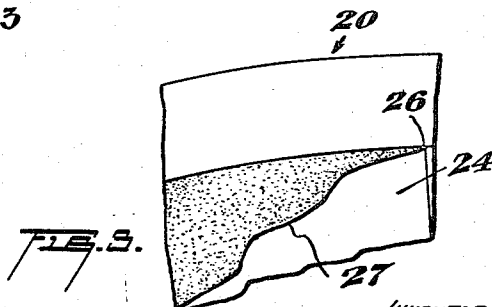
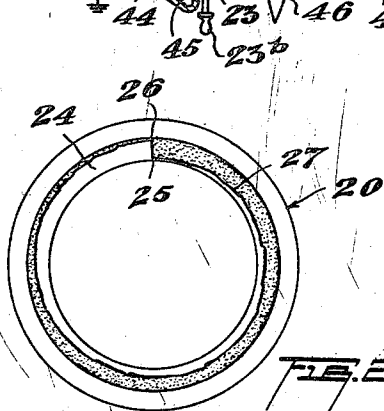
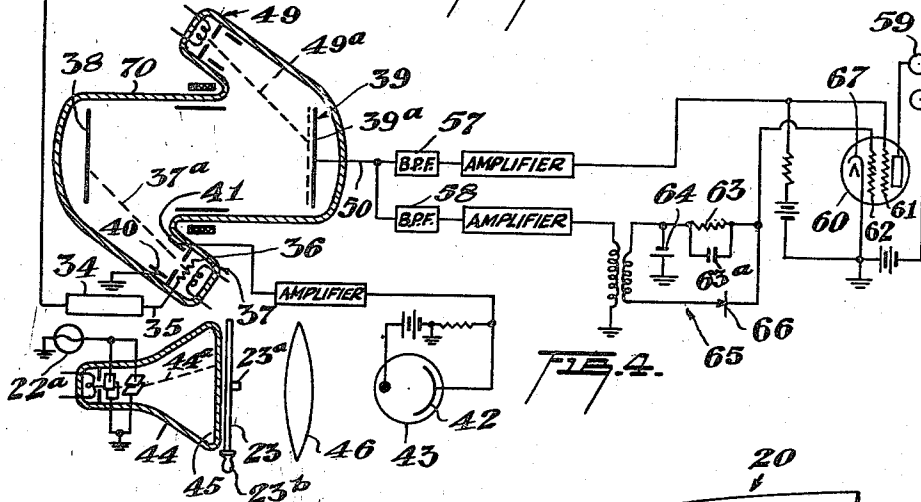
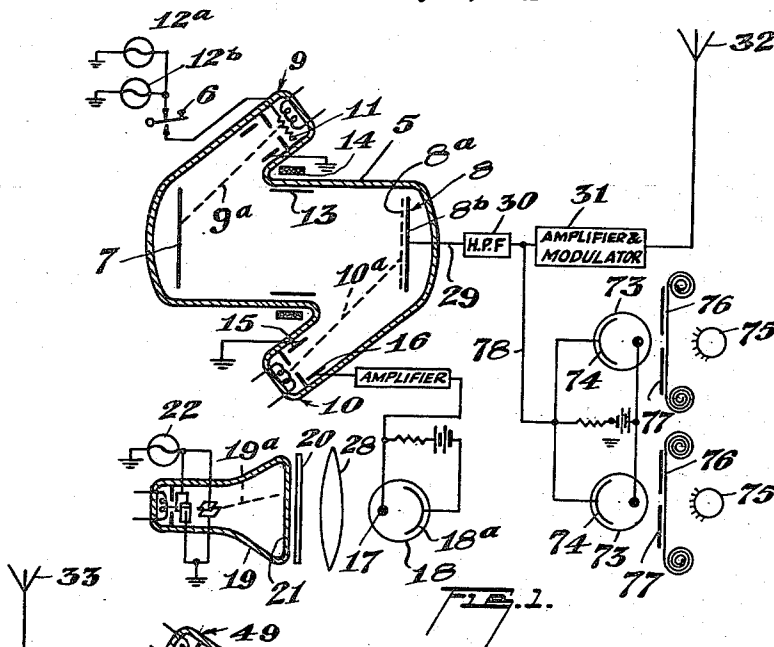


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F. C. P. HENROTEAU
METHOD AND APPARATUS FOR HINDERING INTERFERENCE WITH WIRELESS
TRANSMISSION OF MESSAGES
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INVENTOR,
FRANCOIS C. P. HENROTEAU

By *Ralph B. Stewart*
ATTORNEY

UNITED STATES PATENT OFFICE

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METHOD AND APPARATUS FOR HINDERING
INTERFERENCE WITH WIRELESS TRANSMISSION OF MESSAGESFrançois Charles Pierre Henroteau,
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This invention relates to a method and apparatus for hindering interference with wireless transmission of messages, that is, for preventing what is commonly known as "jamming" of wireless messages. Throughout this specification the word "transmission" is used to indicate the whole operation of getting a message from a sender to a receiver, the word "emission" being reserved for that part of the transmission which is composed of the operations at a sending station.

