Oct. 28, 1947. J. J. B. LAIR 2,429,632

PRINTING TELEGRAPH SYSTEM UTILIZING VARIABLY SPACED IMPULSES

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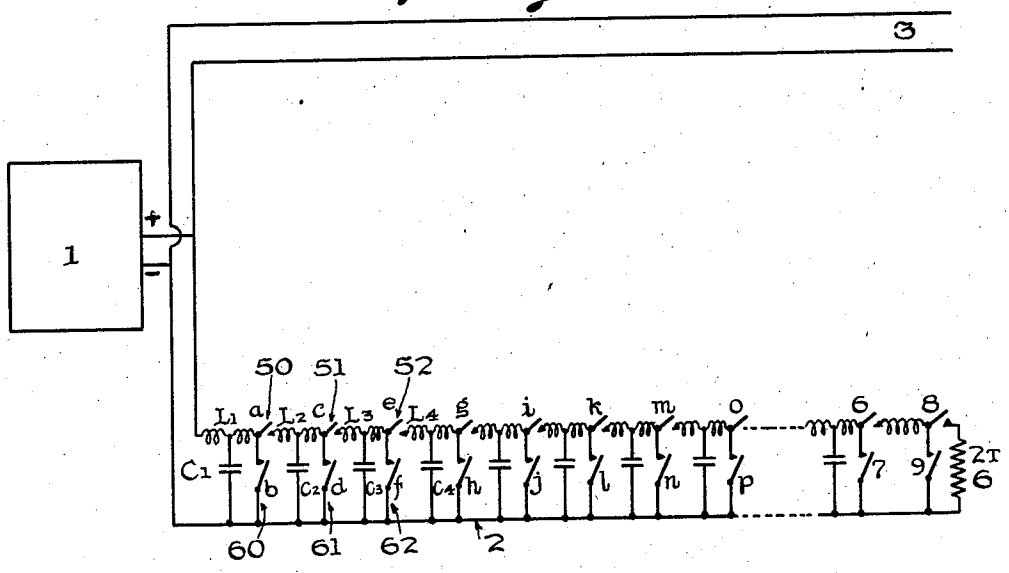
Fig. 1.



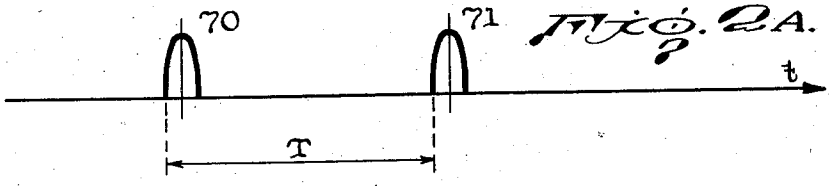


Fig. 2A.

Fig. 2.B.

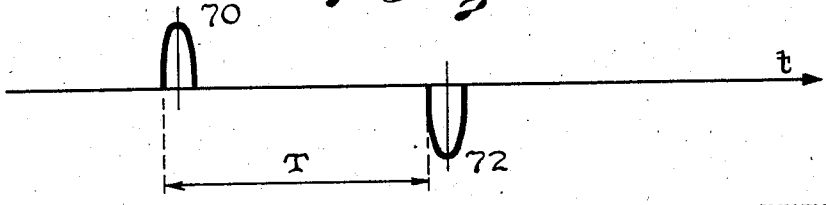


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Fig. 3A.

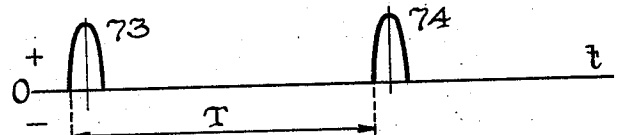


Fig. 3B.

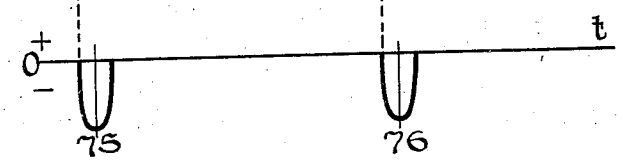


Fig. 4.

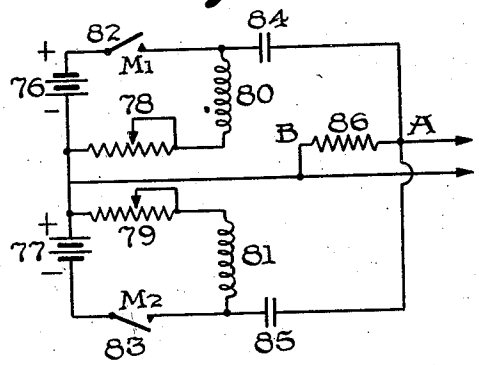
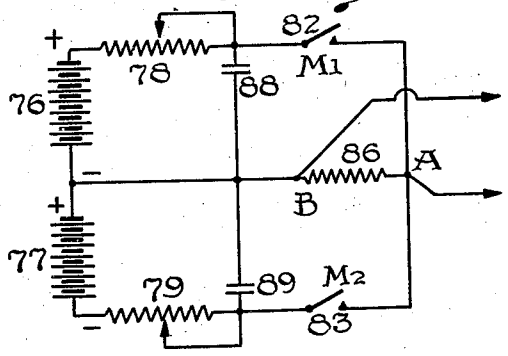


Fig. 5.



