No. 773,198. PATENTED OCT. 25, 1904.

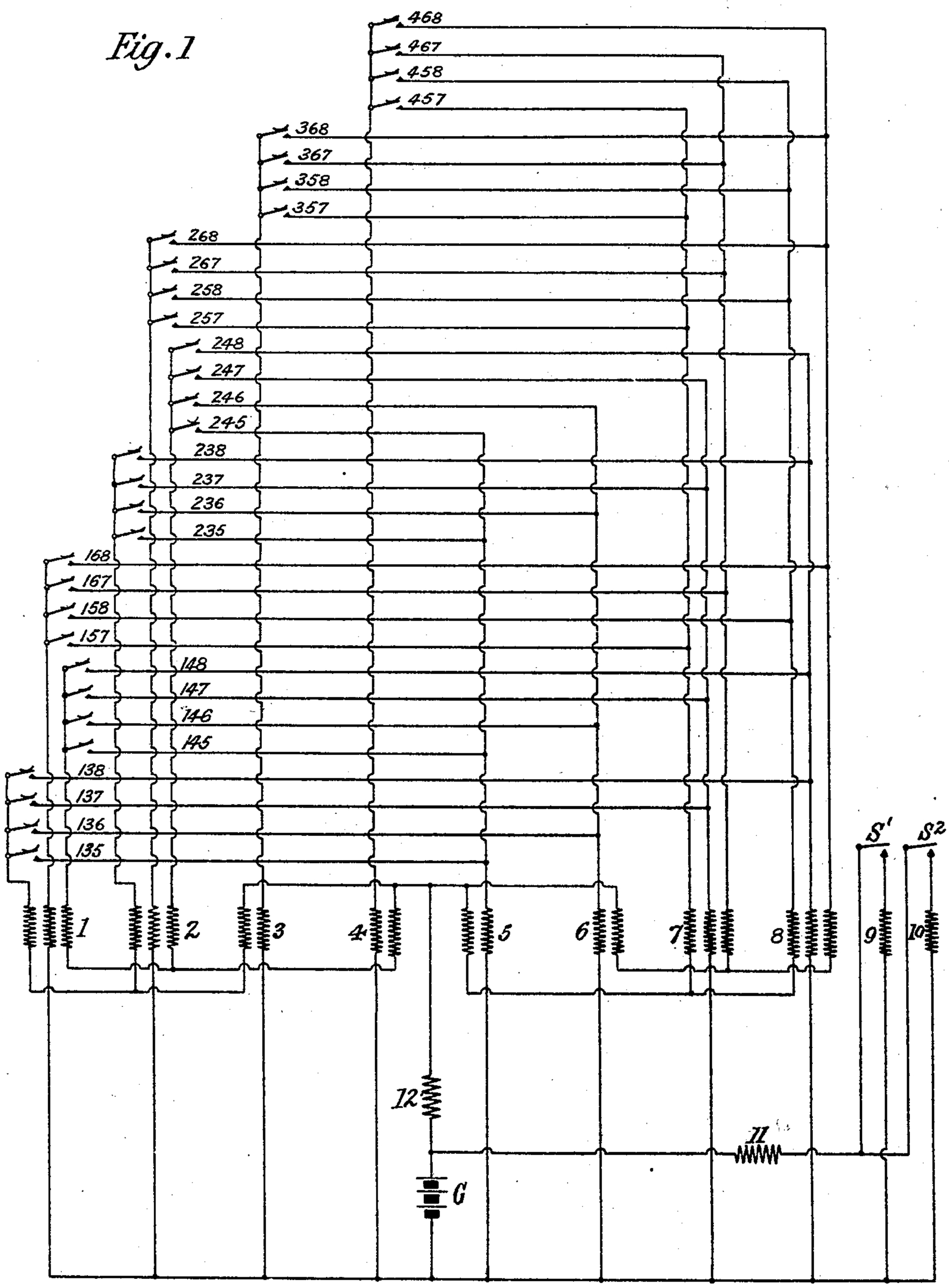
A. C. CREHORE.

TELEGRAPH SYSTEM.

APPLICATION FILED AUG. 12, 1903.

NO MODEL. 8 SHEETS—SHEET 1.

Fig. 1



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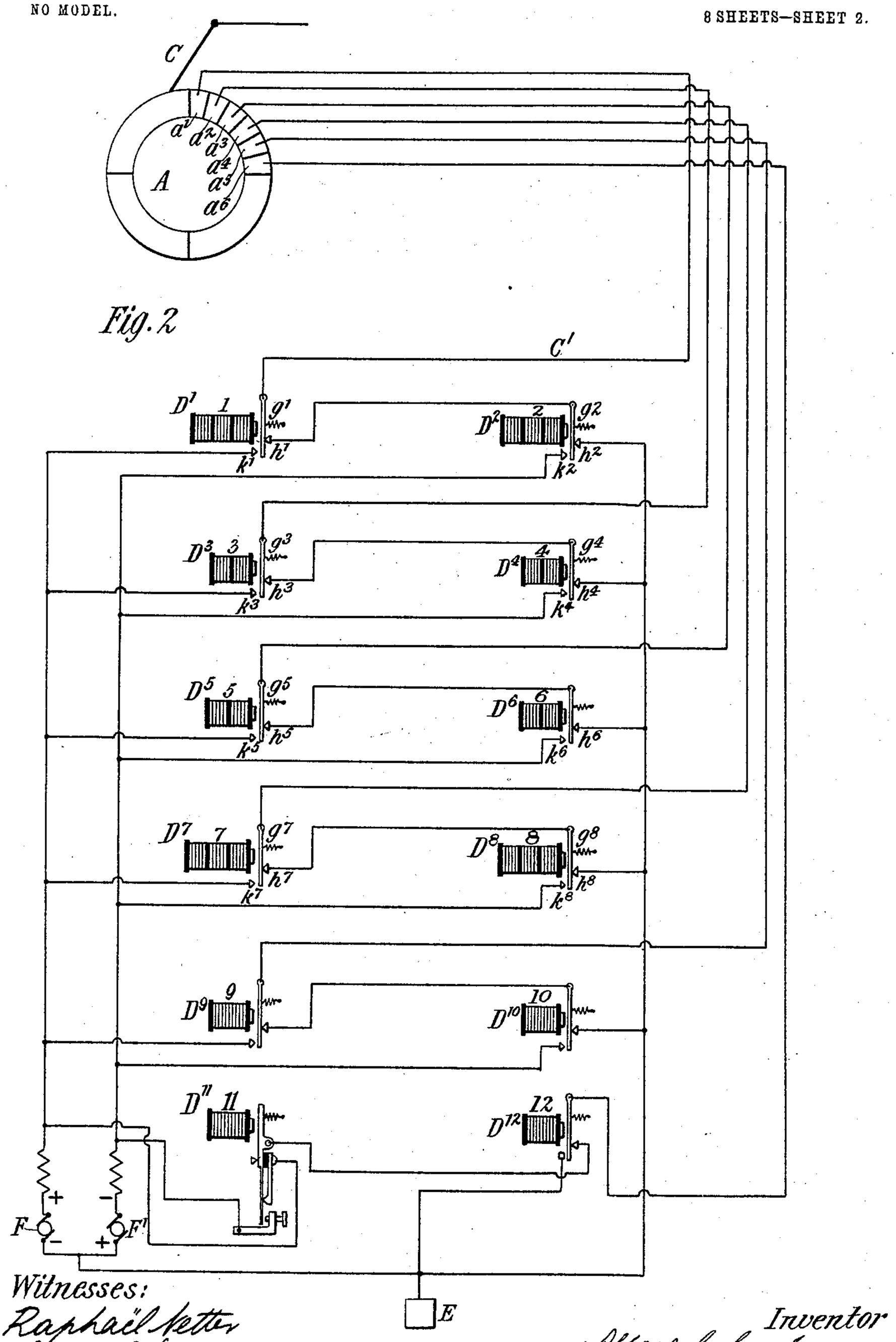
NO MODEL. 8 SHEETS—SHEET 2.

