No. 795,577. PATENTED JULY 25, 1905.

G. A. CARDWELL.

PRINTING TELEGRAPHY.

APPLICATION FILED DEC. 9, 1903

4 SHEETS—SHEET 1.

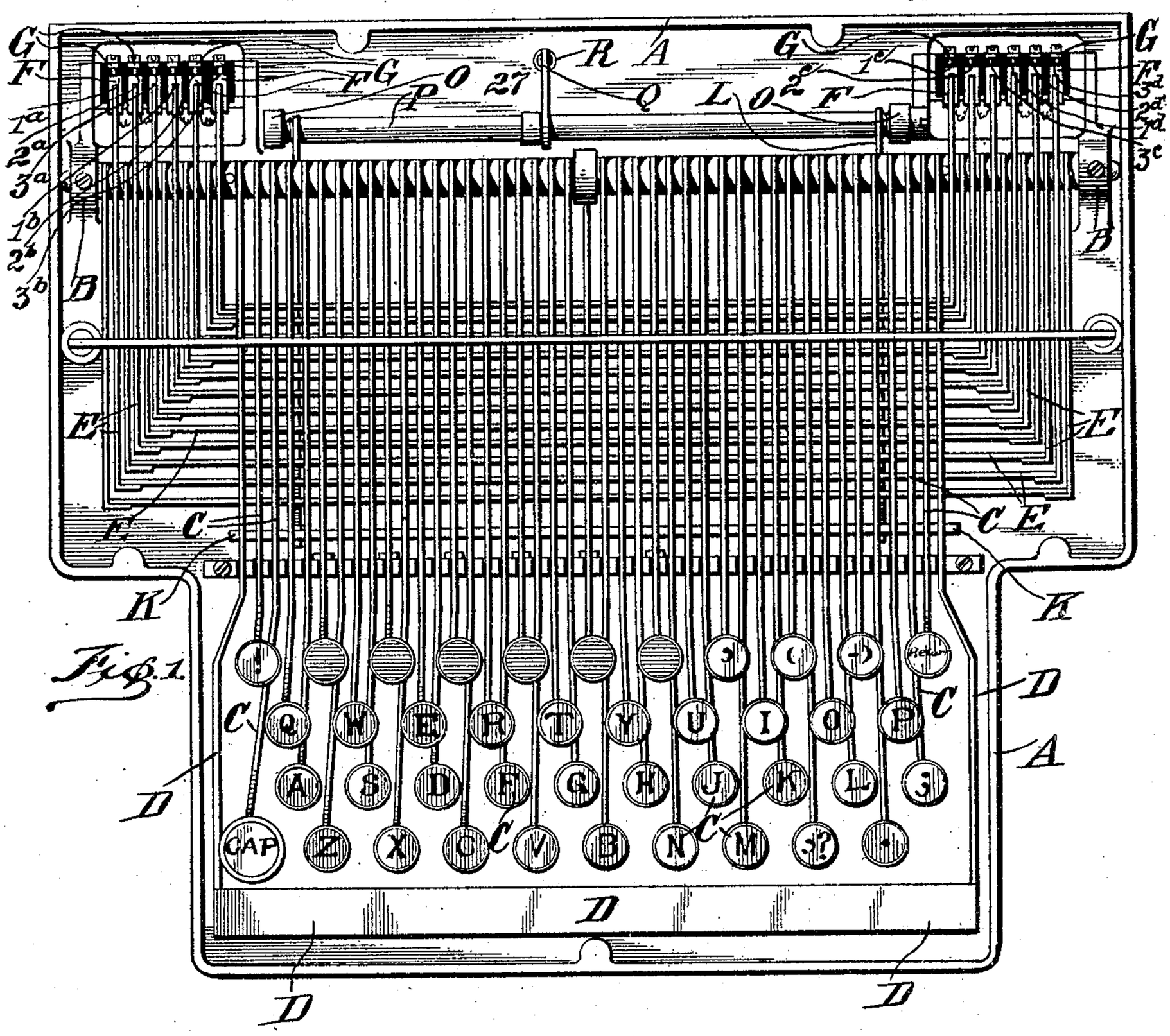

Fig. 1.

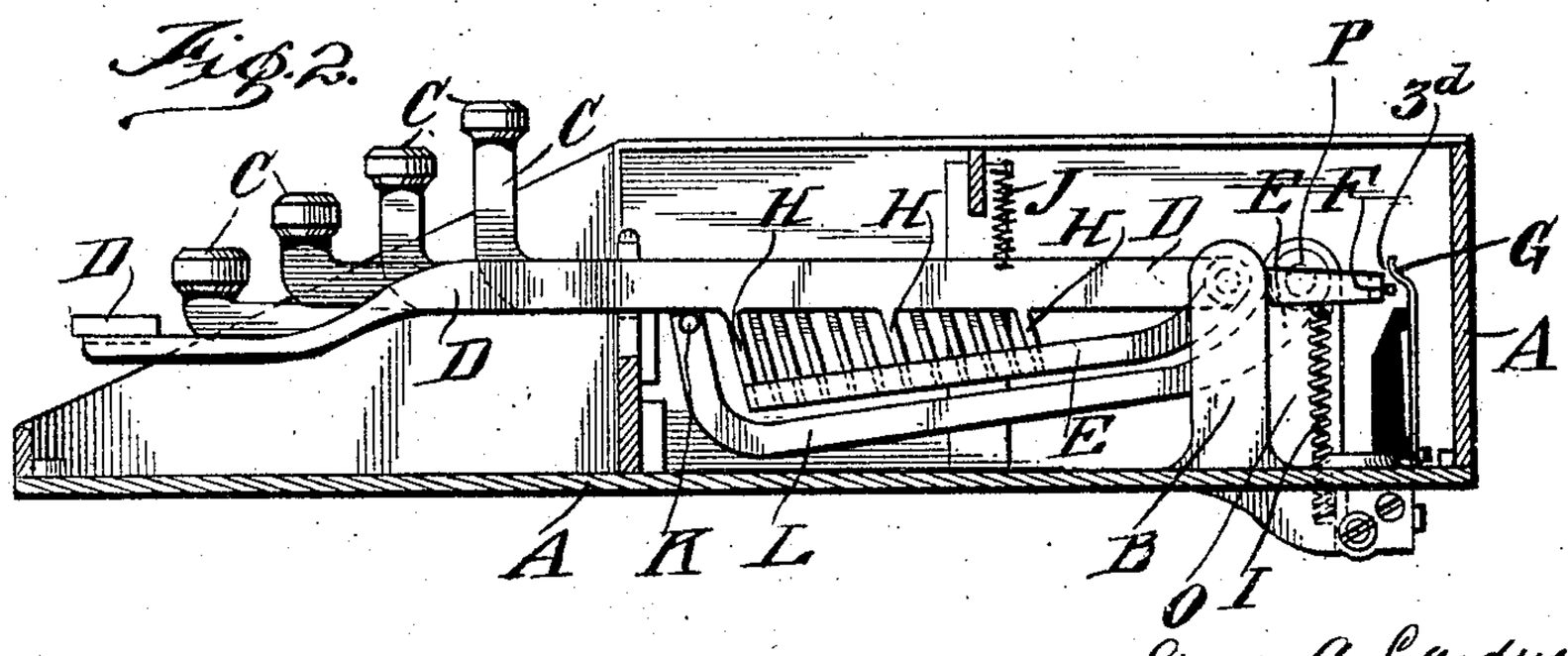

Fig. 2.

Witnesses
E. Mitchell
A. L. O'Brien

George A. Cardwell
Inventor
By Dickerson Brown
Raegener & Bunney
attys.

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4 SHEETS—SHEET 2.