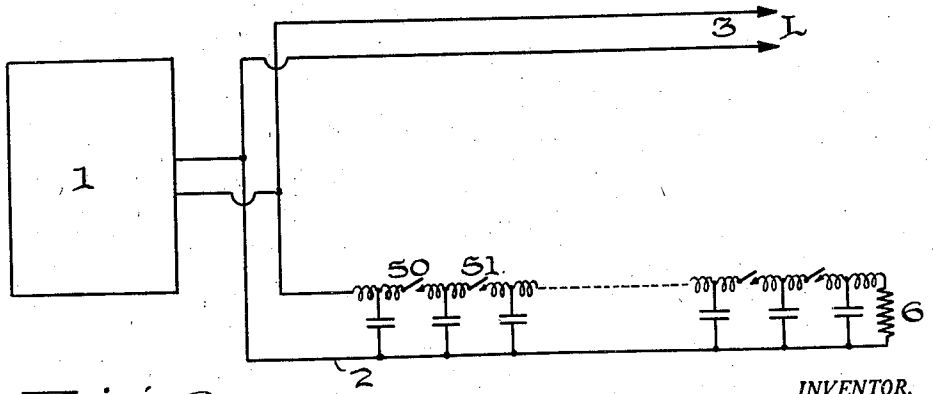


Fig. 6.

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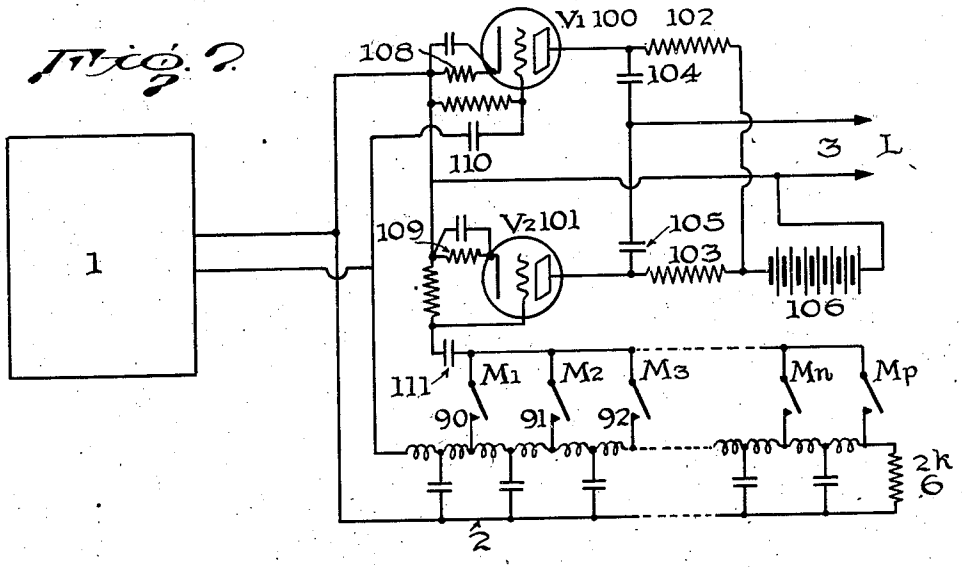
Fig. 7



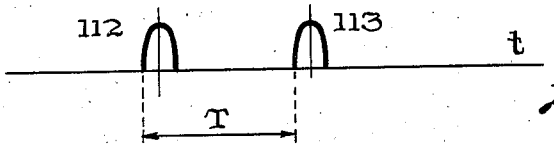


Fig. 8A.

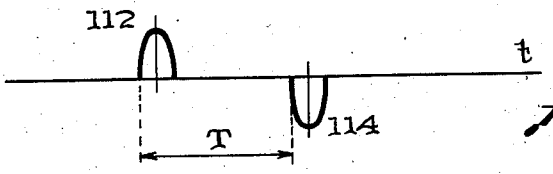


Fig. 8B.

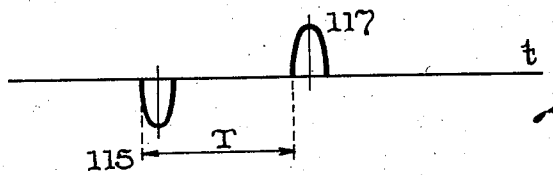
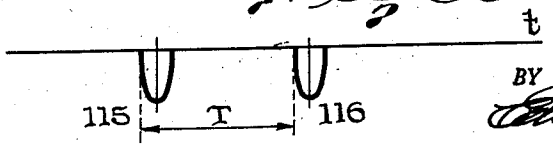


Fig. 8D.

Fig. 8C.



