May 19, 1931. M. COMPARE 1,805,867

TELEGRAPH SYSTEM

Filed Aug. 22, 1927 2 Sheets-Sheet 1

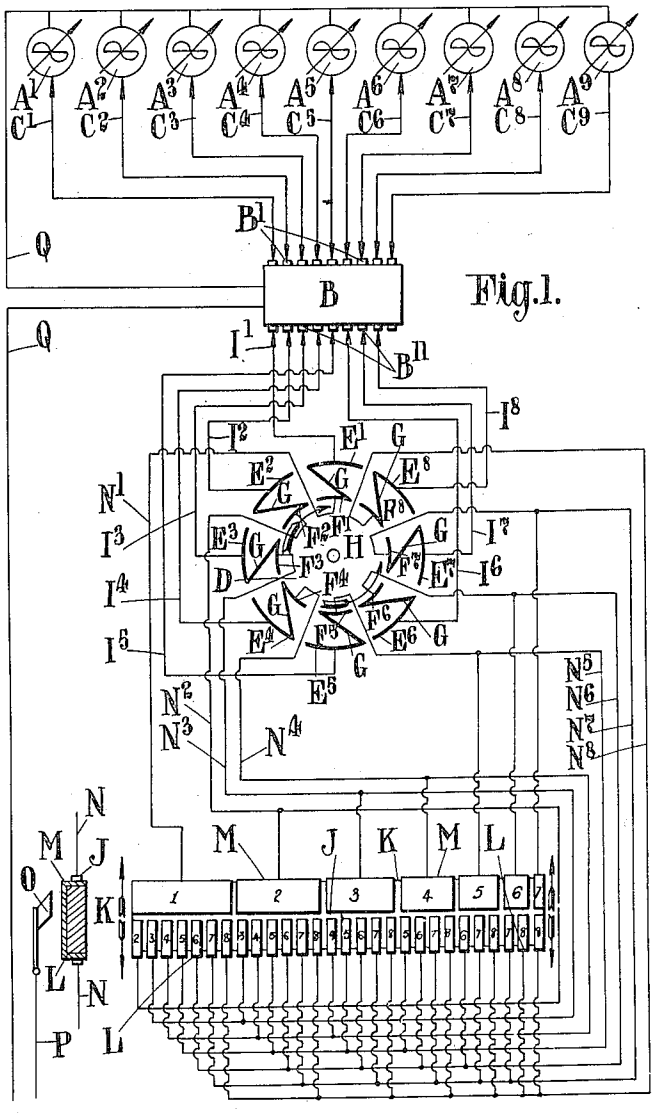


Fig.1.

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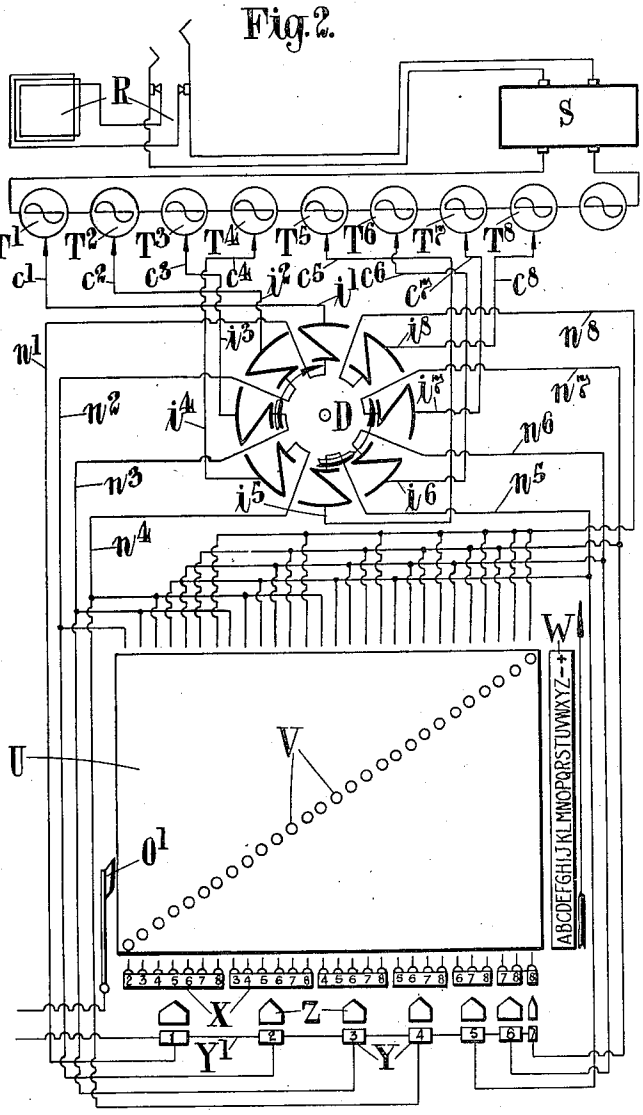
ATTORNEYS.