Many systems have been proposed for the sending of secret signals by wireless. However, all transmissions, except those on very short wave lengths of the order of ten centimetres, are subject to interference by jamming with signals sent out from another source on the same wave length. Thus in war no system for sending secret signals can be of much use when applied to ordinary wave lengths, because of the fact that such signals can be jammed by the enemy and their reception rendered impossible. While this difficulty does not arise with the very short wave lengths referred to, such wave lengths are subject to the practical limitation of being stopped by substantially those subjects which will stop light, and thus have a very short range particularly in close country.

According to the present invention a method is provided which permits the transmission of signals in a form in which they are unintelligible and cannot be jammed. According to the invention, the method comprises distorting a filterable wave to an unfilterable one, modulating a carrier wave with such distorted wave itself modulated in accordance with a message, particularly a Morse type message, and simultaneously modulating the carrier wave with a different unfilterable wave. The filterable wave will normally be one of constant frequency and will be distorted to one of variable frequency, preferably to a substantially aperiodic wave, and similarly the other unfilterable wave will be one of variable frequency and preferably substantially aperiodic. In order to ensure that the variations in amplitude of the wave carrying the message should not betray that message, the other unfilterable wave is preferably of varying amplitude, the variations, when Morse transmission is in question, being of the nature of those obtained by impressing a Morse type message thereon.

More specifically, the method in question comprises recording a wave of constant frequency, converting the resulting record at a variable speed into an electric wave of variable frequency, modulating a carrier wave with this electric wave

itself modulated in accordance with the message, and simultaneously modulating the carrier wave with another wave of differently variable frequency.

- 5 The method of the invention may be carried out in apparatus which comprises a mosaic, means for producing a beam of electrons, means for varying the intensity of this beam in accordance with an electric wave of constant frequency,
- 10 means for scanning the mosaic with the beam to form an electrostatic record of the latter's variations in intensity, means for scanning the mosaic at a speed variable with respect to the speed of recording to convert the record into
- 15 an electric wave of variable frequency, means for causing the wave of variable frequency to be modulated in accordance with the message,
- means for producing another wave of differently variable frequency, and means for modulating
- 20 a carrier wave simultaneously with these waves of variable frequency.

The following detailed description deals with the transmission of Morse type messages in accordance with the invention, since it is probably for such transmission that the invention will find its most useful application. The description is given by reference to the attached drawing, and from it additional features of novelty will appear.

In the drawing,
30 Figure 1 is a diagrammatic illustration of an emitting apparatus constructed in accordance with the invention,

Figure 2 is a face view of a key plate used in such apparatus,

35 Figure 3 is an enlarged detail of part of the key plate, and

Figure 4 is a diagrammatic illustration of a receiver.

The invention is based on the idea of using a
40 key to distort a wave of a given constant frequency into one of variable frequency and modulating this wave with a message at the emitter before or after distortion, and then at the receiver using the same key to reverse the process
45 of distortion and return the wave of variable frequency to one of constant frequency which can be filtered out from all other signals received. It will be clear that, so long as the form of the key is unknown to an enemy, the emitted signals
50 are unintelligible. Moreover, no signal can be sent out which will jam them, because any signal other than one whose frequency varies exactly in accordance with the key will be converted at the receiver into a wave which is not of constant frequency and will thus be rejected by a filter

designed to pass only a wave of the given constant frequency. However, the period of any key which could be practically used is necessarily comparatively short. Consequently if no further steps were taken than those just mentioned an enemy who recorded emitted signals over a considerable period of time equal to a large number of key periods might eventually be able to determine the pattern of the key. It is in order to prevent any such possibility that the other wave of differently variable frequency, which has been referred to above, is used. As this wave is simply a covering wave and is rejected at the receiver by the filter for the wave of given constant frequency, it can be of any desired irregularity, and is preferably substantially aperiodic, so that discovery of the repeating key becomes thus impossible for an enemy.