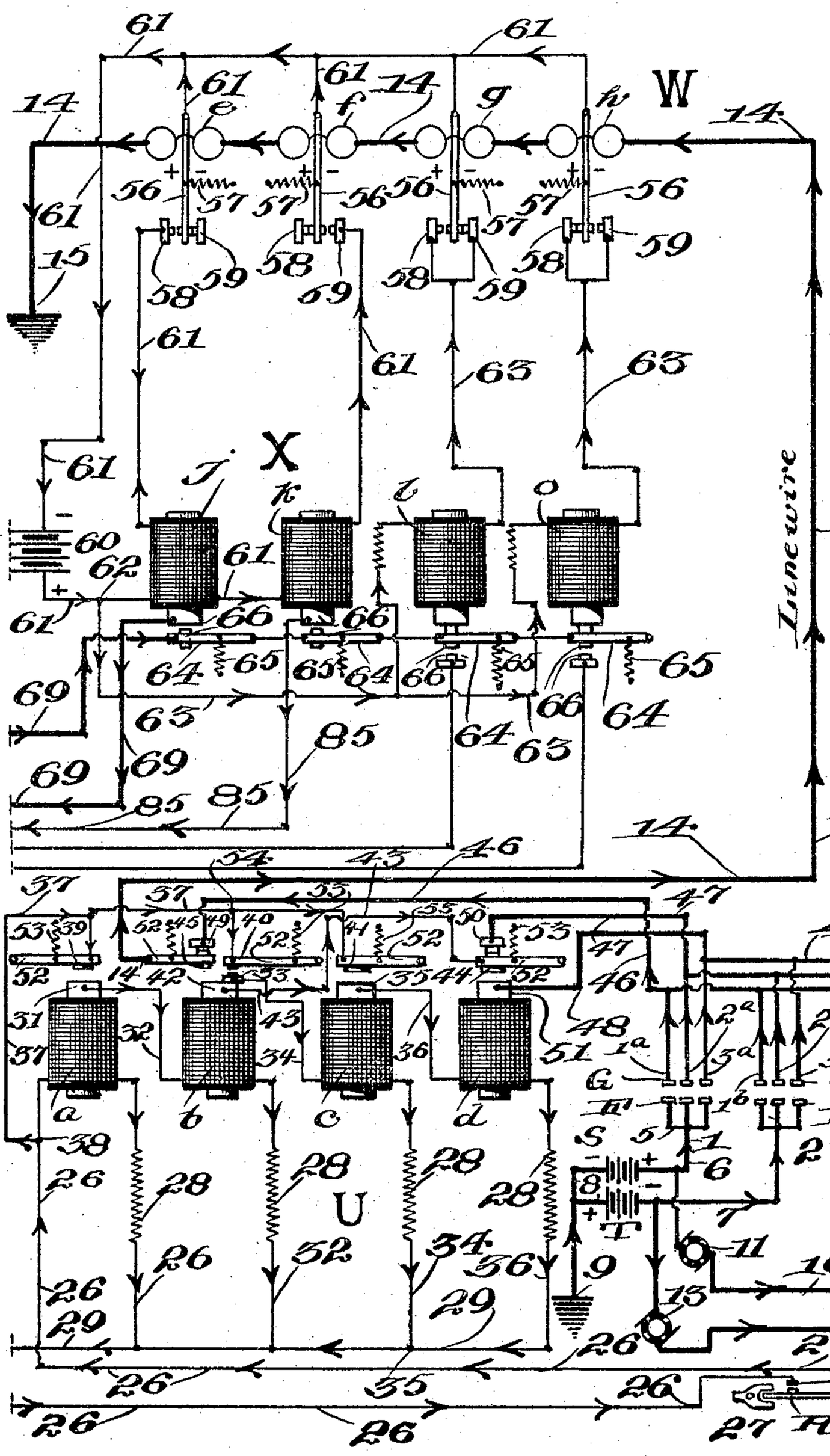

Fig. 3.

Witnesses
C. Dickerson
A. L. O'Brien

George A. Cardwell
Inventor
By Dickerson Brown
Raegener & Bonney
Attys

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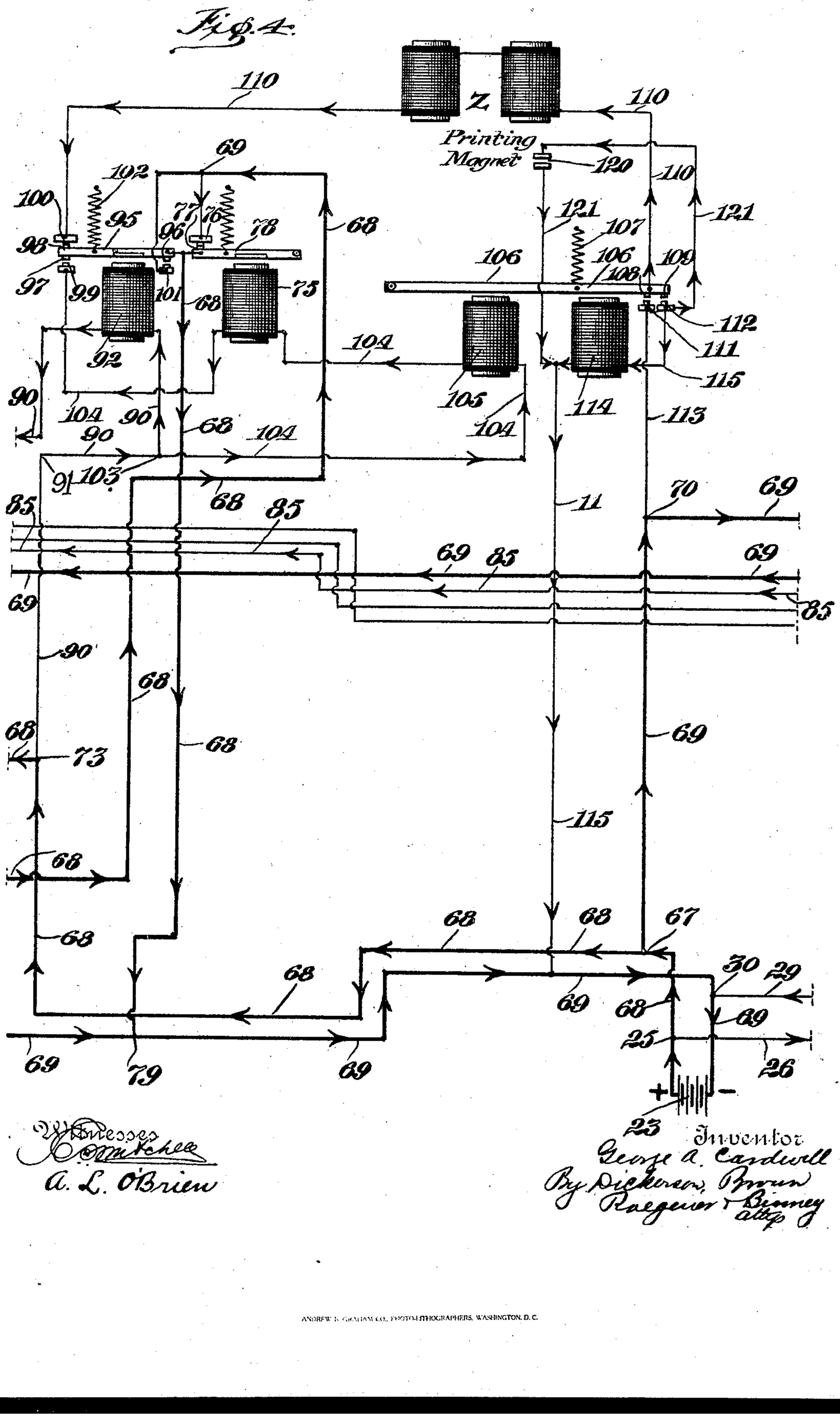
4 SHEETS—SHEET 3.

Fig. 4.



Witnesses
A. L. O'Brien

Inventor
George A. Cardwell
By Dickerson, Brown
Raegener & Bonney
Attys

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G. A. CARDWELL.