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Fig. 2.



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UNITED STATES PATENT OFFICE

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TELEGRAPH SYSTEM

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The present invention relates to a system of telegraphy or radio telegraphy which, while employing any suitable transmitting medium such as Hertzian or controlled waves, electric lines, etc. for the purpose of establishing communication between two or more stations, effects the actual transmission and reception of messages by means of a relatively small apparatus, the operation of which requires no special knowledge of telegraphy or wireless on the part of the operator, owing to the fact that transmission is accomplished by means of an ordinary typewriting machine key-board, whilst the reception of messages is direct, that is to say, in ordinary letter type, thus obviating the necessity of deciphering, involving a knowledge of convenional signs or code letters.

Secrecy of the messages transmitted is obtained by reason of the fact that the message, instead of being made up by the groupings of special or conventional symbols representing letters of the alphabet, numbers, signs, etc. is made up by combinations or groups of different electrical frequencies following one another very rapidly.

Every previous telegraphic or wireless system without exception uses for the purposes of transmission a very small number of widely differentiating characters (such as the dot and dash of the Morse code) which are always liable to be deciphered. Under these systems all messages have to be made up from the same set of characters, which therefore have to be easily distinguished and analysable so as to allow of their being easily arranged in different combinations with a view to the proper spacing of the different arrangements. Under the system with which we are dealing however, this restricted number of characters representing letters or numbers is replaced by what may very well be a considerable number of differentiated characters, viz. by frequencies, the analysis of which is very difficult owing to the fact that the varying frequencies may be quite close together. Moreover the expert decipherer cannot by any means read any given group of frequencies or series of rythmical modulations because the same sign (letter of the alphabet, number or whatever it may be) may also be transmitted in the same message by different combinations or groups of frequencies, whilst on the other hand the same combination in the same message may give different letters. This comes about through the adjustability of the transmitting and receiving controls, and still more through the adjustability of a commutator which forms part of them and which will be dealt with later on.

The substitution of characters referred to above is effected by using a constant fundamental wave frequency, which may be superimposed by differentiated frequency groups (either audible or inaudible) rapidly following one another and variable at will. This superimposing of frequency groups is effected by working the different parts of the transmitting apparatus. The frequency groups are automatically combined and the operator can regulate the turning of them on by means of the controls intended for that purpose.

By using a large number of frequencies in groups of two or more, a practically unlimited number of different possible combinations can be obtained.

The attached drawings show, in diagram form, the object of the invention, and more precisely:

Figure 1 gives the diagram of the working parts of the transmitting apparatus.

Figure 2 the diagram of the working parts of the receiving apparatus.

A in Figure 1 represents the vario-generators or variable frequency generators (the number of these is not necessarily the number shown in the drawings) marked for the sake of clearness as $A^1, A^2, A^3 \ldots A^9$. These generators produce frequencies $V_1, V_2 \ldots V_9$ all of which are different and V_2 is greater than V_1 so that the affixes may be considered to represent the different frequencies. These frequencies are low frequencies with respect to the radio carrier wave. The frequencies generated by these may be either wave inducted currents or strength variations, or again inductance variations, ohmic resistance, etc. The construction of the vario-generators will

vary according to the nature of the current or variation.

