Nov. 9, 1948. 2,453,659

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SECRET TELEGRAPH SIGNALING

Filed Dec. 21, 1942 2 Sheets-Sheet 1

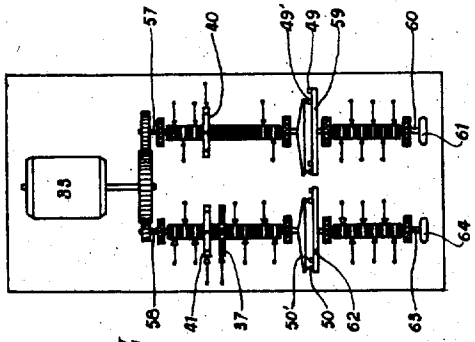


Fig. 4

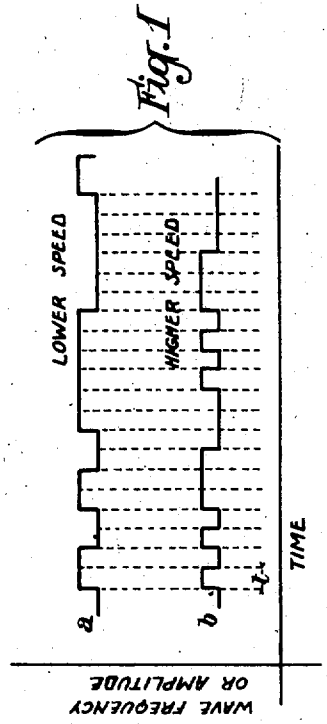


Fig. 1

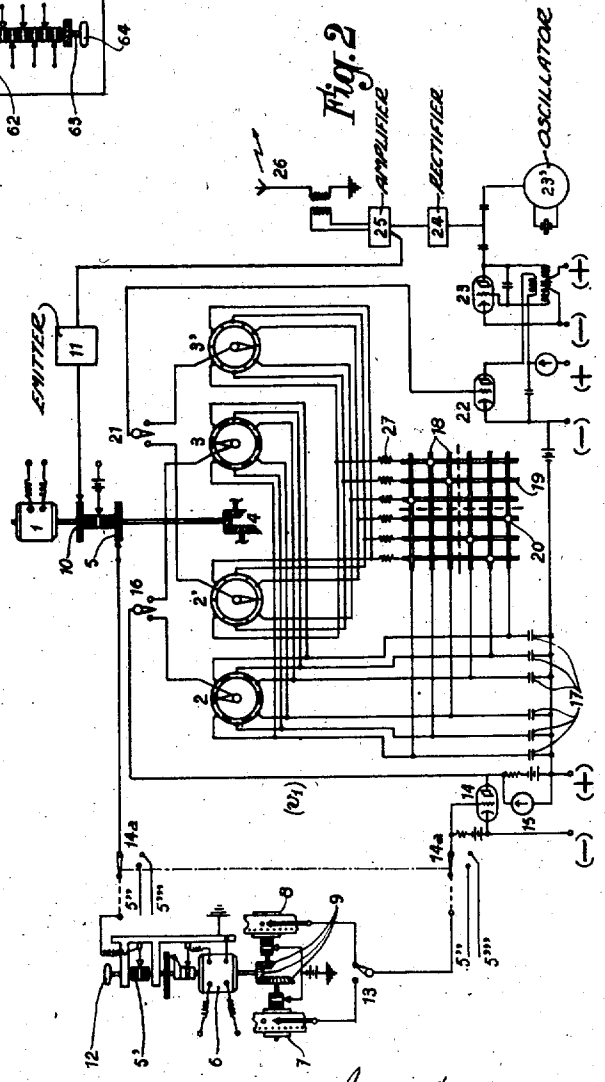


Fig. 2

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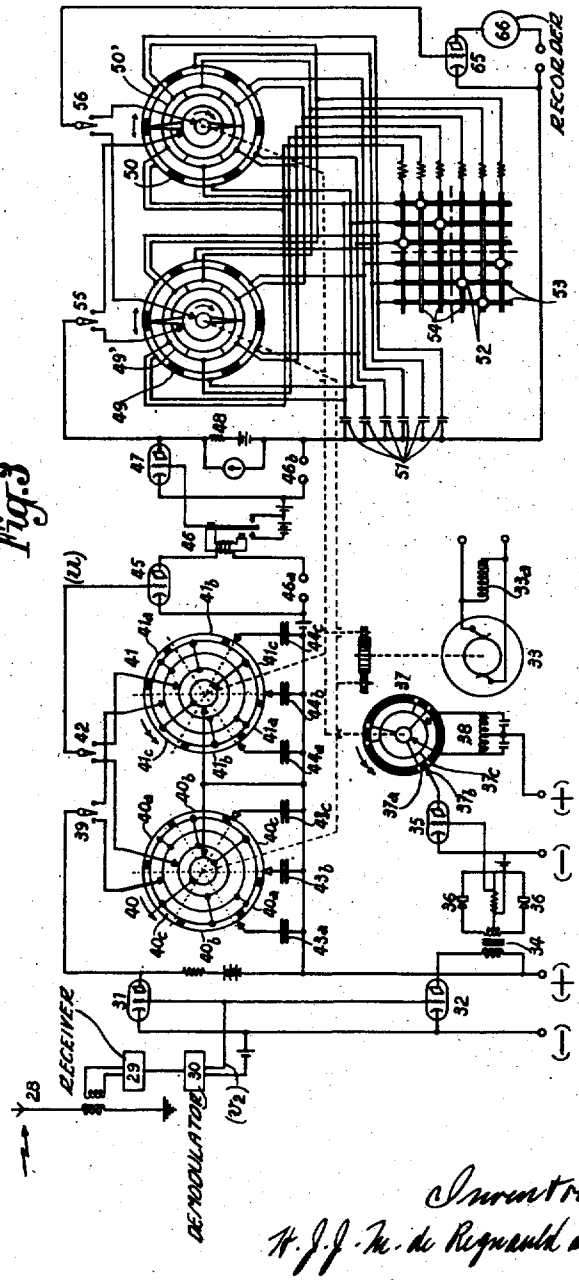
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Fig. 3



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SECRET TELEGRAPH SIGNALING

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Patent expires December 12, 1961

7 Claims. (Cl. 250—8)

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My invention relates to telegraph methods and systems wherein means are provided to secure a secret service by permuting at the transmitter the successive code elements of unit length combined so as to form telegraph characters, and by restoring the normal order of these elements at the receiver.

In my prior U. S. Patent No. 1,612,101 I have described an electric transmission system comprising two machines operating in cooperation, the first one being an automatic keying device which alters the telegraph code while the second is a printing machine adapted to operate in accordance with the altered code. Such a system however involves a number of drawbacks. In the first place its operation becomes uncertain as soon as the unit elements are disturbed by statics and/or by fading; in such a case the current generated by each element in the receiver varies at random and the effect to be retained to represent the sign becomes undetermined; for instance if the said effect is the final intensity of the received current, it may occur that the only part of an element which has undergone a serious disturbance is just the end thereof, in which case this element becomes unidentifiable while it would have been satisfactorily read by means of an undulator. Moreover a given signalling apparatus is unable to match any kind of service and its keying speed cannot be adapted to the highly variable transmission conditions. Finally the synchronizing and phase adjustment are slow.