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APPLICATION FILED DEC. 9, 1903

4 SHEETS—SHEET 4.

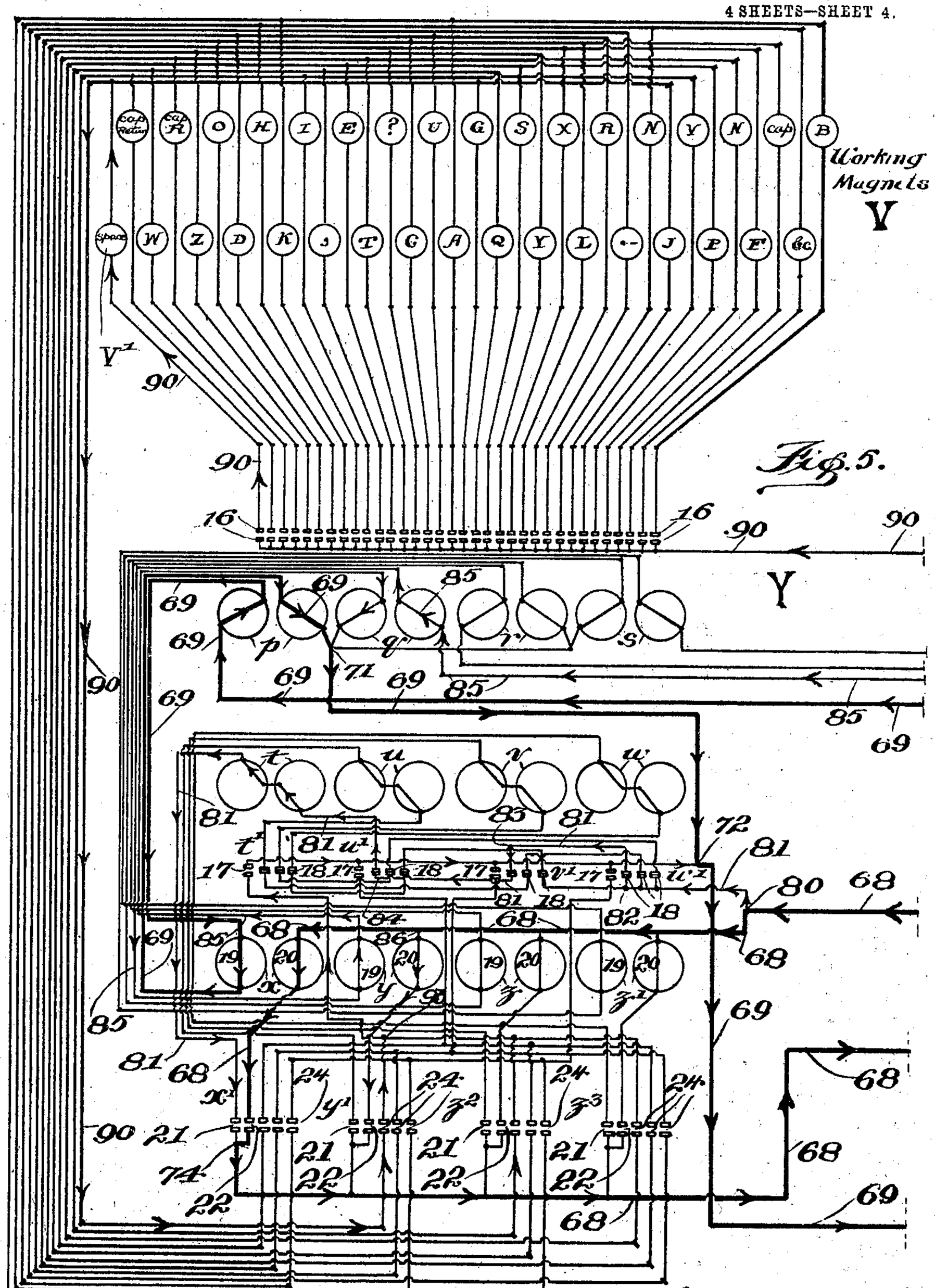

Fig. 5.

Witnesses
Sam'l Kerr
A. L. O'Brien

George A. Cardwell
Inventor
By Dickerson Brown
Raegener & Bonney
Attys

UNITED STATES PATENT OFFICE.

GEORGE A. CARDWELL, OF NEW YORK, N. Y., ASSIGNOR TO FREDERIC J. SWIFT, OF NEW YORK, N. Y.

PRINTING TELEGRAPHY.

No. 795,577. Specification of Letters Patent. Patented July 25, 1905.

Application filed December 9, 1903. Serial No. 184,377.

To all whom it may concern:

Be it known that I, GEORGE A. CARDWELL, a citizen of the United States, and a resident of the borough of Manhattan, city, county, and State of New York, have invented certain new and useful Improvements in Printing-Telegraphs, of which the following is a specification, accompanied by drawings.

This invention relates to printing-telegraph apparatus and systems in which for each letter or symbol to be printed a distinctive series of electrical impulses is employed.

The invention is in some respects an improvement upon the apparatus disclosed and broadly claimed in my basic patent, No. 673,315, granted April 30, 1901; and one of the objects of this invention is to enable electrical means and devices to be employed throughout the system for operating and controlling the apparatus instead of mechanical devices, which, owing to their high time constant, are less desirable than electrical apparatus.

The general principles of operation disclosed in my Patent No. 673,315, above referred to, are carried out in this present invention; but the apparatus in some respects is simplified. In the present case the apparatus includes, as before, a number of working circuits or branches, each including a working magnet and having at least three breaks or gaps, controllable magnets each responding to a characteristic impulse, sets of switches operated by the controllable magnets and each set closing breaks in different working circuits, but not all the breaks in any one working circuit, and the operation of particular sets of switches in a certain order of three at least closes all the breaks of a particular working circuit. The electrical impulses may be distinguished in any desired way, and heretofore it has been found advantageous and practical to utilize differences of strength and polarity. In the present instance differences in strength and polarity may be utilized, and in the operation of the apparatus alternating impulses may also be used.

It has been found practical and advantageous to use in the present instance the following four kinds of impulses, consisting of a positive impulse, a negative impulse, an intermittent positive followed by a short impulse which may be either positive or negative, and an intermittent negative followed by a short impulse which may be either positive or negative. The impulses of different characters are controlled from the transmitting-station and may have any suitable source of supply, as a battery or a generator.

Further objects of the invention will hereinafter appear; and to these ends the invention consists of apparatus for carrying out the above objects, embodying the features of construction, combinations of elements, and arrangement of circuit and parts having the general mode of operation, substantially as hereinafter fully described and claimed in this specification and shown in the accompanying drawings, in which—

Figure 1 is a plan view of the transmitter-keyboard. Fig. 2 is a side view of the same. Fig. 3 is a diagrammatic view of circuits and apparatus embodying the invention at the transmitting-station with part of the receiving-station. Figs. 4 and 5 are diagrammatic views showing the remainder of the circuits and apparatus at the receiving-station. Figs. 3, 4, and 5 are intended to be read side by side, thus forming one complete diagram of circuits and connections.

Referring to the drawings, A represents a suitable frame, (shown in Figs. 1 and 2,) having standards B, to which the key-levers C and spacing-lever D are pivoted. The key-levers C, as usual, represent the characters and letters to be printed at the receiving-station, and by pressing a desired lever or spacing-lever D characteristic impulses in a given or predetermined order are transmitted over the main line to the receiving-station to cause the printing. In other words, according to the present invention, when a given lever is operated at the transmitter, positive impulses, negative impulses, or alternating impulses consisting of either a long positive or a long negative followed by a short impulse which may be of the opposite character are transmitted over the line.

Each key-lever C is constructed to operate a series of auxiliary levers E controlling the electrical contacts F and G, arranged and electrically connected in groups of three in this instance. The contacts F are carried, as shown, by the levers E and coöperate with the contacts G. According to the construction shown each key-lever C is provided with three downwardly-projecting arms or points H, adapted to bear upon three of the auxil-

iary levers E when a key-lever is operated. The auxiliary levers, as shown, are pivoted to the standards B, as are the key-levers, and are provided with retracting-springs I. The key-levers are provided with retracting-springs J. As the auxiliary levers E are pressed down, the contacts F and G are brought into operation to close the circuits hereinafter to be described.

