June 4, 1946. A. V. BEDFORD 2,401,402

SECRET COMMUNICATION SYSTEM

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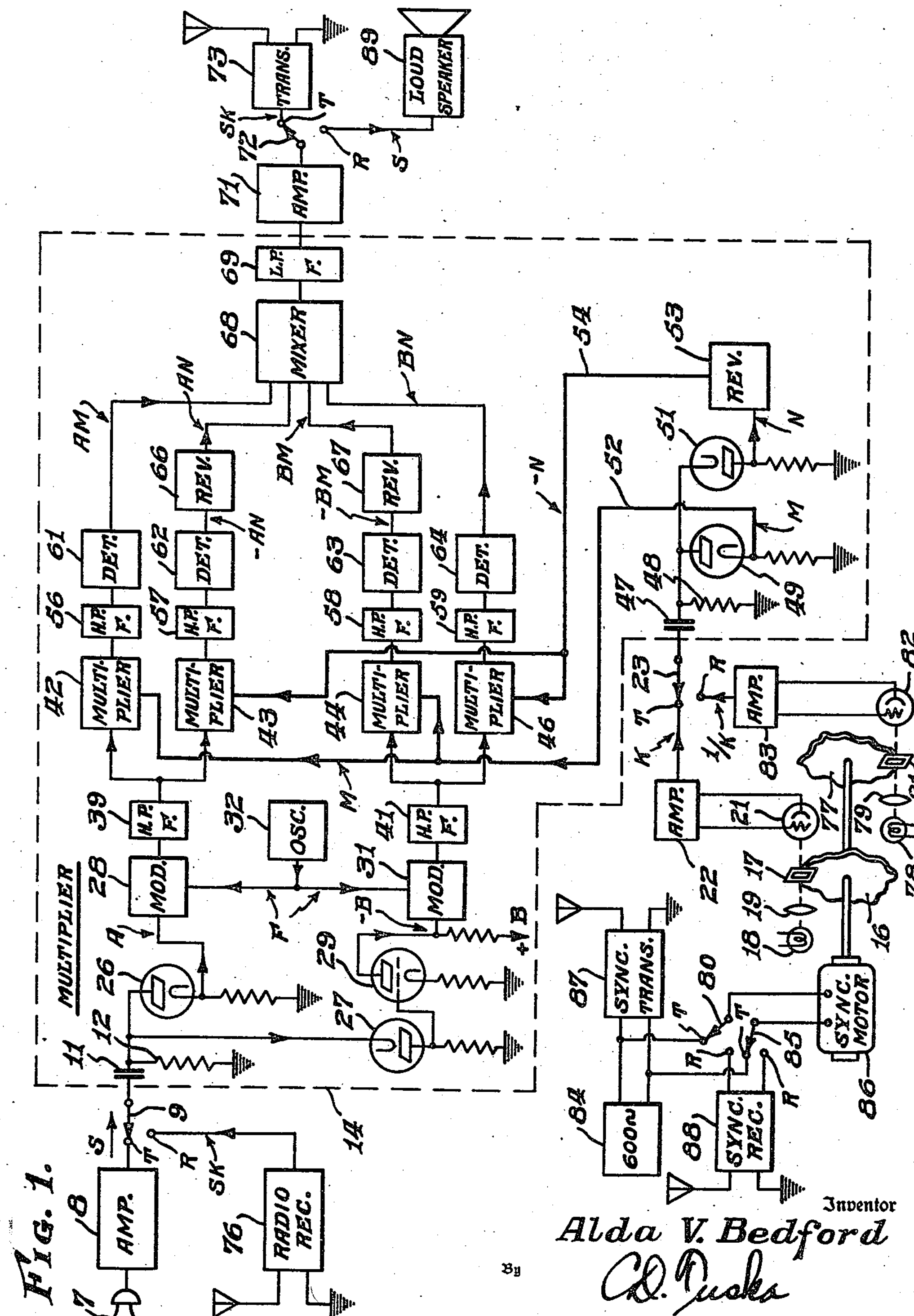
FIG. 1.



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Attorney

June 4, 1946. A. V. BEDFORD 2,401,402

SECRET COMMUNICATION SYSTEM

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FIG. 2.

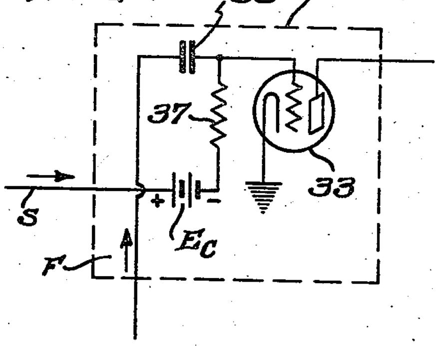


FIG. 3.