Fig. 2



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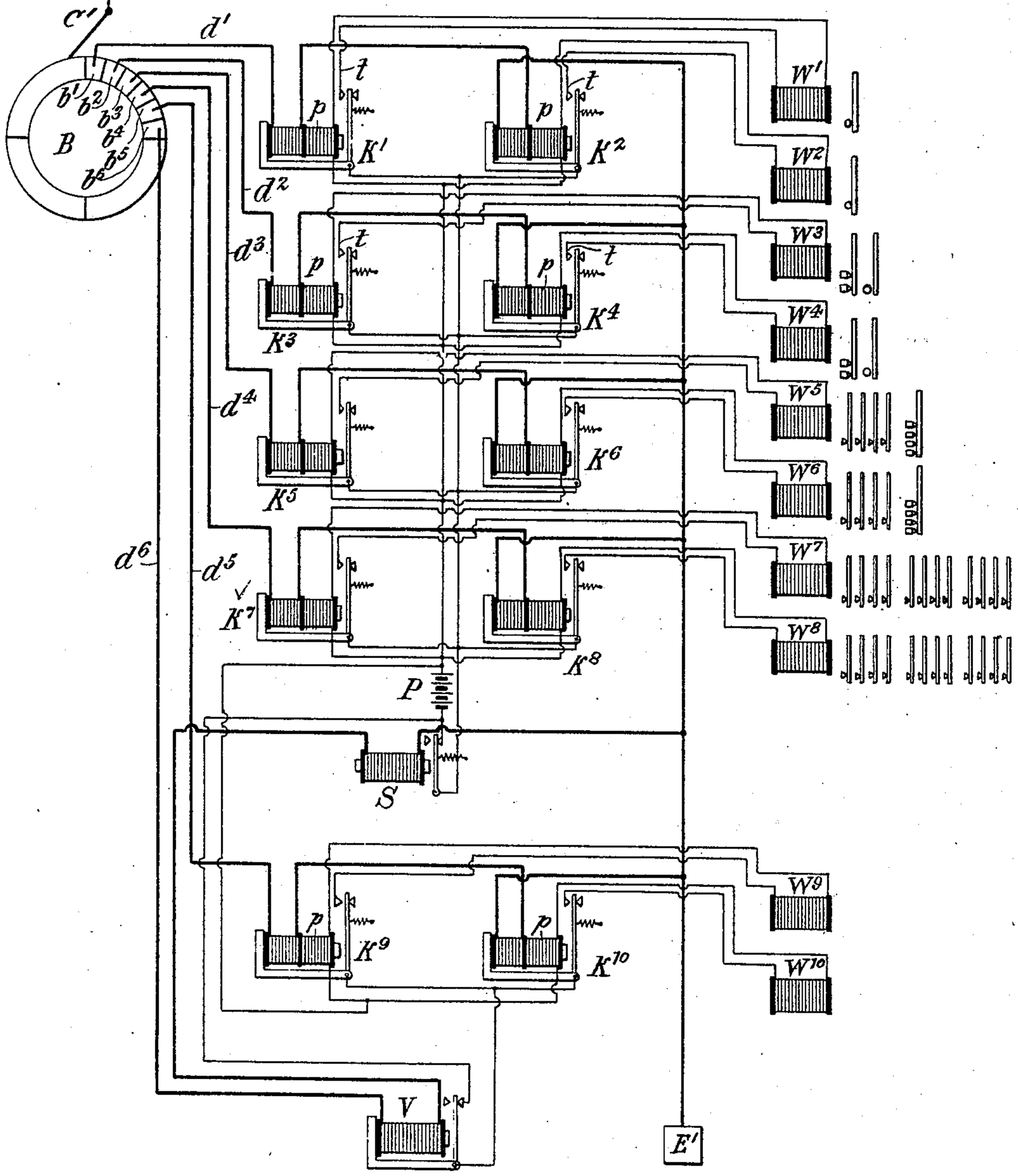
NO MODEL. 8 SHEETS—SHEET 3.

Fig. 3



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NO MODEL. 8 SHEETS—SHEET 4.

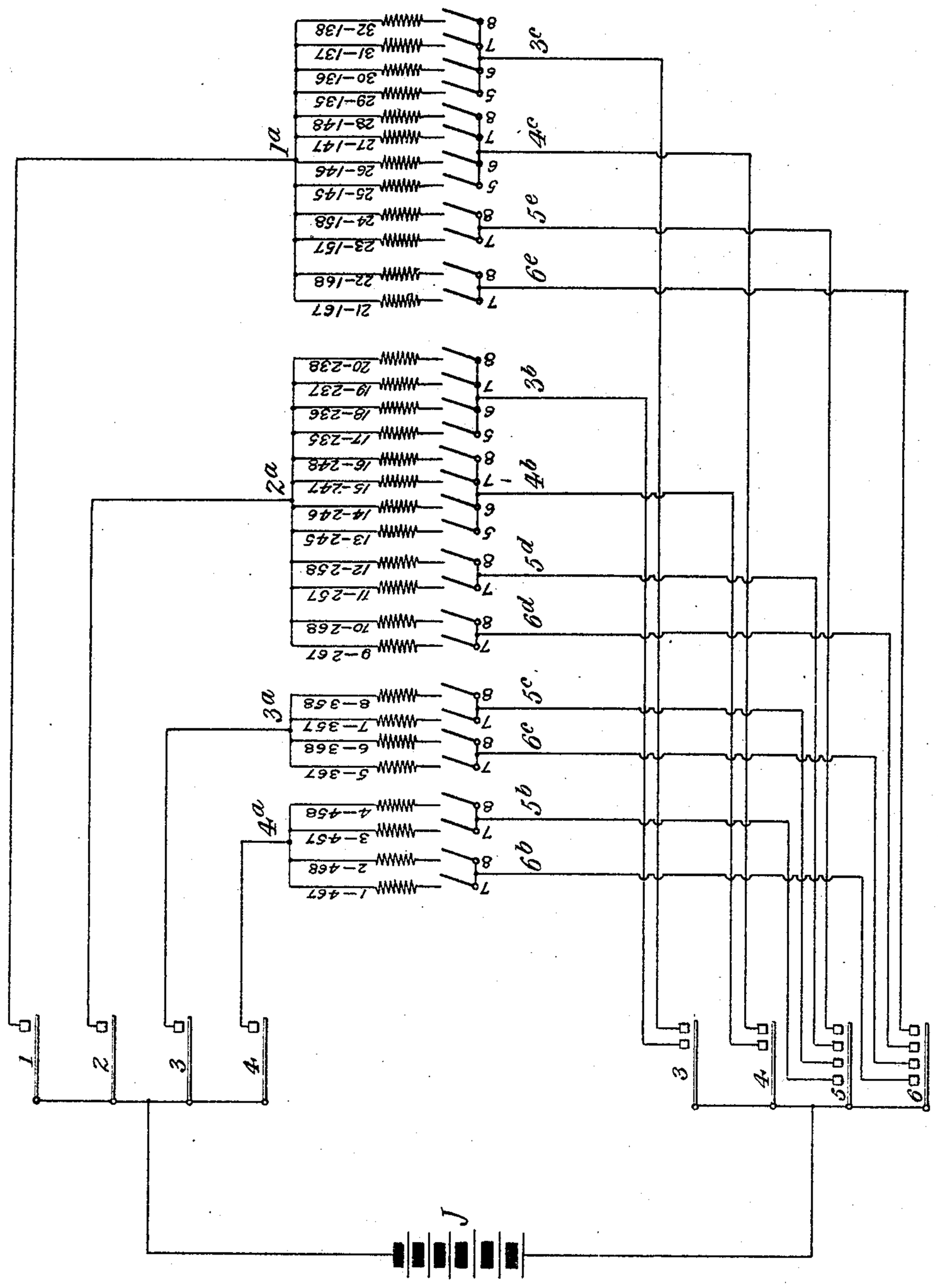

Fig. 4.

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NO MODEL. 8 SHEETS—SHEET 5.

