

April 24, 1945.

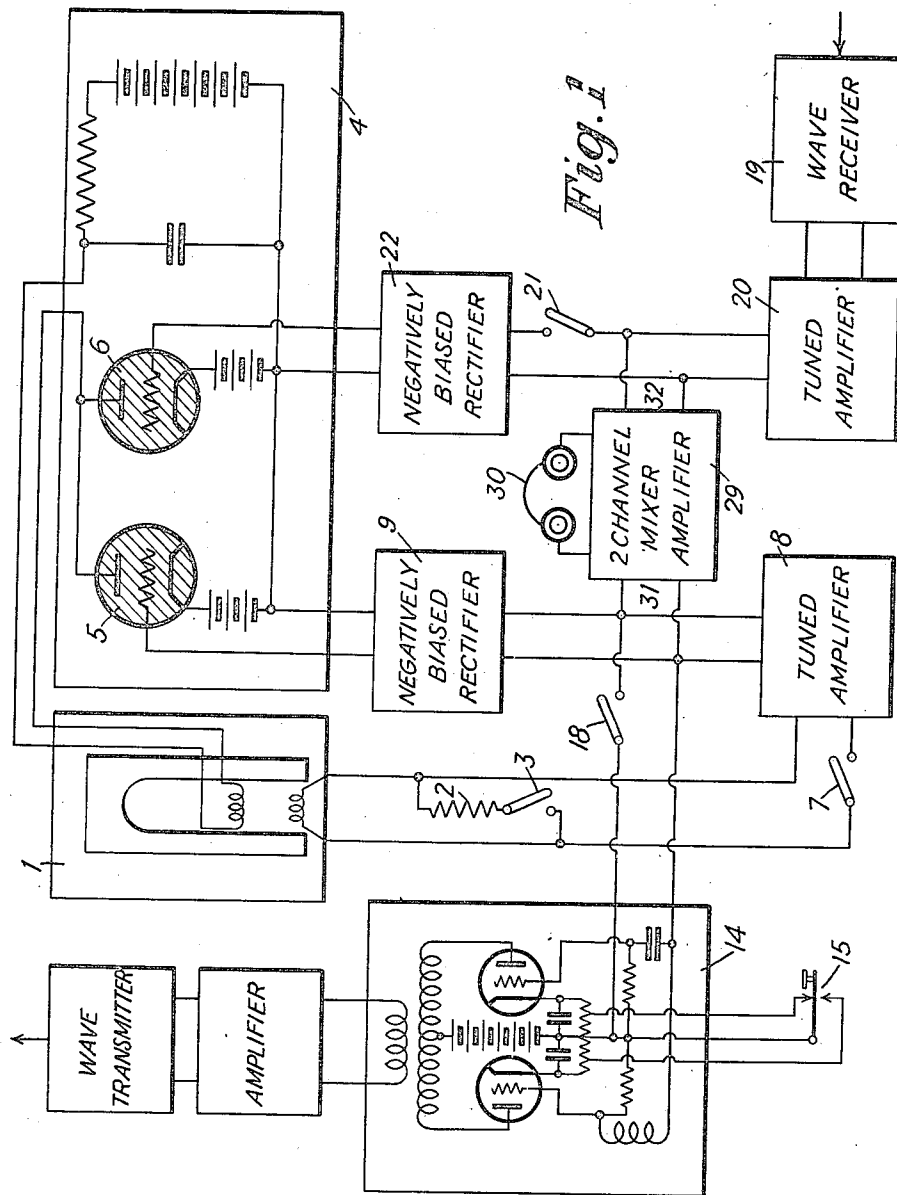
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2,374,495

