

Dec. 9, 1947.

W. H. BLISS

2,432,188

TELEGRAPH SECRECY SYSTEM

Filed June 22, 1944

4 Sheets-Sheet 1

Fig. 1.

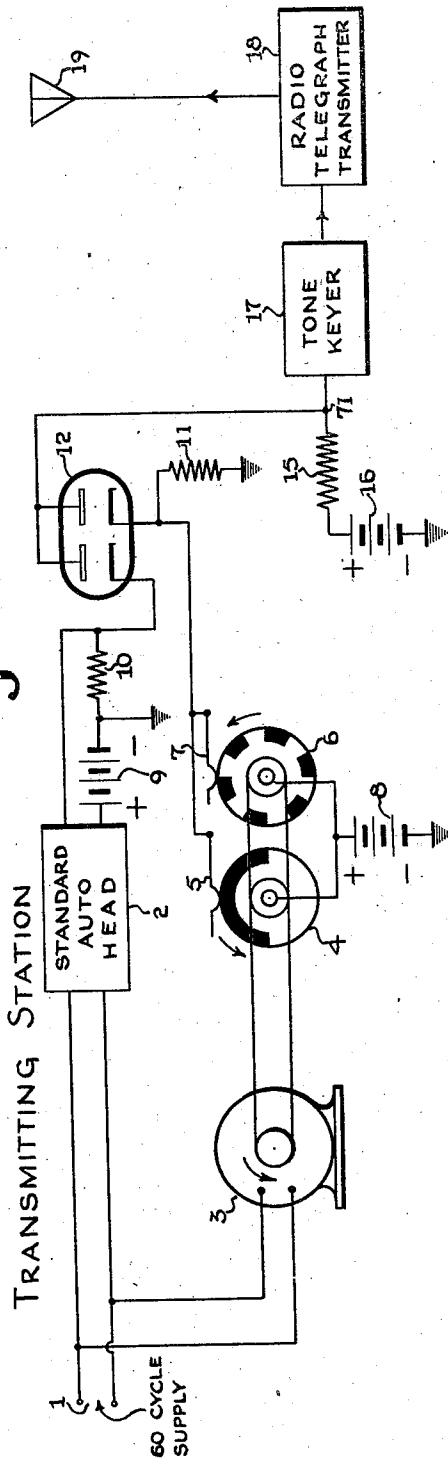
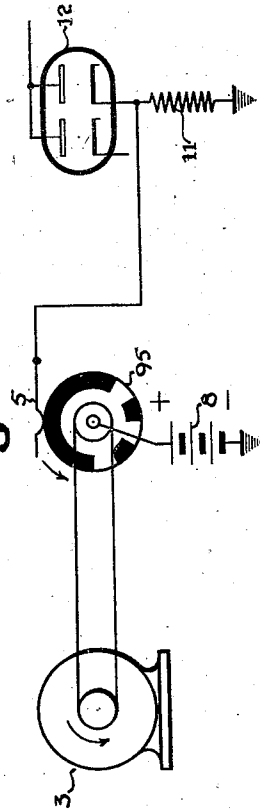


Fig. 4.