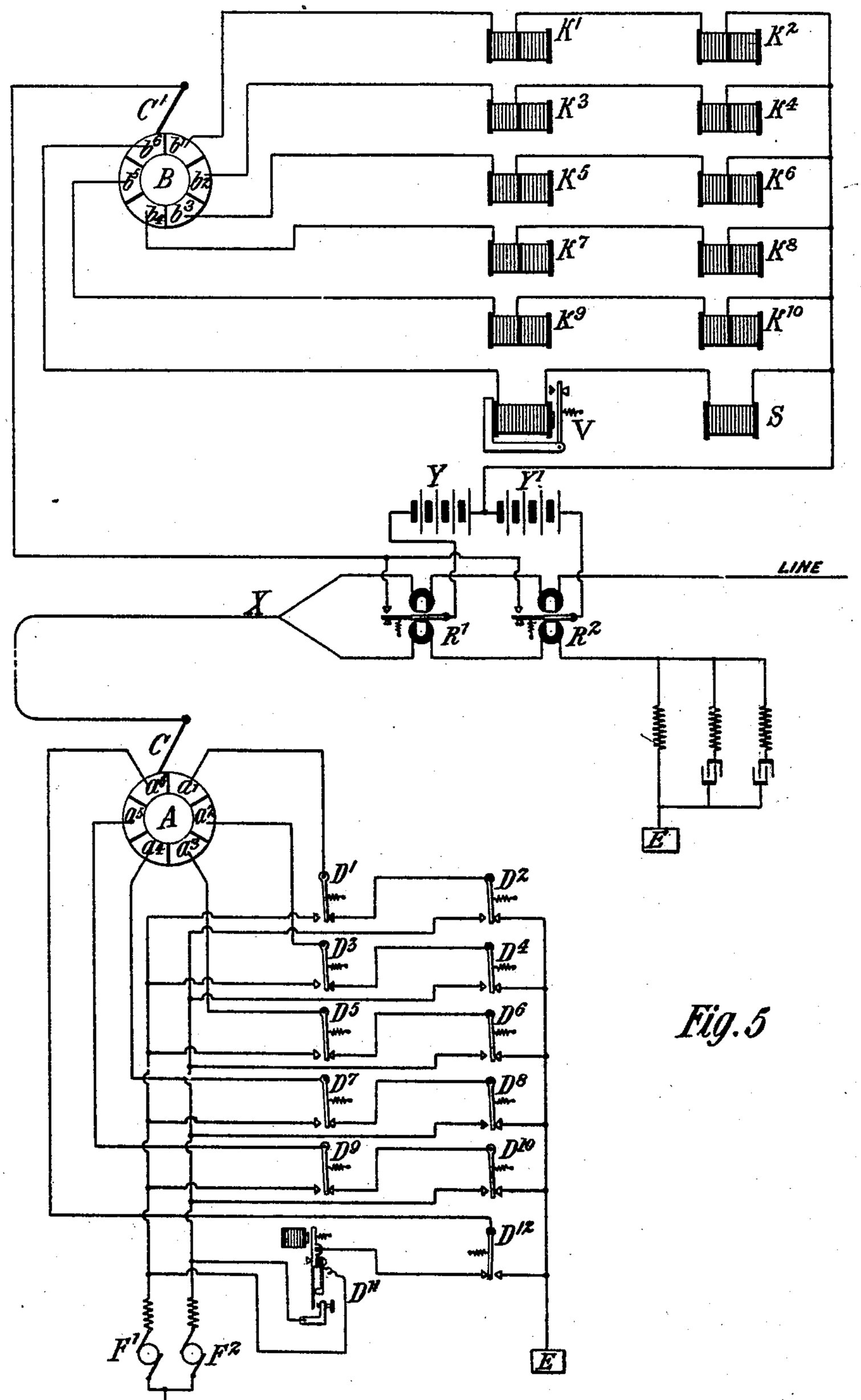

Fig. 5

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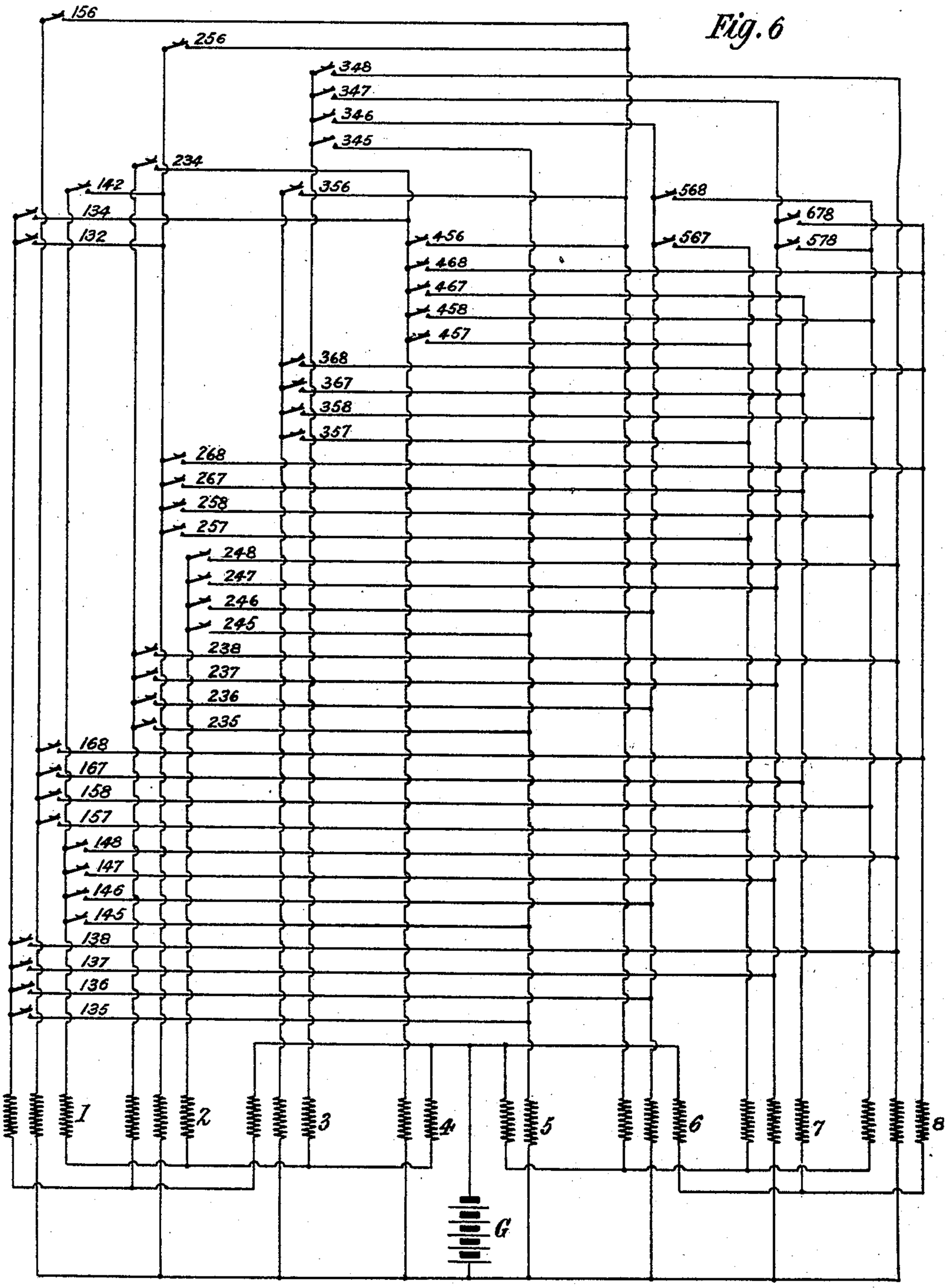
NO MODEL. 8 SHEETS—SHEET 6.

Fig. 6



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NO MODEL. 8 SHEETS—SHEET 7.

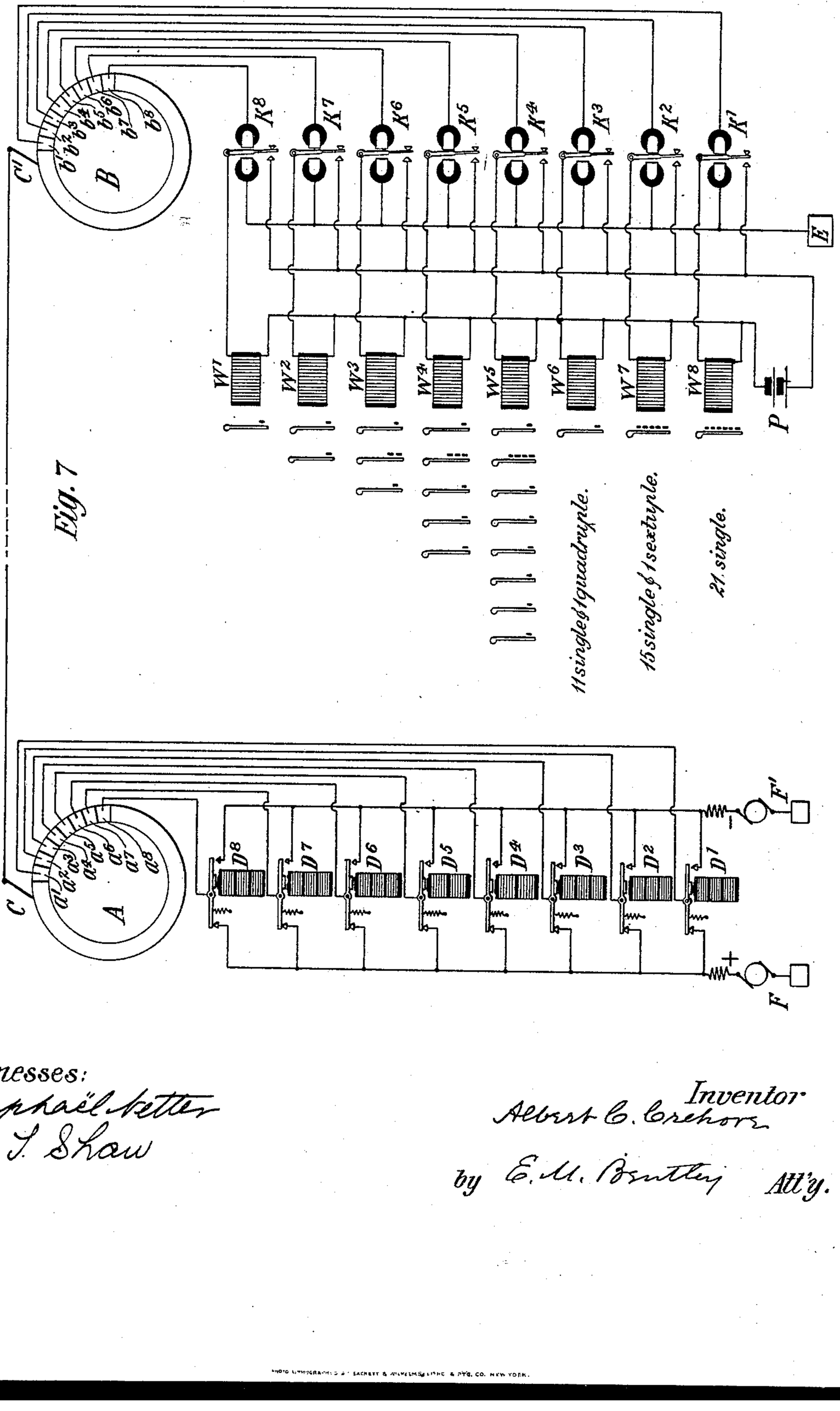

Fig. 7.

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NO MODEL. 8 SHEETS—SHEET 8.

