No. 689,753. Patented Dec. 24, 1901.

H. A. ROWLAND.

MULTIPLEX PRINTING TELEGRAPH.

(Application filed July 26, 1897.)

(No Model.) 8 Sheets—Sheet 1.

FIG. 1.

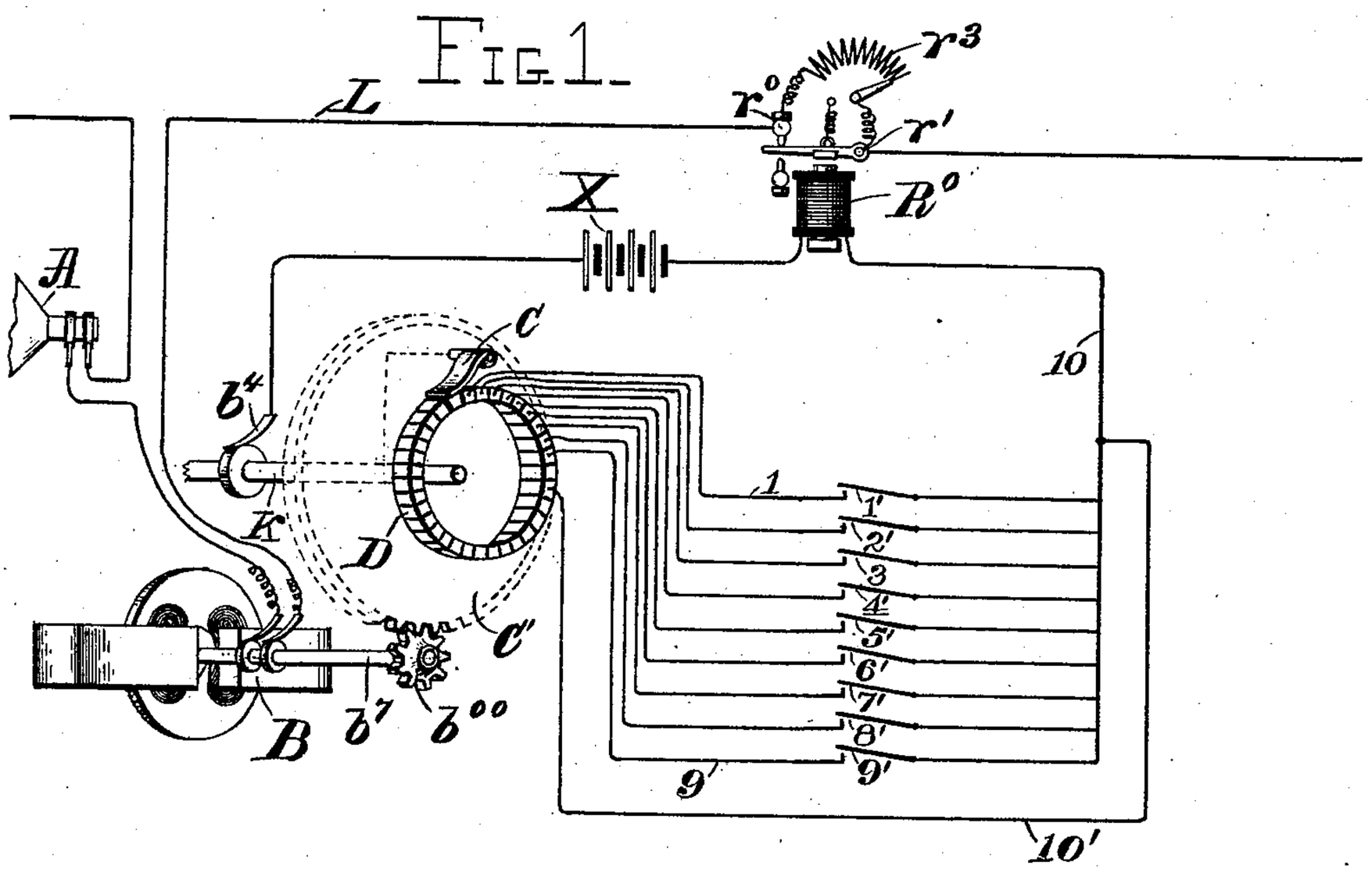


FIG. 2.