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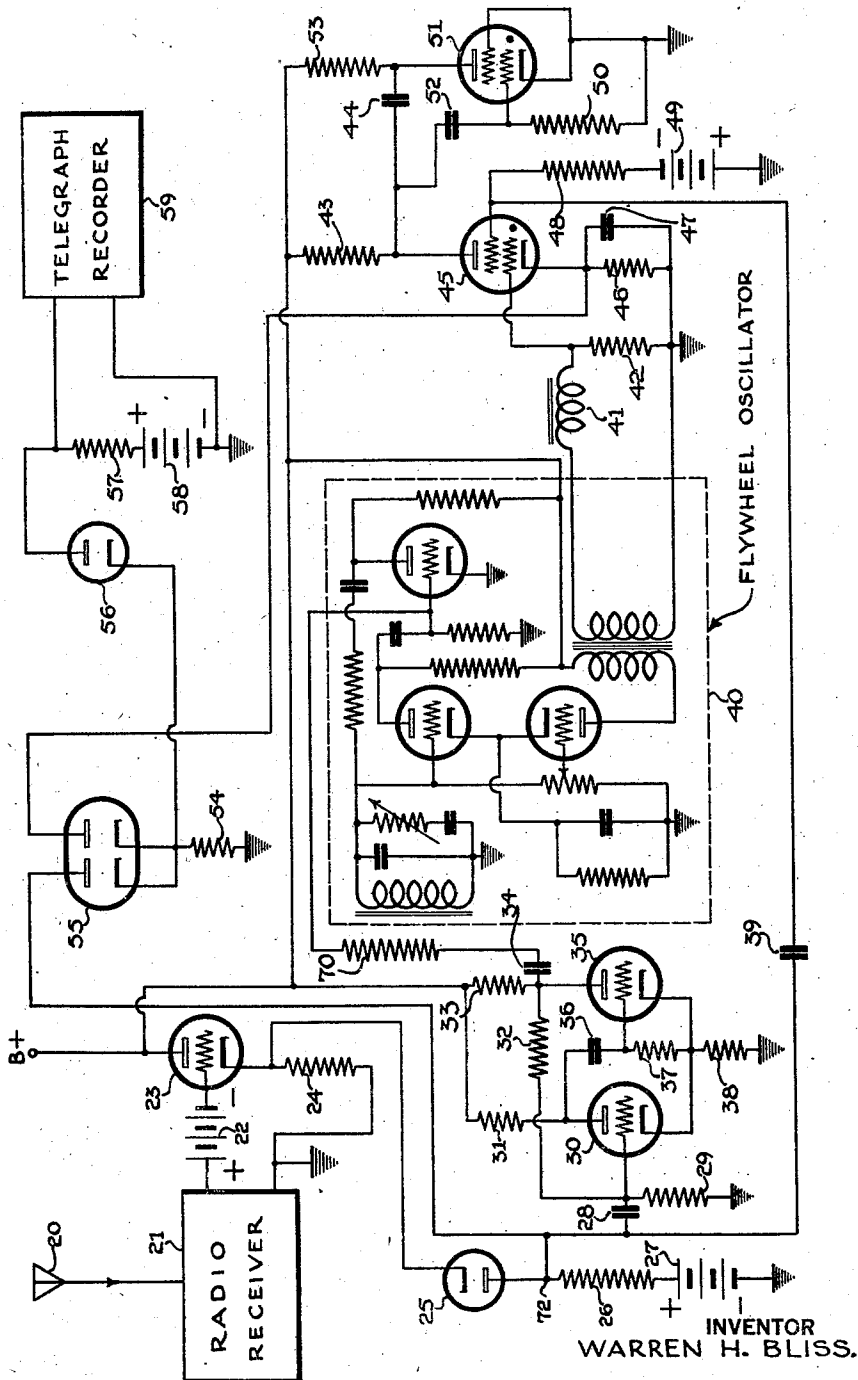
Fig. 2.

RECEIVING STATION.