One object of my invention is to secure a secret telegraphic service over the link connecting two wire networks supplied with keying and recording devices of any kind, provided that their respective telegraph characters may be divisible into successive unit elements having the same duration. Therefore, each signal may be in plain or ciphered language and the kinds of its unit elements are not limited to two as in the Morse and Baudot codes; and the common duration of these elements may be varied at will by the operators as explained below. This is obtained by synchronizing the frequencies or rhythms of the signalling system, Wheatstone or Baudot, for instance, and of two pairs of distributors, one being adapted to control the modulation at the transmitter while the other collects electric current issuing from the receiver. These two groups divide the time into intervals which coincide with the durations of the successive unit elements issued from the signalling device. The transmitter pair comprises two distributors, the first one delivering the incoming elements to devices, such as

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condensers, which store their respective effects, while the second one collects the said effects in a different order and applies same to the modulator. The change in the order may be varied at will by changing the connections between the two distributors. The receiving pair is identical except that its internal connections are so arranged that when its inlet distributor receives the elements in the altered order chosen at the transmitter, its outlet distributor restores the normal order before supplying the elements to the recording or printing apparatus.

Another object of my invention is to devise the secrecy apparatus so as to ensure better immunity against disturbances than usual recording systems, undulator for instance. The secrecy apparatus has therefore to clearly define the effect which is to be retained at the receiver responsive to each code element in order that the latter may be restored at its normal place. This is obtained by deriving the said effect from the whole of the detected current corresponding to the element, or at least from a part thereof as important as permissible with respect to the accuracy of synchronism between time divisions of distributors and keying. The distributor pair at the receiver is therefore provided with an additional distributor which collects the detected current during the largest possible portion of each element, the quantity of electricity supplied by said current being stored in a condenser and the effect designed to represent the element being the voltage of the condenser when it has thus been charged.