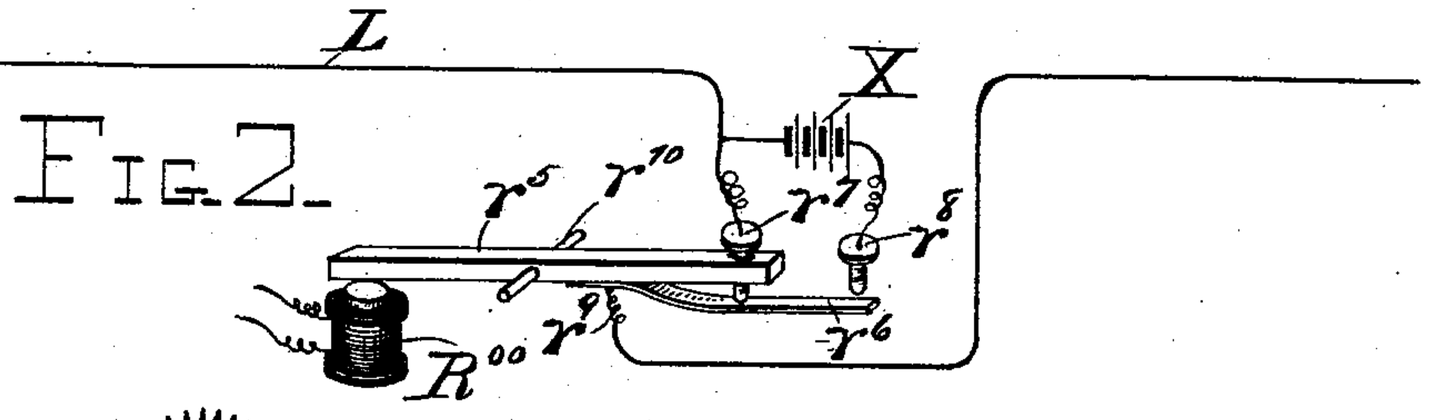