TELEGRAPH
RECORDER

RADIO RECEIVER

4 Sheets-Sheet 2



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4 Sheets-Sheet 3

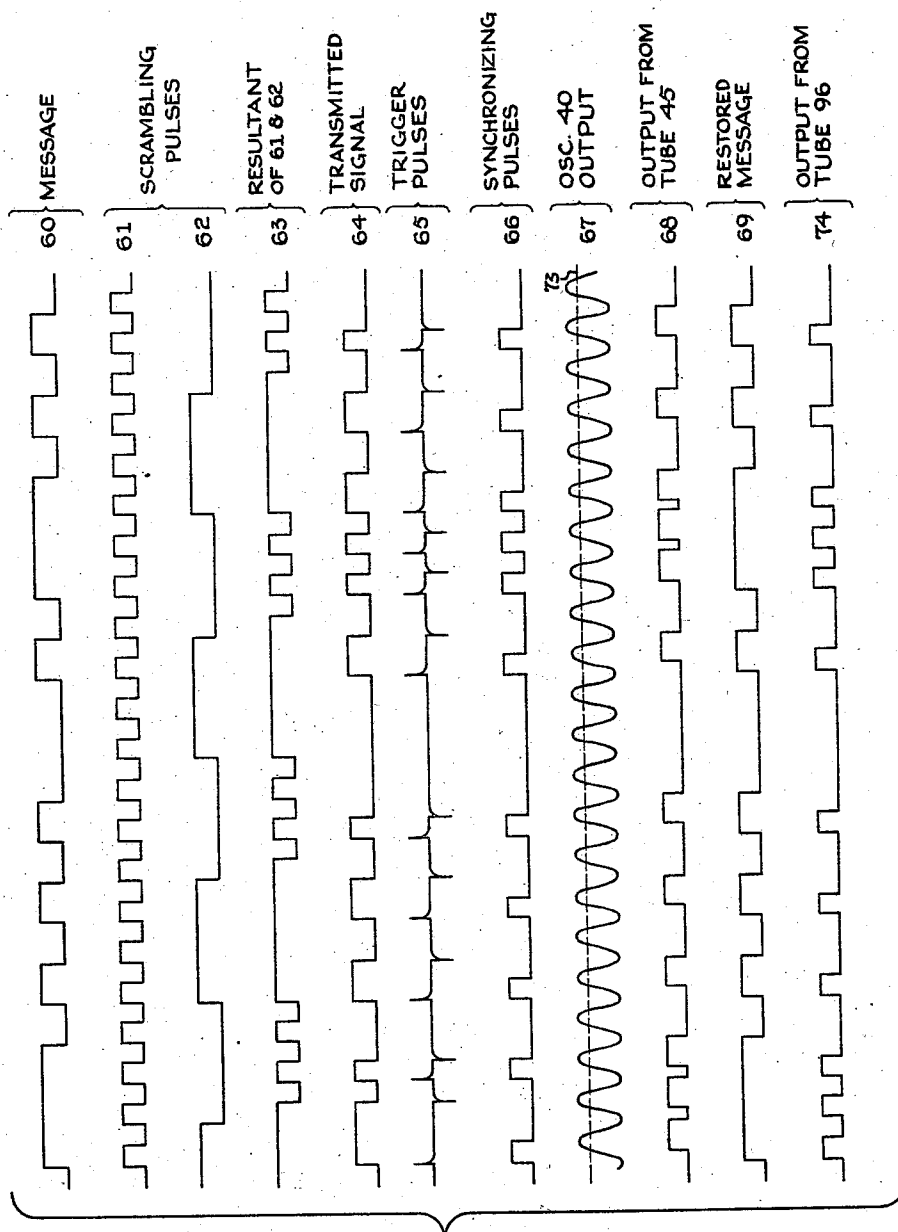


Fig. 3.