Pursuant the above object, a preferred form of my invention consists in combining the method of secrecy characterized by altering the unit elements order at the transmitter and restoring it at the receiver, with the radio-signalling method disclosed in my Patent No. 2,176,168 dated October 17, 1939. On account of this combination, automatic handling of received signals will now enjoy better conditions under statics and fading than those allowed of by the lecture of an undulator tape, instead of much worse conditions as it previously happened in secrecy systems. The said signalling method, which may be carried out by transmitting the unit elements on frequencies $F+f$, $F-f$, and eventually F, comprises managing the receiver so as to translate these elements into detected currents +I, or −I, or zero, respectively, and statics stronger than the signal wave into currents varying at random between +I and −I. According to probability calculation, it results therefrom that even under largest statics the quantity of electricity stored by the

condenser at the end of any one of the unit time intervals for determining the effect responsive to this time interval cannot exceed a given amount of the normal charge due to a correct sign. Consequently, the said method also comprises comparing the charges successively collected from the additional distributor to suitable thresholds so as to distribute these charges into three classes which determine the production of definite effects, such as $i_1 i_2$, and i_3, respectively, whereby effects i_1 or i_2 will affirm the reception of corresponding code elements $F+f$ or $F-f$, whereas all injured elements indistinctly lead to the third effect i_3. Thus, the received signal is restored into its standard form before being applied to the set of secrecy distributors, save the injured elements which may be caused to produce a special mark denoting uncertainty.

A further object of my invention is to permit of adapting keying speed to the varying conditions of ether in a secret communication system of the kind above described. This is obtained by the following means: (1) For each keying speed which may be used there is provided a corresponding set of keys and distributors, and switches are disposed to permit operation by means of any desired set at any time and without any delay for passing from a set to another; (2) the different keying speeds are so selected that the corresponding durations of elements are multiples of a given time unit; (3) the phase relations between the keys and distributors of the sets are such that the transitions between code elements at the lowest keying speed are coincident with transitions at the more rapid speeds.

Another object of my invention is to permit easy changes in the keying speed. It will be observed that the means above referred to under (2) and (3) imply that the keying speeds are derived from a common time division. This permits to synchronize the driving motors of the receiver distributors or of the keying devices dispersed over the wire telegraph network, by means of electric currents or hertzian waves modulated in accordance with the said time division. The keying speed may thus be changed without any re-synchronizing operation and even there occurs no loss of synchronism if, through any mistake, the receiver is adjusted on a keying speed different from the speed actually used at the transmitter.

The waves or currents adapted to synchronize the keying devices eventually scattered on the sending telegraph network as well as the receiver distributors, are issued from a central place, such as the radio station, and they are modulated in accordance with the time division corresponding to the distributor set of this station. The said waves or currents may be independent pilot waves, or they may be the signal wave itself according to a method wherein the transitions between code elements are caused to produce unidirectional impulses which in turn control the speed of the driving motors to be synchronized.

Still a further object of my invention is to shorten the operations by means of which keying devices and distributors are brought into synchronism. According to the known methods the period of the synchronizing wave or current should be equal to the duration of the groups of unit elements within which the elements order is permuted for secret purposes. And since the number n of elements in each group must be rather high in actual practice to avoid deciphering (for instance $n=12$), this period is relatively large

and getting locked synchronisms by means of such a wave or current would be rather slow. According to my invention the synchronizing wave or current is modulated with a much shorter period, preferably equal to the duration of the code element at the lowest keying speed whereby synchronism is rapidly obtained. But with such a synchronizing method a distributor may be synchronized at any one of n angular positions with respect to the master distributor or keying device and one only of these n positions is correct. In order to permit accurate adjustment, my invention provides that the stators of the synchronized apparatus may be manually adjusted as to their angular relations.

To sum up, my invention secures a secret radiotelegraphic service only bound to make use of code characters divisible into unit elements of given length. At the transmitter, the ciphering device admits the incoming series of such elements assembled according to telegraph codes of any kind indifferently, periodically distributes these elements into groups containing a definite number of them, permutes their order in each group, and delivers them to the modulator and to the link which connects the wire networks. At the receiver, where the signal wave may be injured by statics, and other interferences, each unit element is individually restored to the standard form required for deciphering operations by means of an accumulation effect substantially embracing its whole duration, then the series of standard effects is separated into groups corresponding with those at the transmitter, the effects are permutated again in each group so as to recover their normal order, and finally the signal current is delivered to a suitable recording device.

