the armature D of an escapement actuating a toothed disc B, the shaft of which is connected with the switch arm M. In the drawing, the key S is represented in the open-circuit position, so that the winding w' is energized and the armature D is turned clockwise on its shaft. On connection being established with the working contact 21, the disc B will advance a step in known manner. In all circumstances, the switch arm M is in contact with two oppositely disposed contacts such as the contacts 1, 1′ in the position shown; in the next position the ontacts 2, 2′, and so on. The circuit arrangements of the contacts are such that the movements of the switch arm cause an open-circuit wave and a working wave to be generated alternatively. It follows from the drawing that, in conjunction with the condensers k', k^2, and k^3, the tappings 13, 15 and 17 of the coil L determine the open-circuit waves. On the other hand, the tappings 14, 16, and 18 serve, through their connection with the condensers, for the generation of the working waves. Although a sufficient number of waves can be generated by the aid of the tappings alone, the condensers are provided in order that, by adjusting their capacities, the total number of the waves can be further increased. Of course, the number of tappings and also condensers, is entirely a matter of convenience.

The wires r', r^2, and r^3, leading to the tappings for the open circuit waves are provided with interruptors o', o^2, and o^3, which enable the open-circuit waves to be interrupted at convenience and given the character of working waves, during the transmission of the message. These interruptors can be set out of action by shortening the switches s', s^2, and s^3.

The serial order of the working and open-

circuit frequencies during the rotation of the switch arm can be varied at convenience by varying the connections between the contacts themselves, and between said contacts and the condensers and tapped coils. Care must, however, be taken that the two kinds of waves alternate regularly.

The interruptors c^1, c^2, and c^3, interposed beween the coil L and the switch M serve to interchange the open-circuit and working frequencies. If, for example the c^1 be turned over, the wire r' will be connected to the tapping 14, and the wire w' to the tapping 13. In this case, also, the open-circuit wave will be influenced by the interruptor.

It is self evident that the different frequencies can also be generated by means of quite differently connected and designed oscillation circuits, the sole essential point being that an open-circuit wave and a working wave are alternated by means of the switch arm M. There may also be provided between the aerial and the tuned anode or grid circuit of the transmitting valve, a tuned intermediate circuit actuated by a corresponding switch arm also mounted on the shaft of the pinion B, in which case it is advisable, to connect the condensers of the two circuits together, so that during adjustment, equal changes may be made in the frequency groups.

If the changing over of the working frequencies be effected at convenient moments, the manipulation of the key must be separate from that of the interrupting device. Free interruption of this kind can be effected either by hand or automatically. In either case there is no relation at all between the times at which the key and the interruptor perform their individual functions. If an automatic apparatus is used, the construction will be more compact, but is attended with the disadvantage that the serial order of the interruptions is fixed in advance and will therefore be a matter of constant repetition. This drawback is absent in the case of hand control.

In all circumstances the receiving apparatus employed for carrying out the new method must be capable of picking up several working frequencies and transmitting their total effect to a single reproducing device (such as a writing apparatus) &c. Its design depends on the manner in which the signals are transmitted (high-frequency or low-frequency oscillations, or both) and, in view of the receiving circuits already known, can be embodied in various ways.

By the employment of the open-circuit frequencies generated at will, the method according to the present invention assures the requisite secrecy, even when the principle of the transmission is known. This result is due, in the first place to the fact that the method is non-rigid, and that the one group of working-waves can be replaced by another at any moment.

Moreover, the unauthorized listener will be occupied for some considerable time in determining which of the frequencies are to be regarded as the working frequencies, and which as the open-circuit frequencies.

The changing over from the one group of working frequencies to the other is not attended with any appreciable trouble, because the variable members (condensers, variometers, &c.) of the transmitter and receiver can be coupled and designed in such a way that the same manual operations in both stations produce the same change effects.

What I claim is:

1. Method for the wireless transmission of telegraphic messages by means of Morse or other code, wherein the dots and dashes of which the message is composed are transmitted by means of a plurality of working frequencies which are interchanged at will during the transmission of the massage.

2. Method for the wireless transmission of telegraphic messages as claimed in claim 1, wherein one or more spacing frequencies are used between the dots and dashes, which are interchanged at will.

3. Method for the wireless transmission of telegraphic messages as claimed in claim 1 wherein one or more spacing frequencies are used between the dots and dashes, which are interchanged at will, said spacing frequencies being interrupted at will during their transmission.

4. Method for the wireless transmission of telegraphic messages as claimed in claim 1, wherein the group of working frequencies employed is replaced, from time to time, by another, during the transmission of the dots and dashes.

5. Method for the wireless transmission of telegraphic messages as claimed in claim 1, wherein one or more spacing frequencies are used between the dots and dashes, which are interchanged at will, and wherein the alternation of the working and spacing frequencies is effected by means of the sending key.

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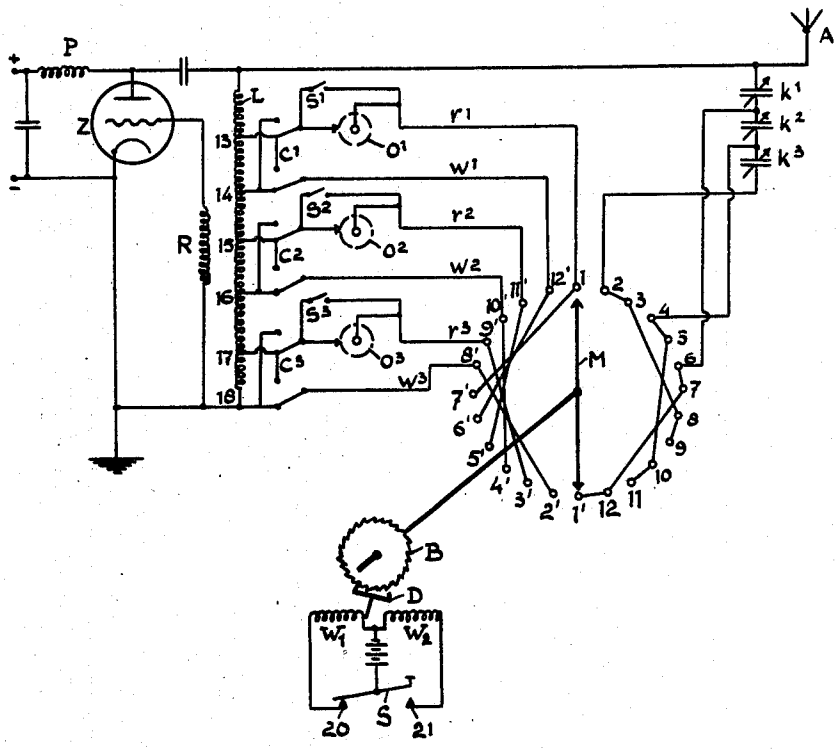

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