'SECRET SIGNALING SYSTEM

Filed Sept. 18, 1943

2 Sheets-Sheet 1



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2,374,495

SECRET SIGNALING SYSTEM

Filed Sept. 18, 1940

2 Sheets Sheet 2

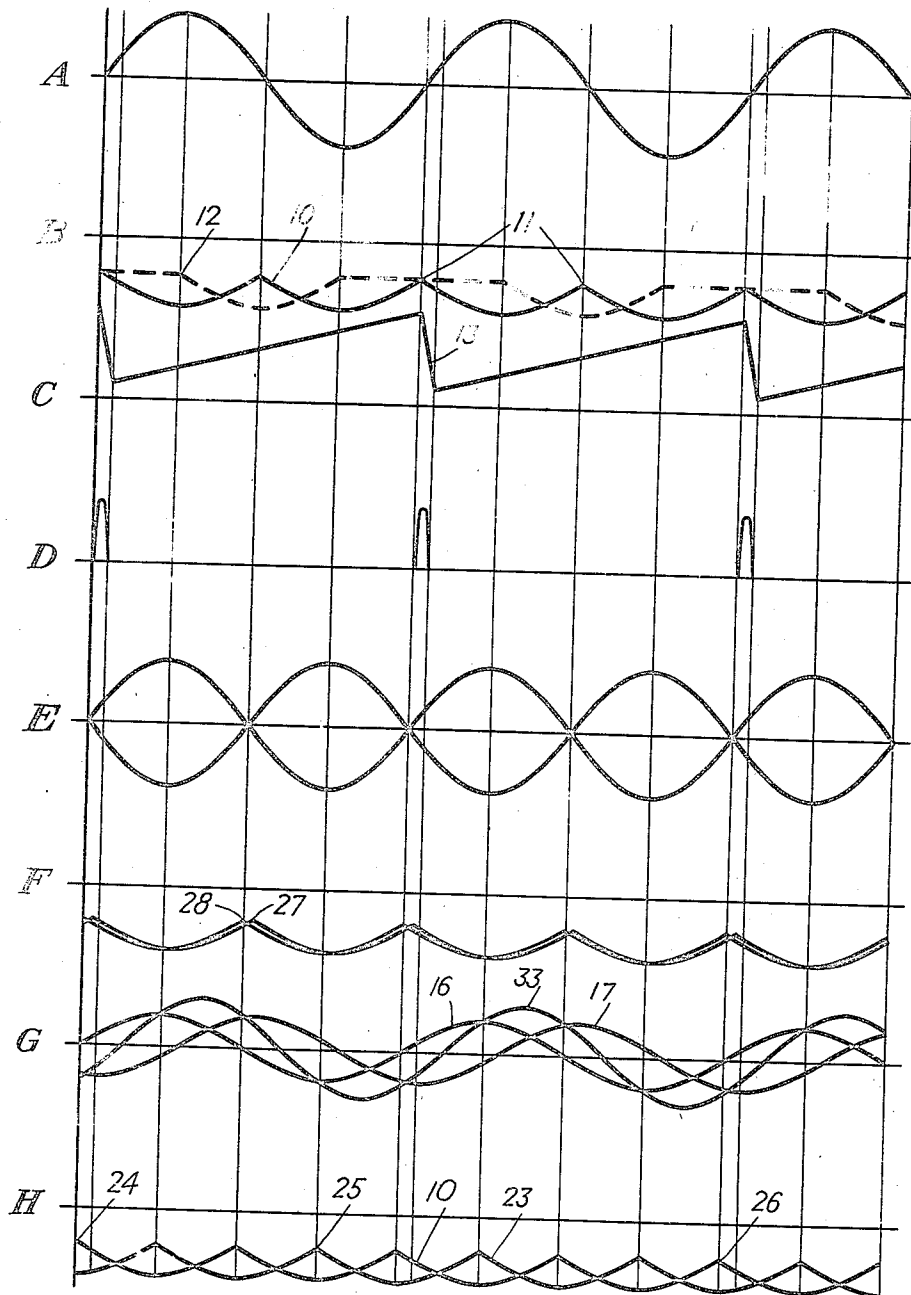


Fig. 2

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2,374,495

SECRET SIGNALING SYSTEM

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Application September 18, 1943, Serial No. 502,893

9 Claims. (Cl. 178-66)

The present invention relates to signal wave transmission and signal wave reception, in which the waves may be propagated by any suitable means whatever and through any medium capable of transmitting wave motion of any kind and relates in particular to such systems possessing the property of secrecy and specifically to submarine signaling.