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PRINTING TELEGRAPH SYSTEM UTILIZING VARIABLY SPACED IMPULSES

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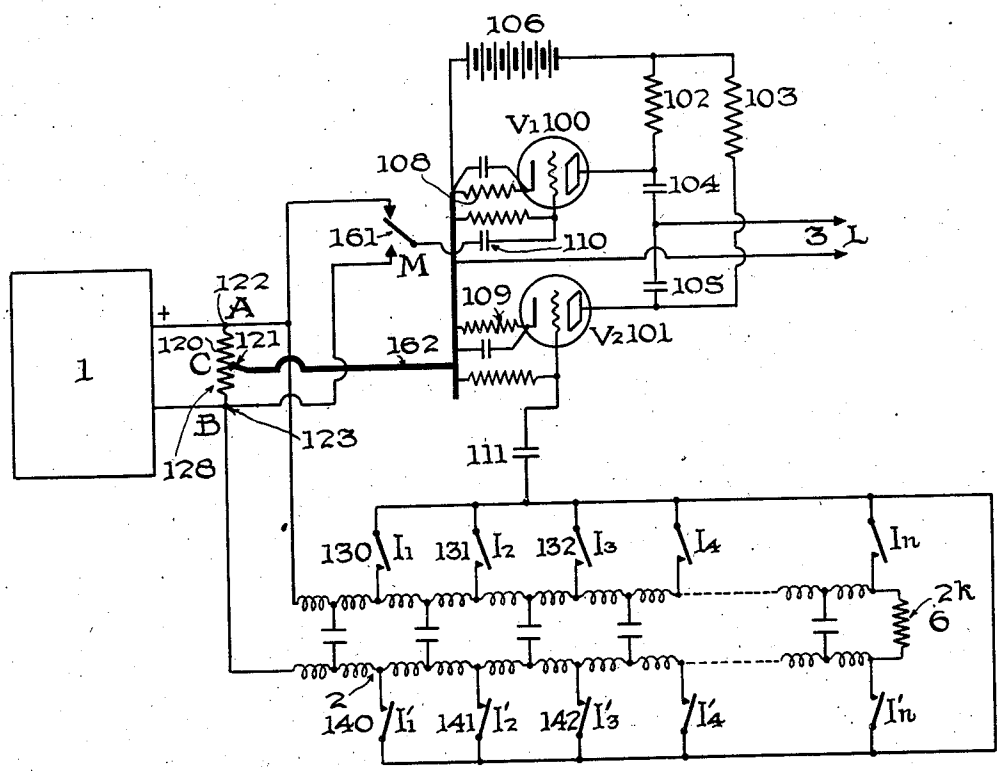
Fig. 9.



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Patented Oct. 28, 1947

2,429,632

UNITED STATES PATENT OFFICE

2,429,632

PRINTING TELEGRAPH SYSTEM UTILIZING VARIABLY SPACED IMPULSES

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Application June 22, 1943, Serial No. 491,804
In France September 12, 1941

12 Claims. (Cl. 178—68)

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The present invention, which is a continuation-in-part of application Ser. No. 488,300, filed May 24, 1943, relates to printing telegraph instruments and particularly to printing telegraph instruments for use in systems in which the transmitted signals are characterized by three currents or line conditions, namely a positive current, a negative current and a zero current, and are sent in the form of impulses displaced or staggered in time. Each letter, figure or symbol to be transmitted and printed accordingly is characterized by the relative staggerings in time with respect to a time origin, of a special combination of impulses, i. e. by an "impulse modulation."

These systems generally use electromechanical devices both at the sending and the receiving ends for selecting the desired characters. These electromechanical devices are usually rather complicated and do not allow the sending of messages at a very high transmission speed.

One of the objects of the present invention is consequently the providing of printing telegraph transmitters that are free from these drawbacks owing to the fact that they do not require any electromechanical selecting device.

According to certain features of the invention, use is made in printing telegraph transmitters of the three current or line conditions type (positive current, negative current and no current) of a pulse generator in association with an artificial line that terminates at its characteristic impedance and is disposed so as to furnish the particular impulses that correspond to the predetermined code of signals under the control of an automatic or manual manipulating device (e. g. a key set or a perforated tape).

The pulse generator sends its pulses simultaneously into the transmission line that leads to the remote receiver and into the artificial line. When there is no manipulation, the pulses directed into the artificial line are absorbed without reflection by the characteristic impedance that terminates it. When there is manipulation, this line is opened or short-circuited at particular points that correspond to the characters to be transmitted; the pulses are then reflected into this line and, upon leaving the line, are directed to the transmission line where their time displacements from the directly transmitted pulses and their polarity (positive or negative) define at the reception end the characters they represent.

According to one feature of the invention, the direction of the reflected pulses is obtained by making use of the following property of artificial

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lines: When a pulse of a certain polarity is sent into the line and is reflected in it by an interruption of the line due to an opening of the circuit, the reflected pulse upon returning to the input of the line will be of the same polarity as the incoming pulse; inversely, if the interruption of the line is due to a short-circuit, the reflected pulse upon returning to the input of the line will be of opposite polarity to that of the incoming pulse. In this way, a reflected positive pulse will be obtained either by sending a positive pulse into the artificial line and causing its reflection by means of an opening of the line, or by sending a negative pulse into the line and causing its reflection by a short-circuit of the line. Inversely, a reflected negative pulse will be obtained either by sending a negative pulse into the line and causing its reflection by means of an opening of the line, or by sending a positive pulse into the line and causing its reflection by means of a short-circuit of the line.

According to other features of the invention, the retarded pulses are obtained without reflection in the artificial line, and simply by making use of their time-lag in propagation over this line as far as the points that correspond to the desired characters, where they are shunted to the transmission line that leads to the receiver. In this case, the polarities of these pulses will be determined in the pulse generator itself which is of such a type as to furnish either positive or negative pulses as desired, by control of the manipulation.

These features, as well as others, are explained in detail in the following description given with reference to the appended drawings, in which:

Fig. 1 illustrates schematically one example of a printing telegraph transmitter according to the invention which employs a pulse generator that generates pulses of a definite polarity, and an artificial line disposed so as to provide pulses of definite time-lag and of positive or negative polarity according to the transmitted characters;

Figs. 2A and 2B show graphs relating to the device of Fig. 1;

Figs. 3A and 3B show graphs in which the directions of the pulses are determined by the pulse generator itself;

Fig. 4 illustrates schematically one example of a pulse generator that emits either positive or negative pulses as required;

Fig. 5 illustrates a variant of the pulse generator circuit of Fig. 4;

Fig. 6 is a schematic view of one example of a printing telegraph transmitter according to the

invention, using a pulse generator of the kind shown in Figs. 4 and 5, and a staggering of the impulses by reflection;

Fig. 7 illustrates schematically one example of a printing telegraph transmitter according to the invention, using a pulse generator of the kind shown in Figs. 4 and 5, and a staggering of the pulses by propagation;

Figs. 8A to 8D show graphs relating to the operation of a printing telegraph transmitter similar to the one shown in Fig. 1 but using a pulse generator of the kind shown in Figs. 4 and 5;

Fig. 9 illustrates a modification of the circuit shown in Fig. 6 which furnishes positive and negative pulses, but which uses a pulse generator that furnishes only unidirectional pulses.