The form of emitter according to the invention which is illustrated in Fig. 1, comprises an emitting tube 5 containing a plate 7 of material capable of emitting electrons and a mosaic 8, the term "mosaic" wherever used in this specification meaning a device of the general type used in television apparatus such as the iconoscope and composed of a multiplicity of mutually insulated tiny conductive electron emissive but not necessarily photosensitive elements (represented by the dotted line 8a) mounted on and insulated from a signal plate (represented by the solid line 8b). Associated with the plate 7 is an electron gun 9 and associated with the mosaic 8 is an electron gun 10, each gun being contained in an appropriate pocket in the tube 5. For purposes of simplicity, each gun is shown as provided with only one pair of deflecting plates so that the electron beams 9a and 10a scan the plate 7 and mosaic 8 respectively along a single line only.

For the purpose of modulating the intensity of the electron beam 9a a modulating electrode 11 is associated with the gun and is connected through a Morse key 6 to two oscillators 12a and 12b which produce two waves (two being used instead of only one for a purpose hereinafter described) both of constant but preferably quite widely different frequencies. The intensity of the beam 9a thus varies in accordance with the resultant of two constant frequency waves modulated in accordance with a Morse message formed by operation of the Morse key 6. The beam 9a with its intensity thus varied scans the plate 7 at a regular rate and causes the emission from the latter of electrons which are directed towards and focussed on the mosaic 8 by an accelerating electrode 13 and focussing coil 14. The action of these electrons on the mosaic produces in the manner well understood an electrostatic record of variations of intensity of the beam 9a and therefore a record of the waves produced by the oscillators 12a and 12b as modulated by operation of the Morse key 6.

The electron beam 10a, unlike the beam 9a, is of constant intensity but, on the other hand scans the mosaic 8 at an irregular rate of speed. In the drawing, one of the deflecting plates 15 for it is shown as grounded and the other plate 16 is connected through an amplifier to the anode 17 of a photoelectric cell 18. When no current passes in this cell the arrangement is such that the beam 10a strikes the lower end of the mosaic 8.

It will be seen, however, that when light falls upon the cathode 18a of the cell, the anode 17 will receive electrons and become more negative,

so that the plate 16 will assume a negative potential and the beam 10a will be caused to move towards the upper end of the mosaic 8. The amount of light falling on the cathode 18a is caused to vary in accordance with a periodically repeated pattern by means of a cathode ray oscillograph 19 and a key plate 20. The cathode ray oscillograph is provided with a fluorescent coating 21 over which a beam of electrons 19a is caused to move in a circular path in any suitable way such as by connecting one deflecting plate of each pair of such plates to ground and the other plate of each pair to an appropriate source 22 of alternating potential.

A face view of key plate 20 is shown in Figure 2 from which it can be seen that the plate has on it a circular path 24 corresponding in size to the circular path described by the luminous spot produced by movement of the electron beam 19a over the fluorescent coating 21. The translucency of this path increases constantly, though at an irregular rate, from the point 25 where it is at a minimum to the point 26 just short of 360° around the circle where it is at a maximum, and then decreases suddenly to the minimum again. In the key illustrated the line 27 represents the boundary between the opaque portion of the path and the translucent portion, the irregularity of this line being shown in Fig. 3 in somewhat more detail than is possible in Fig. 2.

A lens 28 is provided to focus on the cathode 18a any light which passes through the key plate 20. The result of the operation of the cathode ray oscillograph is that the amount of light falling on the cathode 18a of the photoelectric cell 18 constantly increases at an irregular rate in the time which it takes for the luminous spot on the fluorescent coating 21 to make a complete circuit of the path 24. The apparatus is so arranged that the maximum light falling on the cathode 17 is sufficient to bring the deflecting plate 16 to such a potential as to direct the electron beam 10a at the upper edge of the mosaic 8. The sudden decrease in the amount of light falling on the cathode 18a when the luminous spot passes from a point opposite the point 26 to one opposite the point 25 causes a sudden reduction in the potential of the plate 16 and the return of beam 10a to its initial position.

Because of the irregularity in the rate of increase of the translucency of the path 24 and the consequent irregularity in the rate of increase of the potential of the deflecting plate 16, the beam 10a will not move at a constant speed across the mosaic 8 but at a speed varying in accordance with the pattern of the key 20. Movement of the beam 10a across the mosaic results, in the usual way, in the erasing of the electrostatic record formed on the mosaic and the conversion of that record into an electric wave which passes through the wire 29. This electric wave, however, because of the irregular speed of conversion of the record is of a variable frequency governed by the periodically repeated pattern of the key 20. It will be appreciated, moreover, that as a result of the irregular speed of scanning by the beam 10a the duration of the portions of the electric wave passing through the wire 29 corresponding to Morse dots and dashes will be distorted. Thus, for example, assume that the record of a Morse dash is three times as long as the record of a Morse dot. If, during the time that the record of a Morse dash was being erased from the mosaic 8 the beam 10a were moving three times as fast as when the record of a Morse dot was being

erased the durations of the portions of the electric wave passing through the wire 29 corresponding to this Morse dot and Morse dash would be equal.