As shown in Figs. 1 and 2, the cross-lever K is shown extending transversely of the transmitter and arranged beneath the key-levers C, carried upon the arms L, pivoted upon the standards O by means of the shaft P. When any lever C is operated, the cross-bar K is also operated to close the contacts Q and R for a purpose hereinafter to appear.

The contacts F and G, operated by the key-levers and auxiliary levers, as stated, are arranged in groups of three, this having been found a simple and convenient arrangement, although other groupings may be devised. The groups will be numbered 1, 2, 3, and 4, as indicated in Fig. 3. In each group of three pairs of contacts the pairs F and G will be designated by reference characters—as, for instance, in group 1 the pairs of contacts are designated by 1^a, 2^a, and 3^a; in group 2 the pairs are designated as 1^b, 2^b, and 3^b; in group 3 the pairs are 1^c, 2^c, and 3^c; in group 4 the pairs, as will be seen by reference to Fig. 3, are designated as 1^d, 2^d, and 3^d. The same designations appear in Fig. 1 in the plan view of the transmitter, it being understood that the contacts F and G, as indicated, (shown in diagrammatic arrangement in Fig. 3,) are the same contacts, having the same reference characters shown in Fig. 1 connected to be operated by the key-levers.

By the closure of certain of the contacts F and G in the groups referred to positive impulses will be directed over the line, and the closure of other contacts will direct negative impulses over the line. It has been found convenient to so connect the circuits that positive impulses will be directed over the line by the closure of any of the contacts in group 1, while negative impulses will be sent over the line by the closure of any of the contacts in group 2. By the closure of contacts in groups 3 and 4 alternating currents are sent over the line, the closure of any contact in group 3 sending an intermittent long positive impulse followed by a short positive impulse over the line, while the closure of any contact in group 4 sends an intermittent long negative followed by a short negative impulse over the line.

Since there are thirty-six letters or characters to be printed, it will be seen that to carry out the invention there should be thirty-six combinations or permutations of the four preferred characters of impulses to be sent over the line, and it is a comparatively simple matter to so arrange the keyboard that with the four groups of contacts of three each thirty-six different combinations may be made. In making up the combinations of circuit-closures it will be seen that it is only necessary to close any three contacts of the groups in a given order. One suitable combination would be the closure of contacts 1^a in group 1, then 2^b in group 2, and then 3^a in group 1. Such a combination of circuit-closures would send first a long positive impulse over the line, then a long negative impulse, and lastly a long positive again, these impulses acting in a desired manner upon the apparatus at the receiving-station to print a given character. If, for instance, the following sequence was used—that is, a closure of contacts 1^a in group 1, 2^c in group 3, and 3^d in group 4—we should then have first a long positive impulse sent over the line, then an alternating current consisting of a long positive followed by a short positive impulse caused by the closure of contacts 2^c, and then another intermittent current comprising a long negative impulse followed by a short negative impulse controlled by the closure of contacts 3^d in group 4.

With regard to the connections for obtaining the different characters of impulses as described it will be seen that batteries S and T (designated as the "line-batteries") are connected in series with each other and with groups 1 and 2 of contacts F and G. As will be seen, the contacts F of each group are electrically connected with each other by the wires 5, and the positive pole of battery S is connected to group 1 of contacts F and G by the wire 6. The negative pole of battery T is connected to group 2 by the wire 7. The opposite positive and negative poles of batteries T and S are connected to each other by wire 8, and this wire is connected to the ground at 9. The upper contacts G of the groups 1 and 2 are connected to the line connections, as will be described, and it will be seen that when any of the contacts 1^a, 2^a, or 3^a are closed positive impulses will be sent over the line from the batteries S and T, the return-circuit being made from the receiving-station through the ground, while when any of the contacts 1^b, 2^b, or 3^b are closed negative impulses will be sent over the line, the return connection being made, as before, through the ground.

As shown in Fig. 3, group 3 of contacts is connected by the wire 10 with wire 6 to the positive pole of battery S, and in the connection 10 is inserted a circuit-interrupter 11, adapted to rapidly make and break the circuit. This circuit-interrupter 11 may be driven in any suitable manner. The interrupter, as shown, consists of a conducting-disk provided with insulating-segments on its rim. Brushes connected in circuit bear upon the periphery of the disk, so that as the disk is revolved the circuit is rapidly made and broken. Accord-

ing to this arrangement intermittent positive impulses are directed over the line when any of the contacts in group 3 are closed. In like manner the contacts of group 4 are connected by a wire 12 to the negative pole of battery T, an interrupter 13 being inserted in this connection, suitably operated from any source of power, so that when any of the contacts in group 4 are closed negative intermittent impulses are sent over the line. A suitable arrangement of circuits and apparatus, including a source of power, has been described for transmitting the impulses of different characters referred to over the line; but the invention is not to be understood as being limited to any of the apparatus disclosed, as, if desired, a generator or one or more generators could be used in place of the battery referred to, and the electrical connections in themselves are not essential to the invention.

Referring more generally to the remainder of the apparatus at the transmitting-station and at the receiving-station, it will be seen that the transmitting-station comprises the groups of contacts 1, 2, 3, and 4 and the line-controlling magnets U. Of these magnets U there are four, *a*, *b*, *c*, and *d*, supposed to be arranged at the transmitting-station and connected to control the line-wire 14 in such manner that the impulses of different characters will be directed over a single line-wire in succession and automatically as each key-lever is operated. In other words, when a key-lever is operated the impulses of different characters and in proper sequence are automatically transmitted over the line 14, controlled by the line-controlling magnets U.

At the receiving-station there are a series of magnets V, Fig. 5, one for each character or letter to be printed, the operation of said magnets V being controlled by the impulses of different characters sent over the line. The apparatus is designed to control the magnets V, and in carrying out this improved system a series of polarized relays W, Fig. 3, is utilized and a series of controlling-magnets X, the polarized relays W and controlling-magnets X being termed "selecting-magnets," because said magnets select by their operation certain circuits, including the selectable magnets Y, Fig. 5, arranged in groups. These magnets Y are termed "selectable" magnets because they are arranged to be selected and included in circuit by the operation of the selecting-magnets W and X. Z, Fig. 4, represents the printing-magnet, which is the last one to be operated after one of the magnets V has been energized. The magnets V, Fig. 5, may be termed the "letter-selecting" magnets, since they are adapted to control the characters to be printed.

The polarized relays W, forming a portion of the selecting-magnets, may be designated as *e*, *f*, *g*, and *h*, and suitable circuits and connections are arranged between these polarized relays and a local battery 60 for operating the remainder of the selecting-magnets X, (designated as *j*, *k*, *l*, and *o*.) The line-wire 14 includes all of the polarized relays W and is connected to the ground at 15, so that the line-batteries S and T are adapted to be thrown in circuit with the line-wire, with the polarized relays W and with the ground as a return-circuit.

The selectable magnets Y, Fig. 5, may be designated by the characters *p*, *q*, *r*, and *s*, and, as shown, each selectable magnet comprises two solenoids. It has been stated that thirty-six characters are adapted to be printed; but, as shown in the drawings, only thirty-four characters are provided, although provision may be made for thirty-six, and there are therefore but thirty-four letter-selecting magnets V. In the circuit of each magnet V are contacts 16, adapted to be controlled by the selectable magnets *p*, *q*, *r*, and *s* in groups, so that each selectable magnet closes a number of contacts 16. In this instance each selectable magnet Y is supposed to control nine pairs of contacts 16. The magnets *s*, however, in this instance control but seven pairs of contacts 16, two pairs not being shown. In Fig. 5 the pairs of contacts 16 and the selectable magnets Y are shown in diagrammatic relation to each other, this being the simplest form of representation in a complicated arrangement of circuits and apparatus like that described. It is to be understood, however, that suitable armatures and contacts are provided whereby upon the energizing of a given selectable magnet Y the pairs of contacts 16 will be operated, and any suitable mechanical devices may be provided for operating said contacts in groups of nine each.