First referring to Fig. 1, the device illustrated in this drawing comprises a generator 1 which generates pulses of a definite polarity, as indicated by the + and − signs at its output terminals. The pulses proceeding from the generator 1 are sent to the transmission line 3 that leads to the remote receiver or receivers, and also to an artificial line designated in its entirety by the reference number 2.

In the example of an embodiment shown in the drawings, this artificial line 2 consists of a series of T-shaped impedance sections comprising inductance units L_1, L_2, L_3, etc., and capacity units C_1, C_2, C_3, etc., although it may be made up of any suitable type of sections, e. g. of π or lattice shape. The total number of sections depends upon the number of characters to be transmitted. In this arrangement there are half as many impedance sections as there are characters in the code to be transmitted and printed and each section has a series switch 50, 51, 52, etc. capable of opening and closing the artificial line at the respective sections, and a series of shunt switches 60, 61, 62, etc. capable of short-circuiting the line at the respective sections. The line terminates at its characteristic impedance 6, so as to absorb without reflection any pulses from the generator 1 when all the series switches 50, 51, 52, etc. are closed and all the shunt switches 60, 61, 62, etc. are open, this being the normal condition of the line when there is no signalling or manipulation. The first letters of the alphabet to which these switches are assigned are indicated alongside them, *a, c, e,* for the series switches 50, 51, 52 and *b, d, f,* for the shunt switches 60, 61, 62. The condition of the series and shunt switches when there is no manipulation consequently insures that the artificial line 2 will have a condition of continuity between its input terminals and its terminal impedance 6, and also that it will not be short-circuited at any point. While in this condition, if the generator 1 periodically emits pulses to the transmission line 3 and to the artificial line 2, no pulse that comes into line 2 will be reflected to the transmission line 3, and only the directly transmitted pulses will be propagated to the remote receiver.

When signalling, hereinafter termed manipulation takes place, either manually, e. g. by means of a key set (not shown), or automatically, e. g. from a suitable recorder, one of the switches 50, etc. or 60, etc. that corresponds to the desired character is opened or closed. The pulse emitted at this moment by the generator 1 (which may be controlled solely by a manipulation effected by a switch located in the circuit instead of having to emit continuous periodic pulses) is reflected back along the artificial line 2 from the location of the switch that has just been opened or closed by the manipulator.

If the closed switch is one of the switches of the 50, 51, etc. series, in other words, if a discontinuity has been created in the artificial line 2, the reflected pulse will be of the same polarity or direction as the incoming pulse, and consequently as the pulse sent directly into the transmission line 3. The stagger of the two pulses, direct and reflected, of the same polarity on the transmission line 3 will characterize the transmitted signal. If the closed switch be the shunt switch of the same numerical order in the line, the reflected pulse will have on the transmission line 3 the same stagger as the direct pulse, but since the artificial line 2 has in this instance been short-circuited rather than open-circuited at the location of this switch, the polarity of the reflected pulse will be the reverse of that of the direct pulse, and this additional characteristic will define a different signal.

It is consequently evident that with an artificial line of this kind there is constituted a telegraph transmitting system employing two types of currents in which the number of sections of the artificial line is half the number of characters (letters, figures and symbols) to be transmitted.

The pulse generator 1 may be of any well known or suitable design. Furthermore, a line amplifier may, if desired, be inserted at the commencement of the transmission line 3 in order to compensate for the attenuation undergone by the reflected pulses in the artificial line 2. This amplifier should preferably be provided with means for discriminating between the direct pulses and the reflected pulses (e. g. by only being sensitive to one impulse out of each two consecutive pulses in order effectively to amplify only the reflected pulses.

The graphs of the line transmission pulses will accordingly be like that shown as an example in Figs. 2A and 2B. In Fig. 2A, which corresponds to an opening of the switch representing the letter *e,* the direct pulse is indicated at 70. The pulse reflected by opening of the switch 52 is indicated at 71 and is of the same direction as the direct pulse. In Fig. 2B, which corresponds to closure of switch 62, representing the letter *f,* the direct pulse is still designated by the reference number 70. The pulse reflected by the closing of switch 62 is indicated at 72, and it has the same spacing with respect to the pulse 70 as the pulse 71 of Fig. 2A, but is of reverse polarity.

Instead of providing a mode of transmission in which the original pulse remains of the same sign, while two different signals with component pulses of equal stagger are distinguished by their identical or reverse polarity with respect to said original pulse, it is also possible, according to the invention, to provide a method of transmission in which the pulse generator 1 can furnish positive or negative pulses as desired, the reflected pulses being of the same polarity as the original pulses. One half of the signals can then be transmitted with the positive pulses, and the other half with the negative pulses.