The advantages secured by this system are obvious: hitherto barred by interferences, secret radiotelegraphic service will become possible, because the signal current is restored into the standard form required by automatic ciphering. Attempts to unauthorized deciphering will have to face an undetermined problem, due to the lack of correspondence between the definite groups of the ciphering device and the telegraph characters which are allowed to change at will; the elements of a given character may be shared among successive groups; and those of several successive characters mingled and dispersed within a same group, whereby these characters entirely lose their individuality; for instance groups of 12 elements will contain 2.4 characters of a 5-elements Baudot code, ⅔ of the number "0" in the Morse code where a dash is equivalent to three dots, and so on; moreover, such permutations are varying at random owing to the changes occurring in telegraph characters as well as in phase relations between characters and groups, and their possible number may be increased at will by merely enlarging the groups which are freed from any limitation since independent of the telegraph codes; the recited 12 elements groups authorize $(6!)^2=518{,}400$ combinations. Thus, a secret service of high quality is put at the disposal of the public by merely encouraging him to use common signalling apparatus matching his needs and resources, from the most expensive sets to the telephone. Together with this condition, a fundamental one since designed to vulgarize the practice of wiring at home, the hertzian link is managed so as to amalgamate the telegraph networks scattered over the world, by automatically securing the secret transfer of the series of varied

messages directly exchanged between their customers.

In other terms, the present invention discloses the indispensable intermedium between wire networks through radio channels.

In the annexed drawings:

Fig. 1 is a diagram showing frequency or amplitude variations of the radiated wave at two keying speeds.

Fig. 2 diagrammatically shows the distributor set at the emitter.

Fig. 3 illustrates the distributor set at the receiver.

Fig. 4 is a plan view of a double distributor set at the receiver.

In Fig. 1 the telegraphic signal represented is the letter "w" according to the Morse code (two successive dots and one dash). The ordinates represent amplitude or frequency variations respectively, according as the radiated wave is modulated in amplitude or in frequency. t is the time unit controlling time division. Curve a corresponds to the lower keying speed and curve b to the higher speed. The speed ratio is equal to 2.

It will readily be understood that the number of different speeds may be varied at will. For instance there might be provided a third speed wherein the duration of a dot would be $3t$ or more. On the other hand, the duration of a dot could be $2t$ (as in curve a) at the higher speed and $3t$ at the lower one, the speed ratio then being fractional and equal to 3/2. It will also be understood that the invention is not limited to codes based on combinations of two different elements, such as the Morse code, but may also be carried into practice with a three-element code, for instance with a code using frequency modulation above and below a basic value F, the three elements then corresponding to the frequencies $F-f$, F and $F+f$.

In Fig. 2, 1 designates a master motor rotating at constant and stable speed. The said motor drives two sets of transmitting distributors 2, 2' and 3, 3' through gears 4, each distributor comprising a rotating brush cooperating with fixed sectors. In the example shown, which corresponds to the case of Fig. 1, the speed ratio between 2, 2' and 3, 3' is equal to 2. Motor 1 also drives a distributor 5 which synchronizes through a controlled distributor 5' another motor 6 adapted to drive keying devices 7 and 8 through gears 9, the speed ratio between 7 and 8 being equal to the speed ratio between 2, 2' and 3, 3', i. e. to 2. By means of different lines 5''5''', the master distributor 5 may simultaneously control in the same way other keying devices of any kind scattered over the telegraph network connected to the radio-transmitter; provided that all of them work according to the same time division, they may use various telegraph codes and speeds.

Motor 1 may also drive another distributor 10 which modulates a pilot wave adapted to synchronize the receiver apparatus when the signal wave is not used for this purpose. The pilot emitter is indicated at 11.

Distributors 5 and 10 operate with a very short period, which is preferably equal to the duration of the code element at the lower keying speed, i. e. to $2t$ in the case of Fig. 1. As it has been explained, this permits rapid synchronizing of the controlled motors. In order to bring the time divisions of keying devices 7 and 8 into coincidence with those of distributors 2, 2' and 3, 3' respectively, the phase position of the stator at

distributor 5' may be adjusted at will by means of a manual handle 12.