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4 Sheets-Sheet 4

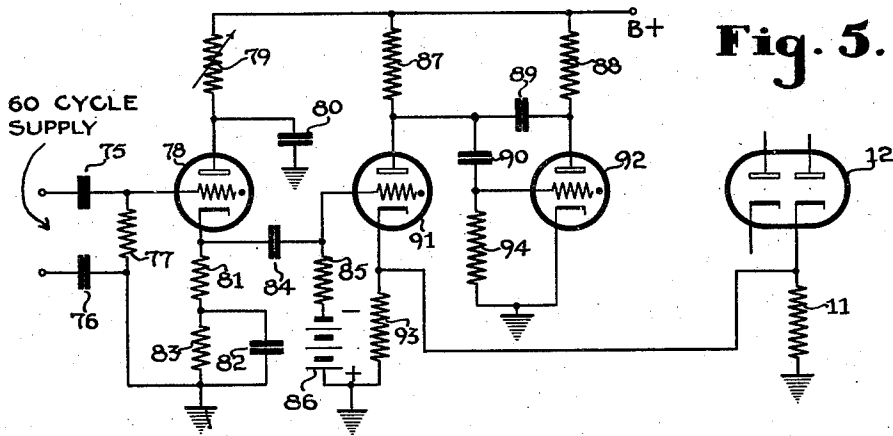
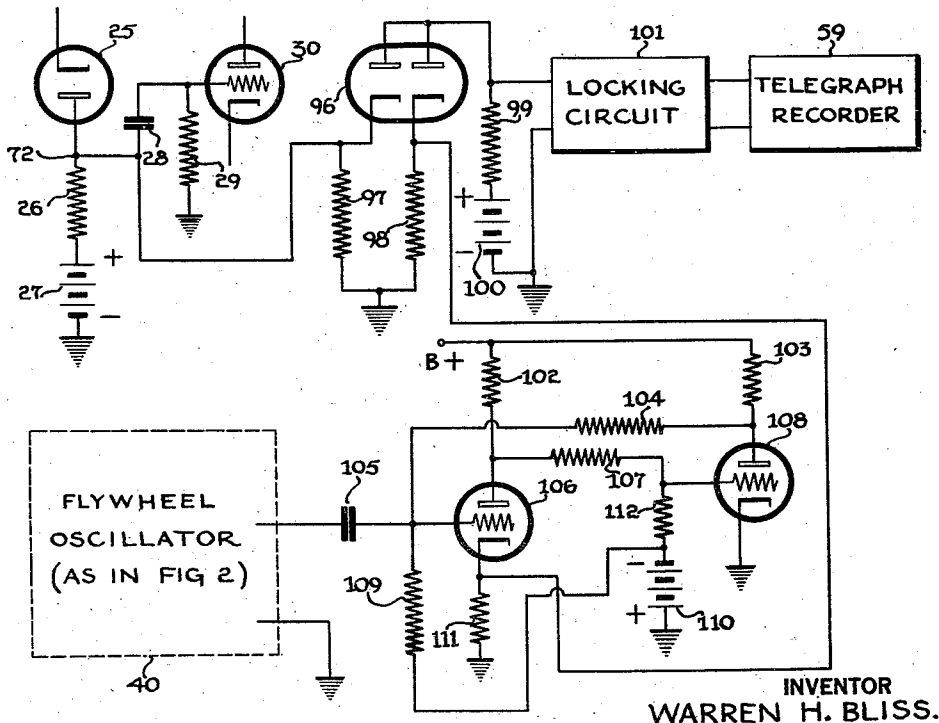


Fig. 6.

RECEIVING STATION



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TELEGRAPH SECRECY SYSTEM

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Application June 22, 1944, Serial No. 541,569

11 Claims. (Cl. 178—22)

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This invention relates to secrecy systems for the transmission and reception of intelligence by wire or radio channels. The fundamental principle involved is that certain portions of standard telegraph dots and dashes may be deleted prior to transmission and automatically replaced at the receiving terminal. By this system the character of the material transmitted by wire or radio appears erratic and unintelligible, but may be readily translated into intelligence at an authorized receiving station by means of suitable equipment when properly synchronized.

It is an object of my invention to provide equipment for scrambling and unscrambling conventional telegraph code signals in such manner that the signals as transmitted would be rendered unintelligible and when properly translated at an authorized receiving station shall be rendered entirely intelligible.

Among the advantages of this system, it will be noted that it does not involve complicated equipment and the nature of the transmitted pattern for a given original code character is variable in a random fashion.

My invention will now be described in more detail, reference being made to the accompanying drawing, in which:

Fig. 1 shows diagrammatically a transmitting circuit arrangement in combination with a plurality of distributors, whereby the signals are chopped into unintelligible fragments;

Fig. 2 shows a circuit diagram of apparatus to be used at an authorized receiving station for reception of the signals and for unscrambling the same;

Fig. 3 shows a plurality of graphs of signal wave forms delineated on a time scale, whereby the original code signals may be compared with the scrambled signals and with wave forms generated at the receiving station for unscrambling; and

Figs. 4, 5, and 6 illustrate respectively each of three alternative embodiments of the invention.

Fig. 1 shows the sending end equipment for a system using radio transmission. Unit 2 is a standard auto head for producing telegraph characters from perforated tape. It is driven by a synchronous motor from a 60-cycle supply. The output of this auto head is fed into a resistor 10 and to one of the cathodes of dual diode tube 12.