In this case, the graphs of the pulses received over line 3 will be as shown in Figs. 3A and 3B. When the pulse generator 1 emits a positive pulse 73 (Fig. 3A), the reflected pulse 74 will still be of the same polarity, i. e. positive, and its stagger will characterize the transmitted signal. When the pulse generator emits a negative pulse 75 (Fig. 3B), the reflected pulse 76 will still be of

the same polarity, i. e. negative, and its stagger will characterize the transmitted signal. Two different signals having a same spacing T between the constituent pulses will accordingly be characterized by the polarity of both of the two pulses of which they consist. It will accordingly be sufficient in this case to provide an artificial line which has a number of sections that is half the number of the signs or letters to be transmitted and which is equipped with a series of series switches, the opening of which latter will cause the reflection of pulses of the same polarity as the incoming pulses. It is evident that use may be made of an artificial line equipped with shunt switches. In this case, the reflected pulse would always have a polarity the reverse of that of the direct pulse. The receivers used with these transmitters will consequently have to be arranged to discriminate between the polarities of the pulses and to be sensitive either to two pulses of the same polarity or to two pulses of opposite polarities while at the same time discriminating the polarity of the first pulse.

Figs. 4 and 5 illustrate schematically two embodiments of single pulse generators that furnish either positive or negative pulses under control of the manipulation. In the circuit of Fig. 4, two batteries 76 and 77 or other sources of direct current, deliver to self-inductance coils 80 and 81, respectively, currents that are adjustable by resistances 78 and 79. Condensers 84 and 85 prevent direct current from flowing in the artificial or phantom line and in the transmission line associated with this generator. The output of the two circuits of the batteries 76 and 77 may be tapped across a common resistance 86.

When, for example, one of the switches of the artificial line (according to the arrangement of the switches) is opened or closed by depressing a key of the signalling key assembly, either switch 82 or switch 83 is opened by the same mechanical control. Assuming that switch 82 has been opened, the current from battery 76 will be cut off. There is then produced at the terminals of inductance coil 80 an extra current surge or kick that furnishes a pulse, the brevity of duration of which depends essentially on the rapidity of interruption, and on the value of inductance 80 and of the time constant of the self inductance-resistance impedance formed by this inductance coil 80. Condenser 84, which is of low capacity, permits passage of the steep front of the positive pulse which is generated in this way and the duration of which can easily be reduced to values of the order of a microsecond.

The operation of the circuit of battery 77 will be similar when switch 83 is opened. However, a negative pulse will then be obtained on account of the reverse polarity of the battery connections with respect to the other elements of the circuit.

In the schematic view of the pulse generator shown in Fig. 5, condensers 88 and 89 are charged slowly by batteries 76 and 77 (since switches 82 and 83 are open) across adjustable resistances 78 and 79. In contrast to the pulse generator of Fig. 4, an impulse is generated by the closing of switches 82 or 83, one of which causes the rapid discharge of condenser 88 or 89 through resistance 86. A positive pulse is obtained by closing switch 82 and a negative pulse by closing switch 83, on account of the reversed connection of batteries 76 and 77 in their respective circuits.

Figs. 6 and 7 illustrate two examples of telegraph transmitters which employ pulse generators that furnish at will either positive pulses or negative pulses, such as those shown in Figs. 4 and 5.

In the arrangement shown schematically in Fig. 6, the positive and negative pulse generator 1 sends pulses simultaneously into the transmission line 3 and into the artificial or phantom line 2 the switches 50, 51, etc. of which are, for example, disposed in series in the line so as to cause pulse reflections when they are opened. The signalling or manipulation is effected by opening simultaneously any one of the switches 50 and either one of the switches 82 and 83 of the pulse generator. The opening of the switch 82 or 83 determines the sending of either a positive or a negative pulse, and the opening of one of the switches 50, 51, etc. determines the stagger between the direct and reflected pulses transmitted to the remote receiver or receivers.

Instead of employing a staggering of pulses by reflection, it is possible, according to another embodiment of the invention, to produce proper staggering by simple propagation into the artificial line 2. Fig. 7 illustrates an example of the use of this feature, using a generator producing either positive or negative pulses, at will. In the form of Fig. 7, generator 1 sends impulses into phantom line 2, each switch 90, 91, 92, etc. of the artificial line 2 serves for withdrawing pulses at the points where each switch is located, every time that a switch is closed. The manually or automatically controlled signalling or manipulation mechanism simultaneously closes one of the switches 90, 91, etc., and either switch 82 or switch 83 of generator 1, so that a pulse of desired polarity is generated and transmitted along phantom line 2 as far as the switch closed.

The direct pulse from generator 1 is transmitted to the control grid of a tube 100 the load impedance of which is indicated at 102 and the anode circuit of which is connected to the transmission line 3 via condenser 104, in order to avoid applying the high anode voltage to this line 3. The pulse retarded by line 2 is transmitted by one of the switches 90, 91, 92, etc. to the control grid of another tube 101 the load impedance of which is indicated at 103 and the anode circuit of which is similarly connected to the transmission line 3 via a condenser 105, used for blocking the flow of direct current. The common source of anode feed is indicated at 106. It should be noted that tubes 100 and 101 should not be adjusted at their cut-off point because they have to amplify either positive or negative pulses. Their biasing is accordingly adjusted by means of resistances 108 and 109. The pulses are applied to the control grids of tubes 100 and 101 via condensers 110 and 111, which latter are of sufficiently low capacity to prevent the signalling manipulation from causing any appreciable accidental surges reaching the line.

Another modification of the telegraph transmitter which incorporates features of the invention includes the use of a pulse generator that can furnish either positive or negative pulses as desired with the type of artificial line illustrated in Fig. 1, i. e. one that can furnish by reflection either positive return pulses or negative return pulses. In this case, the artificial line requires only half the elements or sections necessary in the case of Fig. 1 for transmitting the same number of signals.