A two-way switch 13 permits operation either with keying device 7 or with keying device 8. Current impulses from the operative keying device are transmitted through a switch 14a to an amplifier 14 the plate circuit of which is provided with a potentiometer 15 so adjusted that the voltage difference between its terminals is $-v_1$ or $+v_1$ responsive to operation of the keying device.

One terminal of the said potentiometer is connected to a two-way swtch 16 whereby voltage differences may be applied to the rotating brush of distributor 2 or 3, the fixed sectors of which are individually connected to a number of condensers 17. The other terminals of condensers 17 are connected in parallel with the second terminal of potentiometer 15. Due to this arrangement, each condenser 17 receives a charge $-v_1$ or $+v_1$ according to the kind of element collected by the corresponding sector. Of course correct operation requires that motor 6 should be properly synchronized and adjusted and that distributor 2 (or, respectively, 3) should be in operation when keying device 7 (or, respectively, 8) is operative.

The sectors of distributors 2 and 3 are also individually connected with a set of six bars 18 and there is also provided another set of six bars 19, at right angles with the former. Bars 19 are respectively connected with the six sectors of distributors 2' and 3'. And in each half of set 18 every bar may be connected by means of a removable plug 20 with any bar of the corresponding half of set 19. It will easily be understood that the rotating brushes of distributors 2' and 3' collect the electric charges of condensers 17 in an order which depends upon the respective positions of plugs 20.

The charges or voltages thus collected are led to a two-way switch 21 which permits operation either of distributor 2' or of distributor 3' and they are applied to the grid of a tube 22, thus causing resistance variations in the output circuit of the latter. This output circuit is coupled with an oscillator 23 the frequency of which is thus varied in accordance with resistance variations within tube 22. There is also provided a quartz-controlled master oscillator 23' and the signal wave is obtained by causing oscillators 23, 23' to interfere in a rectifier 24 whereby this wave assumes in turn frequencies $F+f$ and $F-f$ responsively to voltages $+v_1$ and $-v_1$ for respectively representing the two kinds of code elements. It is amplified in 25 and radiated by the aerial 26 together with the eventual pilot wave from emitter 11.

It will be observed that distributors 2 and 3 have their sectors separated by a dead angle, i. e. these sectors are shorter than the angle

$$\frac{2\pi}{n}$$

(or 60° in the example illustrated) corresponding to the division of the circle between the successive elements of each group of n elements. The object of this arrangement is to avoid that, owing to the slight imperfections in the phase relation of motor 6 with respect to the master motor 1, a brush might contact a given sector while the element corresponding respectively to the last or next sector is not yet finished or already beginning.

Resistances 27 are provided between bars 19 and the sectors of distributors 2' and 3' to avoid

condensers 17 being discharged in the very short instant during which the respective brushes of said distributors simultaneously contact two adjacent sectors.

While I have shown distributors 2, 2' and 3, 3' with only six sectors for the sake of clearness, it is understood that in practice more should be provided, twelve being an appropriate number.

The radiated wave, which is modulated in frequency (the two kinds of code elements corresponding to frequencies $F+f$ and $F-f$ in the example shown), is received by the receiver aerial 28 (Fig. 3). It is passed through the known circuits 29 adapted to ensure selection, amplification, frequency changing, frequency drift neutralisation, amplitude control, etc. And it is demodulated in 30, so as to transform the frequency changes $\pm f$ into voltage changes $\pm v_2$ which are applied to a tube 31 adapted to act on the receiver distributors and to a tube 32 acting on the synchronizing means which control the receiver motor 33. Should powerful statics dominate the signal wave in the receiver, the oscillation frequency at demodulator 30 would provisionally come under the control of said statics and vary at random from $F-f$ to $F+f$, approximate frontiers of filters 29, whereby voltages fed to tubes 31, 32 would also vary at random from $-v_2$ to $+v_2$.

The plate circuit of tube 32 comprises a transformer 34 which acts on the grid of an amplifier tube 35 through a push-pull rectifying device 36. Voltage variations resulting from the transitions between the incoming elements are thus transformed into unidirectional current impulses in the plate circuit of tube 35. These impulses are applied to a rotating commutator 37 controlling an additional exciting winding 38 cooperating with motor 33. As clearly shown in the drawings, commutator 37 comprises a number of pairs of sectors 37*a*, 37*b*, the sectors of each pair being in non-adjacent relation. The said sectors are respectively connected to one and the other terminals of winding 38 through sliding brushes while its central point is connected with the plate circuit of tube 35. When motor 33 rotates in synchronism with the time division of the incoming elements, the brush 37*c* connected to the plate of tube 35 is on the dead part between sectors 37*a* and 37*b* (position illustrated in Fig. 3) when a current impulse is delivered by tube 35 and winding 38 is inoperative. But as soon as motor 26 leads or, respectively, lags, current impulses are transmitted to a sector 37*a* or, respectively, 37*b* and winding 38 acts to increase or, respectively, to reduce the exciting field, whereby the speed is corrected. Of course the natural speed of motor 33 should be adjusted as exactly as possible by means of the main exciting winding 33*a* to reduce speed corrections to a minimum.