Commutator wheels 4 and 6 operate at the same speed and are also driven by a synchronous motor connected to the 60-cycle supply. Each wheel has a pick-up brush, and wheel 4 has one insulated and one conducting segment as shown, while

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wheel 6 has six insulated and six conducting segments. Each wheel has all its segments of equal length. For completing the circuits through these wheels the shaft of each is electrically connected to the plus terminal of battery 8 whose minus terminal is grounded. The brush 5 of wheel 4 and brush 7 of wheel 6 are connected to resistor 11 and the second cathode of diode 12.

The anodes of diode 12 are connected to ground through series resistor 15 and battery 16 as shown. The upper end of resistor 15 is connected to a tone keyer 17 which is a conventional device for converting direct current pulses having mark (or space) significance into keyed tone signals. Item 18 is a conventional radio telegraph transmitter which radiates energy from antenna 19.

At the receiving terminal, Fig. 2, the signals are picked up by means of antenna 20 and radio receiver 21. The output of the receiver taken as positive E. M. F. from its detector is fed through a biasing battery 22 to the control grid of a cathode output triode 23. The anode of triode 23 is directly connected to the positive plate supply while the output from cathode resistor 24 is connected to the cathode of a signal limiter diode 25. The anode of this diode is connected through resistor 26 and battery 27 to ground, as shown.

Triodes 30 and 35 comprise a "flip-flop" circuit having a single condition of stability. There are individual anode resistors 31 and 33 and a common cathode resistor 38. The control grid of triode 30 is fed through condenser 28 from the anode of diode 25 and is also connected to the anode of tube 35 through resistor 32 and to ground through resistor 29. There is also a condenser 36 linking the anode of triode 30 to the control grid of triode 35. A resistor 37 connects from the cathodes of the two triodes to the control grid of tube 35.

The output of the above "flip-flop" circuit is connected through condenser 34 and resistor 70 to "flywheel" oscillator 40. This oscillator circuit is preferably the same as that described in United States Patent No. 2,274,841, issued to R. E. Mathes and W. H. Bliss, referring to Fig. 4 therein. Hence, it requires no detailed description herein. The output of this oscillator is supplied through a phase displacing circuit composed of inductance 41 and resistor 42 to the control grid of a gas tetrode 45.

Gas tetrodes 45 and 51 are the essential parts of a second "flip-flop" circuit. There are anode resistors 43 and 53 with a cross-connecting commutating condenser 44. The cathode of tube 45

is connected to ground through resistor 46 and condenser 47 in parallel and the screen grid is connected through resistor 48 and battery 49 in series to ground. This screen grid of tetrode 45 also receives the incoming signal pulses from the anode of diode 25 through condenser 39. The control grid of tetrode 51 is connected to ground through resistor 50 and to the anode of tube 45 through condenser 52. The cathode and screen grid of tube 51 are connected directly to ground.

A combining dual diode tube 55 has one anode connected to the anode of diode 25 and its other anode to the cathode of tetrode 45. The cathodes of diode 55 are both connected to the cathode of diode 56 and to ground through a resistor 54. The anode of diode 56 is connected to a telegraph signal recorder 59 and to ground through series resistor 57 and battery 58. The telegraph recorder 59 may be of the conventional ink slip type frequently used in the art.

Operation

Graph 61 is the brush output waveform of E. M. F. of brush 7, wheel 6, and while graph 62 is the output of brush 5, wheel 4. It is essential that the wheels 4 and 6 and auto head 2 be so synchronized and phased that the outputs have relationships as shown by graphs 60, 61, and 62. It is also necessary that the length of each segment on wheel 4 be an integral multiple of the unit length of the signals shown in graph 60. The length of two successive segments on wheel 6 must also be equal to or an integral submultiple of the signal baud. The combination of the outputs of brushes 5 and 7, produced by their parallel connection, is illustrated by graph 63.

