No. 715,686. Patented Dec. 9, 1902.

T. D. PENNIMAN.

ELECTRIC TELEGRAPH.

(Application filed Jan. 9, 1902.)

(No Model.) 2 Sheets—Sheet 1.

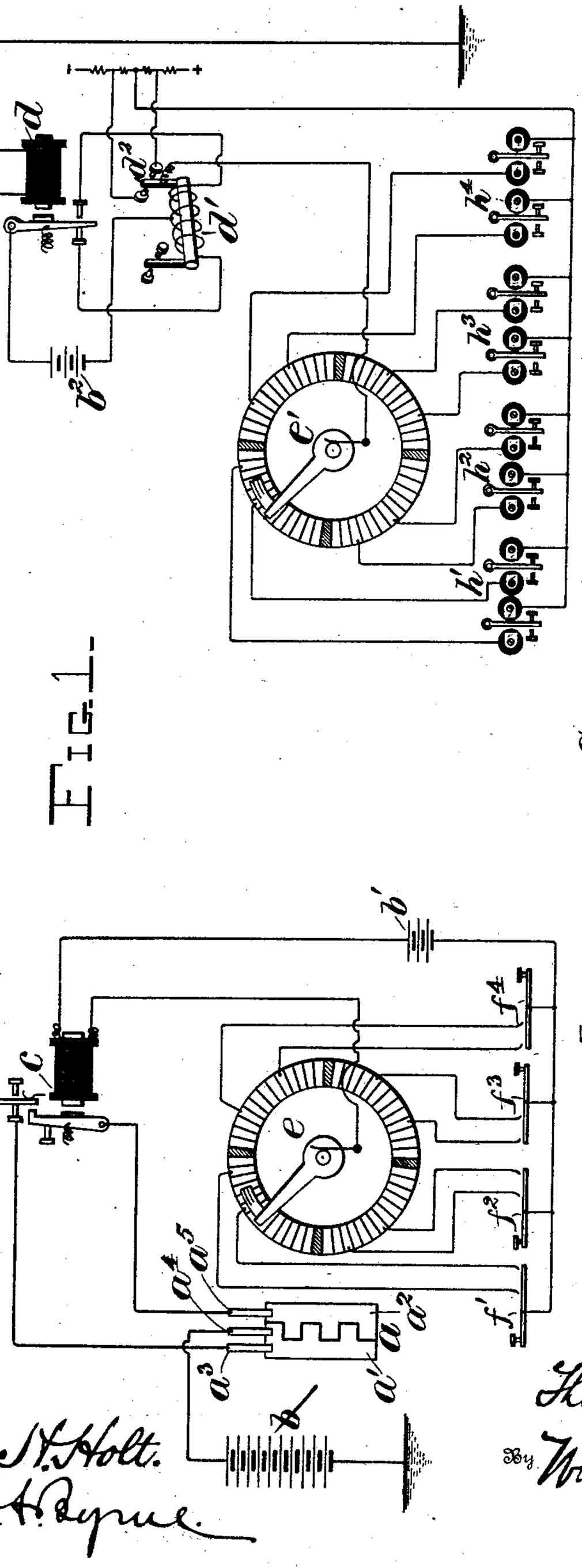

Fig. 1.

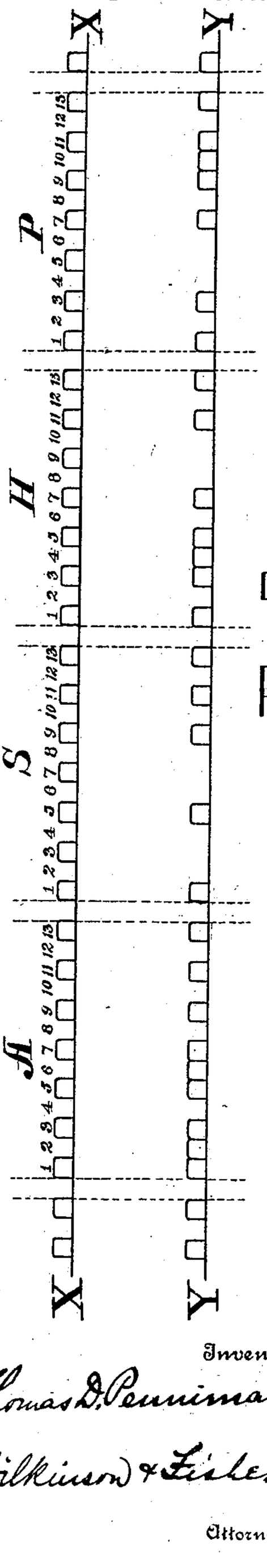

Fig. 2.