In connection with the selectable magnets Y circuit-controlling magnets *t*, *u*, *v*, and *w* are shown, each comprising two solenoids and arranged to control four contacts each. The contacts controlled by the magnets *t*, *u*, *v*, and *w* are arranged in groups *t'*, *u'*, *v'*, and *w'*. The first pair of contacts 17 of each group is normally open and arranged to be closed when the corresponding magnet *t*, *u*, *v*, or *w* is energized. The remaining three contacts 18 of each group *t'*, *u'*, *v'*, and *w'* are normally closed and adapted to be opened when the corresponding magnet *t*, *u*, *v*, or *w* is energized. As hereinbefore stated, any suitable mechanical arrangement of armatures and contacts may be provided whereby the magnets *t*, *u*, *v*, and *w* control the contacts referred to, the diagrammatic arrangement shown being the simplest with the complicated circuits described.

A third set of circuit operating and holding magnets are provided, (designated as *x*, *y*, *z*, and *z'*.) Each of these magnets comprises the solenoids 19 and 20. Each solenoid 19 is arranged to control a group of five

normally open contacts x', y', z^2, and z^3. The contacts 21 and 22 of each group are connected in shunt with each other, and contacts 22 control the circuit of solenoid 20 of each magnet x, y, z, and z', the arrangement of circuits and apparatus being such that after each solenoid 19 has been energized to close the contacts of its respective group then the solenoid 20 of each magnet becomes energized and remains energized, holding the contacts of its group closed throughout the operations to follow unless it is desired that the circuits through the contacts controlled by magnets x, y, z, and z' shall be broken. In this way electrical means are provided for holding the controlling-circuits closed until it is desired that they shall be broken. As before, any suitable means may be provided, as armatures and contacts, for enabling the magnets x, y, z, and z' to control their respective groups of contacts.

The selecting-magnets X, Fig. 3, control the operation of the selectable magnets Y, Fig. 5, which latter magnets are included in the circuit of the local battery 23. As stated, the selectable magnets Y are normally deënergized, and the selecting-magnets j, k, l, and o control the selectable magnets p, q, r, and s, respectively.

The letter-selecting magnets V, also normally deënergized, are connected in circuit with the local battery 23, Fig. 4, and also have included in their circuits the contacts 16, the contacts 24 of the groups of contacts x', y', z^2, and z^3, and the normally open contacts 17 of the groups of contacts t' u' v' w', so that in order to energize any one of the letter-selecting magnets V it is necessary to have three gaps in its circuit closed—namely, at contacts 16, 24, and 17—the contacts at each gap being controlled by a different set of magnets.

The line-controlling magnets U, Fig. 3, are included in the circuit of the local battery 23, it being of course understood that while in this instance one local battery 23 is shown, accomplishing a number of objects, it is not necessary to employ one battery; but any desired number may be employed for carrying out the objects of the invention and for energizing separately the different devices described and to be hereinafter further described.

The line-controlling magnets U (designated as a, b, c, and d) are connected in parallel, and in the operation of the apparatus the magnet a is the first energized, and each line-controlling magnet U as it becomes energized throws the next succeeding one into circuit automatically.

A branch circuit is taken from the point 25 at the positive pole of battery 23, said circuit being led by wire 26 to contact R of the switch 27. After passing through the said switch and contact Q thereof the circuit is continued by the same wire 26 to the magnet a, and from thence through the resistance 28 to the common-return wire 29 back to the point 30, and from thence to the negative pole of battery 23. From contact 31 of magnet a leads a wire 32 for energizing magnet b, and from said magnet the same wire 32 connects with the common return 29. From a contact 33, controlled by magnet b, a wire 34 leads to magnet c and from thence to the common return 29. From contact 35 of magnet c a wire 36 leads to magnet d and from thence to the common return 29.

A branch wire 37 connects the point 38 on wire 26 adjacent magnet a with contact 39 of said magnet, and from said contact the wire 37 continues to contact 40 of magnet b and also to contact 41 of magnet c.

From contact 42 of magnet b a wire 43 leads to contact 44 of magnet d. The main line-wire 14 connects with contact 45 of magnet b.

The contacts G and F of the groups 1, 2, 3, and 4 at the transmitting-station are all connected in parallel to the wires 46, 47, and 48. It will be seen that wire 46 leads to contact 49 of magnet b, wire 47 leads to contact 50 of magnet d, and wire 48 leads to contact 51 of magnet d. The contacts 39, 45, 40, 41, and 44 of the line-controlling magnets U are all carried upon pivoted armatures 52, provided with retracting-springs 53, arranged to hold said armatures and the contacts carried thereby away from the cores of the line-controlling magnets U, so that when said magnets are energized the armatures are attracted and complete the circuits with the contacts carried by the cores, at the same time breaking the contacts wherever they are made with the back-stops.

When one of the key-levers C is operated, as has been explained, three pairs of contacts G F will be closed, and the contacts Q R of switch 27 will also be closed by the operation of the bar K on the shaft P. The closure of the switch 27 embodying contacts Q and R will complete a circuit from the point 25 at the positive pole of local battery 23 by wire 26 through switch 28, and still by wire 26 to and through magnet a and back by way of the common-return wire 29 to the point 30 and the negative pole of the local battery 23. Magnet a is thereby energized, causing it to attract its armature 52 against the influence of the retracting-spring 53 and closing contacts 31 and 39. Upon the closure of contacts 31 and 39 a circuit is completed from the point 38 on wire 26 by wire 37 to and through contacts 31 and 39, and thence by wire 32 to magnet b, and from thence still by wire 32 to the common return 29 and back to the battery 23. The energizing of magnet b causes it to attract its armature 52, and thereby close contacts 42 and 45 and at the same time close contacts 33 and 40. The closure of contacts 42 and 45 of course opens contacts 45 and 49. The closure

of contacts 33 and 40 throws the magnet *c* into the circuit of battery 23, since it is included in shunt to the magnets *a* and *b* between the points 54 and 35. The energizing of magnet *c* causes it to attract its armature 52 and close contacts 35 and 41, which thereby includes magnet *d* in the circuit of the battery 23, as is obvious. The energizing of magnet *d* closes contacts 44 and 51 and breaks contacts 44 and 50.

Before contacts 45 and 49 of magnet *b* are broken it will be seen that there is a complete circuit from the contacts 1^a 1^b 1^c 1^d of the groups of contacts 1, 2, 3, and 4 through wire 46 to and through contacts 45 and 49 and thence to the line-wire 14, so that with the parts shown in the positions indicated in the drawing of Fig. 3 provision is afforded for transmitting impulses to the line when the first pair of contacts in each group 1, 2, 3, and 4 is operated. The energizing of magnet *b* switches the line connection to wire 14 onto the wire 47, which connects with the pairs of contacts 2^a, 2^b, 2^c, and 2^d of the groups 1, 2, 3, and 4. This is accomplished by the closure of contacts 42 and 45 of magnet *b*, which completes the circuit between line-wire 14, wire 43, contacts 44 and 50 of magnet *d*, and the wire 47.

The function of magnet *c* is to energize magnet *d*. When this latter magnet *d* is energized, the line-wire connection 14 is broken with the wire 47 and is switched to the wire 48, because the energizing of magnet *d* breaks contacts 44 and 50 and closes contacts 44 and 51, thereby completing the circuit between wires 14 and 48 by means of wire 43. Wire 48 connects with contacts 3^a, 3^b, 3^c, and 3^d of the groups 1, 2, 3, and 4.

By the apparatus and devices thus described at the transmitting-station it will be seen that automatic provision is afforded for directing impulses of different characters from the line-batteries S and T to the line-wire 14.