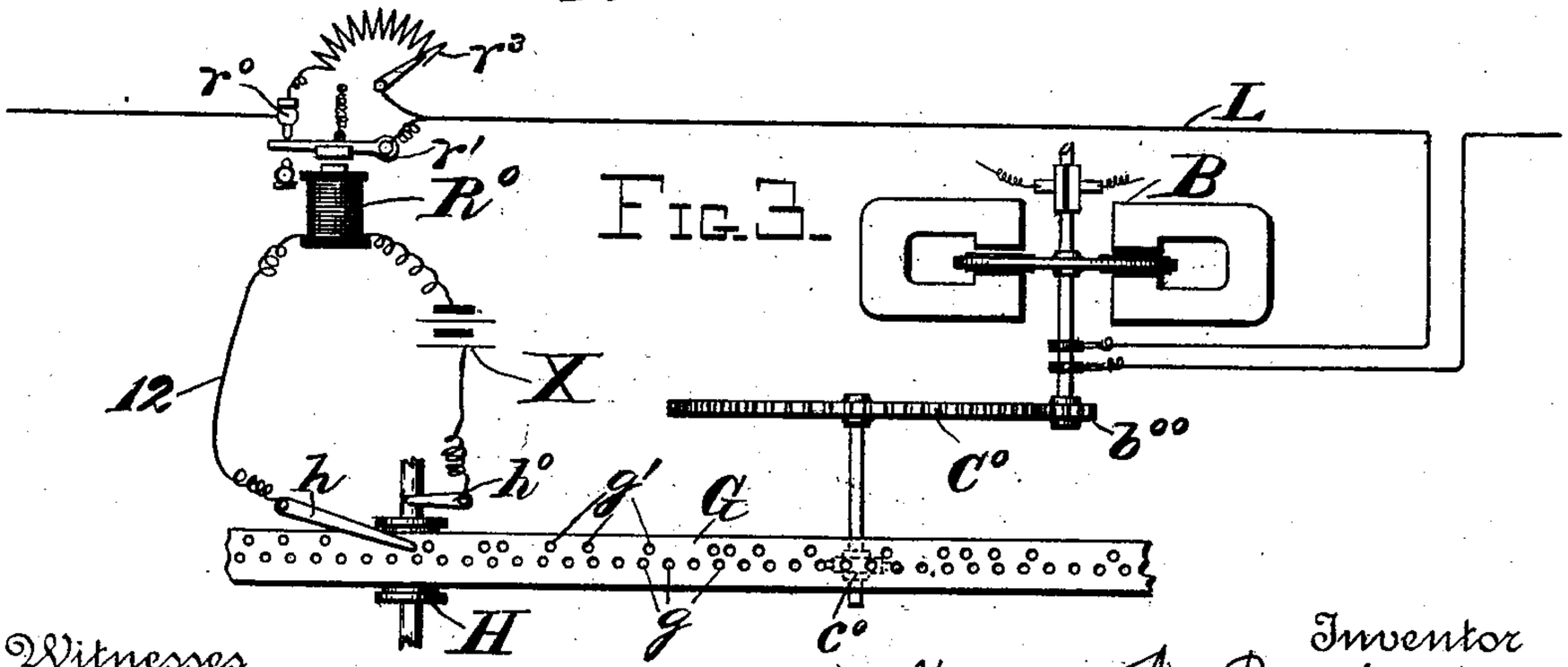