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(No Model.) 2 Sheets—Sheet 2.

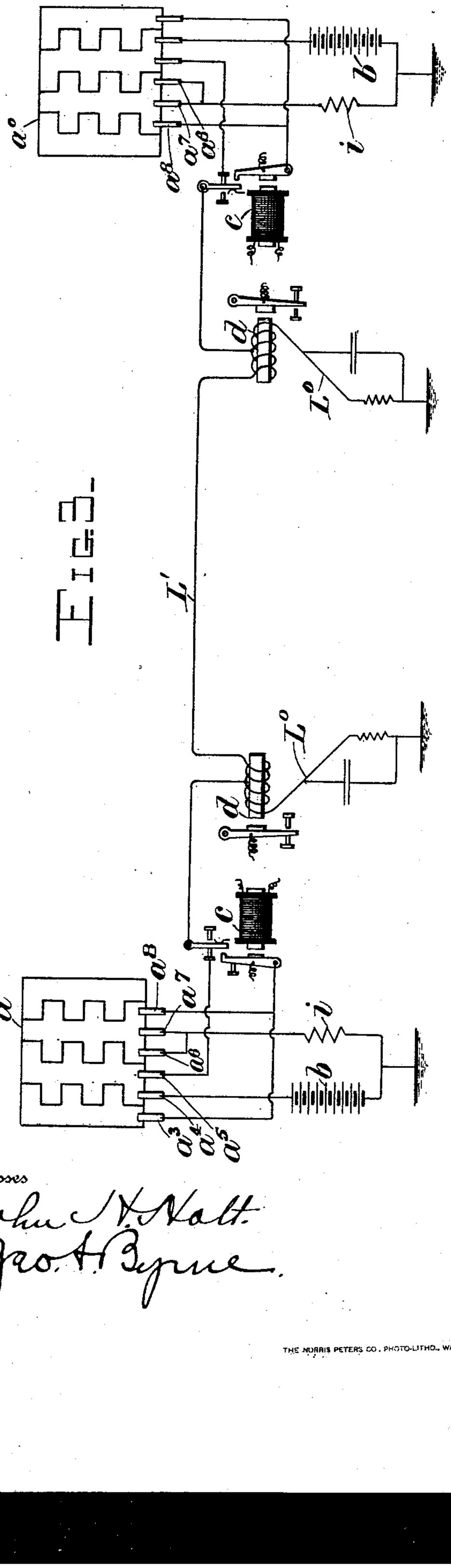

FIG. 3.

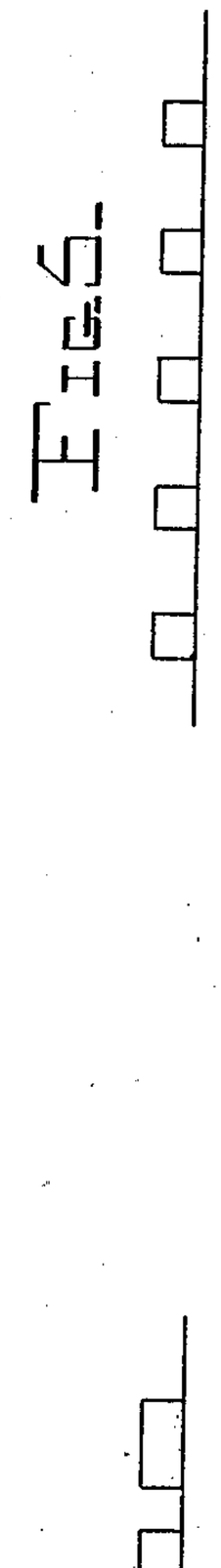

FIG. 5.

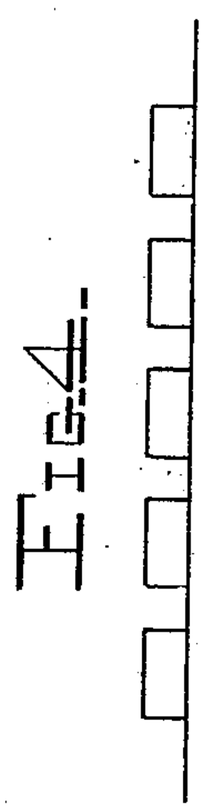

FIG. 4.