The electric wave of variable frequency is fed to an amplifier and modulator 31 where it is used to modulate a carrier wave which is emitted from the antenna 32.

The formation of the record on the mosaic 8 will produce an electric wave which will flow along the wire 29 and may for convenience be referred to as the recording wave to distinguish it from the wave of variable frequency mentioned above which can conveniently be described as the erasing wave since it results from the erasing by the beam 10a of the record on the mosaic 8. This recording wave being an exact reproduction of the compound wave applied to the modulating electrode 11, its emission must be prevented because otherwise being of constant frequency it could be filtered out of the emitted signal by an enemy and the message read. Its emission could be prevented, for example, by using two identical tubes and associated devices, both connected to a single amplifier and modulator 31, recording and erasing alternately, and providing means for blocking passage of current to the device 31 from the tube in which recording is being done as shown in United States Patent No. 2,191,565, particularly in Figure 2. However, the result can be conveniently attained without duplication of apparatus. For this purpose the speed at which the electron beam 9a scans the plate 7 should be either higher than the highest speed at which the beam 10a moves during scanning or lower than the lowest such speed. In the apparatus illustrated the latter has been taken to be the case. The result of the relatively fast scanning by the beam 10a will be that the lowest frequency of the erasing wave passing through the wire 29 will be higher than the highest frequency of the recording wave so that the two waves may be separated by a filter. It is for this purpose that the high pass filter 30 is shown in the line 29, its values being so calculated as to allow the erasing wave to pass but to block the recording wave. When a number of constant frequency waves, for example two as shown, are used, then the lowest erasing scanning speed multiplied by a fraction, of which the numerator is the lowest constant frequency and the denominator, the highest constant frequency impressed on the modulating electrode 11 must be higher than the recording speed, otherwise some of the frequencies in the erasing wave might not pass the filter 30. Of course, the erasing will take, in the circumstances, only a fraction of the time taken for recording and during the remainder of the time required for the beam 9a to perform its traverse of the plate 7 the beam 10a will be inactive. The period, however, between the beginning of one traverse by the beam 10a and the beginning of the next traverse by that beam will be the same as the period between the beginning of one traverse by the beam 9a and the beginning of the next traverse by that beam.

The device 31 besides being connected to the signal plate 8b through the wire 29 is connected to the output of two similar photocells 73, on the cathode 74 of each of which falls the light which passes from a source 75 through a film 76 and mask 77. Each film 76 is a record preferably of an aperiodic wave, and appropriate means are provided for running each record past the mask 77 during the operation of the emitter. Conse-

quently the wire 78 connecting the output of the cells 73 to the device 31 carries a compound wave formed of the two aperiodic waves recorded on the films 76. The purpose of having two records is to avoid the necessity of having either of them very long, because by using two and occasionally changing the relation to each other of the starting points of the two records the practical effect of a single record of great length can be obtained. Thus, for example, if the running time of one record were three minutes and that of the other five, and both started together at the beginning, fifteen minutes would elapse before the resultant compound wave carried by the wire 78 repeated itself. If before the end of this time one record were stopped for a moment while the other was allowed to proceed, repetition at the end of the first fifteen minute period would be prevented and a new period started. Thus by taking two records whose lengths have a comparatively high lowest common multiple and occasionally changing what may be termed by analogy their phase relationship, the compound wave carried by the wire 78 will for all practical purposes be aperiodic. This wave, like that from the signal plate 8b is amplified and modulated in the device 31 on the same carrier wave as that on which the wave carried by the wire 29 is modulated. The carrier wave thus modulated by the two waves of variable frequency is emitted from the antenna 32.

It may be desirable to hide the sharp variations of amplitude in the wave passing to the device 31 from the signal plate 8b and resulting from the making and breaking of the connection between the oscillators 12a and 12b and the electrode 11 through the Morse key 6, since by an analysis of these sharp variations the message might be discovered. Accordingly, the records on the films 76 should be made of varying amplitude and preferably with the same sharp variations of amplitude as would be obtained by the impression of Morse signals thereon. These variations would of course be distributed irregularly rather than in accordance with Morse signals having any meaning. It may be here pointed out that, if desired, the output of the photocells 73 may be connected to the modulating electrode 11 and thus be passed through the tube 5 and distorted by the variable speed scanning. The arrangement shown, however, is simpler and just as satisfactory.