B is an amplifier of the effects produced by the vario-generators A—its construction will vary according to the construction of the latter; the amplifiers of the currents from A, is capable of sending into the circuits QI_1, $QI_2 \ldots QI_8$ the frequencies of the generators $A_1 \ldots A_8$ sufficiently amplified for the transmission of the signals.

Vario-generators A^1, $A^2 \ldots A^9$ are connected either directly, as shown in the drawing, or indirectly by means of controls for the purpose, with amplifier B through conductors C (the ends of which are interchangeable) shown in the drawing for the sake of clearness as C^1, C^2, $C^3 \ldots C^9$.

For the purpose of joining up with the conductors C, the amplifier B is provided with suitable interlocking parts.

D is a commutator normally stationary, the purpose of which is to vary the order of the conductors or connections issuing from the amplifier B before they take up their positions in the circuit. This commutator may be of any suitable construction; the one shown in the drawing is composed of a set of 8 segments E, shown for the sake of clearness as E^1, E^2, $E^3 \ldots E^8$, set out circularwise and placed opposite a second set of 8 segments F, marked F^1, F^2, $F^3 \ldots F^8$, arranged concentrically with the first set so as to make a pair with each of these. The two segments of each pair for instance E^1 and F^1, E^2 and F^2, etc., are connected with one another by means of suitable connecting pieces G, such as contacts, rods, etc.

In the drawings it will be noticed that, whilst the vario-generators connected with the amplifier B number 9, the segments E connected with the amplifier B number 8; this is intended to show that the number of vario-generators varies according to the number of characters, figures, signs, etc., used for transmitting a number of signs (as for instance in the case of alphabets containing a larger number of letters) the number of other parts in the cycle will naturally vary accordingly. The vario-generator or circuit oscillator A^9 is shown only to illustrate that any number of these devices may be used, and that they may be used to the exclusion of the commutator D for purposes other than transmission in accordance with this invention, and at the same time be grouped or associated with the detectors A^1 to A^8.

The commutator D is capable of revolving round its axis H, either to the right or left as indicated by the arrows in the drawing. This movement either way enables the operator to vary the order of the connections at will, as referred to above.

The amplifier B and the segments E of the commutator D are connected either by direct or indirect conductors I, marked, for the sake of clearness as I^1, I^2, $I^3 \ldots I^8$, the ends of these conductors connected with the amplifier B being interchangeable, and in view of this amplifier is provided with suitable connecting pieces.

J is a distributor formed by two or more sets of contacts, which are so arranged as to allow of the formation of different combinations.

In the example shown in Fig. 1 the distributor J is made up of an insulating body K carrying a set of 28 contacts L which are equal and equidistant, and opposite these is a second set of 7 unequal contacts M, also mounted on K.

The commutator contacts are so adjustable relatively that the impulses from any one of the I^1 to I^8 series of leads may be directed along any one of the N^1 to N^8 series of leads. These outgoing leads, N^1 to N^8, from the commutator conduct the impulses to a set of broad contacts M^1 to M^7 and likewise to a series of narrow opposing contacts L^1 to L^8, L^3 to L^8, L^4 to L^8, L^5 to L^8, L^6 to L^8, L^7 to L^8, and L^8 both sets of contacts being situated in close proximity, on the distributor K.

The index figures shown on the two series of contacts may be taken to represent the different frequencies received from the eight oscillation circuits and it will be seen that the connections are such as to make it possible, by selecting a pair of opposite contacts, one from each row, to combine the impulses from any two of the series of eight oscillation generators, so that the whole series of possible permutations is available.

The number of such possible permutations of eight frequencies, combined two at a time, is twenty eight there are therefore twenty eight narrow contacts each one of which, when bridged to its opposing broad contact, represents a symbol or sign which it may be desired to express in transmitting a signal.

A brush O is preferably associated with each one of the narrow contacts and each control is adapted when suitably positioned to complete a circuit first between the input of the wireless modulator and a narrow or lower contact and next between said input and a wider or upper contact. It thus serves to combine the frequencies from two of the oscillators as aforesaid and transmit them in succession as a combination to a continuous-radiation carrier wave connected to the system by the leads Q and P.