Let it be assumed that a given character is to be printed and that the corresponding key-lever is operated, thereby closing the switch 27 at the contacts Q and R and at the same time closing the pairs of contacts 1^a of group 1, 2^b of group 2, and 3^a of group 1. The closure of the pair of contacts 1^a of group 1 sends a positive impulse from the line-batteries S and T, through wire 46, to and through contacts 45 and 49 to the line 14. The closure of switch 27 energizes magnet *a* as described, which in turn switches magnet *b* into circuit, causing a break between contacts 45 and 49, closing contacts 42 and 45, thereby switching the line-wire 14 onto the wire 47. The pair of contacts 2^b of group 2 being in circuit with wire 47, it will thus be seen that a negative impulse from the line-batteries will be transmitted through wire 47 to the line-wire 48. The energizing of magnet *b* also closes contacts 33 and 40, thereby energizing magnet *c*, which in turn energizes magnet *d*. The energizing of magnet *d* switches the line-wire 14 onto wire 48, and contacts 3^a of group 1 being electrically connected to wire 48 it will thus be seen that provision is afforded for transmitting a positive impulse from the line-batteries S and T onto the line-wire 14. As soon as the finger is removed from the key-lever which has been operated the circuit will be broken at the switch 27 and the line-controlling magnets U will become deënergized, the parts assuming their normal positions. As will hereinafter appear, all the portions of the apparatus are restored to normal position when the finger is removed from the key-lever, and the printing takes place as the finger is removed.

It has thus far been described how the impulses of different characters are transmitted to the main line 14, and it is to be understood that the alternating impulses are transmitted in the same manner as already described when the proper key-lever is operated to close one of the pairs of contacts of the groups 3 and 4.

A description will now be given of the operation of the polarized relays W and the controlling-magnets X, these two sets of magnets constituting the selecting-magnets. It will be assumed that the spacing-key D has been operated, which will close contacts 1^a of group 1, sending a positive impulse over the line, 2^b of group 2, sending a negative impulse over the line, and 3^a of group 1, sending another positive impulse over the line by means of the automatic apparatus already described in connection with the transmitting-magnets U. The transmission of the positive impulses over the line will carry into effect certain operations to be described, and referring to the polarized relays W it will be seen that each armature 56 is provided with a retracting-spring 57. The armatures 56 operate between contacts and stops 58 and 59. The springs 57 of polarized relays *e* and *g* normally hold the armatures 56 against the negative stops or contacts 59, while the springs of magnets *f* and *h* normally hold the armatures 56 against the positive stops or contacts 58. According to this arrangement the positive impulse transmitted over the line-wire 14 and through the polarized relays W will cause the armatures 56 of magnets *e* and *g* to be attracted against contacts 58, while the armatures of the other two polarized relays *f* and *h* will not be affected. When the armature 56 of relay *e* is moved against contact 58, a circuit will be completed from the local battery 60 through controlling-magnet *j* as follows: from the positive pole of battery 60 by wire 61 through magnet *j* and thence still by wire 61 through contact 58, armature 56, and back by wire 61 to the negative pole of battery 60. It is to be borne in mind that controlling-magnets *j* and *k* are normally deënergized, while magnets *l* and *o* are normally energized, be-

ing always included in circuit of local battery 60. From the point 62 on wire 61 at the positive pole of battery 60 a wire 63 leads to magnets *l* and *o*, connecting them in parallel. Wire 63 is connected to each of the contacts 58 and 59 of magnets *g* and *h*, and from thence the circuit is completed back to the negative pole of battery 60. Magnet *k* is also in parallel with the remaining controlling-magnets and is included in circuit by means of the wire 61 and contact 59 and armature 56 of relay *f*. According to the construction described it will be seen that neither a positive nor a negative impulse over the main line 14 will permanently affect the normally energized magnets *l* and *o*, because although the armatures of magnets *g* and *h* may be thrown from one side to the other the circuits of magnets *l* and *o* will normally be maintained completed. When alternating currents are sent over the line, however, tending to vibrate one or the other of the armatures 56 of magnets *g* and *h*, one or the other of the magnets *l* and *o* is deënergized by the constant vibration of the armature 56 included in its circuit.

The armatures 64 of magnets *j k* are normally held away from the cores of said magnets by the retracting-springs 65. The armatures 64 of magnets *l* and *o* are normally held attracted against the cores of said magnets, because these magnets are normally energized. The springs 65 tend to pull the armatures away from the cores, so that when these magnets *l* and *o* are deënergized the contacts 66 are closed. When the magnets *j* and *k* are energized, the contacts 66, controlled by said magnets, are closed.

It has been assumed that a positive impulse has been sent over the line-wire 14, which did not affect the operation of magnets *k*, *l*, and *o*, but caused magnet *j* to become energized by the closure of its circuit at contact 58 of polarized relay *e*. The energizing of magnet *j* closed contacts 66 and completed a circuit as follows: from the point 67 on wire 68, connected to the positive pole of local battery 23, through wire 69 to the point 70, from thence still by wire 69 to and through contacts 66 of relay *j*, thence by wire 69 to and through one solenoid of selectable magnet *p*, thence continuing by wire 69 through solenoid 19 of holding-magnets *x*, back by wire 69 through the other solenoid of selectable magnet *p* to the point 71, and then continuing by wire 69 to the point 72, and thence still by wire 69 back to the negative pole of local battery 23.

The energizing of selectable magnet *p* operates to close nine pairs of the contact 16 for an instant, and the energizing of solenoid 19 of holding-magnets *x* closes contacts 21 and 22 of the group of contacts *x'*.

The closure of contacts 22 of group *x'* completes a circuit from the positive pole of battery 23 by wire 68 to the point 73, and thence still by wire 68 to the solenoid 20 of holding-magnet *x*, thence to and through contacts 22 to the point 74, and thence continuing by wire 68 to the point 69 adjacent magnet 75. Connection is made from the point 69 to contact 76, normally completing circuit with contact 77 upon the armature 78, controlled by magnet 75. After passing through contacts 76 and 77 the circuit continues still by wire 68 to the point 79 on wire 69 and thence back to the negative pole of local battery 23. The circuit of wire 68 just described, including the solenoid 20 of holding-magnet *x*, contacts 22 of the group *x'*, and contacts 76 and 77 of magnet 75, will be termed the "holding-circuit." The function of the solenoid 20 of holding-magnet *x* is twofold—first, this solenoid 20 closes contacts 24 of group *x'* and at the same time holds contacts 21 and 22 closed of group *x'*, it being borne in mind that the solenoid 19 of magnet *x* first closed contacts 21 and 22. The circuit of solenoid 20 of magnet *x* is not broken until after the printing has been effected, while the circuit of solenoid 19 of magnet *x* is broken when the circuit of selectable magnet *p* is broken. This statement is true of all of the magnets *x*, *y*, *z*, and *z'*—that is to say, the solenoids 20 act to hold the contacts which are closed at said magnets. By this means mechanical locking devices are entirely done away with, and the high time constant found to exist in such mechanical devices is obviated. The electrical means described operate quickly and are easily controlled from a distance and are not apt to get out of order.

The holding-circuit which was completed by the closure of contacts 22 of group *x'* has been described, and the circuit completed by the closure of contacts 21 of said group *x'* will now be described, as follows: When said contacts 21 are closed, a circuit is completed from the positive pole of the battery 23 through wire 68 to the point 73, from thence to the point 80, and then by wire 81 to the point 82, and thence through normally closed contacts 18 of the group *w'*. From said normally closed contacts 18 the circuit passes still by wire 81 to the point 83 and thence through normally closed contacts 18 of the group *v'*. From thence the circuit continues by wire 81 to the point 84 and through the normally closed contacts 18 of group *u'*, then by wire 81, as before, through the controlling-magnets *t*, and continuing by wire 81 to and through contacts 21 of group *x'*, and thence through the holding-circuit 68 back to the negative pole of the battery 23.

The energizing of the controlling-magnets *t* operates the contacts 18 and 17 of the group *t'*, serving to open the normally closed contacts 18 and close the normally open contacts 17.