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UNITED STATES PATENT OFFICE.

THOMAS D. PENNIMAN, OF BALTIMORE, MARYLAND, ASSIGNOR TO THE ROWLAND TELEGRAPHIC COMPANY, OF BALTIMORE, MARYLAND, A CORPORATION OF NEW JERSEY.

ELECTRIC TELEGRAPH.

SPECIFICATION forming part of Letters Patent No. 715,686, dated December 9, 1902.

Application filed January 9, 1902. Serial No. 89,071. (No model.)

To all whom it may concern:

Be it known that I, THOMAS D. PENNIMAN, a citizen of the United States, residing at Baltimore, in the State of Maryland, have invented certain new and useful Improvements in Electric Telegraphs; and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same.

My invention relates to improvements in electric telegraphs, and more especially to an improved method of transmitting intelligence, consisting in sending over the line a normally intermittent or pulsatory electric current—that is, a series of current impulses of the same polarity separated by spaces and substituting the spaces for impulses and impulses for spaces in combinations to form the letters of the alphabet or other characters and recording the intelligence thus transmitted.

The said invention further consists in dividing the impulses and spaces into groups and allowing each combination of substituted impulses or spaces or both in a group to represent a character or signal.

This invention, moreover, comprises a method by which the apparatus of the Rowland system of multiplex telegraphy may, without practically any changes, be employed upon an ordinary battery or other direct-current circuit. The invention, however, is by no means limited to this specific application, as will be hereinafter shown.

In order to more fully describe my said invention, reference will be had to the accompanying drawings, in which—

Figure 1 is a diagram of circuits and connections, illustrating the principle of my invention. Fig. 2 is a diagram illustrating the method of forming the code by the combination of impulses and spaces. Fig. 3 is a diagram of circuits and connections, showing the application of the principle of the invention to a duplex line; and Figs. 4 and 5 are graphical representations of different forms of current impulses.

Similar characters refer to similar parts throughout the several views.

In carrying out my invention I send over the line normally a series of impulses of the same polarity separated from each other by spaces, comprising what is known in the art as an "intermittent" current, (represented graphically on the line X X, Fig. 2,) and make use of both impulses and spaces as the elements of the combinations which go to make up the letters of the alphabet or other characters of the code. The impulses and spaces are divided into groups of equal numbers, (represented in Fig. 2 as the spaces and impulses included between each pair of vertical dotted lines.) For the purposes of the present description I have assumed that these groups contain each thirteen elements—that is, seven impulses and six spaces—though, as I shall afterward show, this special combination may be varied.

For each letter of the alphabet or other character I select a combination in each group, this combination comprising two impulses, two spaces, or a space and an impulse and substitute on the line for the space of the combination an impulse and for the impulse a space, or, in other words, if an element of the combination falls on an impulse it is suppressed. If it falls on a space, an impulse is substituted. To illustrate, suppose the letter "A" is represented by the elements 2 and 6 of the first group on the line X X. Both of these elements happen to be spaces. Hence for spaces 2 and 6 two impulses would be substituted, when the group becomes as shown in the first group on the left on the line Y Y. Next, suppose the letter "S" is represented by the third and seventh elements of the second group from the left on line X X. These, it will be seen, are both impulses. Hence for this letter the two impulses 3 and 7 would be suppressed, and, again, assuming the letter "H" is represented by the fourth and ninth elements, it will be seen that the fourth element is a space and the ninth is an impulse. In this case the letter would be transmitted by substituting an impulse for space 4 and suppressing impulse 9. The last group on the right of line Y Y represents the letter "P," transmitted by suppressing impulse 5 and inserting an impulse for space 10. I do

not, however, confine myself to combinations of two elements, since each character may be made up of, say, two or more impulses and two or more spaces; but the combinations of two elements are preferred.