The brush O may be conveniently operated by a key board device such as a typewriter or any other preferred means such that the movement of the correct key involves the movement of a specific control and the transmission of a specific signal, represented by the combined frequencies of any two of the oscillation generators according to the particular position of the commutator at the moment. Any con-

venient means are provided for returning the various parts of the distributor system to their initial position after the transmission of each symbol.

It will be understood that the particular frequencies involved for each symbol transmitted may be varied at will by the operator by adjusting the comutator or by changing the natural frequencies of the oscillators so that a very large choice of frequency combinations is possible.

The number of contacts L and M need not, in practice, be necessarily the same as that shown in the drawing and previously described, in which case the numbering of the connections would also vary, always, however, retaining the same order, starting from 1 for the contacts M and from 2, 3, 4, etc. respectively for the contacts L. Thus if X is the number of M contacts, the highest number for L contacts will always be X+1.

The distributor J, instead of being made up of only 2 sets of contacts, as shown in the drawing, may have 3 (or more) sets of contacts, when it is desired to have each group consisting of 2 or more frequencies. In this case the same arrangement will be observed, i. e. each set parallel to the other.

Corresponding to each L contact and conveniently placed in relation to it there is provided a contact control (O) (sectional plan showing same in detail in Fig. 1) which is used for closing the circuit between contact L with which it is connected and the corresponding contact M. When the aforesaid controls O are at rest the circuit is broken between contacts L and M.

The closing of the circuit between the L and M contacts effecting the transmission of the frequency groups, is accomplished by means of two independent movements, the first being the moving of the contact control (O) lever, which brings the parts of the (O) controls intended for that purpose into the plane of the L and M contacts; this movement is controlled mechanically, either directly or indirectly by the typewriting machine keyboard. The latter moves the control, contacts O, against M, L (Fig. 1') in order to bring the part of the O controls intended for that purpose in contact successively with the L and M contacts with a view to closing the circuit. Of course, should the distributor J consist of 3 or more sets of contacts, the movements to be made would have to be effected in such a way as to allow of the O rods touching them all one after the other.

The O contact controls and the A vario-generators are connected with a suitable wave generator (not shown in the drawing) by means of conductors P and Q respectively, the latter conductor passing through amplifier B.

The working of the apparatus is as follows:—

The vario-generators A transmit the frequencies generated to the amplifier B, which amplifies them. The frequencies, through the commutator D (the working of which has already been described) reach the contacts of the distributor J in the order of numerical combinations already described. As soon as the O rods, which are either directly or indirectly controlled by a typewriting machine key-board, are lowered (through solenoids or other means) on to the plane of the distributors contacts, the distributor or the rods are displaced (as described) and the closing of the circuit of the two corresponding vario-generators is effected by means of the operating rod. Thus the frequencies are transmitted to the wave generator. Each vario-generator is so constituted as to be able to generate a certain number of frequencies, which differ from those of the other vario-generators.

In Figure 1, A^1 to A^8 are a series of oscillating circuits or generators of any convenient kind. Each oscillating circuit contains a variable element by which it may be adapted to four different natural oscillation frequencies. Thus the eight circuits together embrace a range of 32 different frequencies.

The receiving station is provided with any suitable aerial R and an amplifier S whence the received trains of impulses pass to a series of resonators T^1 to T^8 adapted to be adjusted to select and respond to, the received combined signal or modulation frequencies from the corresponding oscillators of the transmission station. These frequencies are thus separated out and are passed by leads such as C^1 to C^8 to a commutator identical in arrangement with that at the transmission station and thence by leads such as N^1 to N^8 to a series of relays or the like marked Y^1 to Y^8 and to a series of blocks of contacts marked X^2 to X^8, X^3 to X^8, X^4 to X^8, X^5 to X^8, X^6 to X^8, X^7 to X^8, and X^8. The block contacts X receive leads coming from the different resonators or detectors as indicated by the numbers marked on them and are movable into operative relation to the harmonizer U having contacts V. The total number of these block contacts is twenty eight as in the case of the L contacts of Figure 1.

T represents resonators or detectors marked for the sake of clearness T^1, T^2, T^3 . . . T^9, which operate when they are acted upon by the frequencies superimposed on the constant fundamental waves such as are used for transmission by the transmitting apparatus.