Double diode 12 acts in a very special way to combine the auto head output, graph 60, and the composite brush output, graph 63. Resistor 15 must be several times as large as resistors 10 and 11. With no output from the auto head 2 or brushes 5 and 7, the potential of point 71 is nearly that of ground potential, there being a small voltage drop through the normally conducting diode 12 and resistors 10 and 11. When a positive voltage from only one of the inputs (auto head or brushes) is applied to one of the cathodes of diode 12 this diode section cuts off and there is but a slight rise in potential at point 71 because of the low resistance path through the other conducting diode section. However, when positive voltages are applied simultaneously on the two cathodes of diode 12, conduction through both halves of the tube is blocked and point 71 will rise to and remain at the full potential of battery 16. It should be noted that the potentials of batteries 8 and 9 should be at least equal to that of battery 16.

For the example given in Fig. 3 of transmitting the letters BL the combined output as observed by the potential at point 71 is given by graph 64. This signal, which is similar to telegraph type material but which bears no apparent resemblance to the original message, is then used to key a conventional radio telegraph transmitter. The secrecy of this system lies in the fact that the transmitted signal has a scrambled appearance and is unlike the original code characters. A close inspection of graphs 60 and 64 reveals that the secret message has been derived from the original by deleting certain small parts. These can be supplied again at the receiving terminal.

At the receiving terminal the detector output of the radio receiver 21, Fig. 2, is passed through triode 23 biased beyond the cut-off point to pro-

duce a noise threshold control and also passed through a diode 25 which acts as a peak limiter. At point 72 the recovered signal is essentially the same as that of graph 64 which was transmitted.

This waveform is differentiated by condenser 28 and resistor 29 to give the trigger pulses shown by graph 65. These are applied to a "flip-flop" circuit composed of vacuum triodes 30 and 35. Tube 35 is normally in a state of conduction and tube 30 in a state of non-conduction, and when one of the positive trigger pulses (graph 65) from the anode of diode 25 arrives at the control grid of triode 30, this tube is flipped into conduction for a short period of time. Because of the regenerative action between these two tubes, only one at a time is conducting while the other is biased to cut-off. Since tube 35 has no stable or fixed negative bias it always resumes conduction soon after tube 30 is triggered. For the example shown, the conduction period for tube 30 should be about equal to one-half the unit length of the original signal.

Graph 66 shows the conduction vs. time relation of tube 30 as derived from the wave form of graph 65. Graph 66 also shows the voltage variation at the anode of triode 35 and is fed into oscillator 40 to synchronize it as described in United States Patent No. 2,274,841 (previously mentioned). The output of this oscillator is displaced in phase by inductance 41 and resistor 42 and its waveform as observed across resistor 42 is shown by graph 67.

Gas tetrodes 45 and 51 develop pulses to fill in those parts of the signal deleted at the sending end. The control grid of tetrode 45 receives the output from the oscillator (graph 67) and the screen grid of tetrode 45 has the incoming signal from diode 25 (graph 64) applied to it. Tube 51 is normally conducting and tube 45 normally non-conducting. Tube 45 is triggered every time its control grid and screen grid are simultaneously and momentarily made sufficiently positive. A threshold line 73 is shown in connection with graph 67 to indicate on what part of the cycle tube 45 will fire, provided that an incoming signal potential is simultaneously applied to the screen grid.

Since tetrodes 45 and 51 are interconnected as a "flip-flop" circuit the conduction will always return back to tube 51 after an interval of time determined by the values of condenser 52 and resistor 50. The conduction vs. time characteristic for tetrode 45 is shown as graph 68 and this is the output waveform of this tube as taken from its cathode.

Double diode 55 acts to combine the incoming signal from diode 25 (graph 64) and the filling in signal (graph 68) from tetrode 45. Inspection of graphs 64 and 68 show that at some instants both signals are positive simultaneously and so a diode limiter 56 is used to level off the excess. The output voltage appears across resistor 57 and is identical with the original signal of graph 60. A telegraph recorder 59 may be used to register the received signal.

Fig. 4 illustrates a commutator wheel 95 which performs the combined functions of wheels 4 and 6 of Fig. 1. The output of this wheel 95, as picked up on brush 5, is as shown by graph 63, Fig. 3.