The graphs of pulses received over line 3 will then be as shown in Figs. 8A to 8D in the case of the letters *a*, *b*, *c* and *d*, for example. When the signalling manipulation closes switch 50 (Fig. 1) and switch 82 of Fig. 5 or opens switch 82 of

Fig. 4, the letter *a* is transmitted to the receiver in the form of the pulses 112 and 113 of Fig. 8A. These two pulses are of the same polarity and are spaced apart by an interval T.

When the manipulation closes switch 60 (Fig. 1) and switch 82 of Fig. 5 (or opens switch 82 of Fig. 4), the letter *b* is sent over the line 3 in the form of the pulses 112 and 114 (Fig. 8*b*). These two pulses are of opposite polarity and are spaced apart by an interval T of the same value as for letter *a*.

When the manipulation closes switch 50 (Fig. 1) and switch 83 of Fig. 5 (or opens switch 83 of Fig. 4), the letter *c* is sent over the line 3 in the form of the pulses 115 and 116 (Fig. 8*c*). These two pulses are of the same polarity but the opposite of that of the pulses 112 and 113 (Fig. 8A), and their distance apart is still T.

When the manipulation closes switch 60 (Fig. 1) and switch 83 of Fig. 5 (or opens switch 83 of Fig. 4), the letter *d* is sent over the line 3 in the form of the pulses 115 and 117 (Fig. 8D). These two pulses are of different polarity, the first one being negative, and their stagger or distance apart is still T.

It can consequently be seen that a single time-lag section of the artificial line 2 is sufficient for sending four distinct characters. The number of sections of the artificial line will accordingly be one fourth of the total number of characters to be transmitted.

Instead of using two impulse generating circuits side by side as shown in Figs. 4 and 5 for obtaining either positive or negative impulses, another embodiment of the invention provides for the use of a single generating circuit in association with switching means that reverses the two output terminals of the pulse generator. This reversing means has to be controlled in synchronism with the manipulation device that is used. The order in which the various switchings has to be made is accordingly as follows:

By pressing on the key that corresponds to a figure or a letter, the output reversing means of the pulse generator is placed in the necessary position (positive or negative pulse). By continuing to press, the artificial line 2 is opened (or short-circuited) at the desired location. At the end of its travel, the manipulation key releases the emission of the pulse. Such a sequence of operations, which may be effected in any well known mechanical or electromechanical manner, takes place in a very short time, so that the operations may be said to be substantially synchronous.

It is quite evident that this is very important because it defines a regularity in the operations to be effected, such regularity being indispensable for the proper operation of the instrument.

The transmitter arrangement illustrated schematically in Fig. 9, according to the invention, provides a means for obtaining positive and negative pulses by only using a simple pulse generator employing only the upper or the lower half of the circuit of the types shown in Fig. 4 or Fig. 5. In this arrangement, the graphs of the line signals are similar to those shown in Figs. 8A to 8D. In other words, a single section of the time-lag line is sufficient for obtaining four desired different characters, depending on the manipulation.

The pulse generator 1 feeds into a resistance 120. A mid-tap 121 of this resistance permits the obtaining of positive pulses between the points 121 and 122, and negative pulses between the points 121 and 123. These pulses are sent over an artificial line 2 of the symmetrical or balanced type, as shown by way of example, and it is accordingly possible to deliver either positive pulses by the switches 130, 131, etc. or negative pulses by the switches 140, 141, etc.

The artificial line can furnish positive or negative pulses, but it is also necessary to be able to send the time origin pulse as a positive or negative pulse. This is accomplished by means of a switch 161 which connects the control grid of tube 100 either to terminal 122 or terminal 123 of the output resistance 120 of the pulse generator 1, while the cathodes of tubes 100 and 101 are connected to the mid-point 121 of this resistance by a connection 162. The mean bias value of tubes 100 and 101 is determined by the resistances 108 and 109. Battery 106 feeds the tube anodes through resistors 102 and 103, respectively, and the anodes are coupled to output 3L via condensers 104 and 105.

The manipulation will be effected as in the preceding cases, i. e. the pulse will be released by the pulse generator after the setting in position of switch 161 and one of the switches 130 or 140, depending on the character that is to be transmitted. For transmission of the letter *a*, for example, switch 130 will be closed and switch 161 will connect the terminal 122 of resistance 120 to the control grid of tube 100. The pulse will be released by the generator and this will cause the sending into the line of the two impulses that define the letter *a* by their direction and time displacement. The direct pulse travels from generator 1, via points 122, 161, tube 100 and condenser 104 to line 3L. The retarded pulse travels via 122, line 2, switch 130, coupling condenser 111, tube 101 and condenser 105 to line 3L. For transmission of the letter *b*, switch 130 will also be closed, but switch 161 will be brought into the position in which it connects the terminal 123 of resistance 120 to the control grid of tube 100. Similarly, the letters *c* and *d* will be sent by the closing of switch 140. It can consequently be seen that the first symmetrical section of the artificial line permits the sending of four signals, and similarly for all the other sections of line 2.

The transmission speed of these devices depends on the duration of the impulses and also on the length (in time-lags) of the artificial line. The transmission time in the artificial line is dependent upon the number of sections, i. e. the quarter or half of the number of characters (letters, figures and symbols) to be transmitted, i. e. generally ten or twenty (since 26 letters, 10 figures and 4 symbols usually are transmitted).