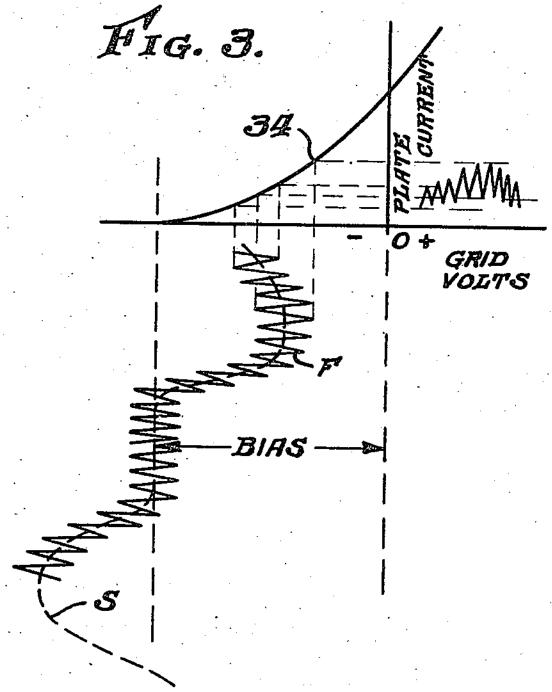
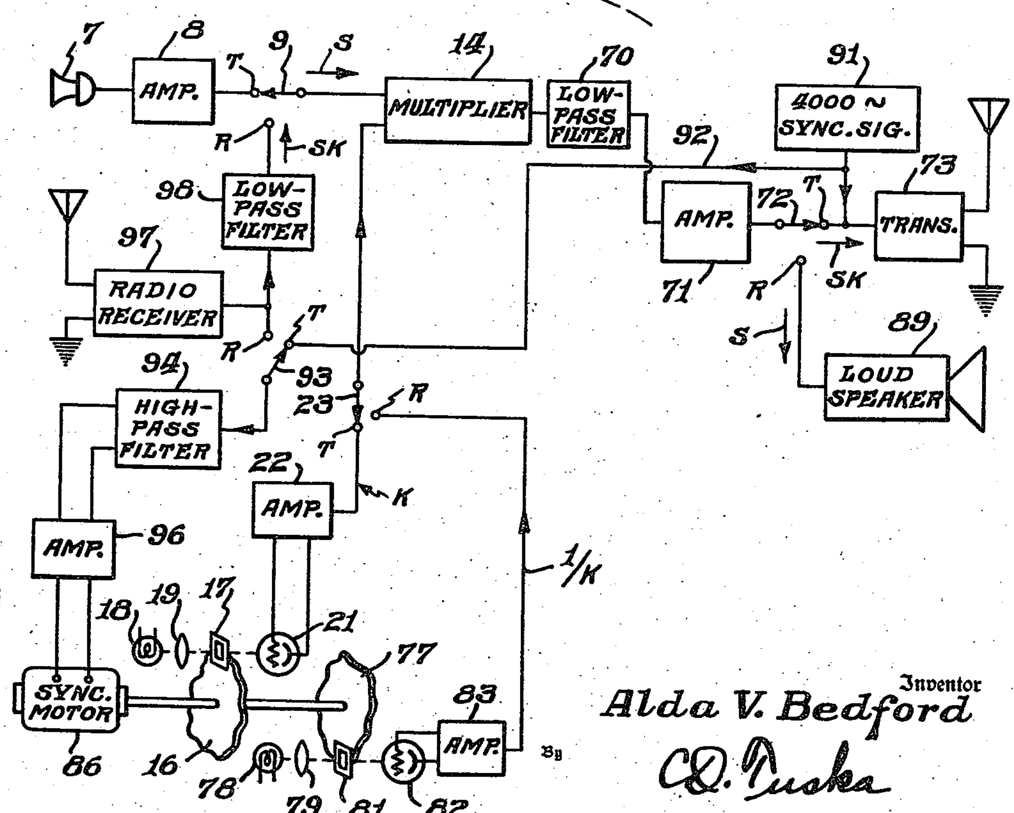


FIG. 4.



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SECRET COMMUNICATION SYSTEM

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FIG. 5.

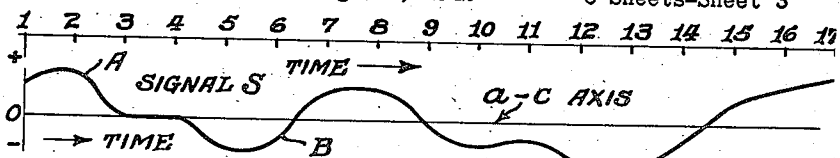

FIG. 6.

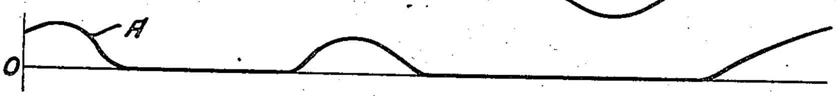

FIG. 7.

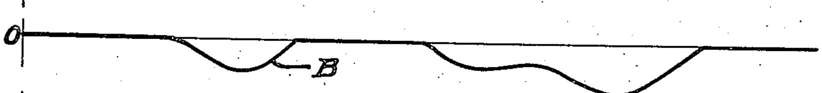

FIG. 8.

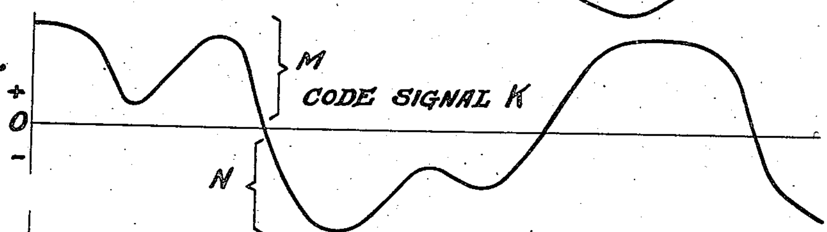

FIG. 9.

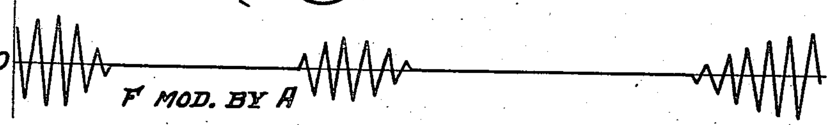

FIG. 10.

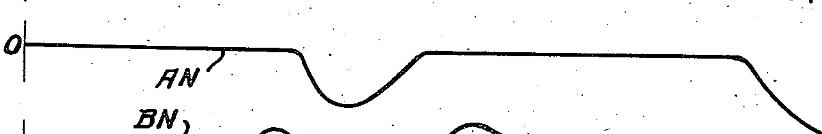

FIG. 11.

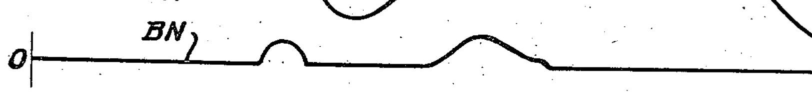

FIG. 12.