FIG. 3.



Witnesses
John N. Holt.
Roy C. Bowen.

Inventor
Henry A. Rowland,
by Whitman & Wilkinson,
Attorneys

No. 689,753. Patented Dec. 24, 1901.

H. A. ROWLAND.

MULTIPLEX PRINTING TELEGRAPH.

(Application filed July 26, 1897.)

(No Model.) 8 Sheets—Sheet 2.

FIG. 4.

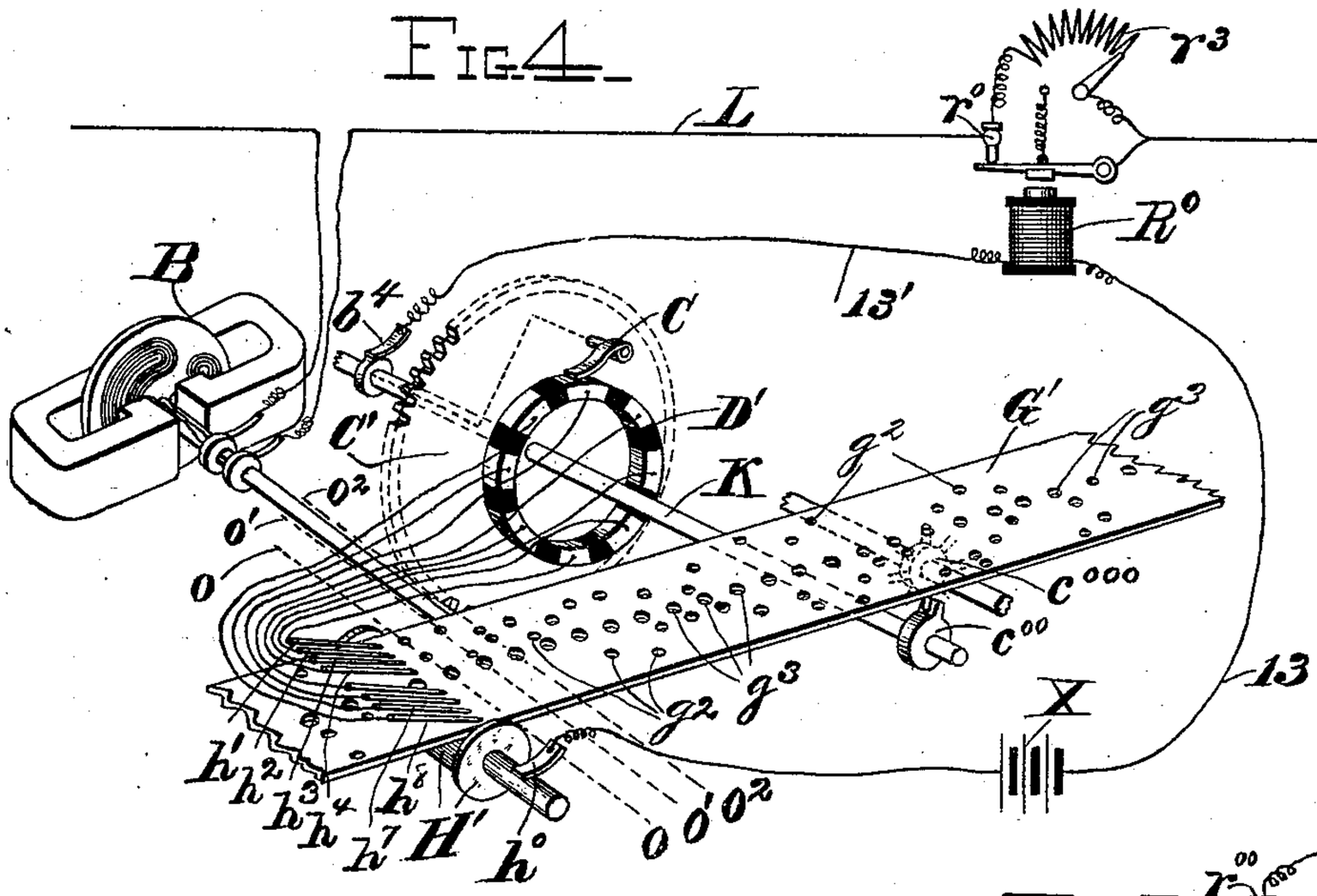


FIG. 6.

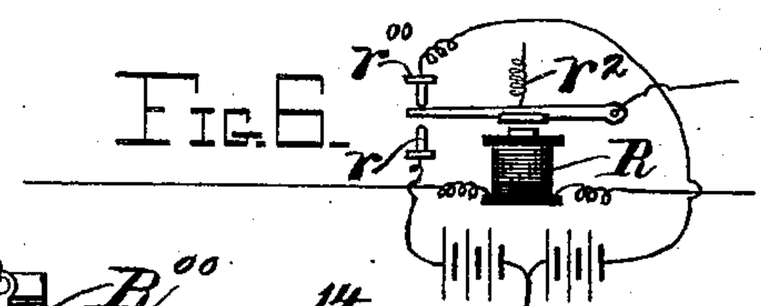


FIG. 5.