The modulated carrier wave emitted from the antenna 32 is picked up at the receiving antenna 33 and passed thence through a demodulator and amplifier 34, whence the received wave of the variable frequency identical with the erasing wave at the emitter passes through a wire 35 to a modulating electrode 36 for controlling the intensity of an electron beam 37a produced by an electron gun 37 in a receiving tube 70 similar to the tube 5 at the emitter. The beam 37a scans a plate 38, similar to the plate 7 in the tube 5, at a speed which varies according to a pattern identical with that according to which the speed of scanning of the beam 10a in the tube 5 is varied and in a manner similar to that described in connection with the tube 5. The scanning of the plate 38 by the beam 37a results in the formation of an electrostatic record on a mosaic 39 similar to the mosaic 8. Thus, the received wave of variable frequency is recorded on the mosaic 39 but in a distorted form as a result of the variable scanning speed of the beam 37a. The scanning movements of this beam are governed by an arrangement similar to that which governs the

scanning movements of the beam 10a. One of the deflecting plates 40 is grounded and the other plate 41 is connected to the cathode 42 of a photoelectric cell 43 similar to the cell 18. Associated with the cell 43 is a cathode ray oscillograph 44 having a fluorescent screen 45 and in which an electron beam 44a moves in a circular path synchronously with the beam 19a in the oscillograph 19, the movement of the beam 44a being controlled by an oscillator 22a synchronized with the oscillator 22. The light from the rotating luminous spot produced by the action of the beam 44a on the fluorescent coating 45 strikes a key plate 23 identical with the key plate 20 and passes therefore through a path on the plate 23 identical with the path 24 described above. Light passing through this path is focussed by a lens 46 on the cathode 42.

If a given portion of the received electric wave reaches the modulating electrode 36 at a time when the beam 37a is performing a part of its traverse of the plate 38 corresponding to the part of the traverse of the mosaic 8 which was being performed by the beam 10a when the portion of the erasing wave corresponding to the given portion of the received wave was being produced, then, if the beam 37a is scanning exactly in step with the beam 10a, the electrostatic record formed on the mosaic 39 will be identical with that formed on the mosaic 8. This will be apparent from a consideration of a simple example, the values mentioned being taken simply for purposes of explanation and having no relation to actuality. Suppose that the total time required for the beam 10a to traverse the mosaic 8 from the bottom to the top is one second and that one traverse of the plate 7 by the beam 9a results in the recording on the mosaic 8 of twelve complete cycles. If the beam 10a traversed the mosaic at a constant rate, the frequency of the erasing wave would be twelve cycles per second. Assume however, that the beam 10a covers the lower half of the mosaic in $\frac{1}{4}$ of a second but takes $\frac{3}{4}$ of a second to traverse the upper half. It thus erases the record of six cycles in the first quarter of a second so that the frequency of the electric wave passing through the wire 29 for the first quarter of a second is twenty-four cycles per second. In each of the last three quarters of a second the beam erases the record of only two cycles so that the frequency of the electric wave passing through the wire 29 for the last three quarters of a second is only 8 cycles per second. Now assume that the beam 37a is moving at exactly the same variable rate of speed as the beam 10a and that it accordingly traverses the lower half of the plate 38 in $\frac{1}{4}$ of a second and the upper half in $\frac{3}{4}$ of a second. If, just as it is about to begin to traverse the plate 38, the front of an electric wave corresponding to that produced during the traverse just described of the mosaic 8 by the beam 10a reaches the modulating electrode 36, the result will be that during the first quarter of a second the intensity of the beam 37a will go through six cycles of variation. Consequently there will be formed on the lower half of the mosaic 39 a record of six cycles. During the next three quarters of a second the intensity of the beam 37a will likewise go through six cycles of variation, so that there will be formed on the upper half of the mosaic 36 a record also of six cycles. The complete record on the mosaic will thus be identical with the record which was erased from the mosaic 8.