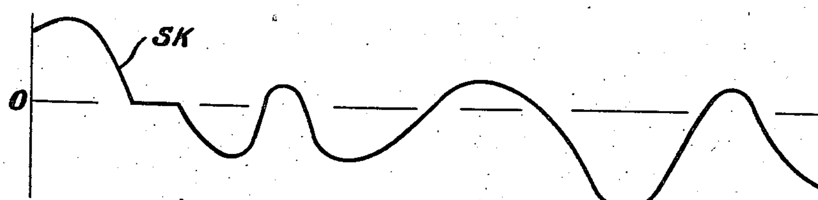

FIG. 13.

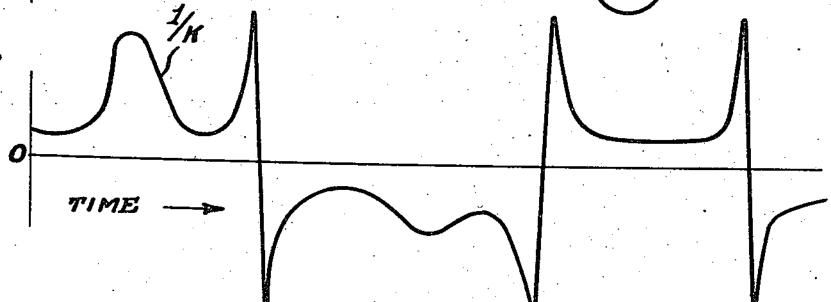

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FIG. 14.

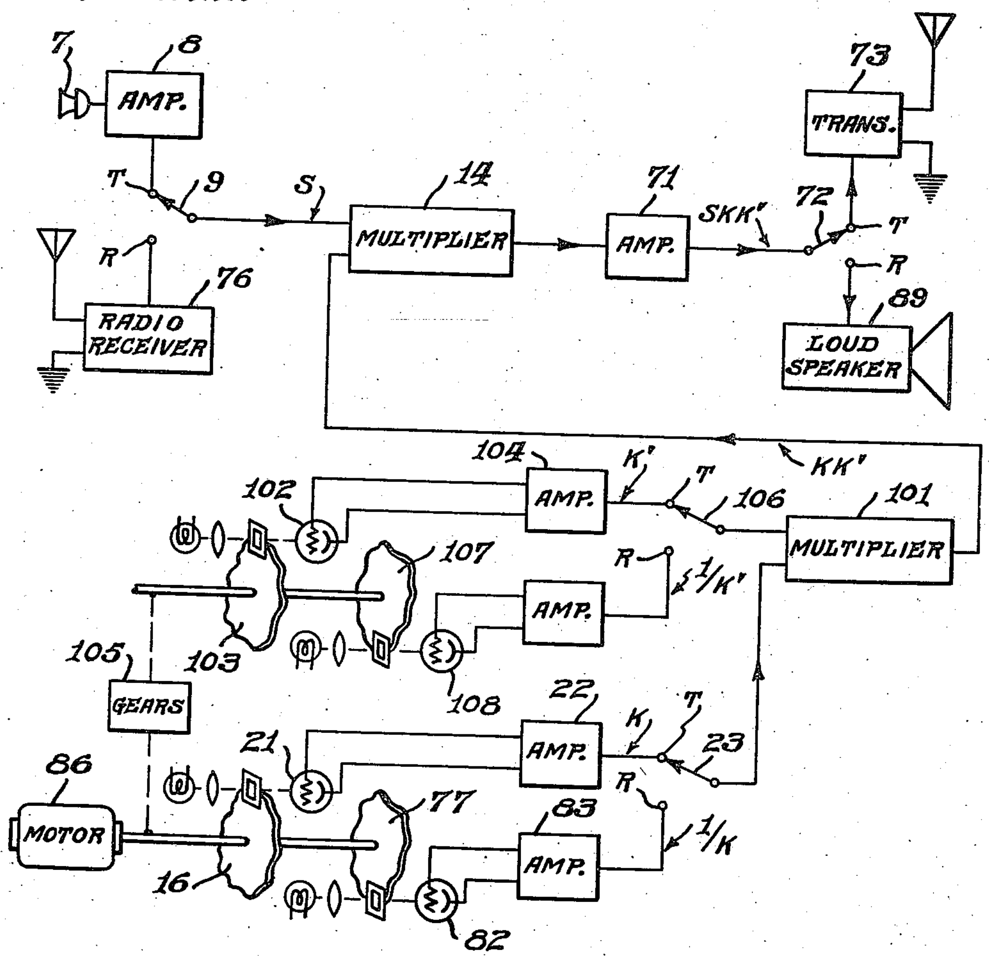

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FIG. 15.

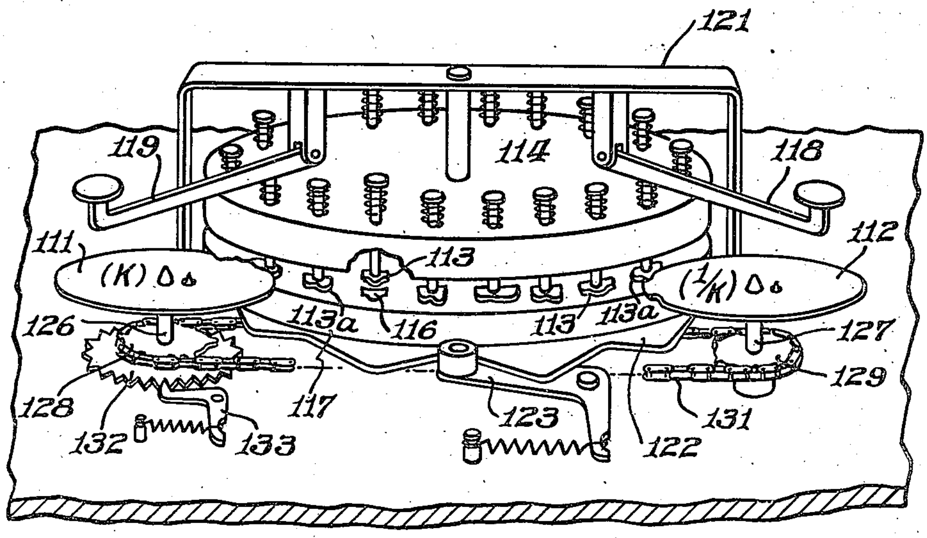

FIG. 16.