A form of apparatus and connections for carrying out the above method is shown in Fig. 1, where *a* represents the development of a commutator for sending the intermittent current to line. This commutator consists, preferably, of two interlocking crown-sections a' and a^2, provided with brushes a^3, a^4, and a^5, the brushes a^3 and a^5 resting continually on the sections a' and a^2, repectively, while the central brush is so situated that it makes contact with a segment of first one section of the commutator and then the other. The commutator may be driven in any suitable manner at preferably a constant or uniform speed. The brush a^4 is connected to a battery *b* or other source, from which is derived the main-line current, while the brush a^3 is connected to the forward contact of a main-line transmitter *c* and brush a^5 to the striker of said transmitter. The tongue of the transmitter is connected to the main line L, which extends to the receiving-station, where it connects to the magnet-coils of a main-line neutral relay *d* and thence connects to earth. The terminal of the battery *b* not connected to the commutator-brush is also grounded. Obviously, if desired, the circuit may be entirely metallic, though this is not necessary. By this arrangement an intermittent current, as represented on line X X, will be sent over the line as long as the commutator *a* rotates and the tongue of the transmitter remains against its forward stop—that is, at each time the brushes a^3 and a^4 are short-circuited an impulse will be sent to line and when brushes a^4 and a^5 are short-circuited a space will intervene. The characters are impressed on the line by causing the transmitter to break the contact between its tongue and forward contact at prearranged intervals and at such intervals connecting the brush a^5 through the transmitter-striker to line. The means that I have shown for thus operating the transmitter comprises among other parts a sunflower *e*, operating in conjunction with keyboards f' f^2 f^3 f^4. When used for multiple transmission, the segments of this sunflower are divided into a plurality of groups, and each group is devoted to independent messages. In the case illustrated there are four groups of thirteen segments each and four segments (the shaded ones) used for separating the groups, making fifty-six in all. The segments of each group are each separately connected to a corresponding number of contacts of a keyboard—that is, there is one keyboard to each group—and the keys of these keyboards are so arranged that each when operated connects in the transmitter magnet-circuit a different combination of segments. Any other device, however, such as a tape, may be used for thus connecting the segment-circuits in combination with the transmitter magnet-coil; but it is preferred to use the form of keyboard shown and described in the patent application of Henrietta H. Rowland, administratrix of Henry A. Rowland, deceased, for improvements in keyboards for use in telegraphy, filed July 24, 1901, Serial No. 69,526. Each keyboard is connected to a common return-wire *g*, which connects to a battery b'. The positive pole of this battery is connected, through the coil of the transmitter, to the sunflower-trailer, as shown. The sunflower-trailer may be driven by any suitable means; but its speed must be such that for each complete impulse or space it will pass over one complete segment. Both sunflower-trailer and commutator *a* should preferably be driven at a uniform speed.

Let us suppose now that the operator at keyboard f' wishes to send the letter "A." To do this, he would operate the key which would connect in circuit with the local battery b' and the transmitter magnet-coil the second and sixth segments of the upper left-hand group. Normally when the trailer arrives upon the second segment the brushes a^3 and a^4 would lie upon separate sections of the commutator. Hence no current would flow to line, which would cause a space; but in the case of the trasmission of the letter above indicated the transmitter attracts its striker, which breaks the connection from the forward contact and makes the connection from the brush a^5 through the striker and tongue to line, and as the brushes a^4 and a^5 would at this time be short-circuited an impulse would be sent to line in place of the space, and likewise when the trailer reaches the sixth segment this segment, being connected in the local battery or keyboard circuit, will cause the transmitter to again operate and send to line an impulse instead of the space, just as in the case of the second impulse; and, again, if the transmitter operates when the brushes a^3 and a^4 are short-circuited this will suppress an impulse. This is well illustrated in the case of the letter "S," which we assume is represented by the third and seventh impulses. In the drawings, Fig. 1, operator at keyboard f^2 is shown as sending this letter. His key for the letter "S" connects in the transmitter-coil circuit the third and seventh segments. The transmitter T will therefore operate when the trailer reaches these segments. At each of these times the brushes a^3 and a^4 will be short-circuited; but inasmuch as the transmitter has broken at these moments the circuit at its forward contact the third and seventh impulses will be suppressed. In the same manner one or more impulses may be suppressed and one or more spaces replaced by impulses in the same group, as in the case of the letter "H," shown in the third group on the line Y Y, Fig. 2. By combining the segments of each group in this manner I may get enough

combinations for the English alphabet, all the numerals, and quite a number of extra signs or symbols besides.

In the drawings I have simply indicated one key of each keyboard by the conventional form of key, though in the actual keyboard above referred to each keyboard is provided with a locking device which permits the keys to be operated only at certain intervals—for example, when the sunflower-trailer is passing over an opposite group of segments to those with which that particular keyboard is connected. The specific form of keyboard, however, forms no part of my present invention.