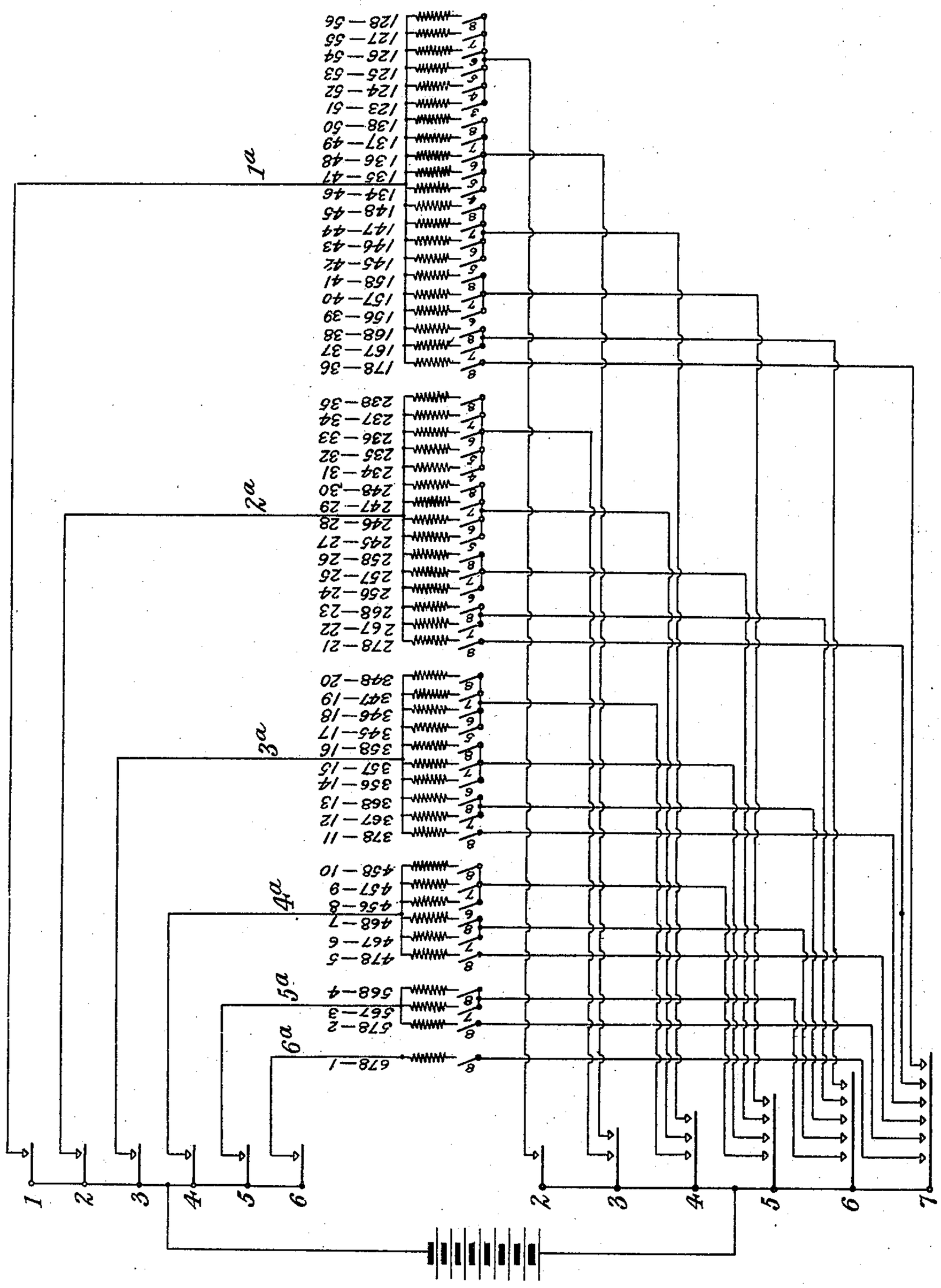

Fig. 8

Witnesses
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by E. M. Bentley Atty.

No. 773,198. Patented October 25, 1904.

UNITED STATES PATENT OFFICE.

ALBERT C. CREHORE, OF YONKERS, NEW YORK.

TELEGRAPH SYSTEM.

SPECIFICATION forming part of Letters Patent No. 773,198, dated October 25, 1904.

Application filed August 12, 1903. Serial No. 169,171. (No model.)

To all whom it may concern:

Be it known that I, ALBERT C. CREHORE, a citizen of the United States, residing at Yonkers, county of Westchester, State of New York, have invented certain new and useful Improvements in Telegraph Systems; and in pursuance of the statute I have set forth in the accompanying drawings and specification as an illustration of the invention that form thereof which I now regard as the best one of the various forms in which the principle of the invention may be embodied.

In the drawings, Figures 1 and 2 show in diagram the arrangements at the transmitting-station. Figs. 3 and 4 show in diagram the arrangements at the receiving-station. Fig. 5 shows a method of duplexing a line to which my system is applied, and Figs. 6, 7, and 8 show a modification.

My invention relates to a system of telegraphy in which the principal object is, first, to transmit messages by means of a keyboard arranged like the keyboard of an ordinary type-writer, each button operating a circuit-closer, and, second, to receive the messages in a corresponding manner on a similar type-writer, the keys being operated by electromagnets.

I do not undertake in my present disclosure to show the details of the transmitting-keyboard, but simply indicate a series of circuit-closers which may in ways well known to the art be arranged in keyboard form with a button for each of the circuit-closers. Likewise, at the receiving-station, I do not undertake to show the details of the receiving type-writer, but simply show a series of magnets which will in any desired manner operate, respectively, the several key-levers of a type-writer, including the key-levers corresponding to the several letters and characters, and in addition suitable shift-keys for capitals and figures and a key for returning the carriage at the end of the line. Such type-writers are already known, and my receiving-magnets may be applied to any special form thereof in any desired manner. By the use of the shift-keys I am able to transmit as many as ninety different characters, using three cases of thirty each with two shift-keys. This number may be increased, if desired, by an extension of the principles hereinafter described. In my system it it also possible to transmit simultaneously a number of messages over the same line in the same direction or in opposite directions.

I do not undertake to claim in this case as a separate matter the transmitting arrangements shown as provided at the sending-station, since it is the ruling of the Patent Office that such matter constitutes an independent invention not claimable herein. It is, however, presented in this case, but merely as an illustration of a complete system.

My invention utilizes as its basis the well-known feature of synchronously rotating "sunflowers" at the transmitting and receiving stations, by means of which the main line or wire is connected in succession to a series of local transmitting-lines at the transmitting-station and to a corresponding series of local receiving-lines at the receiving-station, each set of local lines (comprising one receiving and one transmitting line) being thus momentarily connected through the main line, so that a current sent into any one of the said local transmitting-lines will only be received by the corresponding one of the said local receiving-lines in a manner well understood in the art. The result of this arrangement is that in effect each set of local transmitting and receiving lines uses the main line in substantially the same manner as if they were permanently connected thereto and as if the other sets, which share the same main line in turn, were absent. In some forms of this apparatus designed for duplex work the main line is brought to a single differential relay balanced by an artificial line which distributes current through the local sunflower-circuits, and I will show how this form may be adapted for use in my system, although for convenience I first show the form in which the sunflower is directly in the main line. I also prefer to employ an arrangement I have devised, wherein, as will be hereinafter explained, I use currents of both polarities on the several sunflower-circuits and the main line which connects them; but I may also use currents of the same polarity throughout.

Referring to the drawings, A of Fig. 2, and B of Fig. 3 represent the synchronous sunflowers at the transmitting and receiving stations, respectively, and one-quarter of each sunflower is assigned to each one of four distinct systems which make use of the main line simultaneously. Each quarter of the sunflower is divided into six segments, these six segments being utilized in one of the four transmission systems to provide the combinations necessary to operate my selective arrangement by which any desired key at the transmitting-station will control a corresponding magnet at the receiving-station. The segments at sunflower A are lettered a', a^2, a^3, a^4, a^5, and a^6, respectively, and the corresponding ones at the sunflower B are lettered b', b^2, b^3, b^4, b^5, and b^6. It will be understood that by reason of the synchronism of the sunflowers the segments a' and b' will be connected at the proper moments with the trailing-brushes C and C', respectively, and thereby close a special circuit through special apparatus at both transmitting and receiving stations. In like manner segments a^2 and b^2 will next be connected to the line and establish a different circuit at both stations. The succeeding segments will in the same way be connected up in order. This will manifestly provide six transmitting-circuits acting successively and producing a comparatively small number of elementary effects, which may be combined in different ways to give a much greater number of composite differentiated effects controllable at the sending-station, and each operating at the receiving-station a specified part of the apparatus. Of these six segments I prefer to assign two of them to special purposes—to wit, the segment a^5 to the operation of the shift-keys, and the segment a^6 to the operation of the release-magnets, hereinafter described. This leaves the four segments a', a^2, a^3, and a^4, which may be utilized for the transmitting letters, punctuation-marks, &c., and since I utilize reversed currents with each of the four segments I, in effect, multiply the number of elements to be combined by two, giving eight elements in all assignable to letters and other characters. I find that if these eight elements are combined in groups of three each there are fifty-six possible combinations which might be made; but for a reason which will be hereinafter mentioned I utilize, in the particular form I am now describing, but thirty-two of these fifty-six possible combinations—that is to say, I find that by transmitting at each rotation of the trailing-brushes C and C' three current impulses over any chosen three of the four segments a', a^2, a^3, and a^4, respectively, I may thereby select and operate at the receiving-station any chosen one of a series of thirty-two magnets, the magnet chosen corresponding to the particular group of three sunflower-segments selected at the transmitting-station, and to the transmission therethrough of either a positive or negative impulse, and since there are thirty-two available combinations of three segments with either a positive or negative impulse over each I may select and operate any desired one of the thirty-two magnets and so cause the magnet to print on the receiving type-writer any desired character assigned to it. In other words, the transmission of three impulses is required to select and operate each of the thirty-two receiving-magnets. As already explained, the use of two shift-keys enables me to repeat the effect of all these magnets under the different conditions produced by each of the shift-keys, so that ninety or more different characters may be printed by the use of one line-wire combined with the six local lines at each station. This is, moreover, but a fraction of the capacity of the line, since other systems may be transmitting at the same time in the same direction, while by duplexing the line, as hereinafter described, additional systems may be worked simultaneously over the same line in the opposite direction.