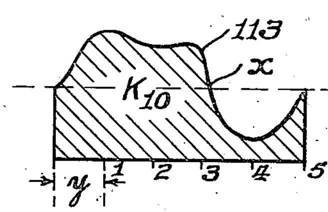

FIG. 17.

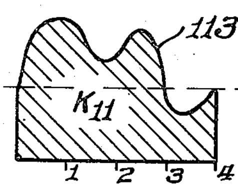

FIG. 18.

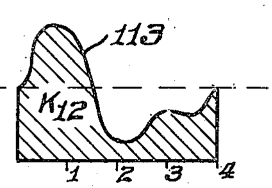

FIG. 16a.

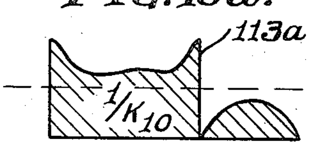

FIG. 17a.

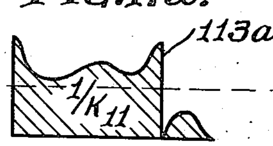

FIG. 18a.

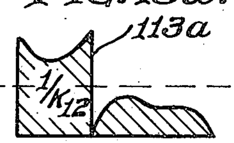

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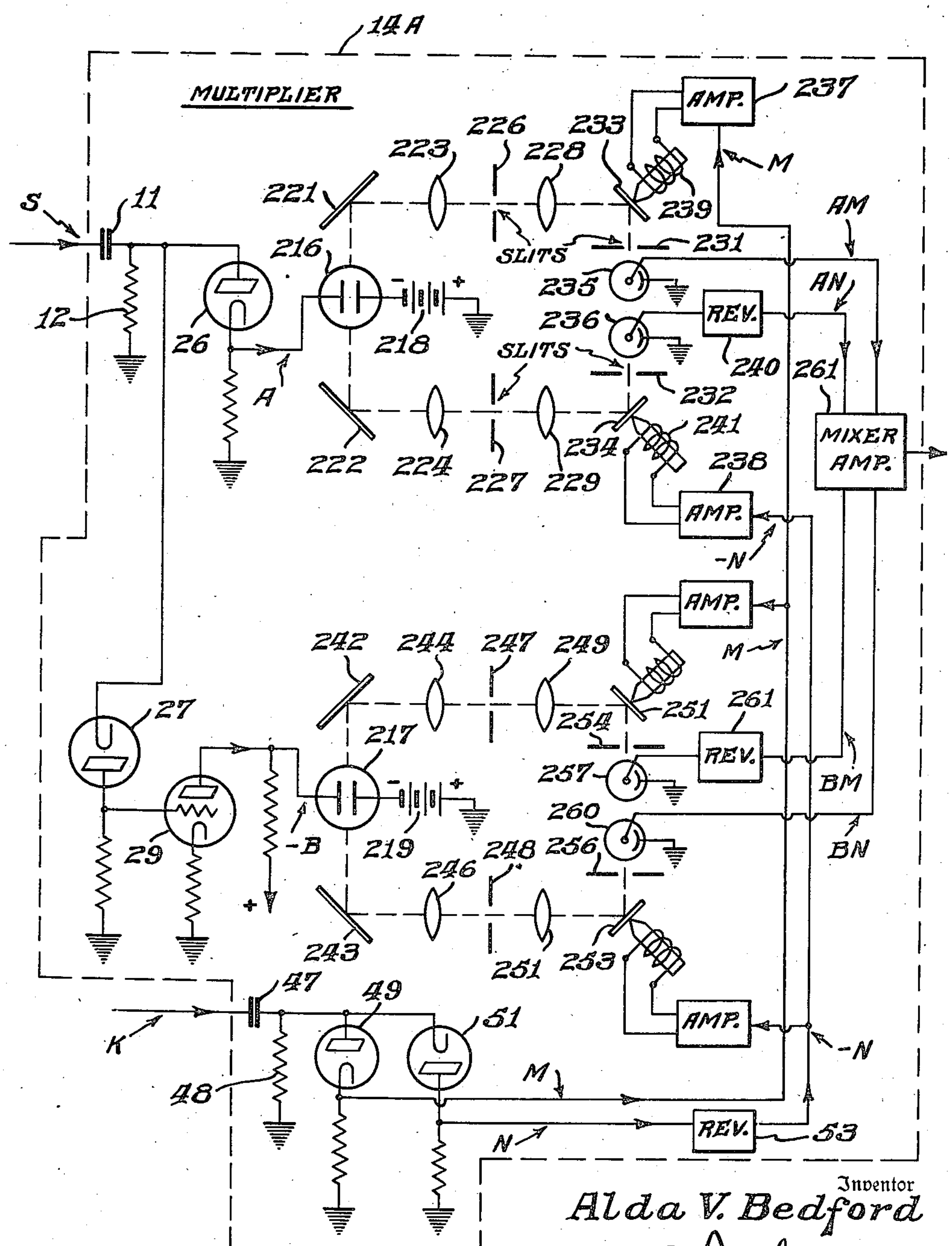
FIG. 19.



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Alda V. Bedford

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Patented June 4, 1946

2,401,402

UNITED STATES PATENT OFFICE

2,401,402

SECRET COMMUNICATION SYSTEM

Alda V. Bedford, Collingswood, N. J., assignor to Radio Corporation of America, a corporation of Delaware

Application August 29, 1942, Serial No. 456,578

19 Claims. (Cl. 179—1.5)

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My invention relates to communication systems and particularly to systems for transmitting information so that it is unintelligible to anyone not provided with the prearranged code information.

An object of the invention is to provide an improved means for and method of transmitting information secretly.

A further object of the invention is to provide an improved means for and method of utilizing a code signal for making a communication signal unintelligible to an enemy or other unauthorized person.

A still further object of the invention is to provide improved means for making code discs or the like for use in a system of the above described character.

In practicing my invention the communication signal S is multiplied by the code signal K before transmission. Thus, an unauthorized person can determine only with considerable difficulty, if at all, how much of the signal amplitude at a certain instant is produced by the communication signal and how much by the code signal. Since the transmitted signal SK is a product of the two signals, there will be no transmission of signals (and, therefore, no transmission of code signal) when there is no communication signal.