Among the objects of this invention are; to provide a broadly novel system of code signaling which is not subject to code detection by any receiver of the prior art; to provide such a system that is capable of operation in any of the known media of wave propagation and to provide such a system that is simple in structure and dependable in operation.

The spirit of this invention may be employed in, or applied to, systems of signaling by means of sound waves through air, solid media or through water, by means of electric waves of current through a conducting medium, by means of magnetic induction waves through space and other media, by light waves through translucent media and by any other means capable of wave propagation.

A specific object of this invention is to provide a system of signal transmission for code work, in which the reception is not as much subject to interference as in the case of amplitude modulation systems and therefore the invention is particularly suited to equal unit code transmission and reception, such as the Baudot code used in mechanical teleprinter operation, which is extensively known to be critically subject to amplitude interference.

In the prior art of code signaling by wave motion where phase modulation has been employed, a carrier-wave usually displaced 90 electrical degrees from the original carrier position is propagated with the modulated wave so that phase detection is possible at the receiving station. Without the reception of a correlated carrier-wave, detection of phase modulation is not possible. In this statement the word "carrier-wave" may be construed to be any frequency by which the phase of the modulation in the detector circuit may be determined.

In the present system, the carrier frequency or in effect the reference frequency by which the phase detection is accomplished, is achieved by a novel detecting circuit which in effect provides its own carrier-wave in its proper phase position and corrects to maintain it in the proper absolute phase angle.

Rather than try to teach the employment of

this invention in its broadest terms and with its greatest refinements of engineering detail, this disclosure will be limited to a simple embodiment of an operative structure which is well suited to teaching the art without extensive engineering refinements.

One of the principal spirits of the invention resides in the fact that the transmitting medium may have but a single frequency transmitted through it at a constant amplitude with only a slight phase shift due to signal modulations therein. Such a transmitted wave is not subject to signal detection by any receiver of the prior art and therefore, since the present receiver is a highly specialized device, the secrecy of such a method of transmission is of a high order and for all practical purposes absolute in the absence of a proper receiver.

It is not claimed that the directional properties of the transmitter are secret but only the modulation character of the transmitted wave. Further features and other objects will be apparent after reading the following description, considered in connection with the accompanying drawings in which Fig. 1 is a diagrammatic exposition of an embodiment of the invention as a combined transmitter and receiver; and Fig. 2 is a series of graphs illustrating the operation of the system steps.

Referring to Fig. 1, 1 is a source of constant frequency, which may be an electrically driven tune fork, which may have any degree of constancy up to one part in 1,000,000 and of which there are common examples on the market in use in watch recorders having an accuracy of one part of 100,000. 2 is a loading device which may be imposed upon source 1 by closing switch 3.

It will be appreciated by those skilled in the art that the period of any oscillatory system can be increased in length or the frequency may be decreased, in other words, the system may be made to oscillate at a slower rate by the imposition additional loading.

The oscillating system 1 runs at a highly standardized frequency with the switch 3 opened and with the switch 3 closed, the oscillating system is loaded just sufficiently that it cannot drift into a higher frequency than its standardized operating limit, the full purpose of this will be fully brought out hereafter.

The apparatus enclosed in area 4 is shown as a simple relaxation oscillator having two gaseous triodes 5 and 6. The relaxation circuit is triggered by either one of the said triodes 5 and 6 and the plate current from the said triodes serv-

ing as driving energy for the oscillator illustrated in the area 1.

With the switch 3 opened and the switch 7 closed, the output voltage of the oscillator 1 is fed through the tuned amplifier 8, through the negatively biased rectifier 9, which serves to trigger the gaseous triode 5.