It will be remembered that the selectable magnets *p* were only momentarily energized, for there was but one positive impulse sent over the line, and as soon as this had been accomplished the magnet *b* of the line-control-

ling magnets U became energized automatically, thereby connecting the line-wire 14 with group 2 of contacts G and F, so arranging the circuits that a negative impulse will be directed over the line 14 when contacts 2^b of group 2 are closed. The operation of the apparatus when a positive impulse is sent over the line has been described, and it already having been assumed that the spacing-key was operated it will be seen that it is necessary to have a complete circuit with all the gaps closed, including the spacing-magnet V′ of the letter-selecting magnets V. The transmission of the negative impulse over the line brings about further operations which tend to produce a closed circuit for the spacing-magnet V′, as will now be described. A negative impulse will cause polarized relay *f* to attract its armature 56 against contact 59, and thereby complete the circuit of controlling-relay *k*. Relay *k* will close its contacts 66 and complete a circuit as follows: from the positive pole of battery 23 to the point 67, by wire 69 to the point 70, thence by wire 69 through contacts 66 of magnet *k* and by wire 85 to one solenoid of selectable magnet *q*, thence still by wire 85 to solenoid 19 of holding-magnet *y*, thence back by wire 85 to the other solenoid of selectable magnet *q* to the point 71, and thence by wire 69 back to the negative pole of battery 23. The energizing of selectable magnet *q* operates nine pairs of the contacts 16 for a moment, and at the same time the energizing of solenoid 19 of holding-magnet *y* closes contacts 21 and 22 of the group *y′*. The closure of contacts 22 of said group *y′* includes the solenoid 20 of holding-magnet *y* in the following circuit: from the positive pole of battery 23 through wire 68 to the point 86 adjacent the solenoid 20 and from thence through contacts 22 back by wire 68 through the holding-circuit to the negative pole of battery 23. The energizing of solenoid 20 of the holding-magnet *y* closes the normally open contacts 24 of the group *y′*. The closure of contacts 21 of group *y′* completes no circuit, because as long as the controlling-magnet *t* remains energized no other one of the magnets *u*, *v*, or *w* can be energized, since the circuits of these magnets *u*, *v*, and *w* pass through the contacts 18, controlled by the magnet *t*. In other words, each one of the magnets *t*, *u*, *v*, and *w* controls the others, so that only one can be energized at a time, and thereby after one of them has been energized—as, for instance, the magnet *t*—said magnet will remain energized until the holding-circuit 68 is broken. As long as said magnet *t*, for instance, remains energized its contacts 17 will remain closed and its contacts 18 will remain open in the group *t′*.

The circuit of the spacing-magnet V′ which it is desired to close contains a pair of contacts 16, the pair of contacts 17 of group *t′*, and a pair of contacts 24 of the group *y′*. So far in the operation of the apparatus contacts 17 and 24 referred to have been closed in readiness for the completion of the circuit of the spacing-magnet V′. After having sent a positive and then a negative impulse over the line as described another positive impulse will be directed over the line by the closure of contacts 3^a of group 1, thus completing the sequence—that is, 1^a of group 1, 2^b of group 2, and 3^a of group 1.

The automatic energizing of magnet *d* of the transmitting-magnets *u* and the closure of contacts 3^a of group 1 transmit a positive impulse through wire 48 over the line 14, thereby operating polarized relay *e* and causing controlling-magnet *j* of the selecting-magnets to become energized. The energizing of magnet *j* completes the circuit to the selectable magnet *p*, thereby closing contacts 16. In this instance when contacts 16 are closed by the selectable magnet *p* a circuit is completed as follows: to the spacing-magnet V′ from the positive pole of the battery 23 by wire 68 to the point 73, and from thence by wire 90 to the point 91, and still by wire 90 to and through magnet 92, and thence by wire 90 to the contacts 16 of the first group, to and through spacing-magnet V′, and thence continuing by wire 90 the circuit passes through contacts 24 of group *y′* to the point 93. From thence the circuit continues by wire 90 to and through the closed contacts 17 of the group *t′*, and the circuit is completed by wire back to the point 72, and from thence by wire 69 to the negative pole of the battery 23. The circuit of the desired magnet V′ has thus been completed and the desired set of characters is brought into position or selected.

The operation of printing is yet to be described, and the final breaking of the holding-circuit 68 to restore the devices at the receiving-station to normal position in readiness for the selection and printing of another character. As has been seen, when the circuit was completed through the spacing-magnet V′ the magnet 92 was energized, being included in the same circuit. This magnet 92 controls an armature 95, provided with contacts 96, 97, and 98, said armature being normally held away from the core of the magnet 92. Contact 98 is adapted to coöperate with contact 99, and contact 98 coöperates with contact 100, while contact 96 coöperates with contact 101. When magnet 92 is energized, armature 95 is attracted against the tension of its retracting-spring 102 and contacts 98 100 are broken, while contacts 97 99 and 96 101 are closed. The closure of contacts 97 99 completes a circuit from the point 103 on the wire 90 as follows: from said point 103 by wire 104 through magnet 105, thence through magnet 75, thence through contacts 97 and 99 to the armature 95, and thence to the holding-circuit 68, and by said wire 68 back to the negative pole of the battery 23.

The energizing, as described, of magnet 75 causes it to attract its armature 78 against its retracting-spring and open contacts 76 and 77; but since contacts 96 and 101 were previously closed by the energizing of magnet 92 the holding-circuit will not be broken, but will merely be switched through contacts 96 and 101 by means of the connections shown. The energizing of magnet 105 causes it to attract its armature 106 against the tension of the spring 107. Said armature 106 carries contacts 108 109, connected to each other and to the wire 110, leading to the printing-magnet Z. From said magnet the wire 110 continues to contact 100. When armature 106 is attracted, it brings contacts 108 and 109 into coöperation with contacts 111 and 112. Contact 111 is connected by wire 113 to wire 69 and thence to the positive pole of battery 23, while contact 112 is connected to magnet 114 by wire 115 and thence by said wire to wire 69, connecting with the negative pole of the battery 23. By this arrangement of circuits it will be seen that the energizing of magnet 105 operates to complete the circuit of magnet 114, which holds the armature 106 attracted after magnet 105 becomes deënergized. As the finger is removed from the key-lever which has been operated at the transmitter the circuit of the letter-selecting magnet V, which has been finally completed, is broken, which deënergizes the selectable magnet p, q, r, or s, which has been included in circuit, and also deënergizes the magnet 92 in series therewith. Armature 95 is retracted, and thereby the holding-circuit 68 is broken at contacts 96 and 101, which restores the parts to normal position. The circuits of magnets 75 and 105 are also broken; but the holding-magnet 114 remains energized, being directly in circuit with the local battery 23. When armature 95 is retracted, it will be seen that contacts 98 and 100 come into coöperation, which completes the circuit of the printing-magnet Z as follows: from the point 70 on wire 69, through contacts 111 and 108, thence by wire 110, through printing-magnet Z, thence through contacts 98 and 100 to wire 68, and back to the negative pole of battery 23. As the printing takes place contacts 120, which are normally open, are closed—that is, completing a shunt-circuit 121 around holding-magnet 114—which deenergizes said magnet and permits its armature 106 to be retracted, thereby breaking the circuit of the printing-magnet Z.

The operation of the apparatus may be summed up briefly, as follows: It has been assumed that the magnet V′ of the letter-selecting magnets V is to be energized by completing a circuit therethrough. To so complete a circuit, the spacing-lever upon the transmitter was operated, thereby closing three of the pairs of contacts G and F. The particular pairs of contacts closed were the pairs 1^a of group 1, 2^b of group 2, and 3^a of group 1. At the same time switch 27, comprising Q R was closed. The closure of contacts Q R first energized magnet a of the line controlling or transmitting magnets U, and the automatic operation of the magnets U thereafter takes place, automatically switching the wires 46, 47, and 48 into electrical connection with the line-wire 14 in the proper sequence to include contacts 1^a, 2^b, and 3^a in series with the line, one after another. By this means characteristic impulses were sent over the line 14, in this particular instance a positive, a negative, and then a positive impulse being transmitted. Instead of this particular sequence of impulses the alternating currents, as described, may be combined with the positive and negative impulses, in any case and in any combination or sequence of characteristic impulses the automatic operation being, as described, in connection with the magnets U.