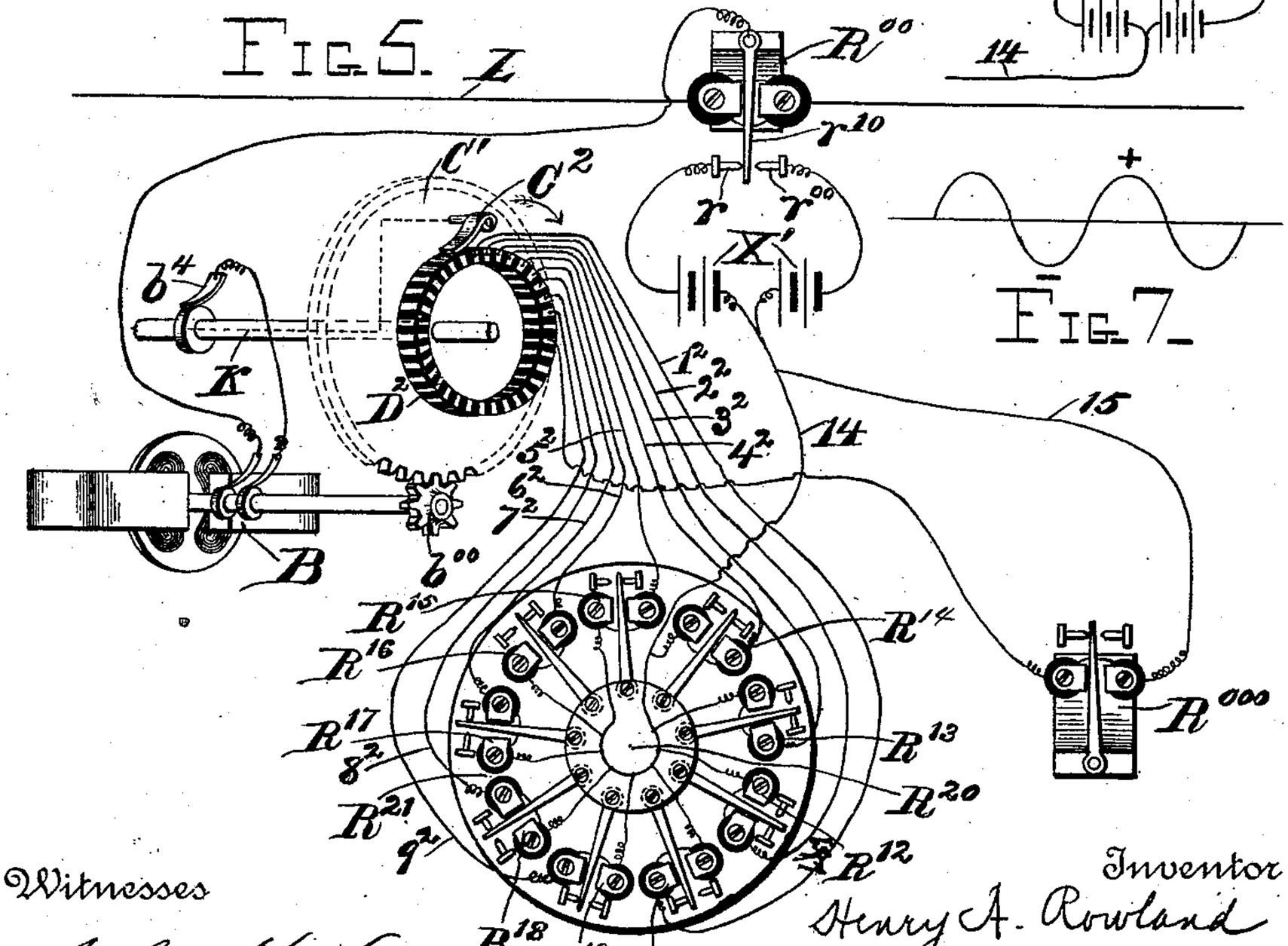


FIG. 7.

Witnesses

John N. Naef,

Percy C. Bowen

Inventor

Henry A. Rowland

by Whitman & Wilkinson,

Attorneys

No. 689,753. Patented Dec. 24, 1901.

H. A. ROWLAND.

MULTIPLEX PRINTING TELEGRAPH.

(Application filed July 26, 1897.)

(No Model.) 8 Sheets—Sheet 3.