Referring to Fig. 2, the curve along the abscissa A represents the input voltage of rectifier 9, Fig. 1. The curve 10 along abscissa B, Fig. 2, represents the output of negatively biased rectifier 9, that is, rectifier 9 is a full wave negatively connected rectifier having considerable negative bias.

By employing such a method the gaseous triode 5 is triggered by voltage points shown at 11, Fig. 2, which occur at the zero position of the alternating current wave, giving a high precision of phase position between the triggering voltage of the triodes and their output currents. It will be appreciated that in all synchronizing methods in which an unrectified sine wave is utilized to lock in circuits, the locking position is necessarily an indefinite one, due to the locking point being indeterminate by reason of the various different rates-of-change in the slope of the applied sine curve. In the present method, the locking position being at the zero point, this indeterminate position is eliminated and a highly accurate phase fixation is achieved.

In practice, I may sometimes combine with wave 10 a half wave of rectification 12, Fig. 2, which eliminates every other triggering point, as will be understood by those skilled in the art, upon inspection of the curve.

As will be pointed out further on, in the present embodiment I only use every other zero point in curve 10 and the intervening points are useless, but the description of the operation will be limited to that without the use of curve 12.

Curve 13, Fig. 2, along the abscissa C represents the familiar saw-tooth voltage of the relaxation oscillator 4 and the short period impulses along abscissa D represent the driving current supplied to oscillator 1.

It is appreciated by those skilled in the art of accurate timing, that any oscillating system more closely follows its own natural period and is less influenced to force oscillations, the shorter the period that the driving energy is applied to the system, so that this method of short impulse driving power for oscillator 1, is conducive to a high order of constancy of frequency in the oscillator shown in area 1, by the same token that this is true in astronomical pendulums.

With the oscillator 1 operating at its standardized frequency, and with 18 closed, the output of tuned amplifier 8 is fed to the phase modulation device 14, which in the present case consists of a push-pull circuit with the tubes operating 90° out of phase and means for cutting in and out one or the other by a device such as a telegraph key 15. The output of phase modulator 14 is fed into an amplifier and wave transmitter, as shown in Fig. 1.

As stated in the beginning of the specification, this wave transmitter may be any means whatever to convert the phase modulated current-wave into any of the types of propagated waves thereabove mentioned.

If the present invention is employed as a submarine signaling device the wave transmitter can then be one of the several sound wave transmitters well known in the art.

The operation of the transmitter then comprises the wave transmission through some

propagation medium of a single wave which is shifted slightly in absolute wave position, as a result of modulation.

Referring to Fig. 1, when the telegraph key 15 is in the up-position, a continuous wave is transmitted having a highly accurate fixed phase position with reference to time and space and when the key 15 is in the down-position this same wave is transmitted but with its phase position shifted backward, with reference to time.

Referring to Fig. 2, the curve along the abscissa G, identified by 16, would represent the phase position of the transmitted wave of the up-position of key 15 and wave 17 would represent the phase position of the transmitted wave for the down-position of the key, both waves having exactly the same frequency.

In the method of modulation employed, there is no energy transient in the modulation circuit proper and only an infinitesimal energy transient in the system as a whole and since this transient occurs in such a short period of time with reference to the signal length it is imperceptible in prior art detection systems.

The method of transmission then is a simple one of transmitting a wave of a single frequency and shifting it back and forth with respect to time, at the modulation points.

When Fig. 1 is to be utilized as a receiver of such a wave as has been described, the transmitting circuit may be electrically disconnected from the oscillator by opening switch 18, leaving switch 7 open and closing switch 3, the oscillator 1 being now at rest since no driving energy is being received by it.

When an unmodulated wave, from a distant transmitter similar to 14, is received by wave receiver 19, the resultant current passes through tuned amplifier 20. By closing switch 21, the received wave is fed through the negatively biased rectifier 22, which in turn operates the gaseous triode tube 6 in an exactly similar manner to that heretofore described for the circuit connected with gaseous triode 5, the difference being that oscillator 1, under this set of conditions, is, by the principle of forced oscillation, made to not only follow the frequency of the incoming wave but adjust itself perfectly to its relative phase position.