If the duration or width of an impulse is designated by θ, for the purpose of selecting signals that correspond to two adjacent sections of the artificial line, the shortest distance in time that can be practically used is equal to θ. In order to insure greater certainty of operation, it is possible and suitable to make this distance equal to 1.5 θ or more according to the nature of the transmission line with which the device is associated.

If, for example, we take a time θ equal to 2 microseconds and 20 sections for 40 signs to be transmitted (Fig. 1), the length of the artificial line will be from 40 to 60 microseconds depending upon whether the stagger time per cell is taken to be equal to θ or to 1.5 θ.

It is evident that a signal can be sent only when there has elapsed a time equal to the transfer

time after the emission of a pulse. A subsequent signal can therefore only be transmitted 40 to 60 microseconds after the sending of a preceding signal, and this permits the sending of about 10,000 to 15,000 signals per second. Such a speed may be utilized in the case of automatic signalling manipulation over a perforated or recording tape, since the transmission takes place automatically.

In the case of an artificial line that permits the sending of four signals per section instead of two, the above figures will have to be doubled.

For simple instruments, pulses of greater widths will have to be used. It is evident however, in the case of direct manipulation by the operator, that there is no risk of his jumbling the signals by too rapid manipulation, irrespective of the speed with which he strikes the keys.

The transmission speed of the device under consideration also depends on the maximum recording speed of the associated receiver or receivers. In the case of ordinary types of receivers, it will be necessary to use impulses of longer duration and artificial lines that provide a greater stagger or displacement of the pulses.

The invention makes it possible in every case to use the time intervals available between two consecutive signals for placing the transmission line at the disposition of one or more other operators, in other words to effect multiple transmissions by means of pulses of short duration.

It will be noted that circuit arrangements have been provided whereby two or more pairs of pulses are produced which have the same stagger relation but differ in their polarity to provide two different signals. It is immaterial whether the generator or generator means generates impulses of two polarities and the switching means in the artificial line develops a delayed pulse of the same polarity or the generating means generates a pulse of a single polarity and the switching means for the artificial line produces a delayed pulse of two different polarities. In either case a series of two pairs of pulses may be produced having the same stagger relation but different polarities namely two pulses of the same polarity and two pulses of opposite polarity but with the same stagger relation if the generating means provides pulses of different polarities or two pulses of the same polarity (positive or negative) and two pulses of opposite polarity but with the same stagger relation if the switching means is utilized to develop the signals. In a circuit in which both the generator means and the switching means produce pulses of opposite polarity then a series of four pulse signals may be transmitted each having the same stagger relation but differing in polarity namely two positive pulses, two negative pulses, a positive primary pulse and a negative secondary or delayed pulse and lastly a negative primary pulse and a positive secondary or delayed pulse, each of which may be used as a separate distinct signal.

Although the invention has been described by means of certain particular examples or embodiments, it is evident that it is by no means limited thereto but on the contrary is capable of numerous modifications and adaptations within the scope of the following claims.

Having described my invention, I claim:

1. A printing telegraph system of the type in which the characters to be transmitted are translated into signals consisting of pulses spaced by different time staggers, comprising a pulse generator generating pulses of definite polarity, a transmission line receiving pulses of constant polarity directly from said generator, an artificial line connected to said generator and having a plurality of impedance sections producing retardations in the pulses it receives from said generator said artificial line being arranged to reflect these pulses into said transmission line with different time staggers relatively to said directly received pulses, means in each impedance section for opening and closing the artificial line thereat, and means in each impedance section for making and breaking a short-circuit of the artificial line thereat, both said means being selectively operable in the course of signalling to vary the polarity of the staggered pulses of a signal reflected into said transmitting line whereby the transmitted signal is defined by the stagger in combination with the polarity of its component pulses.

2. A printing telegraph system of the type in which the characters to be transmitted are translated into signals consisting of pulses spaced by different time staggers, comprising a pulse generator generating pulses of both polarities, a transmission line receiving said pulses directly from said generator, an artificial line also connected to said generator and having a plurality of impedance sections producing retardations in the pulses it receives from said generator said artificial line including a plurality of switches operable so as to reflect these pulses into said transmission line with different time staggers relatively to said directly received pulses, there being a switch in each impedance section for rendering it operable and inoperable to so reflect pulses, said switches and said pulse generator being simultaneously and selectively controllable in the course of signalling to vary the polarity of the pulses delivered to said transmission and artificial lines by said generator whereby the transmitted signal is defined by the stagger in combination with the polarity of the component pulses from the artificial line.

3. A printing telegraph system of the type in which the characters to be transmitted are translated into signals consisting of pulses spaced by different time staggers, comprising a pulse generator generating pulses of both polarities, a transmission line receiving said pulses directly from said generator, an artificial line also connected to said generator and having a plurality of impedance sections producing retardations in the pulses it receives from said generator said artificial line being provided with a plurality of switches controlling direct propagation of these pulses and their delivery with stagger to said transmission line relatively to said directly received pulses, there being a switch in each impedance section and movable for rendering the section operable and inoperable to so reflect pulses, said switches and said pulse generator being simultaneously and selectively controllable in the course of signalling to vary the polarity of the pulses delivered to said transmission and artificial lines by said generator whereby the transmitted signal is defined by the stagger in combination with the polarity of the component pulses from the artificial line.