If the condition mentioned at the beginning of

the last paragraph does not hold good, then the record on the mosaic 8 will not be reconstituted on the mosaic 39. For example, in the specific case discussed above, if the front of a wave corresponding to the front of the wave produced during the described traverse of the mosaic 8 by the beam 10a were to reach the modulating electrode 36 $\frac{1}{4}$ second after the front of the wave to which it corresponds had left the signal plate 8b, and the beam 37a were scanning exactly in step with the beam 10a, the former would already have traversed the lower half of the plate 38 and would be about to begin the slow part of its traverse. In the next quarter of a second, during which it would traverse only one-sixth of the total length of the plate 38, its intensity would go through six cycles of variation and consequently a record of six cycles would be made on one-sixth of the length of the mosaic 39. During each of the next two quarters of a second the intensity of the beam 37a would go through two cycles of variation, and consequently two cycles would be recorded on each of the upper two sixths of the length of the mosaic 39. If the resulting record were scanned at a constant speed the resulting electric wave would be of variable frequency.

If, however, the key plate 23 were turned through an angle of 90° with respect to the key plate 20, then the beam 37a would start its traverse of the plate 38 $\frac{1}{4}$ second later than the beam 10a started its traverse of the mosaic 8. Consequently, the beginning of the traverse of the plate 38 by the beam 37a would, in the example just discussed, coincide with the arrival at the modulating electrode 36 of the front of the electric wave generated during the first quarter of a second of the movement of the beam 10a, so that the record formed on the mosaic 39 would be of a wave of the same constant frequency as that generated by the oscillator 12.

The electrostatic record formed on the mosaic 39 is scanned periodically by a beam 49a from an electron gun 49, this beam being moved exactly in step with the scanning of the plate 7 by the beam 9a. The scanning by the beam 49a erases the electrostatic record from the mosaic 39 and converts it into an electric wave which, in the simplest form of apparatus when only one wave of constant frequency was used at the emitter, passes from the signal plate 39a through a band pass filter designed to permit the passage only of a constant frequency wave identical with that produced by the oscillator at the emitter, any current which passes this filter being fed to, for example, a pair of head phones.

As shown in the drawing, the key plate 23 is rotatably mounted on a central support 23a and is provided with a handle 23b to allow an operator to rotate it as desired. From the discussion which has preceded it will be seen that unless the key plate is at the proper angular position, at the most only occasional pulses at irregular intervals will pass the band pass filter referred to, and the operator will accordingly hear no intelligible signal in his head phones. Therefore, when, as a result of moving the key plate 23 by means of the handle 23b he does hear an intelligible signal, he will know that the receiver is properly tuned, since unless there is more than one emitter with the same key plate, it would be impossible for him to receive intelligibly a signal sent out by any other emitter. It will be appreciated also, that when the key plate 23 is in the proper angular position the desired signal will be received but any jamming signal which

an enemy may have attempted to use will be stopped, as will be also the composite aperiodic wave produced by the records 76 at the emitter. For example, if an enemy were to send out a jamming signal of a particular constant frequency, this would be converted by the operations in the receiving tube 70 to a wave of variable frequency which would thus be rejected by the band pass filter.

Although enemy jamming signals will on the whole be rejected, yet unless steps are taken to prevent this, they may cause some disturbance in the desired received signals. This can best be illustrated by an example. Assume that only one wave of constant frequency is used at the emitter and that its frequency is 10,000 cycles. Assume also that at one instant the rate of scanning by the electron beam 37a was such that the frequency of a wave passing through the wire 50 and resulting from a jamming signal, was 9,000 cycles, but that as a result of the increase in the scanning speed this frequency increased in a given short period of time to 11,000 cycles. In passing from the lower to the higher frequency the jamming wave would at one moment have had the same frequency as the desired constant frequency wave and would thus pass the band pass filter. If its amplitude at this moment were sufficient, a sound which might be confused with a Morse dot might thus be produced in the headphones. Any really serious effect of this could be avoided by using instead of the ordinary Morse system, where the signals are composed of dots and dashes, a modified system where the signals are composed of long and short dashes so that dots would have no significance in the received message (it is for this reason that reference has been made to a "Morse type message"), but such a departure from normal signalling practice might be difficult.

Figure 4 shows an arrangement at the receiver by which all or practically all of the extraneous dots mentioned may be eliminated without the elimination of any Morse dots, and it is for the purpose of this arrangement that the use in the emitter of two constant frequency waves instead of only one has been illustrated and described. The arrangement is based upon the fact that extraneous dots will never appear at the same instant in the two constant frequency waves unless a number of jamming signals have been sent out by an enemy and one of these, after distortion by the variable erasing speed, happens to be momentarily at the frequency of one of the desired constant frequency waves at the instant that another is at the frequency of the other of such waves.