Fig. 5 illustrates an electronic system which performs the same function as commutator wheel 6. A condenser 80 is slowly charged through series resistor 79 from the B+ plate supply. A gas triode 78 with series cathode resistors 81 and 83 periodically discharges this condenser 80 when

its potential rises to a certain value. Cathode bypass condenser 82 maintains the cathode at an average positive potential which prevents a continuous discharge of condenser 80.

Each time condenser 80 is discharged a positive pulse will be developed across resistor 81. This pulse will be passed on through condenser 84 to the control grid of gas triode 91.

In order to properly synchronize the operation of the circuit of Fig. 5 with the standard auto head 2 and commutator wheel 4 a 60-cycle synchronizing voltage is fed into the control grid of triode 78 through condensers 75 and 76. By adjustment of variable resistor 79 the frequency and synchronism of the pulses developed at the cathode of tube 78 are properly determined.

Gas triodes 91 and 92 comprise a "flip-flop" circuit with tube 92 being normally and stably conductive. Each pulse from triode 78 causes tube 91 to become conductive for a short interval of time but the state of conduction always returns to tube 92. Because of the above explained action a waveform like that illustrated by graph 61, Fig. 3, is developed at the cathode of triode 91. This output may be used in place of the output from commutator wheel 6.

A circuit identical with that of Fig. 5 may also be used in place of commutator wheel 4. In this case drive motor 3 would not be needed.

Fig. 6 illustrates a modification of the receiving station equipment which takes the place of the arrangement shown in Fig. 2. The receiving station here shown uses vacuum tubes 106 and 108 in place of the gas tetrodes 45 and 51 of Fig. 2. The oscillator unit 40 is the same in both embodiments. Other circuit components which are the same in Figs. 2 and 6 are given like reference numbers. Also for the sake of simplicity, certain portions of Fig. 2 are not shown in Fig. 6, even though they may be essential to the operation of the alternative embodiment.

The output of oscillator 40 causes triodes 106 and 108 to be alternatively conductive since this circuit is of the "flip-flop" type. The circuit connections for tubes 106 and 108 are conventional; including, as shown, anode resistors 102 and 103, grid resistors 109 and 112, a cathode resistor 111 between ground and the cathode of tube 106, and resistors 104 and 107 for cross coupling between the anode of one tube and the grid of the other tube. The output of this flip-flop circuit is taken from the cathode of tube 106 and is of the form shown by graph 61, Fig. 3.

The operation of the circuit arrangement shown in Fig. 6 is further explained as follows: The incoming signal as shown by graph 64 in Fig. 3 develops anode potential variations at point 72 of Fig. 6. These anode potential variations are passed directly to the left-hand cathode in the twin diode tube 96 and also through capacitor 28 to control tube 30 as previously explained. The two diode sections of tube 96 in cooperation combine the incoming signal with the output from tube 106 to produce a waveform represented by graph 74 in Fig. 3. This waveform is converted into the desired output waveform shown by graph 69 by means of a conventional locking circuit 101, such, for example, as that shown in United States Patent No. 1,948,103, granted February 20, 1934, to James L. Finch.

The space paths in both sections of tube 96 are rendered normally conductive by connecting a battery 100 and a resistor 99 in circuit between the anodes and ground. The cathode potentials

are independently controllable by the potential drop in each of the two cathode resistors 97 and 98. Hence the resultant anode potential variations are reflected in variations of potential drop in resistor 99, the latter constituting a resistive coupling means for the locking circuit 101.

The output from the locking circuit 101 is communicated to a telegraph recorder 59 in the same manner as indicated in Fig. 2. In other respects, the operation of the circuit arrangement of Fig. 6 will be readily understood in view of the foregoing description.

Various other modifications of my invention may be made by those skilled in the art in view of the foregoing description, but will be understood to be comprehended within the scope of the invention as claimed.

I claim:

1. In a signaling system, a keying device arranged to transmit message code signals the marking and spacing elements of which are of dot unit length and multiples thereof, a second keying device arranged to produce a complex repeating pattern of marking and spacing elements having a dot unit length which is an even number fraction of the first said dot unit length, means for synchronously combining the effects of the two said keying devices to produce an enciphered signal train wherein discontinuities are introduced into the marking elements of said message code signals, receiving apparatus responsive to said enciphered signal train, a time delay device associated with said receiving apparatus and arranged to elongate the received marking elements of said enciphered signal train in such manner as to cancel said discontinuities, and means for combining the effects of said time delay device with the received train of enciphered signals in such manner that the intelligence of said message code signals is restored.