4. A printing telegraph system of the type in which the characters to be transmitted are translated into signals consisting of pulses spaced by different time staggers, comprising a pulse generator, a transmission line receiving pulses directly from said generator, an artificial line connected to said generator and a movable control

switch in each section, and having a plurality of impedance sections producing retardations in the pulses it receives from said generator said artificial line being arranged to introduce its pulses into said transmission line with different time staggers depending on the switch positions, relatively to said directly received pulses, and means for changing the polarity of said pulses in the course of signalling whereby the transmitted signal is defined by the stagger in combination with the polarity of the component pulses from the artificial line.

5. In a system according to claim 2, a generator yielding positive and negative pulses including two sources of direct current connected at opposite poles, two induction coils energized respectively by said sources, a switch between the positive pole of one source and its induction coil, a switch between the negative pole of the other source and its induction coil, a connection between said switches, a resistance tapped across the junction of said sources and said connection said resistance feeding the output of the generator to the transmission line and artificial lines, and condensers blocking flow of direct current into said lines, said switches being operable in the course of signalling.

6. In a system according to claim 2 a generator yielding positive and negative pulses including two sources of direct current connected at opposite poles, a pair of condensers arranged to be charged at a predetermined rate by said sources, a connection between said condensers, two switches connected one to discharge pulses from the positive terminal of one source and the other to discharge pulses from the negative terminal of the other source, and means for introducing such positive and negative pulses into said transmission and artificial lines said switches being operable in the course of signalling.

7. A printing telegraph system of the type in which the characters to be transmitted are translated into signals consisting of pulses spaced by different time staggers, comprising a pulse generator generating pulses of definite polarity, a transmission line receiving pulses of constant polarity directly from said generator, an artificial line connected to said generator and having a plurality of impedance sections producing retardations in the pulses it receives from said generator said artificial line being arranged to introduce these pulses into said transmission line with different time staggers relatively to said directly received pulses, means in each impedance section for opening and closing the artificial line thereat, and means in each impedance section for making and breaking a short-circuit of the artificial line thereat, both said means being selectively operable in the course of signalling to vary the polarity of the staggered pulses of a signal introduced into said transmitting line whereby the transmitted signal is defined by the stagger in combination with the polarity of its component pulses.

8. A printing telegraph system of the type in which the characters to be transmitted are translated into signals consisting of pulses spaced by different time staggers, comprising a pulse generator generating pulses of both polarities, a transmission line receiving said pulses directly from said generator, an artificial line also connected to said generator and having a plurality of impedance sections, each with a control switch therein, for selectively producing retardations in the pulses it receives from said generator said

artificial line being arranged to introduce these pulses into said transmission line with different time staggers dependent upon switch position relatively to said directly received pulses, the switch in each impedance section rendering it operable and inoperable to so introduce pulses, said switches and said pulse generator being simultaneously and selectively controllable in the course of signalling to vary the polarity of the pulses delivered to said transmission and artificial lines by said generator whereby the transmitted signal is defined by the stagger in combination with the polarity of the component pulses from the artificial line.

9. In a signalling system, in combination, a pulse generator for generating pulses of either polarity, a transmission line, an artificial line, a circuit connecting the two lines in parallel to the generator, a plurality of impedance sections in the artificial line each comprising a condenser connected across the line and an inductance in series in the line, a switch in series with each inductance and movable to open or close the line at a point just beyond its inductance whereby to cause a pulse in the artificial line to be reflected back into the transmission line from the place of the first open switch, and with no change in polarity, whereby simultaneous and selective operation of the generator and a switch results in a pair of selectively spaced pulses, of like polarity being transmitted by the transmission line.

10. In a signalling system, the combination of a pulse generator generating pulses of at least one polarity, a transmission line connection to receive pulses directly from said generator; an artificial line having a length proportional to the number of pulse polarities generated and such that separate pulses result including a plurality of series impedance sections and a plurality of shunt impedance elements constituting a plurality of impedance sections, a series switch for each section of said artificial line, and a shunt switch for each section of said artificial line, said artificial line being connected with the transmission line connection to receive pulses from the generator and to reflect the pulses therefrom into said transmission line connection at different time intervals following the receipt of pulses from said generator; and means for selectively operating said series and shunt switches to determine the length of the artificial line and the stagger interval between the primary pulse and the reflected pulse and the polarity of the reflected pulse.

11. In a signalling system, the combination of a pulse generator generating pulses of at least one polarity, a transmission line connection to receive pulses directly from said generator; an artificial line having a length proportional to the number of pulse polarities generated and such that separate pulses result including a plurality of series impedance sections and a plurality of shunt impedance elements constituting a plurality of impedance sections, a normally closed series switch for each section of said artificial line, and a normally open shunt switch for each section of said artificial line, said artificial line being connected with the transmission line connection to receive pulses from the generator and to reflect the pulses therefrom into said transmission line connection at different time intervals following the receipt of pulses from said generator; and means for selectively operating said series and shunt switches to determine the length of the artificial line and the stagger interval be-

tween the primary pulse and the reflected pulse and the polarity of the reflected pulse.

12. In a signalling system, the combination of a pulse generating means for generating pulses of at least one polarity, a transmission line connection to receive pulses directly from said generating means, an artificial line having a length proportional to the number of pulse polarities generated and such that separate pulses result including a plurality of impedance sections and at least one movable switch means in each section, said artificial line being connected to the transmission line connection to receive pulses from said generating means, the switch means being positionable for controlling said artificial line to transmit delayed pulses therefrom into said transmission line connection at different time intervals following the receipt of pulses from said generating means, operating mechanism for selectively operating said switching means, and at least one of said means producing pulses of opposite polarity whereby both the stagger interval between the primary pulse and the delayed pulse and the polarity of the pulses may be selected.

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