Commutator 37 is so arranged that it may effect one speed correction for each element at the lower keying speed. At the higher speed one current impulse is inoperative between two successive pairs of sectors 37*a*, 37*b*, which is without any inconvenience.

When the synchronizing is ensured by means of a pilot wave, the latter is directly applied to commutator 37 after demodulation.

Voltage variations from amplifier tube 31 are led to a two-way switch 39 and thence to one or the other of a pair of rotating distributors 40, 41 respectively adapted to operate at the lower and at the higher keying speed. The rotor of each distributor, 40 for instance, comprises two groups of three sectors 40*a*, 40*b*, 40*c*. Sectors

40*a* are connected by a slip-ring and brush arrangement with switch 39; sectors 40*b* are connected in the same manner with another two-way switch 42; sectors 40*c* are connected with the anode source of tube 31 together with one plate of three condensers 43*a*, 43*b* and 43*c*, the other plates of which are connected to fixed brushes contacting distributor 40 at 60° from each other.

Distributor 40, for instance, is so timed that a sector 40*a* comes into contact with a brush corresponding to a condenser (43*b* in the case illustrated) shortly after the beginning of a code element. The quantity of electricity delivered by tube 31 responsive to this sign is thus stored in condenser 43*b*. When the element is ended, or preferably shortly before, condenser 43*b* cooperates with a sector 40*b*, whereby the voltage u resulting from its charge is applied to the grid of a tube 45. Condenser 43*b* thereafter cooperates with a sector 40*c* whereby it is discharged and ready to receive a fresh charge responsive to another incoming element. Sector 40*a* is somewhat smaller than 60° by matter of safety against slight timing imperfections; sector 40*b* extends over 60°, i. e., the angle corresponding to the duration of an element; and sector 40*c* is somewhat longer than 60° to bring the total angular extension of the sector group to 180°, i. e. the angle corresponding to the duration of three elements. It will easily be understood that condensers 43*a*, 43*b* and 43*c* operate in succession.

Distributor 41 is quite similar to distributor 40, with sectors 41*a*, 41*b* and 41*c* and condensers 44*a*, 44*b* and 44*c*. Since it corresponds to the higher keying speed, it is rotated at twice the speed of distributor 40, which is indicated by a double arrow while the latter has a simple arrow. It will be observed that commutator 37, though adjusted to indifferently correspond to both keying speeds, rotates at the same speed as distributor 41 (which corresponds to the higher keying speed) because one revolution of these distributors indifferently extends over six elements at the higher speed or over three elements at the lower speed. But of course the constructional arrangement could be different. The drawing very diagrammatically shows in dashed lines the mechanical connections between motor 33 and commutator 37 or distributors 40 and 41.

As above explained, the cumulative effect representing a code element, which effect is the charge of a condenser 40*a* to 40*c* or 41*a* to 41*c*, acts on the grid of tube 45. The anode circuit of said tube controls a two-contact relay 46 which in turn controls the grid bias of a tube 47. In my aforesaid U. S. Patent 2,176,168, I have explained how in frequency modulation signalling the cumulative effect produced by statics currents over the duration of each unit sign cannot exceed a definite amount, say forty per cent, of the effects normally produced by undisturbed code signs, provided that the modulation index $2fT$, that is to say, the ratio of the frequency changes f to keying frequency $\frac{1}{2}T$, be at least equal to 5 or 6. This may be proved through probability considerations by comparing over the said duration T ($T=t$, or $T=2t$ . . ., according to the keying speed), on the one hand the normal charge IT supplied at the anode circuit of tube 31 by the current I which corresponds to voltages v_2 and frequency changes f, on the other hand the charges supplied by statics currents varying at random from $-I$ to $+I$. U designating the final voltage reached in cumulative devices such as condensers 43*a* to 43*c* or 44*a* to 44*c* responsive to