At the receiver the signal S is obtained by multiplying the received signal SK by the reciprocal of the code signal, i. e., $SK\times 1/K=S$. The code signal 1/K is produced at the receiver by suitable means such as a code disc which is held in synchronism with the code-signal-producing means at the transmitter.

The invention will be better understood from the following description taken in connection with the accompanying drawings in which

Figure 1 is a block and circuit diagram of one embodiment of the invention,

Figure 2 is a circuit diagram of a modulator unit that may be utilized in the system of Fig. 1,

Figure 3 is a group of graphs that are referred to in explaining the operation of the modulator of Fig. 2,

Figure 4 is a block diagram illustrating another way of synchronizing the code signal producing means at transmitter and receiver,

Figure 5 to 13 are graphs that are referred to in explaining the invention,

Figure 14 is a block diagram illustrating another embodiment of the invention,

Figure 15 is a perspective view of apparatus for cutting code discs for the transmitter and receiver,

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Figures 16 to 18a show, by way of example, the shapes of certain dies for cutting contours on code discs to obtain the code signal K and its reciprocal 1/K, and

Figure 19 is a block and circuit diagram showing another embodiment of the invention.

In the several figures, like parts are indicated by similar reference characters.

Referring to Fig. 1, the invention is shown applied to radio apparatus that may be switched for operation either as a transmitter or as a receiver. The several switches are shown in the position for transmitter operation. This is the operation of the apparatus that will first be described. A microphone and a speech amplifier are shown at 7 and 8, respectively. The signal S is applied through a switch 9 to the multiplier unit 14 which is enclosed by broken lines. The code signal K may be produced by means of a code disc 16, a mask 17, a light source 18, a condensing lens 19, and a photoelectric cell 21. Signal K is supplied through an amplifier 22 and a switch 23 to the multiplier unit 14.

In the specific example of Fig. 1, the signal S (Fig. 5) is split into the two portions that are positive and negative with respect to the A. C. axis of the signal by means of diodes or other suitable rectifiers 26 and 27. The signal is supplied to the diodes 26 and 27 through a coupling capacitor 11 and a grounded grid leak resistor 12 of suitable low resistance. The positive portion A (Fig. 6) is applied to a modulator 28. The negative portion B (Fig. 7) is reversed in polarity by an amplifier stage 29 having unity gain and applied to a modulator 31. A carrier-frequency signal F is applied to modulators 28 and 31 from a source 32 whereby carrier waves modulated by signals A and —B, respectively, appear in their output circuits. The output of modulator 28 (after being filtered by high-pass filter 39) is shown in Fig. 9.

Modulators 28 and 31 may be of any suitable type, but, preferably, modulate linearly so that no signal distortion is introduced. One suitable modulator is shown in Fig. 2. It comprises a vacuum tube 33 having a grid voltage-plate current characteristic such as shown at 34 in Fig. 3. A negative bias voltage Ec is applied to the grid of tube 33 through resistor 37. The carrier frequency signal F is applied to the grid through a coupling capacitor 38 while the signal S is applied through resistor 37. Thus the location of the carrier signal F with respect to the tube characteristic 34 is varied by the signal S as shown in Fig.

3 and a modulated carrier wave is produced. This action is, of course, well known in the art.

The outputs of modulators 28 and 31 are passed through high pass filters 39 and 41, respectively, to remove the original audio signal S and are then applied to multiplying units 42—43 and 44—46, respectively. As explained below, each multiplier unit has applied to it either the positive portion or the negative portion of the code signal K. Each of the units 42, 43, 44 and 46 may be a unit like the modulator shown in Fig. 2 where the tube characteristic is like that shown in Fig. 3, or stated differently, each of the units 42, 43, 44 and 46 may be a variable mu tube which has its gain varied by the code signal.

The code signal K (Fig. 8) is split into the two portions that are positive and negative with respect to the A. C. axis of the signal. This may be done by applying signal K through a coupling capacitor 47 and a low impedance grid leak resistor 48 to a pair of diodes 49 and 51. The positive portion M (Fig. 8) is supplied through a conductor 52 to the multiplier units 42 and 44. The negative portion N (Fig. 8) is reversed in polarity by an amplifier stage 53 and supplied through a conductor 54 to the multiplier units 43 and 46. Assuming, for example that the multiplier units 42, 43, 44 and 46 are like the modulator circuit of Fig. 2, it will be understood that at each unit the code signal (either M or —N) is applied to the control grid through a resistor while the signal modulated carrier wave from either modulator 28 or modulator 31 is applied through a coupling capacitor to the control grid.

The resulting output of unit 42 is the carrier signal or wave F modulated by signal A times signal M, that is, the output is F modulated by AM. Similarly, the outputs of units 43, 44 and 46 are, respectively, F modulated by —AN, F modulated by —BM and F modulated by BN.

The facts that the outputs of the multiplier units are the carrier signal F modulated by the product of the communication signal and the code signal will be apparent if it will be kept in mind (referring to Fig. 3) that the carrier-frequency output of a modulator or multiplier unit is proportional to the applied low frequency signal. For example, the carrier-frequency output of modulator 28 is proportional to signal A (the positive portion of S) and the carrier-frequency output of multiplier unit 42 is proportional to the code signal M. More specifically, if the tubes in units 28 and 42 each have a characteristic such as to provide linear modulation, the carrier-frequency output of unit 28 is CFA where C is a constant, and the output of unit 42 is CC'FAM where C' is a constant.

The outputs of multiplier units 42, 43, 44 and 46 are passed through high pass filters 56, 57, 58 and 59, respectively, to filter out any of the original or low frequency code signal that may be present. These outputs are next applied to detectors 61, 62, 63 and 64, respectively, to produce the detector outputs AM, —AN, —BM and BN, respectively. The outputs of detectors 62 and 63 are reversed in polarity by amplifier stages 66 and 67, respectively, to produce outputs AN and BM, respectively. Figs. 10 and 11 illustrate, by way of example, the signal products AN and BN for the signals S and K shown in Figs. 5 and 8.