Each of the resonators or detectors T has a fundamental oscillation period peculiar to itself and therefore only responds to the action exerted on it by the corresponding frequency; it follows that, even though all the resonators or detectors are simultaneously exposed to the action of all the frequencies

emanating from the amplifier each one of them only attains its maximum amplifying effect when acted upon by the frequency with which it is harmonized.

D is a commutator exactly similar in construction and formation to the corresponding commutator D of the apparatus shown in Fig. 1 and is manually shifted to correspond to the position of the commutator at the sending station to change the allotment of the frequencies to the different characters.

U is an automatic harmonizer capable of combining afresh and regrouping the frequencies as an when they are received by the aerial, and in such a way that each frequency group effected by the harmonizer U shall correspond to the same combination as is effected by the distributor J of the transmitting control. In this way the receiving apparatus will be able to signal the same letter of the alphabet, the same number, sign, etc. as is transmitted, as will subsequently appear.

The harmonizer U is formed by any body suitable for the purpose, as for instance, a cylinder, shown as a developed cylinder, and on it are arranged the contacts V, the number of these latter being the same as the L contacts of the transmitting apparatus (Fig. 1); i. e. the same as the number of letters of the alphabet to be used in the message, after allowing as well for the possible number of signs, numbers, controls, etc. The arrangement of the contacts V will vary in relation to the construction of the harmonizer U; in the example shown in the attached drawing, the distributor being shown as a rectangular plane, representing a developed cylinder, the contact media are set out in the direction of one of the diagonals of the rectangle representing one turn of a helix and the harmonizer rotates about its axis.

As the harmonizer is cylindrical and turns or oscillates about its axis, its motion is produced by means of a limiting relay each time that the composition of a frequency group is effected, controls being arranged in such a way as to bring the harmonizer back again each time to initial position. In the drawing the direction of its movement is indicated by an arrow. The text comes out in written form either by the direct or indirect action of a control W (controlled, as will be seen later, by each one of the frequency groups as and when they are received and combined).

The aforesaid control W is so arranged as to carry the characters representing the letters of the alphabet, numbers, signs, etc. required for the messages, as shown in the drawings. With a view to arranging for the characters, used in the text of the message, to be typed on to paper (or any other suitable medium) the operator must see that:—

(1) The different characters carried by the control (W) are arranged in order relatively to the sheet of paper, following their natural order in the formation of the words; this is accomplished by moving the control W relatively and conjointly with the movement of the harmonizer U.

(2) After the characters to be typed have been brought into line the control W must strike the paper on which the message is to be typed, or, alternatively, the sheet must be pressed as firmly as is necessary against the characters carried by the control W; in both cases provision should be made for some means, either direct or indirect, of inking the characters, as for instance by using an ordinary typewriting ribbon.

The typing worked by the control W is effected when the combination of a frequency group is completed through the working parts of the receiving apparatus. The effect of this operation is that the characters corresponding to the combination of frequencies, as produced by the transmitting apparatus are typed out by the action of the control W under the influence of the frequency groups transmitted by the transmitting apparatus and with the help of the mechanism and different working parts of the receiving apparatus.

X are bodies, similar as regards number and arrangement to the contacts (M) of Fig. 1; these bodies (X) are provided with 28 contacts arranged in the same way as contacts (L) are in regard to contacts M, which will be readily understood on studying the numbering in the drawings.

The bodies (X) are movable relatively to the harmonizer (U) so as to allow the contacts with which they are provided to coincide with the corresponding contacts (V) of the control (W). The bodies (X) are displaced by the blow of hammers Z pushed by the corresponding appliance Y. In the drawing the bodies (X) are connected together and also joined to the return circuit by conductor Y'.

The small hammers (Z) when at rest, can either exercise continuous pressure in the direction of the bodies X or press on the appliances (Y).

In the first case the appliances Y hold the hammers fast only releasing them when the cycle closing the contacts is effected; on the other hand, in the second case the appliances (Y) should push the hammers (Z) with the necessary force and rapidity against the bodies (X) to allow of the circuit closing the contacts being effected.