the normal charge IT, relay **46** is therefore adjusted to close its contacts **46***a* or **46***b* only when the variable bias *u* of tube **45** respectively exceeds +0, 4U or falls below −0, 4U. Thus, the anode current of tube **47** may only assume over each time interval T the one of three definite intensities i_1, i_2, i_3, according as contact **46***a* is closed, or contact **46***b*, or no contact at all; and the two first events certainly denote the reception of unit elements $F+f$ or $F-f$, whereas huge statics as well as fading will certainly cause the third event. Consequently, marks of length T corresponding to i_1 or i_2 must be deemed correct when occurring in a two-sign code transmission, whilst marks i_3 surely denote an uncertainty to be automatically discarded at the final stage of the reception. With a code combining elements of three kinds, corresponding to frequencies $F+f$, F, $F-f$, marks i_1i_2 must again be trusted, but now marks i_3 indifferently denote the correct unit sign F or any injured element; the uncertainty is not fully avoided, but instead of concerning all elements at random it only affects one of them, whereby it may be withdrawn by repeating the signal.

Current variations from the anode circuit of tube **47** therefore reproduce as accurately as possible the elements radiated by the emitter, for these elements have been restored into their standard form after an automatic analysis of the detected current which is highly preferable than estimates practicable on an undulator tape. But these elements are still in the altered order chosen at the emitter for secrecy purposes. To restore the correct order, the said current variations, transformed into voltage variations by a resistor **48**, are brought to act on distributors similar to those used at the transmitter and operating in a similar way. These distributors therefore need no detailed explanations and will be very briefly described below.

As at the transmitter there are provided two pairs of distributors **49**, **49'** and **50**, **50'** one for the lower keying speed, the other for the higher, each pair comprising an inlet distributor **49** or **50** whereby voltage variations are stored in condensers **51** as electric charges, and an outlet distributor **49'** or **50'** whereby the charges thus stored are collected in an order which depends upon the positions of plugs **52** connecting two sets of bars **53** and **54**. The only difference, which is of mere constructional character, is that in each pair the distributors are concentric instead of being adjacent. Switches **55** and **56** permit operation with any pair of distributors at will according to the keying speed used at the transmitter.

It will be understood that if the plug arrangement on the set of bars at the receiver and at the transmitter are identical, the order of the elements is restored provided, of course, the receiver and transmitter distributors are not only locked into synchronism, but also brought into correct phase relation since the synchronized machines may run at a number *n* of relative positions (six in the simplified example illustrated), one only of which is correct. As in the case of motor **6** the proper phase relation is obtained by manual adjustment of the distributor stators.

Fig. 4 diagrammatically shows a possible construction for the receiver distributors, commutator and associated parts. Motor **33** drives two shafts **57** and **58** at two speeds in the ratio 2:1. Shaft **57** (low speed shaft) carries distributor **40**, with the corresponding slip rings, and distributors **49**, **49'** which are in the form of rotating brushes cooperating with two concentric sets of sectors

carried by a plate **59**. The connections with the said sectors are effected through slip-rings carried by a shaft **60** which is angularly adjustable by means of a handle **61**. The high speed shaft **58** is similarly arranged and also cooperates with a plate **62** carried by a co-axial shaft **63** adjustable by means of a handle **64**, but the said high speed shaft **58** also carries commutator **37** with the corresponding slip rings.

Finally the voltages collected by the operative outlet receiver distributor **49'** or, respectively, **50'** (Fig. 3) are applied to the grid of a tube **65** which controls the printing or recording apparatus **66**.

It should be understood that the above description has been given merely by way of example and that it does not limit the scope of my invention, the details of which may vary within the ambit of the appended claims.

I claim:

1. In telegraph signalling based on combinations of unit length impulses, the method of automatically securing secret correspondence along a link interconnecting keying and recording devices operating in compliance with their own telegraph codes, which comprises admitting signal currents from one of said keying devices, controlling said keying device to keep its unit impulses in step with the unit intervals of a predetermined timing; and carrying out the following similar operations at both terminals of the link: separating like unit intervals into groups, separately storing effects of signal currents occurring during successive intervals in each group, and collecting the stored effects in a changed order, the changes respectively carried out at transmitter and receiver terminals being reciprocal ones, whereby signals are delivered to the recording devices as they issue from the keying device.