The signals AM, AN, BM and BN are added in a suitable mixer circuit 68 whereby the mixer output is the complete signal SK illustrated in Fig. 12. This is passed through a low pass filter 69 to remove any carrier frequency that may be present. It is then amplified by an amplifier 71 and supplied through a switch 72 to a radio transmitter 73 or to a wire line, if preferred.

From the foregoing it will be apparent that the transmitted signal SK may be made to bear so slight a resemblance to either the communication signal S or the code signal K that neither one of these signals can be determined by unauthorized persons except by laborious "cut and try" methods. The coded wave SK has neither the same shapes, frequencies or amplitudes as the original waves.

The code signal K should provide enough reversals of the communication signal S (speech signal for example) to destroy any semblance of the original tones and harmonics. For example, if signal S contains no frequencies higher than 3000 cycles per second, the coding disc 16 may be provided with 50 positives and 50 negative lobes and rotated at 20 revolutions per second whereby the "average frequency" of signal K would be about 1000 cycles per second. If the disc 16 is three inches in diameter each lobe would average about one-tenth inch in length along the disc periphery so that no difficulty should be encountered in obtaining adequate accuracy in making the coding and decoding discs with simple equipment.

The receiver for decoding the signal SK may be the same apparatus as in Fig. 1 with the switches 9, 23 and 72 thrown to their lower contact positions R. The multiplier 14 is unchanged. The signal SK is supplied from a radio receiver 76 through the switch 9 to the multiplier 14. A decoding signal 1/K produced by a disc 77 and associated light source 78, condensing lens 79, mask 81 and photoelectric cell 82 is supplied through an amplifier 83 and the switch 23 to the multiplier 14.

The code disc 16 at the transmitter and the code disc 77 at the receiver are held in synchronism and in the proper phase relation by suitably synchronizing means. For example, at the transmitter a 600-cycle per second current from a source 84 may be supplied through switch arms 80 and 85 to a synchronous motor 86 which rotates the code disc 16 and 77. The 600-cycle current also modulates a radio transmitter 87 for the transmission of synchronizing signal to the receiver. At the receiver the switch arms 80 and 85 are in their lower positions R whereby the received 600 cycle current is supplied from a radio receiver 88 to the synchronous motor 86. In some cases it may be preferable to transmit the synchronizing signal over a wire line.

The received signal SK is decoded in the receiver multiplier 14 since the multiplier output is $SK(1/K)=S$. The signal S may be supplied through the switch 72 to headphones or to a loudspeaker 89. No detailed discussion of the decoding operation of the multiplier 14 is required since it has previously been shown how it operates to multiply the signal supplied to diodes 26 and 27 by the signal supplied to diodes 49 and 51. If these two signals are SK and 1/K, respectively, it follows that their product is the desired signal S.

It may be noted that if the modulators 28 and 31 are biased to cut-off as shown in Fig. 3, the diodes 26 and 27 may be omitted since the modulator tubes themselves act as rectifiers and are not affected by the negative portion of the signal. It will also be evident that the code signal for transmission may be 1/K and the decoding signal K instead of vice versa as assumed in the foregoing description.

For the purpose of illustration the ordinate values for the waves of Figs. 5 to 13 are given in the table below:

Time	S	A	B	K	M	N	AM	AN	BM	BN	SK	1/K
1	0.7	0.7	0	2.0	2.0	0	1.4	0	0	0	1.4	0.5
2	.9	.9	0	1.8	1.8	0	1.6	0	0	0	1.6	.56
3	0	0	0	.4	.4	0	0	0	0	0	0	2.5
4	0	0	0	1.3	1.3	0	0	0	0	0	0	.77
5	−.6	0	−.6	1.7	1.7	0	0	0	−1.02	0	−1.02	.59
6	−.5	0	−.5	−.8	0	−.8	0	0	0	.40	.4	1.25
7	.5	.5	0	−2.0	0	−2.0	0	−1.0	0	0	−1.0	−.5
8	.6	.6	0	−1.5	0	−1.5	0	−.9	0	0	−.9	−.67
9	0	0	0	−.7	0	−.7	0	0	0	0	0	−1.43
10	−.5	0	−.5	−1.1	0	−1.1	0	0	0	.55	.55	−.91
11	−.4	0	−.4	−.4	0	−.4	0	0	0	.16	.16	−2.5
12	−.7	0	−.7	1.2	1.2	0	0	0	−.84	0	0	.83
13	−1.0	0	−1.0	1.9	1.9	0	0	0	−1.9	0	0	.53
14	−.4	0	−.4	1.9	1.9	0	0	0	−.76	0	0	.53
15	.3	.3	0	1.5	1.5	0	.45	0	0	0	0	.67
16	.7	.7	0	0	0	−1.1	0	−.77	0	0	0	−.91
17	.9	.9	0	0	0	−1.7	0	−1.5	0	0	0	−.59

Fig. 4 illustrates another way in which the coding and decoding discs may be synchronized. The transmitter carrier wave is modulated by a synchronizing signal having a frequency, such as 4000 cycles per second, outside the frequency band of the speech or other communication signal, the upper limit of this band being determined by the low pass filter 78. The 4,000-cycle source, which is indicated at 91, also supplies synchronizing signal over a conductor 92 and through a switch 93, a high pass filter 94 and an amplifier 96 to the synchronous motor 86.

Similar apparatus at the receiving station is put in condition for reception by moving switches 9, 23, 72 and 93 to the contact positions R. The radio receiver 97 now passes the signal SK through a low pass filter 98 to the multiplier 14 and passes the 4000-cycle synchronizing signal through the high pass filter 94 to the motor 86. Thus the coding and decoding discs at transmitter and receiver are held in synchronism in a system requiring the transmission of only one carrier wave.

Figure 14 shows an embodiment of the invention designed to transmit messages that will be still more difficult for a person not provided with the code key or code disc to decode. An additional multiplier 101 is employed which may be a duplicate of the multiplier 14. The output of multiplier 101 is fed into the multiplier 14 the same as the code signal K is fed into it in the embodiment of Fig. 1.