2. In a code signal transmitting system employing marking and spacing code elements which are of dot unit length and multiples of that length, the method of enciphering said code elements which includes periodically mutilating certain but not all of the marking elements of said signals by interrupting their continuity during time intervals which represent an even fraction of the time interval of a dot code element.

3. In a code signal receiving system employing marking and spacing code elements which upon reception are characterized by cryptic discontinuities in their marking elements of dot unit length and multiples of that length, the method of deciphering said code elements to restore their message significance which comprises generating control pulses at an even harmonic frequency with respect to the dot unit frequency of the message signals, producing "fill-in" potentials during limited time intervals which commence with said control pulses and are coextensive with said cryptic discontinuities, and combining the effects of said "fill-in" potentials with those of the received code elements to produce a train of message signals.

4. The method according to claim 3 and including the step of synchronizing said control pulses with the steep wave fronts of the received marking code elements.

5. An enciphering system comprising a cryptic code element keying device arranged to deliver successive discrete trains of periodic pulses, a message keying device arranged to deliver marking and spacing signals of dot unit length and multiples thereof, the dot frequency of the message keying device being sub-harmonically re-

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lated to that of the cryptic code element keying device, means for combining the effects of the two said keying devices in such manner that a selected portion of the marking elements of the message signals are replaced by discrete cryptic code elements, and means for transmitting an enciphered train of signals composed in part of said cryptic code elements and composed in part of unmutated message code elements.

6. An enciphering system according to claim 5 and including a twin diode discharge tube in the means for combining the effects of the two said keying devices, said tube having a common output circuit connected to its two anodes, independent resistors connected between each of its cathodes and ground, a direct current source having its negative terminal grounded and its positive terminal connected to said common output circuit, and means controlled by each of the keying devices for applying positive potentials to the respective cathodes in said tube thereby to interrupt the emission of electrons from either of said cathodes alone or both together.

7. A system for enciphering code signals comprising a keying device for composing marking and spacing elements of dot unit length and multiples thereof representing message characters, a second keying device having electronic oscillation generating means for producing an arbitrary series of dot and dash symbols at a rate harmonically related to the dot frequency of the message signals, and electronic means for combining the effects of the two said keying devices.

8. A system for deciphering a signal train composed of marking and spacing elements the dot unit frequency of which bears a harmonic relation to the dot unit frequency of certain message signals into which said train is to be resolved, said system comprising electronic oscillation generating means for producing a periodic train of pulses, electronic means controlled by said pulses for developing a rectangular wave, a twin diode discharge tube for combining the effects of said signal train as received with the effects of said rectangular wave, and means responsive to the operation of said tube for recording said message signals.

9. A system in accordance with claim 8 and in-

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cluding means for synchronizing said oscillation generating means with the received signal train.

10. In an enciphering and deciphering system employing a signal train composed of marking and spacing elements wherein the dot signal is of unit length duration and other elements are an integral multiple of said unit length, and wherein the basic dot unit length of a message signal train is also an integral multiple of said unit length, the method of rendering signals unintelligible during transmission and of restoring the original intelligence thereof upon reception, which comprises combining said message train with an arbitrarily composed series of spacing elements of the first said unit length, the intervening marking elements of said series being partly of the first said unit length and partly of an integral multiple of that length, said spacing elements being effective to disintegrate the coincident marking elements of the message train, and restoring the marking elements of the message train by filling in the spacing gaps produced by such disintegration.

11. In a code signal transmitting system employing marking and spacing code elements which are of dot unit length and multiples of that length, the method of enciphering said code elements which includes mutilating all of those marking code elements which are of multiple dot unit length and only certain ones but not all of those marking code elements which are of dot unit length by interrupting their continuity during time intervals which represent substantially an even fraction of the time interval of a dot code element.

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REFERENCES CITED

The following references are of record in the file of this patent:

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