According to the arrangement in question, two band pass filters 57 and 58 are provided, one designed to pass a wave of the frequency of that produced by the oscillator 12a and the other to pass a wave of the frequency of that produced by the oscillator 12b. The final receiving device for the desired signals, shown for the sake of example as a pair of headphones 59, is connected in the plate circuit of a four electrode tube 60 having two grids 61 and 62, of which the grid 61 is fed with current passing through the filter 57 and the grid 62 is fed by rectified current which has passed through the other filter 58. This latter grid is connected to a negative biasing battery 64 through a load resistor 63, which is in a circuit 65 including a rectifier 66 so disposed as to pass current through the resistor only in a direction opposing the polarity of the

battery 64. When current, representing for instance a Morse dot or dash, passes the filter 58, the resulting rectified current flow in the circuit 66 will produce a potential on the grid 62 opposing that of the battery 64 and will thus unbias the grid to allow passage of electrons from the cathode 67 to the plate 68. A condenser 63a may be shunted around the resistor 63 in order to keep the grid potential as uniform as possible during passage of current through the circuit 65.

From the above description it will be seen that a signal will be heard in the headphones 59 only when current flows simultaneously through both the filters 57 and 58, that is practically only when a Morse dot or dash is received. If current flows only through the filter 58, then there will be no modulation of the current in the plate circuit of the tube 60, because the potential of the grid 61 will stay constant. If, on the other hand, it flows only through the filter 57, then there will be no current at all in the plate circuit because the grid 62 will be at its normal biased potential. Thus, in either case, the extraneous dot will be cut out.

It may be pointed out that the invention is applicable to multiplex communication and could, for example, be used in systems of the type shown in application Serial No. 252,030, filed January 20, 1939, or application Serial No. 381,906, filed March 5, 1941.

What I claim is:

1. The method of hindering interference with wireless transmission of messages, which comprises distorting a wave adapted for selection from all other waves by means of a filter to a wave unadapted for such selection, modulating a carrier wave with such distorted wave itself modulated in accordance with a message, and simultaneously modulating said carrier wave with a different wave unadapted for selection from all other waves by means of a filter.

2. The method of hindering interference with wireless transmission of Morse type messages, which comprises distorting wave adapted for selection from all other waves by means of a filter to a wave unadapted for such selection, modulating a carrier wave with such distorted wave itself modulated in accordance with a Morse type message, and simultaneously modulating said carrier wave with a different wave unadapted for selection from all other waves by means of a filter.

3. The method of hindering interference with wireless transmission of Morse type messages, which comprises distorting a wave adapted for selection from all other waves by means of a filter to a wave unadapted for such selection, modulating a carrier wave with such distorted wave itself modulated in accordance with a Morse type message, and simultaneously modulating said carrier wave with a different wave unadapted for selection from all other waves by means of a filter and having variations of amplitude of the nature of those obtained by modulation with a Morse type message.

4. The method of hindering interference with wireless transmission of messages, which comprises distorting a plurality of different waves each adapted for selection from all other waves by means of a filter to waves unadapted for such selection, modulating a carrier wave with such distorted waves themselves modulated in accordance with a message, and simultaneously modulating said carrier wave with a different wave unadapted for selection from all other waves by means of a filter.

5. The method of hindering interference with wireless transmission of messages, which comprises distorting a plurality of different waves each adapted for selection from all other waves by means of a filter to waves unadapted for such selection, modulating a carrier wave with such distorted waves themselves modulated in accordance with a message, and simultaneously modulating said carrier wave with a different wave unadapted for selection from all other waves by means of a filter and having variations of amplitude of the nature of those obtained by modulation with a Morse type message.

6. The method of hindering interference with wireless transmission of messages, which comprises distorting a wave of constant frequency to one of variable frequency, modulating a carrier wave with such distorted wave itself modulated in accordance with a message, and simultaneously modulating said carrier wave with another wave of differently variable frequency.

7. The method of hindering interference with wireless transmission of Morse type messages, which comprises distorting a wave of constant frequency to one of variable frequency, modulating a carrier wave with such distorted wave itself modulated in accordance with a Morse type message, and simultaneously modulating said carrier wave with another wave of differently variable frequency.

8. The method of hindering interference with wireless transmission of Morse type messages, which comprises distorting a wave of constant frequency to one of variable frequency, modulating a carrier wave with such distorted wave itself modulated in accordance with a Morse type message, and simultaneously modulating said carrier wave with another wave of differently variable frequency having variations of amplitude of the nature of those obtained by modulation with a Morse type message.

9. The method of hindering interference with wireless transmission of messages, which comprises distorting a wave of constant frequency to one of variable frequency, modulating a carrier wave with such distorted wave itself modulated in accordance with a message, and simultaneously modulating said carrier wave with a substantial aperiodic wave.