Multiplier 101 supplies the product of two code signals K and K′ to the multiplier 14. The code signal K′ may be produced by means of a photoelectric cell 102 and a code disc 103 that is driven, preferably through gears 105, by the synchronous motor 86. Signal K′ is supplied through an amplifier 104 and a switch 106 to the multiplier 101. When the code signal K is also supplied to multiplier 101 its output is KK′. This is assumed to be the condition for transmission. The resulting signal obtained for transmission is SKK′.

For reception, the several switches are moved to the R position and the signals 1/K′ and 1/K are supplied to the multiplier 101. The decoding signal 1/K′ is produced by a disc 107 and associated photoelectric cell 108. Thus the signal supplied to the loudspeaker 88 is

$$SKK'1/K1/K'=S$$

To make the double coding system of Fig. 14 most effective, the shafts carrying the code discs 18—77 and 103—107 should be so geared together that they run at speeds that differ slightly, say by one percent. The combined coding wave KK′ will then repeat (assuming the particular disc design previously described) only after the passage of some 5,000 to 10,000 lobes of the coding wave KK′, or about once every five seconds. This would make an early solution of the code by an enemy unlikely, especially when it is considered that he must not only obtain a substantially correct wave shape, but he must phase it correctly.

Fig. 15 illustrates apparatus that may be employed for making coding and decoding discs. Two such discs are shown at 111 and 112, respectively, in the process of being cut to the desired shape. A plurality of male dies 113 and 113*a* are mounted around the periphery of a rotatable supporting disc 114. One of the dies 113 is shown pulled above its normal "rest" position to show the lower die 116 more clearly. The corresponding female dies 116 are formed in a disc 117 which rotates with the disc 114. Levers 118 and 119 are pivoted on a supporting frame 121 so that when they are depressed the dies cut contours on the discs 111 and 112 that will generate the signals K and 1/K, respectively.

In the specific design of Fig. 15 alternate dies 113 cut a contour to produce signal K while the other dies 113*a* cut a contour to produce signal 1/K. A notched disc 122 and a positioning arm 123 properly position the K and 1/K dies with respect to discs 111 and 112 each time the supporting discs 114 and 116 are rotated to make a new cut.

The supporting shafts 126 and 127 are held in a definite rotatable relation by means of sprocket wheels 128 and 129 connected by a chain 131. A toothed wheel 132 and a positioning arm 133 insure rotation of the code discs 111 and 112 a whole number of spaces or distance units *y* measured along the periphery of the discs. Since the length of each die is a whole number of said units, as indicated in Figs. 16 to 18, this facilitates positioning the discs 111 and 112 for the next cut to be made by the dies 113. It will be evident that various modifications may be made in the code cutting apparatus. For example, the code discs 111 and 112 may be diametrically opposed with respect to the supporting disc 114 and all K dies located along one half or side of disc 114 and all 1/K dies located along the half or side of disc 114. Any particular coding disc may be cut by using either a few or all of the dies 113 and in any random sequence.

Figs. 16, 17 and 18 show dies 113 of three separate shapes or wave forms K_{10}, K_{11} and K_{12}. Figs. 16*a*, 17*a* and 18*a* show the dies 113*a* having the corresponding reciprocal wave forms $1/K_{10}$, $1/K_{11}$ and $1/K_{12}$. The positive and negative values of K and 1/K are measured from the broken lines in Figs. 16 to 18a, these lines representing a certain radial distance from the center of the code discs 111 and 112. It may be noted that where the value of K is zero, at a point x, in Fig. 16, the corresponding correct value of 1/K is infinity but no serious distortion is caused by making 1/K some convenient definite value at this point.

It will be understood that the code signals K and 1/K may be generated in various ways. For example, phonograph recordings of K and 1/K might be used and the signals taken off by the usual phonograph pickup. Another method is to use a disc of film or other photographic material located in front of a cathode ray tube, the code having been recorded on the film as variable density. The disc is then scanned by sweeping the luminous spot on the tube fluorescent screen in a circle and a photoelectric cell picks up the light transmitted through the film.

My invention is not limited to any specific apparatus for multiplying a signal by the coding wave K or the decoding wave 1/K. Fig. 19 shows another type of multiplier 14A that may be substituted for the multiplier 14 in Fig. 1. The components A and —B of signal S are applied to light sources such as neon lamps 216 and 217, respectively, that may be modulated. Batteries 218 and 219 may be provided to maintain a suitable D.-C. potential across the lamps 216 and 217.

Light from lamp 216 is directed over two paths as by means of mirrors 221 and 222. Lens systems 223 and 224 concentrate the light on slits in diaphragms 226 and 227. These slits are imaged by lens systems 228 and 229 upon slits in diaphragms 231 and 232, respectively, after reflection from galvanometer mirrors 233 and 234. Each of the mirrors 233 and 234 is rocked about a pivot point whereby the amount of light passing through the slits of diaphragms 231 and 232 and falling upon photoelectric cells 235 and 236 varies in accordance with the signal rocking the mirror. The mirrors 233 and 234 are rocked or vibrated by the code signal components M and —N, respectively, these components passing through amplifiers 237 and 238 to the mirror driving coils 239 and 241. The structure for the galvanometer mirrors and their driving mechanism may be as described in Dimmick Patent 1,936,833. The resulting outputs of photoelectric cells 235 and 236 are AM and —AN, the output —AN being reversed by a reversing amplifier stage 240.

Similarly, light from lamp 217 is directed by mirrors 242 and 243 through lenses 244 and 246, diaphragms 247 and 248, lenses 249 and 251 to the galvanometer mirrors 252 and 253, and from galvanometer mirrors 252 and 253 through the slits of diaphragms 254 and 256 to photoelectric cells 257 and 260. The outputs of photoelectric cells 257 and 260 are —BM and BN. The signal BM is reversed by an amplifier 261. The signals AM, AN, BM and BN are added to produce the complete coded signal SK.