Each characteristic impulse or combination of impulses transmitted over the line has a certain effect on the polarized relays W, which in turn control the controlling-magnets X. The controlling or selecting magnets X determine which of the selectable magnets Y are to be energized at a time. Each selectable magnet p, q, r, and s of the series Y has in series with it one of the magnets x y z z', so that when a selectable magnet Y is energized one of the controlling or holding magnets x y z z' is energized. The first selectable magnet Y selected by the first characteristic impulse or impulses sent over the line remains energized but momentarily, and then another magnet Y is selected and momentarily energized. It is not until the third selectable magnet is chosen or selected that a complete circuit is afforded through one of the letter-selecting magnets V, because it is not until the said third time that a selectable magnet is chosen that all of the gaps or breaks in the circuit of one of magnets V are closed.

The energizing of a selectable magnet Y—as, for instance, the magnet p and the magnet x in series therewith—serves to close one of the gaps referred to, as at the contacts 17 in the group t', and then the energizing of another selectable magnet q, together with magnet y in series therewith, serves to close another of said gaps, as at the contacts 24 in the group y'. The final selectable magnet chosen, which in the instance described is again a magnet p, serves to close the contacts 16, and thus complete the circuit desired to the spacing-magnet V′.

In the operation of the apparatus the gaps at contacts t' and 24, referred to, are maintained closed by a holding-circuit and holding-magnets, which holding-circuit is not broken until at the time the printing is accomplished. After the last characteristic impulse or series

of impulses have been sent over the line the holding-circuit is automatically broken and the parts are restored to normal position.

According to this invention any three kinds of impulses other than those described could be utilized and a different working or letter-selecting magnet selected, according to the permutation of the three kinds of current. In this way a large number of working magnets can be selected without repeating any impulse in a series, whereby a particular magnet is selected. By utilizing as a third impulse a repetition of the first of the series of impulses a still larger number of series or permutations can be obtained. The invention contemplates, therefore, not only means whereby printing or working magnets are selected by a series of three or more impulses unlike in character and in order of sequence, but also by a series of impulses in which the first impulse shall be repeated to form the third impulse of the series. By utilizing four characters of impulses, as hereinbefore indicated, and employing series or sequences of three of such impulses to operate each working magnet, in which sequences the third impulse may be a repetition of the first impulse of the sequences, thirty-six working magnets may be employed, and any one of them may be definitely selected and operated.

The apparatus at the transmitter-station affords means for transmitting different kinds of impulses over the line in different combinations and permutations, while the magnets U operate automatically to control the transmission of the impulses to the line. The selecting-magnets W and X afford means for utilizing the impulses to select the selectable magnets Y, according to different combinations and permutations in a given order of three at least.

The selectable magnets Y include what may be termed the "primary circuits," which circuits also include the solenoids 19 of the holding or non-interference magnet x, y, z, and z'. It will be seen that the selectable magnets control the working circuits, which include the working or letter-selecting magnets V. The circuits including the solenoids 20 of the holding-magnets x y z z' and also including auxiliary magnets t, u, v, and w may be termed "secondary" circuits or "non-interference" circuits, and it will be seen that the secondary or non-interference circuits so defined are controlled by the primary circuits above referred to. The working circuits, including the magnets V, may be termed "tertiary" circuits, each tertiary circuit including at least three breaks. These breaks are arranged in sets or series, one set of breaks or pairs of contacts being designated by the reference-numeral 16 and arranged to be controlled by the selectable magnets Y. Another set of breaks in the tertiary circuits are controlled by the holding-magnets, and a third series of breaks are controlled by the auxiliary magnets t, u, v, and w.

According to the arrangement described the tertiary or working circuits are controlled both by the primary and secondary circuits, and the secondary circuits prevent interference with the operation of printing until printing has been effected. One of the functions therefore of the secondary circuits is to prevent interference between the different circuits and devices of the apparatus.

When printing is effected, the holding circuit or circuits which have been brought into operation are automatically broken by means of the magnet 92. No tertiary or working circuit can be energized until all three of the breaks or gaps therein have been closed, and this cannot take place until the selectable magnets Y have been operated in a given order of three at least.

Obviously some features of this invention may be used without others, and the invention may be embodied in widely-varying forms.

Therefore, without limiting the invention to the construction shown and described, I claim, and desire to obtain by Letters Patent, the following:

1. A printing-telegraph system, comprising a plurality of working circuits or branches, each including a working magnet and having at least three breaks or gaps, selectable magnets controlled by characteristic kinds of impulses, sets of switches operated by the selectable magnets and each set closing breaks in different working circuits, but not all the breaks in any one circuit, and the operation of particular sets of switches in a certain order of three at least closing all the breaks of a particular working circuit, and electrical means for preventing interference with the operation of printing.

2. A printing-telegraph system, comprising a plurality of working circuits or branches, each including a working magnet and having at least three breaks or gaps, selectable magnets controlled by characteristic kinds of impulses, sets of switches operated by the selectable magnets and each set closing breaks in different working circuits, but not all the breaks in any one circuit, and the operation of particular sets of switches in a certain order of three at least, one of which sets is operated twice, closing all the breaks of a particular working circuit, and electrical means for preventing interference with the operation of printing.

3. A printing-telegraph system, comprising a plurality of working circuits or branches, each including a working magnet and having at least three breaks or gaps, selectable magnets controlled by characteristic kinds of impulses, sets of switches operated by the selectable magnets and each set closing breaks in different working circuits, but not all the breaks in any one circuit, and the operation

of particular sets of switches in a certain order of three at least closing all the breaks of a particular working circuit, selecting-magnets and circuits therefor controlling the selectable magnets, and non-interference magnets for preventing interference with the operation of printing.

4. A printing-telegraph system, comprising a transmitter adapted to send electrical impulses of different kinds or characters over the line, a main line, line-controlling magnets in said main line, auxiliary circuits controlled by said line-controlling magnets, selectable magnets included in said auxiliary circuits, a plurality of working circuits, each including a working magnet and having breaks, sets of electrical switches operated by said selectable magnets and closing breaks in different working circuits, but not all the breaks in any one working circuit, and the operation of particular sets of switches in a certain order closing all the breaks of a particular working circuit, and electromagnetic means for preventing interference with the operation of printing.

5. A printing-telegraph system, comprising a plurality of working circuits or branches, each including a working magnet and having at least three breaks or gaps, selectable magnets controlled by characteristic kinds of impulses, sets of switches operated by the selectable magnets and each set closing breaks in different working circuits, but not all the breaks in any one circuit, and the operation of particular sets of switches in a certain order of three at least, one of which sets is operated twice, closing all the breaks of a particular working circuit, selecting-magnets and circuits therefor controlling the selectable magnets, and non-interference magnets for preventing interference with the operation of printing.

6. A printing-telegraph system, comprising a transmitter adapted to send electrical impulses of different kinds or characters over the line, a main line, line-controlling magnets in said main line, auxiliary circuits controlled by said line-controlling magnets, selectable magnets included in said auxiliary circuits, a plurality of working circuits, each including a working magnet and having breaks, sets of electrical switches operated by said selectable magnets and closing breaks in different working circuits, but not all the breaks in any one working circuit, and the operation of particular sets of switches in a certain order, one of which sets is operated twice, closing all the breaks of a particular working circuit, and electromagnetic means for preventing interference with the operation of printing.

In testimony whereof I have signed this specification in the presence of two subscribing witnesses.

GEORGE A. CARDWELL.

Witnesses:
HERBERT G. OGDEN, Jr.,
E. VAN ZANDT.