A set of rods or other suitable controls (O) is arranged for the purpose of transmitting through suitable conductors to the working parts concerned with the writing, to close the circuit each time this latter operation is effected.

C^1, C^2, C^3 ... C^8 are conductors connecting

the resonators or detectors T with the commutator D.

$N^1, N^2, N^3 \ldots N^8$ are conductors connecting the commutator D with the contacts carried by the bodies (X) and with the appliances Y according to their numerical order.

All the aforesaid conductors are arranged in the same order as the corresponding conductors in Fig. 1.

All that has been said of the transmitting apparatus as regards the number and construction of the different appliances (and their parts) and as regards the order of the connections, is also applicable to the receiving apparatus, which will be readily understood on noticing that for each of the component parts of the transmitting apparatus there is a corresponding or similar component part in the receiving apparatus.

The working of the apparatus is as follows:—

The frequency groups superimposed on the constant fundamental wave frequency, as emitted by the transmitting apparatus, are received by the aerial, the effects of these groups are amplified by the amplifier which transmits them to the resonators or detectors, the latter being in grouped or parallel sets. The purpose of the resonators or detectors is to close electric circuits when the maximum resonance is attained. As has already been pointed out, although all the resonators or detectors are acted upon by the frequencies proceeding from the amplifier, only that one, the fixed normal frequency of which corresponds to the frequency about to arrive, can attain the maximum amplitude; and only at that moment is the modification in the circuit effected. Hence the detectors, which may be Siemens detectors, separate the frequencies received.

The circuit passes through the commutator in the same way as in the transmitting apparatus observing the same order of connections; the same analogy holds good for appliances (Y) and for the contacts carried by the bodies (X) and the same order is observed as described in Fig. 1 as regards the connectors between the commutator and the contacts L and M.

As already pointed out, the appliances (Y) are joined up with the return circuit in any way that is found suitable.

When the amplifier transmits a frequency, the resonator or detector with the corresponding oscillation period attains the maximum amplitude and gives rise to the modification in the circuit, so that the appliance Y, which corresponds to the aforesaid detector, acting through the conductors C and N, works the corresponding hammer, moving the body X (which is connected with it) relatively to the harmonizer as already mentioned.

This first movement of the circuit is not by itself sufficient to effect the writing since (as has already been repeatedly pointed out) the impression of each letter or sign, as well as the transmission of these, is not effected by one frequency only, but by a group of frequencies; and in the system under consideration a group consists of two frequencies and the second frequency must therefore join up with the first before the writing of a letter or sign can be effected.

The arrangement of the parts is such that upon the reception of a signal comprising a combination of two frequencies such as 3 and 4 and the consequent response of two corresponding resonators the frequencies are separated out and the first one arriving, say No. 3, will energize the Y relay numbered 3 which through any means such as a hammer 2 will move its associated block of contacts X^4 to X^8 relatively to the harmonizer U so that the contact points of this block are positioned for co-operation with the corresponding V contacts.

A second frequency arriving, say No. 4, will then act upon No. 4 of the contacts points in this corresponding block contact. The circuit is thus completed and the frequencies are again combined and pass through the corresponding V contacts to operate the printing mechanism for the recording of the signal.

The same thing is seen to occur when a second frequency, received by the aerial and transmitted to the amplifier, comes into operation as before, acting through an electric current, on one of the contacts carried by the body X corresponding to the resonator or detector worked by the second frequency. The closing of a complete circuit between one of the contacts V and one of the contacts carried by the bodies X is then set up; with the assistance of the necessary mechanism the writing of a letter or sign is thus effected by the control W. Suitable controls are arranged in such a way as to bring back all the working points concerned either to their initial positions or to a position of rest, after each letter or sign has been imprinted.

The operation is repeated successively and rapidly as often as is required to effect the writing of the whole text of the message.

It is as well to point out that, when the harmonizer is formed by a cylindrical body and when its movement is rotatory on its own axis and continued throughout the whole time of the transmission, the commencement and termination of the rotation will be operated before and after the transmission of the text by the transmitting apparatus, always by means of frequency combinations. The movements of the harmonizers are obtained, for instance by means of a limiting relay each time the composition of a frequency group is effected, controls being arranged in such a way as to bring the harmo-

nizer back again each time to its initial position.