In this way oscillator 1 is forced to assume the phase position of the transmitted wave sent out by the wave transmitter from a distant station, having a phase position corresponding to the up-position to the key 15 in Fig. 1, in the distant station. Thus the phase position of the unmodulated wave from the transmitting station is established in oscillator 1, operating as a part of the receiving station.

So long as oscillator 1 is driven by the received wave it will follow its frequency and phase position even with the switch 3 closed, as is now its position, as is understood by those skilled in the art.

However, upon closing switch 7, the oscillator will follow whichever triggering voltage point occurs first.

Referring to Fig. 2, curve C, after the voltage of the relaxation oscillator has been triggered as shown in curve 13, the value of this voltage drops to such a low point so rapidly that any subsequent triggering voltage has no effect upon it until the voltage has had time to regain nearly its maximum value.

If, after oscillator 1 has been phased with an unmodulated incoming wave and if switch 21 were

opened, the frequency of oscillator 1 will be reduced slightly, say to one part in 10,000 below normal, in which case the voltage wave output of this oscillator will drift backwards in phase relation slightly.

However, if switch 21 is allowed to remain closed and the phase position of the triggering voltage applied to gaseous triode 6 is suddenly shifted backwards, the tube 6 will lose control of the phase position of oscillator 1, and oscillator 1 will continue to oscillate in its original phase position with the exception of the slight drift backward.

When the received wave is reestablished to the unmodulated phase position of the standardized oscillator in the distant station, gaseous triode 6 again takes control of the phase position oscillator 1 and reestablishes it back in its standardized position. This will be more fully understood with reference to Fig. 2 in which curve 10, abscissa B, represents the triggering voltage of both triodes 5 and 6, when the triggering voltages are in phase and therefore illustrated by the single curve 10. This represents the case when the key in the distant station is in the up-position. When the key in the distant sending station is in the down-position, the triggering voltages are represented along abscissa H, Fig. 2, curve 10 remaining in the same phase position and curve 23 being shifted 90° behind curve 10. Because of the fact of the voltage drop in curve 13, abscissa C, Fig. 2, and its subsequent slow rise, this voltage does not reach a value which will permit the tubes to be triggered by any subsequent triggering voltage until a complete cycle has elapsed. In other words, only at points 24, 25 and 26, abscissa H.

In fact, however, for long periods of holding the key 15 in the down-position the local oscillator 1 will have a tendency to drift slightly, as illustrated along abscissa F by the curve 27, which is slightly behind the relative standardized position so that when the key in the distant station is returned to its up-position and the transmitting wave is advanced to its standardized phase position, the triggering voltage on triode 6 will be slightly ahead of the triggering voltage for triode 5 and which advanced position is illustrated by curve 28, abscissa F, Fig. 2. In this way the phase position of the oscillator is returned to its standardized position, or as it is referred to in telegraph engineering, it is in this way corrected.

Between the local oscillator circuits and the receiving circuit is a two-channel mixer amplifier 29, supplied with a translating device 30. These mixing channels are so constructed that when the key in the distant sending station is in the up-position, the voltages in the translating device 30 exactly neutralize each other, as is shown along abscissa E, Fig. 2. When the key is in the down-position at the distant transmitting station, the phase position of the input side 31 of the amplifier 29 remains substantially in its original phase position, as can also be illustrated by curve 16, Fig. 2, and the voltage across the channel 32 of amplifier 29 is shifted back to a position which can also be illustrated by curve 17, Fig. 2, the vector sum of which is illustrated by curve 33, which represents the signal current in translating device 30, which is present under the system of operation for the key in the distant sending station in the down-position and the current in translating device 30 being substantially zero with the key in the up-position, as above explained.

It will be appreciated by those skilled in the art,

that the phase correction method herein described is obviously applicable, without invention, to amplitude modulation where phase shift is not employed.