10. The method of hindering interference with wireless transmission of Morse type messages, which comprises distorting a wave of constant frequency to one of variable frequency, modulating a carrier wave with such distorted wave itself modulated in accordance with a Morse type message, and simultaneously modulating said carrier wave with a substantial aperiodic wave having variations of amplitude of the nature of those obtained by modulation with a Morse type message.

11. The method of hindering interference with wireless transmission of messages, which comprises recording a wave of constant frequency, converting the resulting record at a variable speed into an electric wave of variable frequency, modulating a carrier wave with said electric wave itself modulated in accordance with a message, and simultaneously modulating such carrier wave with another wave of differently variable frequency.

12. The method of hindering interference with wireless transmission of Morse type messages, which comprises recording a wave of constant frequency, converting the resulting record at a variable speed into an electric wave of variable frequency, modulating a carrier wave with said

electric wave itself modulated in accordance with a Morse type message, and simultaneously modulating such carrier wave with another wave of differently variable frequency.

13. The method of hindering interference with wireless transmission of Morse type messages, which comprises simultaneously recording a plurality of waves of constant frequency, converting the resulting record at a variable speed into a composite electric wave of variable frequency, modulating a carrier wave with such electric wave itself modulated in accordance with a Morse type message, and simultaneously modulating such carrier wave with another wave of differently variable frequency.

14. Apparatus for hindering interference with wireless transmission of messages, which comprises means for distorting a filterable wave to an unfilterable wave, means for producing another unfilterable wave, and means for modulating a carrier wave simultaneously with said other unfilterable wave and with said first mentioned unfilterable wave itself modulated in accordance with a message.

15. Apparatus for hindering interference with wireless transmission of Morse type messages, which comprises means for distorting a filterable wave to an unfilterable wave, means for producing another unfilterable wave, and means for modulating a carrier wave simultaneously with said other unfilterable wave and with said first mentioned unfilterable wave itself modulated in accordance with a Morse type message.

16. Apparatus for hindering interference with wireless transmission of messages, which comprises a mosaic, means for producing a beam of electrons, means for modulating the intensity of said beam with an electric wave of a constant frequency, means for scanning said mosaic with said beam to form an electrostatic record of the variations in intensity of the beam, means for scanning said mosaic at a variable speed to convert said record into an electric wave of variable frequency, means for causing said wave of variable frequency to be modulated in accordance with a message, means for producing another electric wave of differently variable frequency, and means for modulating a carrier wave simultaneously with both said waves of variable frequency.

17. Apparatus for hindering interference with wireless transmission of Morse type messages which comprises a mosaic, means for producing a beam of electrons, means for modulating the intensity of said beam with an electric wave of a constant frequency, means for scanning said mosaic with said beam to form an electrostatic record of the variations in intensity of the beam, means for scanning said mosaic at a variable speed to convert said record into an electric wave of variable frequency, means for causing said wave of variable frequency to be modulated in accordance with a Morse type message, means for producing another electric wave of differently variable frequency, and means for modulating a carrier wave simultaneously with both said waves of variable frequency.

18. In apparatus of the class described, means for producing a beam of electrons, a deflecting plate for said beam, means for maintaining said plate at a constant potential, a second deflecting plate for said beam, a photoelectric cell having a cathode and an anode connected to said second deflecting plate, a cathode ray oscillograph having a fluorescent coating and means for producing an electron beam which forms a luminous

spot where it strikes said fluorescent coating, a screen of variably increasing translucency from a predetermined minimum to a predetermined maximum interposed between said fluorescent coating and said cathode, means for focussing on said cathode light passing through said screen of variable translucency, and means for causing said electron beam to scan said fluorescent screen from the point opposite the point of minimum translucency on said screen of variable translucency to the point opposite the point of maximum translucency on said last mentioned screen.

19. Apparatus for receiving signals composed of two waves of constant frequency distorted to waves of variable frequency with their amplitudes varied in accordance with a Morse type

5 message, comprising means for reversing the distortion of the waves to reconstitute the waves of constant frequency, filters for said waves of constant frequency, a multi-electrode tube having a filament, a plate, a first grid and a second grid, means for feeding one of said reconstituted waves of constant frequency to said first grid, means for biasing said second grid normally to block passage of electrons from said filament to said plate, and means for rectifying the other wave of constant frequency and feeding the rectified current to said second grid to neutralize the bias thereof.

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FRANÇOIS CHARLES PIERRE
HENROTEAU.