Referring to Fig. 2, I will now begin the explanation of the method of selection at the transmitting-station. On the sunflower A each of the segments a' a^2 a^3 a^4 is connected to two independently-controlled transmitters by which either a positive or negative impulse may be delivered to the segment, these transmitters being lettered, respectively, D' D^2 to D^8. The transmitters are also capable of producing three conditions on each sunflower-segment—to-wit, the transmission of a positive current, the transmission of a negative current, and the transmission of no current with line connected to ground. The third condition is the normal one, while either of the other two conditions may be produced according as one or the other of the two transmitters provided for each segment is operated. Each transmitter has an operating-magnet in a local circuit controlled, as will be explained, by the finger of the operator. Referring to the transmitters D' and D^2, both of the contact-levers g' g^2 are shown in their normal position, held by their springs against their back stops h' h^2, which are connected to each other through the lever g^2 and to ground E. The respective positive and negative terminals of the dynamos F F' are connected to the front stops k' k^2, &c., the other dynamo-terminals being connected to ground E. The lever g' is connected to the line c' extending to sunflower-segment a', and thus in the condition shown the line c' is connected directly to the ground and the circuit of both dynamos is open. If, however, the lever g', operated by the magnet 1 of transmitter D', is attracted, a positive current from dynamo F will flow through the front stop k', the lever g', and line c' to segment a' and thence to the main line whenever the trailing-brush C comes

in contact with said segment a'. In a similar manner when the lever g^2, operated by magnet 2 of transmitter D^2, is attracted a negative current will be transmitted from dynamo F′ through front stop k^2, lever g^2, opposite back stop h', lever g', and thence over the same route, and it is manifest that if any three of the transmitter-levers are simultaneously attracted and maintained attracted while the trailer C is passing over the sunflower-segments, there will be three impulses transmitted in succession over the main line. It should be noted, however, that both transmitters pertaining to any one of the four segments cannot be operated at the same time, because it is impossible to send simultaneously both a positive and a negative impulse on the same line. It is for this reason that the fifty-six possible combinations of eight elements in groups of three are reduced to thirty-two available combinations which may be utilized in this form of my system—that is to say, the fifty-six theoretically-possible combinations of three include all that can be made up from the eight units or elements, and these eight units or elements comprise the four periods of time corresponding to the four segments $a' a^2 a^3 a^4$, during each of which period a negative or a positive current may be sent, or eight units or elements in all, differentiated in time and polarity. There must hence be some of the fifty-six combinations which include both a positive and a negative at the same time-period, together with either a positive or a negative at some other time period to make up the three units or elements. Such groups are but theoretical, so far as concerns this special form of my invention, and since there are twenty-four of them they reduce the fifty-six theoretical groups to thirty-two available ones.

The foregoing arrangement of transmitters may be utilized in other systems than the one particularly described herein. It is suitable for any situation wherein there is a line-wire that comes to the transmitter either through a sunflower or more directly and on which it is desired to produce the three named conditions of either a positive or negative current or no current. It is particularly suited to such a situation when it is also desired to produce, as in the present case, the aforesaid three conditions on a multiplicity of different line-wires without employing more than two generators and without short-circuiting either generator under any normal working condition. In general this arrangement comprises the two contact-levers each having front and back contacts, one lever being connected to the line and the second lever being connected to one of the contacts of the first one. Of the three remaining contacts one is connected to ground and the other two to the respective generator-terminals. Thus in the normal or no-current condition the line is connected to ground through circuit-breaking devices, which are operated and the ground connection broken every time that the line is connected to either generator-terminal, while such connection to one generator-terminal breaks the circuit leading to the other generator-terminal to prevent a short circuit. It also provides for the grounding and consequent discharge after the transmission thereon of a current impulse of either polarity.

It is evident that there are eight magnets provided for operating the eight transmitters, and if the circuit of each of the eight magnets were provided with a circuit-closer or key a skilled operator could manually use these eight keys in transmitting, depressing three of them at a time for each letter and learning by practice which three to depress for each respective letter. It is equally evident that a suitably-perforated tape might be used to operate the three transmitters corresponding to each of the respective characters; but in order to avoid this, or if tape is used to perforate the tape itself, I have devised a combination of circuits by which the closing of a single contact-key corresponding to a definite letter or character will energize the three transmitter-magnets which correspond to that letter or character. The leading feature of this arrangement is the provision of two or more energizing-coils on each of the transmitter-magnets, each coil being capable of energizing the magnet and causing the operation of its contact-lever, while the several coils are contained in separate circuits from the battery and the circuits so arranged that the single operator's key assigned to a particular character may control the three magnets which have to be energized for such character. Thus it appears from Fig. 2 that transmitter-magnet 1 has three energizing-coils, and magnets 2, 7, and 8 have likewise three coils each, while magnets 3, 4, 5, and 6 have two coils each.

Turning to Fig. 1, which shows the local circuits through which the transmitters are controlled, G is a battery from which the transmitter-magnets 1 to 8 are energized under the control of thirty-two keys, numbered, respectively, according to the three magnets which they control. The magnet 12 (see Fig. 2) is included in series with battery G in that part of the battery-circuit which is common to all of the group of magnets 1 to 8, so as to be operated every time that any one of the thirty-two keys is operated, the function of this magnet being described hereinafter. It may also be mentioned for future reference that the same battery G also serves for the operation of similar transmitter-magnets 9 and 10, (see also Fig. 2,) which operate the transmitters D^9 and D^{10} and are controlled, respectively, by the operator's keys S′ and S^2, while it may be further noted that the circuits of these magnets 9 and 10 are connected directly to the

battery G through the magnet 11 of a transmitter D^{11}, but without including the aforesaid magnet 12. As already mentioned, this group of transmitters D^9 D^{10} D^{11} D^{12} controls the transmission over the remaining sunflower-segments a^5 and a^6, which are assigned to the operation of the shift-keys of the receiver and to the releasing-magnets of the receiver, as will be hereinafter described. It is not necessary to follow out in detail each one of the circuits from the battery G through the several coils of the group of transmitter-magnets 1 to 8; but, for example, we may assume the operator's key 135, representing, say, the letter "S," to be depressed, and by tracing the circuits from that key it will be found that it serves to energize coils in the corresponding transmitter-magnets 1, 3, and 5 in series, all of the other coils being open-circuited at the time. In like manner key 267, representing some other character, may be depressed. By following the circuits it will appear that coils will be energized in transmitter-magnets 2, 6, and 7, while all the other coils remain on open circuit. By this arrangement I require but one contact for each key, although by means of that one contact I energize three different magnets, each key automatically selecting the group of three magnets which corresponds to the character which the key is to transmit, while the magnets in turn connect either a positive or a negative dynamo-terminal to the corresponding three of the four segments a' a^2 a^3 a^4 of the sunflower. Since the synchronous rotation of the sunflower is extremely rapid, the trailer C will pass over the three energized segments while the key is depressed and will transmit three impulses in succession over the main line and at the receiving-staaion deliver them to the three segments of sunflower B, which correspond, respectively, to the three energized segments of sunflower A.

Turning next to the receiving-sunflower B, Fig. 3, it will be noted that each of the respective segments b' b^2 b^3 b^4 is connected to a pair of polarized relays in series (they may be in parallel) and thence to the ground E'. Thus the segment b' is connected by the wire d' (shown in heavy lines) to the polarized relay K', thence to the polarized relay K^2, and thence to the ground. In like manner segment b^2 is connected by wire d^2 to ground through the polarized relays K^3 and K^4. The remaining two of the first four segments are connected in like manner to their respective pairs of relays, the circuits of the several segments being all shown by the heavy lines. Since the impulses coming to any one of the segments—for instance, segment b'—may be either positive or negative, the corresponding relays K' and K^2 are so arranged that but one of them shall operate at a time, one responding to positive and the other to negative impulses. The same is true of the corresponding relays connected to the remaining segments. Remembering that the three impulses arrive in succession during the time that the trailing contacts are passing over the first four segments of the sunflowers, it will be manifest that the three relays will in consequence be operated in succession; but for my purpose I prefer that the three relays after having operated shall remain energized until the trailing brushes have passed off from the four segments b', b^2, b^3, and b^4, and to that end I provide a locking device, consisting in this case of a retaining-coil p on the core of each relay, which will be automatically energized by the attraction of the relay-armature itself and remain energized, so as to maintain the armature in its attracted position until the trailing contacts have passed beyond the four segments and reached the segment b^6, when in the manner hereinafter described there will be transmitted through segment b^6 at some period after the sending-key is raised a releasing impulse which will break the circuits of the retaining-coils on the three several relays which have been operated. Were it not for this locking device it is manifest that each relay would receive but a very brief impulse each time that the trailers on the two sunflowers passed over the segments corresponding to the circuit which connects the relay with its respective transmitter at the opposite station, provided the said transmitter was acting at the time. As a result the three relay-armatures at the receiving-station corresponding to the key which happened to be depressed at the sending-station would merely vibrate so long as the key was held down; but, as will be explained hereinafter, the proper action of the printing-magnets requires that the relays controlling them should not thus vibrate, but should be held firmly closed so long as the key at the sending-station remains depressed. Hence the locking arrangement and releasing devices therefor are provided. Each of the said retaining-coils p is connected in a local circuit (shown by the light lines in Fig. 3) which is closed by the relay to which the circuit pertains on the attraction of the relay-armature, this local circuit also including in series (or, if desired, in parallel) with the retaining-coil a secondary relay, which in turn serves for the energizing of the printing-magnets. Thus each retaining-coil is connected on one side directly to one terminal of local battery P and on the other side is connected to its secondary relay-magnet W' or W^2 or W^3, &c., whence the circuit leads to the front stop t of the relay. Since the relay-armature is connected to the opposite terminal of said local battery P, the attraction of the armature against stop t instantly closes the circuit just traced and energizes both the retaining-coil and the secondary relay, which remain energized, firmly holding their arma-

tures until the said circuit is broken. This does not occur, however, until the sending-key has been raised. The circuit is broken by a release-magnet S, which is connected to segment b^6 of the sunflower B and energized every time that the trailing contact C′ passes the said segment, provided none of the thirty-two sending-keys is depressed. The releasing sunflower-segments a^6 and b^6 need not be placed immediately adjacent to the other segments of the same group, but may be at some other point in the sunflower—say diametrically opposite a^3 and b^3—so that the release will not occur too soon after or too soon before the operation of the other segments of the same group. This will, however, be claimed in another application.