I claim as my invention:

1. The method of communication which comprises producing a communication signal and a distorting signal, multiplying the values of said signals as measured from their alternating current axes by each other to obtain their product, transmitting said product to the point of reception and there multiplying said product by a signal that is substantially the reciprocal of said distorting signal, said last multiplication also being a multiplication of the signal values as measured from their alternating-current axes.

2. The method of communication which comprises producing a communication signal and a distorting signal each of which comprises frequency components lying within a common frequency band, multiplying said signals by each other to obtain their product, transmitting said product signal to the point of reception and there multiplying said product signal by a signal that is substantially the reciprocal of said distorting signal.

3. A system for transmitting a communication signal from a transmission point to a reception point which comprises means at the transmission point for producing a distorting signal, means for multiplying said communication signal by said distorting signal to obtain their product, and means located at the point of reception for multiplying said product by a signal that is substantially the reciprocal of said distorting signal, both of said multiplications being a multiplication of the signal values as measured from the alternating-current axes of the signals.

4. In a system for secret transmission of a communication signal, a communication unit that includes means for producing a distorting signal and means for multiplying the instantaneous amplitude of said communication signal as measured from its alternating-current axis by the instantaneous amplitude of said distorting signal as measured from its alternating-current axis to produce a product signal.

5. In a system for secret transmission of a communication signal comprising frequency components that lie within a certain frequency band, a communication unit that includes means for producing a distorting signal comprising frequency components that lie within a frequency band at least a portion of which is common to a portion of said certain frequency band, and means for multiplying said communication signal by said distorting signal to produce a product signal, said multiplication being a multiplication of the signal values as measured from the alternating-current axes of the signals.

6. A system for secret transmission of a communication signal from a transmitter to a receiver, said transmitter including means for producing a coding signal and means for multiplying said communication signal by said coding signal to produce a product signal, means for transmitting said product signal to the receiver, said receiver including means for producing a decoding signal that is substantially the reciprocal of said coding signal, and means for multiplying said product signal by said decoding signal, both of said multiplications being a multiplication of the signal values as measured from the alternating-current axes of the signals.

7. The invention according to claim 6 wherein means is provided for maintaining said code signal producing means and said decoding signal producing means in synchronism.

8. A transmitter-receiver unit for the transmission and reception of a communication signal, said unit comprising means for producing a distorting signal, multiplier means for multiplying signals by each other when applied thereto, switching means for applying said communication signal and said distorting signal to said multiplier means to obtain their product, means for producing a decoding signal that is substantially the reciprocal of said distorting signal, and switching means for supplying a received prod-

uct signal and said decoding signal to said multiplier means to obtain the original communication signal.

9. In the method of communication, the steps which comprise producing a communication signal having an A.-C. axis, producing a distorting signal having an A.-C. axis, multiplying that part of the communication signal located on one side of its A.-C. axis by that part of the distorting signal located on one side of its A.-C. axis, separately multiplying said part of the communication signal by the part of the distorting signal located on the other side of its A.-C. axis, separately multiplying the other part of the communication signal located on the other side of its A.-C. axis by said first part of the distorting signal, separately multiplying said other part of the communication signal by said second part of the distorting signal, and adding said products.

10. The invention according to claim 9 wherein said multiplication is accomplished by modulating a carrier wave successively by the two signal parts and then demodulating the resulting modulated carrier wave.

11. The method of communication which comprises producing a communication signal and a plurality of distorting signals, combining said distorting signals, multiplying said communication signal by said combined distorting signal to obtain their product, and transmitting said product signal to the point of reception and there multiplying said product signal by a signal that is substantially the reciprocal of said combined distorting signal.

12. The method of communication which comprises producing a communication signal and a plurality of distorting signals, multiplying all of said signals by each other to obtain their product, transmitting said product to the point of reception and there multiplying said product by the reciprocal of the product of said distorting signals, each of said multiplications being a multiplication of the signal values as measured from the alternating-current axes of the signals.

13. A system for secret transmission of a communication signal from a transmitter to a receiver, said transmitter including code signal producing means, said code signal producing means comprising a plurality of code discs which are geared together for rotation at slightly differing speeds, and means for multiplying said communication signal by said code signal to produce a product signal, means for transmitting said product signal to the receiver, said receiver including means for producing a decoding signal that is substantially the reciprocal of said coding signal, and means for multiplying said product signal by said decoding signal.

14. In a system for secret transmission of a communication signal, a communication unit that includes means for producing a code signal, a second means for producing a code signal, means for causing the time relation of said code signals to change with respect to each other slowly in a predetermined manner, and means for combining said code signals, and means for multiplying said combined code signal and said communication signal by each other to obtain their product, said multiplication being a multiplication of the signal values as measured from the alternating-current axes of the signals.

15. The invention according to claim 14 wherein each of said code signal producing means comprises a code disc and wherein said code discs are geared together for rotation at slightly different speeds.

16. In a system for secret transmission of a communication signal, a communication unit that includes means for producing a code signal, a second means for producing a code signal, means for causing the time relation of said code signals to change with respect to each other slowly in a predetermined manner, and means for multiplying said code signals and said communication signal by each other to obtain their product.

17. The method of multiplying a communication signal by a code signal which comprises modulating a light beam by one of said signals and modulating the resulting modulated beam by the other of said signals.

18. Apparatus for obtaining the product of two signals which comprises a lamp which may be modulated, means for modulating said lamp by one of said signals to obtain a modulated light beam, means including a galvanometer mirror for modulating said modulated light beam in accordance with the other signal, and a photo-electric cell positioned to receive the light after the second modulation.

19. Apparatus for obtaining the product of two signals which comprises a lamp which may be modulated, means for modulating said lamp by one of said signals to obtain a modulated light beam, a galvanometer mirror, means for directing said beam to said mirror, means positioned in the path of the beam reflected from said mirror to pass an amount of light depending upon the position of the path of the reflected beam, and means for vibrating said mirror in accordance with the other signal whereby said amount of light is varied, and a photoelectric cell positioned to receive the light passing through the means positioned in said path.

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