It will be further appreciated by those skilled in the art, that the present invention when embodied in a voice frequency carrier code telegraph system, may be further modulated upon a second carrier-wave, such as a radio frequency carrier-wave, by well known engineering procedure without further invention.

The term "carrier" as employed herein, is hereby defined to mean that prime unmodulated frequency which is employed in the transmitter in fixing the modulation characteristics of the signal frequencies transmitted and the corresponding prime unmodulated frequency which is employed in the receiver to determine the modulation characteristics of the signal frequencies received.

The foregoing description has been limited to a simple embodiment well adapted to teaching the spirit of the invention but the scope thereof is covered in the claims hereunder.

What I claim is:

1. In a carrier phase-modulated-wave communication system in combination, sending terminal equipment for transmitting one frequency of wave propagation, when modulated, modulated by absolute phase position, a transmitting path to a receiving station, receiving terminal equipment including a local oscillator to determine the modulation of the received signal wave, the phase position of said oscillator being responsive to the unmodulated phase position of said wave and to the unmodulated position only, and detection means responsive to the modulated position of said wave.

2. In a telegraph signal system receiving terminal equipment in combination, a local alternating current generator for timing in the reception current, a source of periodic current for driving said generator, said source being provided with two timing elements, each and either, for fixing the period thereof, and said source being responsive to either timing element during any one timing period thereof but not responsive to both during any one timing period thereof.

3. In a telegraph signal system receiving terminal equipment in combination, a local alternating-current generator for timing received signal current, a source of periodic current for driving said generator, said current having an independent frequency below that of the received signal current, said source being provided with two timing elements, each and either, for fixing the period of said current, one of said timing elements being responsive to the frequency of the signal current received, the other of said timing elements being responsive to the said source per se, and frequency of the said source being determined by either timing element during any one timing period thereof but not determined by both timing elements during any one timing period thereof.

4. A system of phase-modulated carrier-wave transmission and reception having station terminal equipment for transmission of signals at a predetermined wave frequency, a transmitting medium, station terminal equipment for reception of signal waves including a local oscillator having its phase position corrected by said carrier-wave during periods of unmodulated carrier-wave reception, and means in said equipment providing for the operation of said oscillator, uncorrected by said carrier-wave, at a frequency less

than that of first said frequency during periods of modulated carrier-wave reception.

5. A system of phase-modulated carrier-wave transmission and reception having, station terminal equipment for the transmission of said carrier-wave, a transmitting medium and station terminal equipment for the reception and detection of said wave, and said equipment including a local oscillator with a correction means therefor responsive during intervals of reception of unmodulated carrier-waves and during said intervals only.

6. In a system of phase-modulated carrier-wave transmission and reception providing marking and spacing signals through a transmitting medium, transmission and reception equipment, and detection means in said reception equipment including a local oscillator corrected during reception of said marking signals and during said reception only.

7. In a system of phase-modulated carrier-wave transmission and reception providing marking and spacing signals through a transmitting medium, transmission and reception equipment, and detection means in said reception equipment including a local oscillator corrected during reception of said spacing signals and during said reception only.

8. In a phase-modulated carrier-wave communication system operating at a predetermined

transmitting frequency in combination, transmitting terminal equipment for phase modulation of said carrier-wave, a transmitting path to a receiving station, receiving terminal equipment including a local oscillator free of correction to operate at a frequency less than aforesaid frequency during the reception of modulated signals, and means in the receiving terminal equipment for correcting the frequency of the said local oscillator during the reception of unmodulated signals.

9. In a system of phase-modulated carrier-wave transmission and reception having station terminal equipment for transmission and reception of signals, transmission terminal equipment for the generation and transmission of a carrier-wave having a fixed time phase position, means in last said terminal equipment providing modulated time phase position transmission of said carrier-wave under signal operation, a transmitting medium, reception terminal equipment including a local oscillator for the detection of last said transmission, and means in last said equipment providing the correction of said oscillator by received carrier-waves having said fixed time phase position and providing operation of said oscillator free of said correction by said carrier-waves having modulated time phase positions.

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