It will be observed that there are eight of the receiving-relays K′ K², &c., giving eight operating agents, of which three are to be utilized for each letter or character, and, as already described, there are thirty-two different combinations which may be produced with these eight agents operating in groups of three, and it remains to be explained how each group of three relays causes the operation of one specified printing-magnet corresponding to that particular combination.

Referring to Fig. 3, there are shown eight secondary relays W′ to W⁸, which are operated, respectively, by the polarized relays K′ to K⁸. Of these secondary relays W′ W² each controls a single contact, which in turn, as will be hereinafter described, controls each a single main group of printing-magnet circuits, the subgroup within the main group being then picked out by a second relay and the individual in the subgroup being picked out by the third relay, there being, as above explained, three relays operated for each character. In like manner the secondary relays W³ and W⁴ are controlled, respectively, by the polarized relays K³ and K⁴, and each controls three contacts, one of each three being a main-group contact. The secondary relay W⁵ is controlled by the polarized relay K⁵ and controls a set of eight contacts. In like manner relay W⁶ is controlled by polarized relay K⁶ and controls a set of eight contacts. Again, polarized relay K⁷ controls secondary relay W⁷, which in turn controls twelve contacts, and in like manner polarized relay K⁸ controls secondary relay W⁸, which controls twelve contacts. It is thus evident that by taking the polarized relays in groups of three a wide variety of local connections may be established through the contacts operated by the several secondary relays, and the manner in which these are so arranged that any one of thirty-two printing-magnets may be selected by the action of a specified group of three polarized relays will be explained by referring to Fig. 4, wherein J is a local battery that serves to energize all the printing-magnets. The battery J of Fig. 4 is connected on one side to contacts 1, 2, 3, and 4, which select and control four groups 1^a, 2^a, 3^a, and 4^a of printing-magnets, which are altogether thirty-two in number, and on the other side to contacts 3, 4, 5, and 6, which select and control subgroups within the four main groups through the intervention of the individual selector-contacts 5, 6, 7, and 8. It is immaterial which of the secondary relay-magnets W′ W² W³, &c., are chosen to work these contacts, provided they are properly related to the polarized relays K′ K², &c.—that is, the contact 1 will be controlled by relay K′, the contact 2 by relay K², the three contacts 3 by relay K³, the three contacts 4 by relay K⁴, the eight contacts 5 by relay K⁵, the eight contacts 6 by relay K⁶, the twelve contacts 7 by relay K⁷, and the twelve contacts 8 by relay K⁸. For convenience the contacts which select the groups and subgroups are classed together, the groups 1^a, 2^a, 3^a, and 4^a being controlled, respectively, by the secondary relay-magnets W′, W², W³, and W⁴, as indicated by the circular contacts adjoining the armatures of these magnets in Fig. 3. The subgroups distinguished by the square contacts in Fig. 3 are controlled by the several secondary relay-magnets as follows: Subgroups 3^b and 3^c are controlled by W³, subgroups 4^b and 4^c by W⁴, subgroups 5^b, 5^c, 5^d, and 5^e by W⁵, and subgroups 6^b, 6^c, 6^d, and 6^e by W⁶. The individual printing-magnets are controlled through the triangular contacts in Fig. 3, four of them by W⁵, four by W⁶, twelve by W⁷, and twelve by W⁸, (thirty-two in all.)

Referring to Fig. 4, the several printing-magnets are numbered and also marked by the combination of the three selector-contacts which control them, respectively. Thus the first printing-magnet 467, printing, say, the letter "P," will be controlled by (*a*) one of the group-selector contacts controlled by W⁴, which picks out group 4^a, (*b*) by one of the subgroup-selector contacts controlled by W⁶, which picks out the subgroup 6^b, and (*c*) by the one of the individual contacts controlled by W⁷, acting to pick the individual printing-magnet 467. These three contacts are in series, so that they must all be closed to energize the magnet 467, and they are the only three in series which will be closed by the coöperation of the three relays K⁴, K⁶, and K⁷ and the secondary relays W⁴, W⁶, and W⁷. Other contacts will of course be closed at the same time, but the only complete circuit will be through printing-magnet 467. At the sending-station the key 467 will be depressed, which will in the manner described energize transmitter-magnets 4, 6, and 7. Magnet 4 will connect sunflower-segment a^2 to ground through generator F′ with negative terminal to line, and magnet 6 will connect segment a^3 to ground also through generator F′, while magnet 7 will connect segment a^4 to generator F and ground, but with the opposite terminal to line.

Then as the trailers pass synchronously over the sunflowers in their next succeeding rotation negative impulses will pass first through segments a^2 b^2, operating polarized relay K^4, and next through segments a^3 b^3, operating polarized relay K^6, and finally a positive impulse will pass through segments a^4 b^4, operating polarized relay K^7. The relay-armatures will be held by the respective retaining-coils until a current is received by the release-magnet S, which cannot occur till after the sending-key is raised. Then the release-current will flow the next time that the sunflower trailers reach segments a^6 b^6 and operate the said neutral relay-magnet S, Fig. 3. This magnet S controls the circuit of battery P, that supplies both the retaining-coils and the secondary relays, both of which have been held with attracted armatures from the moment of operation until released by the said releasing-current.

It remains to explain the operation of the shift-keys for printing capitals and figures, respectively, as in ordinary type-writer operation. It is manifest that I might assign two of the thirty-two magnets which I have provided for printing letters and punctuation-marks to this duty, but at the sacrifice of those two magnets for their described function, or I might enlarge the number of combinations by working with groups of four instead of three; but I prefer to employ a separate segment on the sunflowers for shifting, since, as will be explained, I thereby require but two key movements to print a capital or figure, just as in the present type-writers, a single retained depression of the shift-key serving to set and maintain the apparatus in condition for capital or figure printing so long as the corresponding shift-key is held down.

Referring to Fig. 1, S' and S^2 are the shift-keys for capitals and figures, respectively, both acting, like the letter-keys, to close a circuit from battery G, the former through transmitter-magnet 9, coördinate with transmitter-magnets 1 to 8, and the latter through a similar magnet 10. Both 9 and 10 are in series with a release transmitter-magnet 11, corresponding to magnet 12. Magnets 9 and 10 act on transmitters D^9 and D^{10}, similar to D' D^2, &c., by which either a positive or negative generator-terminal is connected to sunflower-segment a^5, according to whether 9 or 10 is energized. Likewise at the receiving-station the sunflower-segment b^5 acts, like the others, to transmit the positive or negative impulse which comes over the line when the trailers are properly related to the segments a^5 and b^5, respectively, to polarized relays K^9 and K^{10} in series which control, respectively, the capital and figure shift-magnets W^9 and W^{10}. The relays K^9 and K^{10} are also provided with retaining-coils, like the other relays, and with a release-magnet V in series with release-magnet S and segment b^6 and having a like function with respect to polarized relays K^9 and K^{10} and shift-magnets W^9 W^{10} that magnet S has with respect to the other polarized and secondary relays. Receiver V is, however, polarized and S is neutral, and they are so connected that the impulses received every time the trailers pass segments a^6 b^6 operate both relays, provided no key has been depressed at the transmitting-station. If either the capital or figure shift-key S' or S^2, Fig. 1, is closed, transmitter D^{11}, which is operated by magnet 11 and, as already described, is energized whenever either key S' or S^2 is closed, will reverse the current which flows to segments a^6 b^6 through the contacts of transmitter D^{12} and cause receiver V, Fig. 3, to make solid contact with its back stop, while S continues to vibrate each time that the trailers pass segments a^6 b^6. Hence the next time that an impulse is received in either relay K^9 or K^{10} so as to bring the lever against its front stop t, it will become locked by closing a circuit from battery P through the retaining-coil of the relay, which is also in circuit with the corresponding secondary relay W^9 or W^{10}, and so remain until the capital or figure key is released. This also closes either magnet W^9 or magnet W^{10} continuously so long as the capital or figure key is depressed, and thus sets the receiving type-writer in the condition to receive either capitals or figures, for it will be evident that the printing of the other combination characters may be effected without interference while the capital or figure key remains closed. It is thus like an ordinary type-writer in this respect.

For clearness the operation of the system will now be described, beginning with the depression of a key by the transmitting operator until the desired character is finally printed. For example, let it be required to print the letter capital "A." Before any key is depressed the normal condition of the circuits is that no current is flowing through sunflower-segments a', a^2, a^3, a^4, or a^5, but an impulse is passing through segment a^6 at each rotation of the trailers. The corresponding relays K to K^{10} are each receiving no current and are controlled only by the retractile springs or by their magnetic bias, the levers being against the back stops, so that there is no local circuit established in any of the retaining-coils p, Fig. 3, or in the secondary relays W' to W^8. Since some of these secondary relays must be closed in order to cause one of the printing-magnets to depress one of the character-keys on the type-writer, none of these keys will be depressed normally. By referring to Figs. 1 and 2 it will be seen that no current flows in magnet 12 of transmitter D^{12} until some key is closed, and its lever is therefore held against the back stop by the retractile spring, thus normally putting generator F to line through segment a^6. Current is normally received, therefore, by both relays V and S in circuit with segment b^6 every time trail-