Messages sent to line in the manner above set forth may be received in a variety of ways. If the Rowland printing-telegraph receiver is employed, all that is necessary is to connect the coil-terminals of the differentially-wound main-line polar relay d' of the Rowland system to the tongue and tongue-contacts of the main-line neutral relay d of my system through a battery or other source of current b^2, or by the proper use of resistances the two relays may be connected in any number of ways. The rest of the receiving apparatus, comprising the synchronously-operated sunflower e' and selecting-relays h'–h^4, are parts of the Rowland system adapted to operate in conjunction with the telegraphic page-printer shown and described in the Patent No. 689,754, granted to Henry A. Rowland, December 24, 1901, the sunflower e' in this case corresponding to the sunflower e. While this apparatus forms no part of my present invention, I will describe, briefly, how it operates to record the messages sent by my method. As the current sent over the line in this case is intermittent, the tongue of the neutral relay d will be drawn into engagement with its forward contact for each impulse and remain against its back stop for each space. With the connections shown this will cause the tongue d^2 of the polar relay d' to vibrate between its contacts, as current will be sent from the battery b^2 through its coils alternately in opposite directions. If, however, an impulse is inserted where a space would normally be or an impulse suppressed where it would normally remain, this will cause the tongue of the relay d to remain against the contact to which it was last sent until a space occurs if an impulse be inserted or until an impulse comes along if an impulse be suppressed. This will have exactly the same effect on the local receiving apparatus shown as suppressing impulses of the alternating current in the Rowland system. The normal vibration of the tongue d^2 of the polar relay d operating in conjunction with the sunflower e', connected through its trailer and selecting-relays to a source of direct current, as shown, sends to each of the selecting-relays h'–h^4 an impulse as the trailer passes over the segment of the sunflower to which the relays are connected, and normally the impulse received by any relay is always of the same polarity; but the impulses that normally—that is, when no signal is sent—pass to adjacent relays are of opposite polarity—that is, if relay No. 1 receives normally positive impulses, relay No. 2 receiving normally negative impulses. The selecting-relays are, however, so wound that the impulses distributed in this manner send all their tongues against their back stops, it being only when they receive impulses of opposite polarity to the normal impulse that their tongues are sent against their forward stops, which when done in certain prearranged combinations operates the page-printing machine described in Patent No. 689,754, above referred to. One of these printers would be connected to each group of selecting-relays, and hence there would be a printer for each keyboard, each printer receiving signals from its corresponding keyboard only.

Let us assume now that the operator at key f' sends the letter "A." This letter being represented by the insertion of impulses for spaces 2 and 6, the tongue of the relay d will remain against its forward stop while the trailer of the receiving-sunflower is passing over its second and sixth segments of the group corresponding to the group at the transmitting end connected to key f'. This will cause the relays h', connected to the second and sixth segments, to receive impulses of the opposite polarity to the normal impulses, which will send their tongues against the forward stops, as before stated. Likewise the tongue of the relay d will remain against its back stop twice as the operator at key f^2 sends the letter "S," for example, and so on through the series. It must be understood, of course, that two relays are shown in each group simply for the purpose of explanation. In actual practice there are eleven in each group.

Thus it will be seen that by simply connecting the main-line polar-relay coil-terminals to my neutral main-line relay I am enabled to use the whole of the Rowland receiving apparatus without altering it in any respect; but while my invention may be readily adapted to the Rowland system it may also be used with the well-known Morse register or Bain or Wheatstone receivers or other systems. Indeed, I do not limit my invention to any particular method of receiving. Moreover, I may employ any suitable means for driving the trailer of the receiving-sunflower in synchronism with that of the transmitting-sunflower, though I prefer to employ the synchronizer shown and described in the patent application of Henry A. Rowland for improvements in synchronous telegraph systems filed February 24, 1899, and serially numbered 706,729, Patent No. 691,667.