2. In telegraph signalling based on combinations of unit length impulses, a system for automatically ensuring communication secrecy over the link interconnecting keying and recording devices operating with their own telegraph codes, which comprises means at the input terminal of the link for modulating control waves in compliance with a predetermined frequency, a switch for admitting signal currents from one of the keying devices, means responsive to said control waves for keeping unit impulses issuing from this device in step with unit intervals of a timing related to the said frequency, means for separating these unit intervals into groups, means for separately storing effects of signal currents respectively occurring during successive intervals in each group, means for collecting these stored effects in an altered order to be used over the link; means at the output terminal for separating unit intervals of time into like groups as at the input terminal, said separating means consisting of automatic means for causing divisions in intervals to coincide and of manual means to bring like groups of such intervals into phase coincidence, means for separately storing effects of currents received over successive intervals in each group, and means for collecting the stored effects in an order reciprocal to that chosen at the transmitter, whereby signals are delivered to the recording device as they issue from the keying device.

3. In telegraph signalling based on combinations of unit length impulses, the method of automatically securing communication secrecy at various keying speeds over a link alternately fed by keying devices operating with their own telegraph codes, which comprises, assigning to each of said devices a scale of speeds at which the re-

sulting impulse frequency is a harmonic of a given frequency, operating said keying devices at their assigned speeds, controlling the phase of the keying operation to keep the resulting unit impulses at any of these speeds in step with subdivisions of the same given frequency, and at both terminals of the link practising at any speed similar operations which consist in separating the series of impulses into groups, separately storing effects of signal currents occurring during successive subdivisions in each group, and collecting the stored effects in a changed order, the changes respectively carried out at transmitter and receiver terminals being reciprocal ones, whereby signals are delivered at the output of the link as they issue from the keying devices.

4. In telegraph signalling based on combinations of unit length impulses, a system for automatically securing communication secrecy along a link carrying signals transmitted in various codes and keying speeds, which comprises keying devices operating according to a scale of speeds at which the resulting impulse frequency is a harmonic of a given frequency, means for controlling phases of said devices so as to keep unit impulses issuing therefrom at any of said speeds in step with subdivisions of the same given frequency; a plurality of permutators for shuffling the unit impulse order at the input of the link, each permutator corresponding to one of the possible speeds and being operative over a cycle formed by a given number of time subdivisions corresponding to this particular speed; a plurality of similar permutators for restoring the impulses to their normal order at the other end of the link; and switches for connecting at any speed the convenient set of permutators.

5. A system for securing secret telegraphic service over the link designed to alternately connect keying and recording devices which utilize in pairs their own telegraph characters all based on sequences of code elements succeeding one another at the same substantially constant frequency, which comprises, at the sending station a master distributor for dividing the time into groups of successive uniform intervals independently of the character sequences, means under the control of the master distributor for maintaining locked synchronism between these time intervals and the code elements of the keying device set in operation, means for admitting the signal wave issued from this device, means for separating the series of admitted elements into the groups defined by the master distributor, storage means to store the respective effects of code elements in each group sequentially, means for permuting the stored effects according to the law chosen for ciphering, modulation means for adapting the permuted effects to transmission over the interconnection link, means for effecting this transmission, demodulation means, at the receiving station a local distributer for dividing time into groups of uniform intervals designed to correspond with those at the transmitter, in combination automatic means for controlling the local distributer so as to keep its time intervals in locked synchronism with the received code elements and manual means for causing the phase of its groups to coincide with the phase of groups determined at the other end

of the link, means under the control of the local distributer for separating the received code elements into same groups, storage means to store the respective effects of code elements in each group, means for permuting the stored effects so as to reconstitute their normal order, and means for delivering these effects to the recording device set in operation.

6. In a telegraph system, a keying device for generating telegraph characters all divisible into successive unit elements having the same given length, means for periodically separating these elements into groups independently of the characters sequences, means for permuting these elements within each group, means for transmitting the series of permuted elements from the sending station to the receiving station, storage means for accumulating each received element over its whole duration substantially so as to derive a final effect from this accumulation, means for separating these effects into same groups, means for permuting again the effects within each group so as to restore them to their initial order, and convenient means for recording the effects.

7. In a telegraph system, a keying device for generating telegraph characters all divisible into successive unit elements having the same given length, means for periodically separating these elements into groups independently of the characters sequences, means for permuting the elements within each group, means for transmitting the series of permuted elements from the sending station to the receiving station, storage means for accumulating each received element over its whole duration substantially so as to derive a final effect from this accumulation, means for individually transforming the said accumulative effects into standard effects by distributing them among three definite classes according to their values with respect to the limits of these classes, means for separating the series of standard effects into same groups, means for permuting again the effects within each group so as to restore them to their initial order and means for recording the effects.

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