ers C C′ touch these segments. The armature of S is normally vibrating, for a current of either polarity will operate it. Relay V being polarized might be connected so that its armature will vibrate or not, depending upon the sense in which its coils are connected. It is connected, however, so that its armature is normally vibrating; but if the current coming into this segment should be either interrupted or reversed its armature will come to rest firmly against the back stop. A reversal of the current will not interrupt the neutral relay S, however. To print the letter "A," the operator must first depress the capital shift-key S′, Fig. 1. The effect of this is to energize the magnets of the two transmitters D^9 and D^{11}, and the effect of operating transmitter D^{11} is, as already described, to reverse the current in segment a^6 without interrupting it and to cause a reverse-current impulse to be received by relays S and V, Fig. 3, the next time the trailers make contact with a^6 b^6. This will cause armature of relay V to remain firmly against its contact, while S continues to operate the next time trailers make contact with a^6 b^6, and hence the retaining-coils p on relays K^9 and K^{10} will hold their armatures over the next time they make contact with the front stop. At the same time transmitter D^9 puts current on segment a^5, which was before connected to earth, and causes relay K^9 to become locked, and this in turn operates magnet W^9, which depresses the capital shift-key of a type-writer in a well-known manner. This key will remain depressed as long as the shift-key S′ at the transmitting-station is depressed, and this is the only effect produced on the receiving type-writer by its operation. The letter "A" is next depressed while holding capital shift-key S′ down, and this, by means of the circuits shown in Fig. 1, closes transmitters (let us say, for example) D^2, D^4, and D^7. At the same time current now operates transmitter D^{12}, which removes all current from segments a^6 b^6 and puts the segment a^6 to ground. This causes the release-relay S, Fig. 3, to come against its back stop firmly and puts the circuits of relays K′ to K^8 in condition to become locked as soon as the next impulse is received by any of them. Impulses are received by relays K^2, K^4, and K^7 the next time the trailers come into contact with the segments a' b', a^2 b^2, and a^4 b^4, respectively, and these three relays become locked as long as the key A is held down. These relays close the secondary relays W^2, W^4, and W^7, which operate the switches having these numbers 2, 4, and 7 in Fig. 4, and thus closes printing-magnet 247, which prints the letter capital "A" by operating the key of the receiving type-writer in the well-known manner. The capital letter will be printed because the capital shift-key is being held depressed by magnet W^9. If this is the only capital which is to be printed, the capital shift-key S′, Fig. 1, may be released as soon as the capital has been printed, even before the letter-key is raised, for the only effect produced at the receiving-station by raising this key S′ is to cause the current impulses in relay K^9 to cease. This can do no harm, however, for the relay K^9 will remain locked until some current is received by relay V, and no current can be received by this relay until the letter "A" is released by the transmitter, since this key controls transmitter D^{12}, removing all current from relays V and S until the key is raised. When the letter "A" is finally raised at the transmitter, the whole system immediately returns to the normal condition already described and is ready to receive the next character to be transmitted.

My duplex arrangements will next be described, making reference to Fig. 5, which shows both the transmitting and receiving apparatus at one station, it being understood that similar transmitting and receiving apparatus will be located at the opposite station. The keyboard and the transmitters will be arranged in the manner already explained; but the connection from trailer C of the transmitting-sunflower A is not directly to line, as in the above-described arrangement, but is to the apex X of an ordinary duplex receiving apparatus, which contains, however, two differential polarized relays R′ R^2, one side of each of which is connected in the main line and the other in the balancing artificial line. These two relays R′ and R^2 will act as the receiving-relays responding to impulses from the farther end of the line, but are non-responsive to the impulses transmitted to the line from the home station through sunflower A and trailer C. B is a receiving-sunflower operating synchronously with the transmitting-sunflower at the distant station and having its several circuits provided each with a pair of polarized relays K′ K^2, K^3 K^4, &c., which are similar to those already described. The trailer C′ of sunflower B is connected to the front contacts of both receiving-relays R′ and R^2, the relay-armatures being connected, respectively, to the terminals of the positive and negative batteries Y and Y′. The several sunflower-circuits after passing through their respective pairs of relays are all connected to the common terminal of the batteries Y Y′. Assume, for instance, that a positive-current impulse is received over the main line and actuates the relay R′. This will close the connection from the battery Y to the trailer C′, whence it will pass through that one of the sunflower-segments which happens to be at that time in contact with the trailer—say b'—and from that segment it will go through the relays K′ and K^2 and cause one or the other of them to operate in the manner already described. The local circuit will be closed from the relays K′ and K^2 to the opposite terminal of the battery Y. In like manner if a nega-

tive impulse comes over the line it will energize the other receiving-relay, R^2, and in like manner close a local circuit through the other battery, Y′, to the sunflower-segment which happens to be at that time under the trailer and thence through the corresponding pair of relays to the opposite battery-terminal, causing the operation of that relay of the pair which responds to negative currents. Remembering that the incoming positive or negative impulses are transmitted from a distant sunflower A in synchronism with the sunflower B it is manifest that the corresponding sunflower-segments at opposite ends of the line are in communication with each other in the same manner as they would be if the sunflowers were connected directly to line in accordance with the arrangement heretofore described and that each transmitter D′ D^2, &c., at one station will transmit its positive or negative impulse to the proper pair of relays K′ K^2, &c., at the opposite station just as before. In other respects the apparatus will be no different from that which I have already explained. I do not lay claim to the invention of this general method of operating synchronous sunflowers through an intervening polarized relay; but I do regard as novel the arrangement described wherein there are two such relays R′ and R^2 included in the main line, which control, respectively, the positive or negative impulses in the local circuits containing the relays K′ K^2, &c. By the application of this expedient to my system I may duplicate the capacity which the line may have for transmission in one direction by giving it an equal capacity for transmitting in the opposite direction at the same time.

My further modification, in which I utilize or may utilize, if I desire, all of the fifty-six possible combinations of eight transmitter-circuits arranged in groups of three, is explained in connection with Figs. 6, 7, and 8. The characteristic feature of this arrangement is that the transmitters are normally set to send a current of one polarity to the line at every rotation of the sunflower, but for communication purposes are temporarily reversed to send a current of the opposite polarity. At the receiving-station each of the local sunflower-circuits will contain but one polarized relay instead of two, as heretofore described. This relay will have such adjustment that the armature remains set at one side or the other, as it may have been left by the preceding current impulse. Normally when not in use for message transmission these relays will receive the normal current polarity and will maintain their armatures in position to open the local circuits containing the several secondary relays W′ W^2, &c. When, however, they are energized by a reversed current from the corresponding transmitter in the transmission of a message, they will close the circuits of their secondary relays, which circuits will remain closed until the key depressed by the finger of the operator is released, when the normal polarity of current will be again transmitted on the next rotation of the sunflower and the local circuits of the secondary relays, closed as above mentioned, will be again opened. This, it will be observed, avoids the necessity of the locking-coils and the releasing agencies and requires at least two rotations of the sunflowers to print a letter and set the apparatus in condition to print the next letter, the first rotation transmitting the reversed current determined by the letter to be printed and the second rotation serving to restore the normal polarity of current and, in effect, to release the secondary relays and the printing-magnet controlled thereby.

Referring to Fig. 6, the arrangement at the transmitting-keyboard will be found to be essentially similar to that already described; but instead of utilizing only thirty-two of the possible combinations of eight coils arranged in groups of three I find that it is possible without employing more than three coils upon any one of the transmitter-magnets to utilize forty-eight of the fifty-six possible combinations, while by extending the same arrangement so as to provide four coils on some of the magnets the entire fifty-six combinations may be utilized. I have, however, shown herein only forty-eight, which will ordinarily be adequate for this form of the invention. It will be unnecessary to describe Fig. 6 in detail, since it is like Fig. 1, with the exception that a third coil has been added to magnets 3 and 6, which in Fig. 1 contain but two coils each. By combining these additional coils with the others according to the principles already explained I am enabled to add sixteen keys to the thirty-two found in Fig. 1, and I have arranged these keys in a separate group at the top of the figure. By this means I have forty-eight keys or, if desired, fifty-six keys on my transmitting-keyboard, each having but a single contact and yet each serving to operate three of the transmitter-magnets, the three operated by one key being different from any other group of three operated by any of the other keys. I have designated the additional keys in Fig. 6 by the three numbers corresponding to the three transmitters controlled by the keys, respectively.

The general arrangement of the transmitters and the receiving-relays is shown in Fig. 7. In this figure the transmitters are designated, as before, D′ D^2 to D^8. Each consists of an ordinary pole-changer normally closing the respective sunflower-circuit to ground through one of the generators—for instance, generator F—which sends a positive current to the line. So long as the parts are in the normal position (shown in Fig. 7) each rotation of the trailer C introduces a positive current into the line through each of the sun-

flower-segments in succession. When, however, one of the transmitter-magnets is energized, it will reverse the current through the corresponding sunflower-segment, and when three such transmitters are thus operated for the transmission of a letter the three segments corresponding thereto will each give a negative current to the trailer C, while all the others continue to give the trailer a positive current. As soon as the key which operates the three transmitters is raised the parts will be restored to the normal condition shown in the figure, and on the next round of trailer C all of the segments will give to it the normal positive current. At the receiving-station each of the sunflower-segments is connected to ground through a polarized relay K' K^2, &c., each relay controlling a local circuit from battery P through one of the secondary relays W' W^2, &c. Each polarized relay will maintain the local circuit which it controls open so long as the normal positive impulses are received by it; but on the receipt of a negative impulse it will close its local circuit, its armature then remaining in the position in which it was left by the negative current, thereby retaining the local circuit closed until a positive current is again received. This avoids, of course, the necessity for the locking-coils and the releasing devices therefor described in connection with the first form of the invention. The operation, however, will be somewhat slower in this case, since the trailer will have to traverse a greater number of sunflower-segments for each pointing system operated over the line. Of course so long as a transmitting-key is depressed the three segments controlled by it will continue to transmit negative currents, which will, however, produce no additional effect after the corresponding receiving-relays have once acted. It is only after the transmitting-key is raised that a succeeding rotation of the sunflower will restore the apparatus to its normal condition. The printing-magnets are arranged in the same general way I have already described; but if their number has been increased, as it may be, having eight independent circuits, it is necessary to provide six primary groups instead of four, which are again divided into six subgroups instead of four, while the individual magnets are increased in number and of course require an additional number of contacts.