It still has to be shown how the operator of the transmitting station should operate his apparatus so as to restrict his communications to a single pre-arranged receiving station out of the large number of receiving stations to which he would be in a position to transmit messages.

In Figure 2 contacts V are shown for convenience as being spirally arranged on a cylindrical base U, but it will be understood that in practice these contacts are arranged in any suitable manner so that they may be accessible to the contacts X.

Suitable mechanism is provided for giving a rotary or any other desired movement to the cylinder U or other corresponding element in the harmonizer and for returning the parts to their initial position after the reception and recording of each symbol.

The distributors D, and the harmonizer U and the sending distributor J, at both the sending and receiving stations, may be driven and controlled by any suitable means, and are operated in a definite timed relation.

It will be clear that with an apparatus as above described a transmission station is able to communicate with a desired receiving station by adjusting the combined frequencies in any prearranged way, also that a very large range of choice of frequencies is given to the operator, and further that, by a simple manipulation of the parts, the frequencies representing any given symbol, can be varied at will even during the transmission of messages, if so arranged with the receiving station.

It should be understood that more than two frequencies may be combined in each signal if desired, the apparatus being arranged in accordance therewith, also that the number of oscillators resonators, natural frequencies, contacts and other parts mentioned in this specification are chosen for convenience of explanation only, and are not essential to the apparatus which may be designed in a great variety of ways within the scope of the invention.

What I claim is:—

1. Method of transmitting signals consisting in successively conveying at a transmitting station groups of electrical impulses comprising a plurality of different frequencies upon a conveying means, each group corresponding to a signal and the frequencies of each group being conveyed into said conveying means, in collecting at the receiving station said different frequencies conveyed by said conveying means and in setting into action by means of said different frequencies a plurality of resonators of a set of resonators for controlling local control-circuits at the receiving station.

2. Method of transmitting signals consisting in building the signals by means of groups comprising a number of different frequencies, in varying at will at the transmitting station said frequencies for tuning said station with a particular receiving station of a plurality of receiving stations, in conveying the frequencies of each group to the receiving stations, in collecting exclusively at the receiving station with which said transmitting station is tuned said groups of conveyed frequencies and in setting into action by said received frequency groups a plurality of resonators of a set of resonators for controlling local circuits.

3. Method of transmitting signals consisting in superimposing, at the transmitting station, upon a carrier wave having a constant frequency common to all the stations, groups of waves comprising a plurality of different frequencies, each group corresponding to a signal detecting the resulting modulated wave at the receiving station and operating sets of resonators by said detected wave and controlling local control circuits at the receiving station by the received modulated waves.

4. Method of transmitting signals consisting in superimposing, at the transmitting station, upon a carrier wave having a constant frequency common to all the stations, groups of two different frequencies, each group representing a signal and the frequencies of each group being superimposed on said carrier wave, in detecting at the receiving station the resulting modulated wave in order to prepare and complete a control circuit by said two frequencies.

5. Method of transmitting signals consisting in building the signals by means of groups comprising a plurality of different frequencies, in varying at will, at the transmitting station, said frequencies for tuning said transmitting station with a receiving station out of a number of receiving stations, successively superimposing upon a carrier wave, having a constant frequency common to all the stations, said groups of frequencies, in detecting said modulated wave at the receiving station with which said transmitting station is tuned and thereupon operating successively a plurality of resonators by the detected wave for controlling local circuits.

6. Method of transmitting signals consisting in successively superimposing at the transmitting station upon a carrier wave, having a constant frequency common to all the stations, groups of two different frequencies, each group representing a signal and the frequencies of each group being superimposed on said carrier wave, varying at will the frequencies of each group corresponding to a given signal by modifying the connections of the local transmitting circuits, varying at the receiving station the connections

of the local control circuits according to the variations in the local circuits of the transmitting station, detecting the resulting modulated wave in order to prepare said control circuits by the first frequency and to complete said control circuit by said two frequencies.

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