I have shown in Fig. 1 the application of the invention to a synchronous multiplex system by which all four operators may send messages in one direction over the line at the

same time. This line may be duplexed by connecting the main-line apparatus, as shown in Fig. 3, in which case four messages may be sent each way simultaneously. In this case I employ a main-line relay *d* at each end of the line and wind it differentially, one of its coils being traversed by the real line L′ and the other by an artificial line L^0, after the ordinary practice of duplexing, and, as is also the practice in duplexing, I employ a source of current *b* at each end of the line. In the case of a duplex line it is necessary to keep the line always grounded, notwithstanding the suppression of impulses—that is, grounded through the battery when sending an impulse and grounded through a resistance when sending a space. For this purpose I extend the commutator, as indicated at a^0 in Fig. 2, and provide it with three extra brushes a^6, a^7, and a^8. The brushes a^6 and a^7 are short-circuited and connected to earth through suitable resistance *i*, while the brush a^8 is permanently connected to the striker of the transmitter. By this arrangement the current may be modified exactly as indicated in Fig. 2 and described.

The method of duplexing shown is simply the well-known differential duplex, which forms no immediate part of my present invention and which is too well known in the art to require an explanation of its theory or a detail description of its mode of operation.

In the foregoing description I adapted the form of current in which the impulses and spaces were of the same length. I do not, however, confine myself to this specific form. For example, the spaces may be short and the impulses long, as in Fig. 4, or the spaces may be long and the impulses short, as in Fig. 5. Further, I do not confine myself to positive impulses, as the method operates as well if all are negative. I may, furthermore, modify the spaces and impulses in any desired combinations suitable for the code employed. I may also employ with my method a current with impulses alternating in polarity and of the same or different intensities, but the direct current is preferred.

Having thus described my invention, what I claim, and desire to secure by Letters Patent of the United States, is—

1. The improvement in the transmission of intelligence which consists in sending over a circuit a succession of electrical impulses separated by spaces, and substituting spaces for impulses and impulses for spaces in combinations to form the characters of a code.

2. The improvement in the transmission of intelligence which consists in sending over a circuit a succession of electrical impulses of the same polarity separated by spaces, and substituting spaces for impulses and impulses for spaces in combinations to form the characters of a code.

3. The improvement in the transmission of intelligence which consists in sending over a circuit a succession of electrical impulses separated by spaces, substituting spaces for impulses and impulses for spaces in combinations to form the characters of a code and recording the intelligence thus transmitted.

4. The improvement in the transmission of intelligence, which consists in sending over a circuit an intermittent electric current, and substituting the spaces between the impulses for impulses, and impulses for spaces in combinations to form the characters of a code.

5. The improvement in the transmission of intelligence, which consists in sending over a circuit a succession of electrical impulses of the same polarity, separated by spaces, and substituting one or more impulses for spaces and one or more spaces for impulses to form the characters of a code.

6. The improvement in the transmission of intelligence, which consists in sending over a circuit a succession of electrical impulses, separated by spaces, and forming the characters of a code by selecting equal groups of spaces and impulses and changing the character of the groups by altering the relative positions of the spaces and impulses in prearranged combinations.

7. The improvement in the transmission of intelligence, which consists in sending over a circuit an intermittent electric current, and forming the characters of a code by selecting equal groups of spaces and impulses and changing the character of the groups by altering the relative positions of the spaces and impulses in prearranged combinations.

8. The improvement in the transmission of intelligence, which consists in sending over a circuit an intermittent electric current, forming the characters of a code by selecting equal groups of spaces and impulses and changing the character of the groups by altering the relative positions of the spaces and impulses in prearranged combinations, and recording the intelligence thus transmitted.

9. The improvement in the art of transmitting intelligence, which consists in sending over a circuit a succession of electrical impulses of the same polarity, making up the elements of a code out of impulses and intervening spaces, altering the character of the same number of elements for each character of the code, and determining the character of the code by the combinations of impulses thus changed.

10. The improvement in the art of transmitting intelligence, which consists in sending over a circuit an intermittent electric current, making up the elements of a code out of impulses and intervening spaces, altering the character of the same number of elements for each character of the code, determining the character of the code by the combinations of impulses thus changed, and recording the intelligence thus transmitted.

11. The improvement in the art of transmitting intelligence, which consists in impressing upon an electric circuit a succession of unidirectional electrical impulses sepa-

rated from one another, by alternately connecting and disconnecting the said circuit to and from a source of direct electromotive force, and inserting impulses in the place of spaces and substituting spaces for impulses in combinations and in accordance with a preselected code.

In testimony whereof I affix my signature in presence of two witnesses.

THOMAS D. PENNIMAN.

Witnesses:
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JOHN H. HOLT.