Referring to Fig. 8, there will be found the fifty-six individual magnets, numbered, respectively, according to the three transmitters which control them and also indicated by the serial numbers from 1 to 56. The six groups into which they are divided are indicated, respectively, as 1^a, 2^a, 3^a, 4^a, 5^a, and 6^a, and these groups are primarily controlled by the six respective contacts operated by the respective secondary relays W' to W^6, inclusive. The six subgroups are again controlled by contacts operated by the respective secondary relays from W^2 to W^7, inclusive. The contacts for the individual printing-magnets are operated by the several secondary relays, as indicated by the numbering of the contacts in Fig. 8. It will thus be found that secondary relay W^8 operates twenty-one of the individual contacts, but none of the group contacts. W^7 operates fifteen of the individual contacts and six subgroup contacts, and in like manner the respective secondary relays operate individual contacts and group contacts according to the schedules indicated in Figs. 7 and 8, the magnets W' and W^2 being the only ones which operate group contacts only and no individual contacts. It is unnecessary, in view of the description already given of the arrangement in Fig. 4, to explain in further detail the circuits of Fig. 8, it being sufficient to say that the depression of any one of the transmitting-keys will cause the operation of three secondary relays at the receiving-station, which in turn will close the circuit of one only of the fifty-six printing-magnets corresponding to the key which happens to be depressed.

What I claim as new, and desire to secure by Letters Patent, is—

1. The combination in a system of electrical communication, of a plurality of receiving-relays, means for successively energizing said relays in groups, each group containing less than the full number of relays, a series of magnets greater in number than the relays and a local circuit for each magnet containing a plurality of circuit-closers corresponding in number to the relays comprising a group.

2. The combination in a system of electrical communication of a plurality of receiving-relays, means for successively energizing the said relays in groups, each group containing less than the full number of relays, a series of magnets, each magnet of the series corresponding to one of the relay groups, and a local circuit for each magnet containing circuit-closers in series controlled respectively by the relays comprising the group corresponding to the said magnet.

3. The combination in a system of electrical communication of a plurality of receiving-relays, means for energizing said relays in groups, a magnet controlled by each group of relays and locking devices for maintaining the action of the said magnet.

4. The combination in a system of electrical communication of a plurality of receiving-relays, means for successively energizing the said relays in groups, each group containing less than the full number of relays, secondary relays responding in groups to the respective groups of receiving-relays, and individual magnets each having a number of circuit-closers in its circuit corresponding re-

spectively to the secondary relays in one group and operated thereby.

5. The combination in a system of electrical communication of a plurality of receiving-relays, means for energizing the said relays in groups, a group of secondary relays controlled by a group of receiving-relays, an individual magnet controlled by the group of secondary relays, locking devices for both groups of relays and means for releasing said locking devices.

6. The combination in a system of electrical communication of a plurality of receiving-relays, energized in groups by corresponding groups of transmitters at the transmitting-station, a magnet controlled by each relay-group, locking devices for said magnet, and a releasing-magnet for said locking devices controlled from the transmitting-station.

7. The combination in a system of electrical communication of a plurality of receiving-relays, means for energizing the said relays in groups, individual magnets controlled by each group of relays, locking devices for maintaining the action of said magnet after the operation of the relays, and a releasing-magnet for said locking devices controlled from the transmitting-station.

8. The combination in a system of electrical communication of a plurality of receiving-relays, means for energizing said relays in groups, an individual printing-magnet controlled by each group of relays, locking and releasing devices for said magnets, and a shift-key magnet with locking and releasing devices therefor independent of those of the printing-magnets.

9. The combination in a system of electrical communication of a series of magnets at the receiving-station each controllable individually from the transmitting-station, locking and releasing devices therefor also controllable from the transmitting-station and a shift-key magnet provided with locking and releasing devices controllable independently of those for the said series of magnets.

10. The combination in a system of electrical communication of a series of magnets at the receiving-station, a corresponding series of transmitting-keys at the sending-station and means for controlling the said magnets individually by the respective keys consisting of transmitters controlled in groups by each of the said keys, a line-wire transmitting the currents from each group of transmitters, receiving-relays responding successively in groups to the respective transmitter-groups, and a circuit for each of the said series of magnets controlled by one of the said groups of receiving-relays.

11. The combination in a system of electrical communication of a series of magnets at the receiving-station responding individually to a series of transmitting-keys at the sending-station and intermediate apparatus comprising a series of local lines at each station, synchronous devices at each station for successively connecting the said local lines together in pairs, transmitters included in the respective local lines of the transmitting-station, means for operating a group of two or more of said transmitters by one of the transmitting-keys, a series of relays at the receiving-station responding in groups to the respective groups of transmitters and means for controlling each individual magnet of the first-named series of magnets at the receiving-station by one of the several groups of receiving-relays.

12. The combination in a system of electrical communication, of a line-wire between the transmitting and receiving stations, synchronous devices at each station for connecting the said line-wire to a series of local lines in succession, the local lines being all connected to the same transmitting or receiving apparatus, a transmitting apparatus comprising, first, transmitting-contacts in each of the said local lines at the transmitting-station for sending either a positive or a negative current impulse to the said line-wire from each of the local lines, second, magnets controlling said contacts, third, a series of keys each controlling a group of said magnets, and a receiving apparatus including, first, a plurality of receiving-relays contained in the respective local receiving-lines and responding in groups to the said transmitters; second, secondary relays; third, a series of magnets divided into groups and subgroups and, fourth, contacts for each group and subgroup and also for each individual magnet controlled by the said secondary relays.

13. The combination in a system of electrical communication, of a line-wire between the transmitting and receiving stations, a plurality of local lines at each station, all connected to the same transmitting or the same receiving apparatus, synchronous devices at each station for connecting the line-wire to the said local lines in succession, means for transmitting current impulses from a group including a portion of said local lines through the line-wire at each rotation of the synchronous devices, receiving-relays in the respective circuits of a group containing a portion of the aforesaid local lines at the receiving-station and an individual magnet at the receiving-station having its circuit provided with a plurality of circuit-closers controlled respectively by the relays of the said receiving-relay group.

14. The combination in a system of electrical communication of a plurality of receiving-relays connected to the segments of a receiving-sunflower, an individual magnet controlled by a group of the said relays, a locking-circuit and a magnet controlling said cir-

cuit contained in a local line also connected to a segment of the said sunflower.

15. The combination in a system of electrical communication of a line-wire, a series of magnets at a receiving-station controlled respectively by a group of receiving-relays, a plurality of sunflower-segments connected respectively to a plurality of receiving-relays, a locking-circuit at the receiving-station, a releasing-magnet for said circuit connected to an additional segment of the sunflower and a shift-key magnet controlled by still another segment of the sunflower.

16. The combination in a system of electrical communication of a series of magnets at the receiving-station operated respectively by a corresponding series of transmitting-keys at the transmitting-station, a shift-key magnet controlled individually by a transmitting-key, locking devices for said series of magnets and also for the shift-key magnet, a releasing-circuit, releasing devices for the said series of magnets responding to currents of both polarities on said releasing-circuit and releasing devices for the shift-key magnet responding to currents of but one polarity on the said releasing-circuit.

17. The combination in a system of electrical communication of a series of magnets at the receiving-station controlled respectively by a series of keys at the transmitting-station and means for retaining each magnet in its energized condition so long as its controlling-key is depressed and means for restoring it to its normal condition after the said key has been raised.

18. The combination in a system of electrical communication of a series of magnets at the receiving-station responding individually to a group of receiving-relays, a series of transmitting-keys at the transmitting-station, each controlling a different group of receiving-relays, a local circuit for each of said series of magnets, means for retaining said circuit closed during the operation of the corresponding transmitting-key and for releasing it after the said key has been raised.

19. The combination in a system of electrical communication of a series of magnets at the receiving-station each controlled by a group of receiving-relays contained respectively in a series of sunflower-circuits, transmitting devices in a corresponding series of sunflower-segments at the transmitting-station, locking devices at the receiving-station, a releasing-circuit therefor controlled from the transmitting-station, means for operating the said transmitters and the corresponding receiving-relays in groups and means for subsequently operating the said releasing-circuit.

20. The combination with a series of local lines at the receiving end of a line-wire adapted to be connected to said local lines in succession, of a series of polarized relays in said lines, means for energizing said relays in groups, locking devices for said relays, releasing devices for said relays controlled by a separate local line and a series of magnets responding individually to the respective groups of relays.

21. The combination with a series of local lines at the receiving end of a line-wire adapted to be connected to said local lines in succession, of a series of polarized relays in said lines, means for energizing said relays in groups, a locking-coil controlled by each relay, a common releasing-magnet for said locking-coils contained in a separate local line and a series of magnets responding individually to the respective groups of relays.

22. The combination with a line-wire of means at the transmitting-station for connecting it to a series of local lines in succession, transmitting contact devices included in each of said local lines respectively and operated in groups, corresponding receiving-relay magnets included in a similar series of local lines at the receiving end and responding in groups to the transmitted impulses, and a series of magnets one for each group of impulses controlled by said relays.

23. The combination with a line-wire, of synchronous devices at both the receiving and transmitting ends of the line for connecting it to a series of local lines in succession, transmitting devices at the sending end of the line comprising contacts in each of the local lines with means for operating the contacts in groups, each group corresponding to a character to be transmitted and comprising the same number of contacts, receiving apparatus at the receiving end of the line comprising relays in the respective local circuits responding in groups to the transmitter groups and each group containing the same number of relays, and a series of magnets each corresponding to and controlled by one of the respective groups of relays.

In witness whereof I have hereunto subscribed my name, before two subscribing witnesses, this 10th day of August, 1903.

ALBERT C. CREHORE.

Witnesses:
G. W. HOPKINS,
L. T. SHAW.