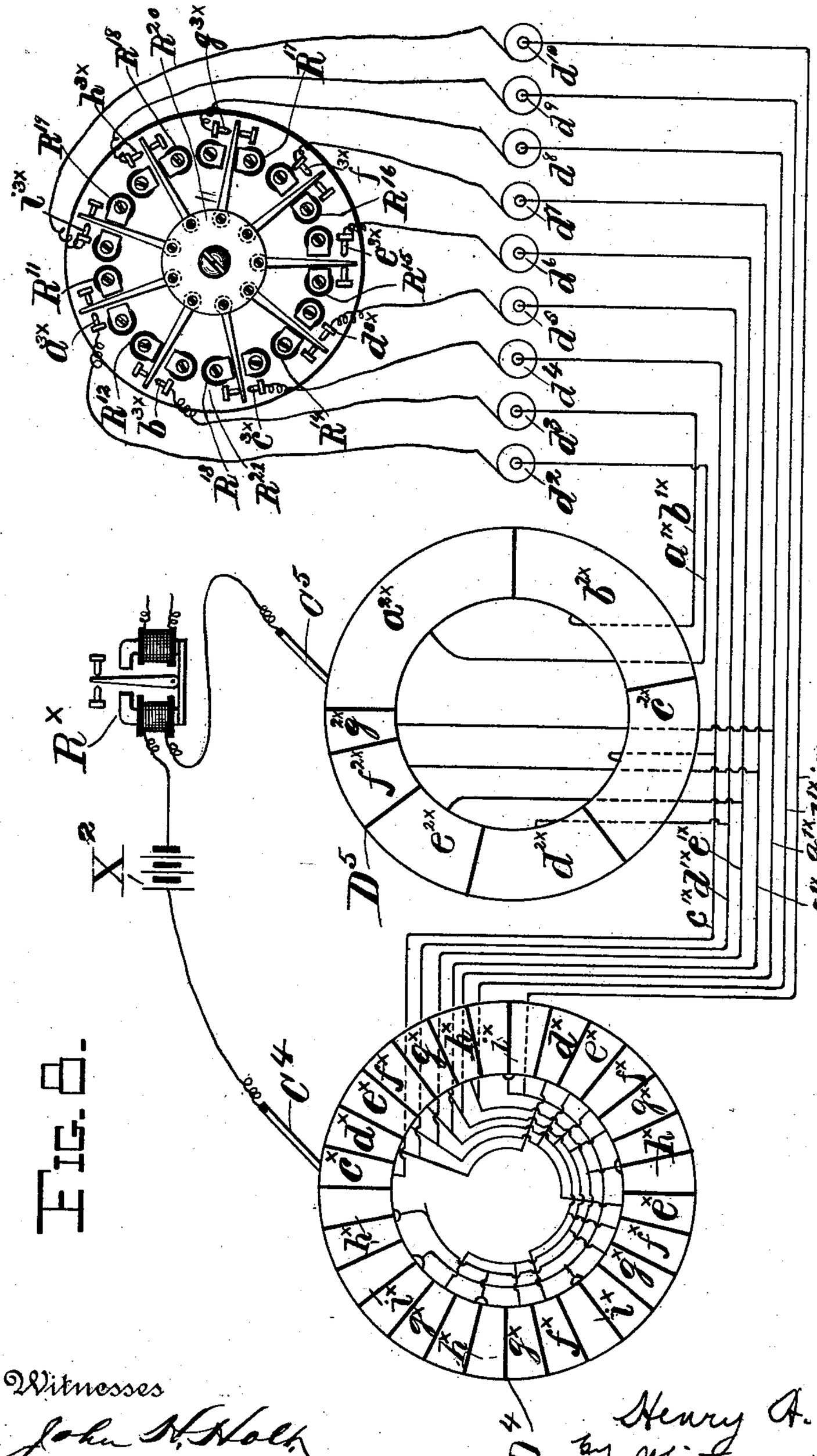


FIG. 6.

Witnesses
John H. Holt.
Roy C. Bowen.

Inventor
Henry A. Rowland,
by Whitman & Wilkinson,
Attorneys.

No. 689,753. Patented Dec. 24, 1901.

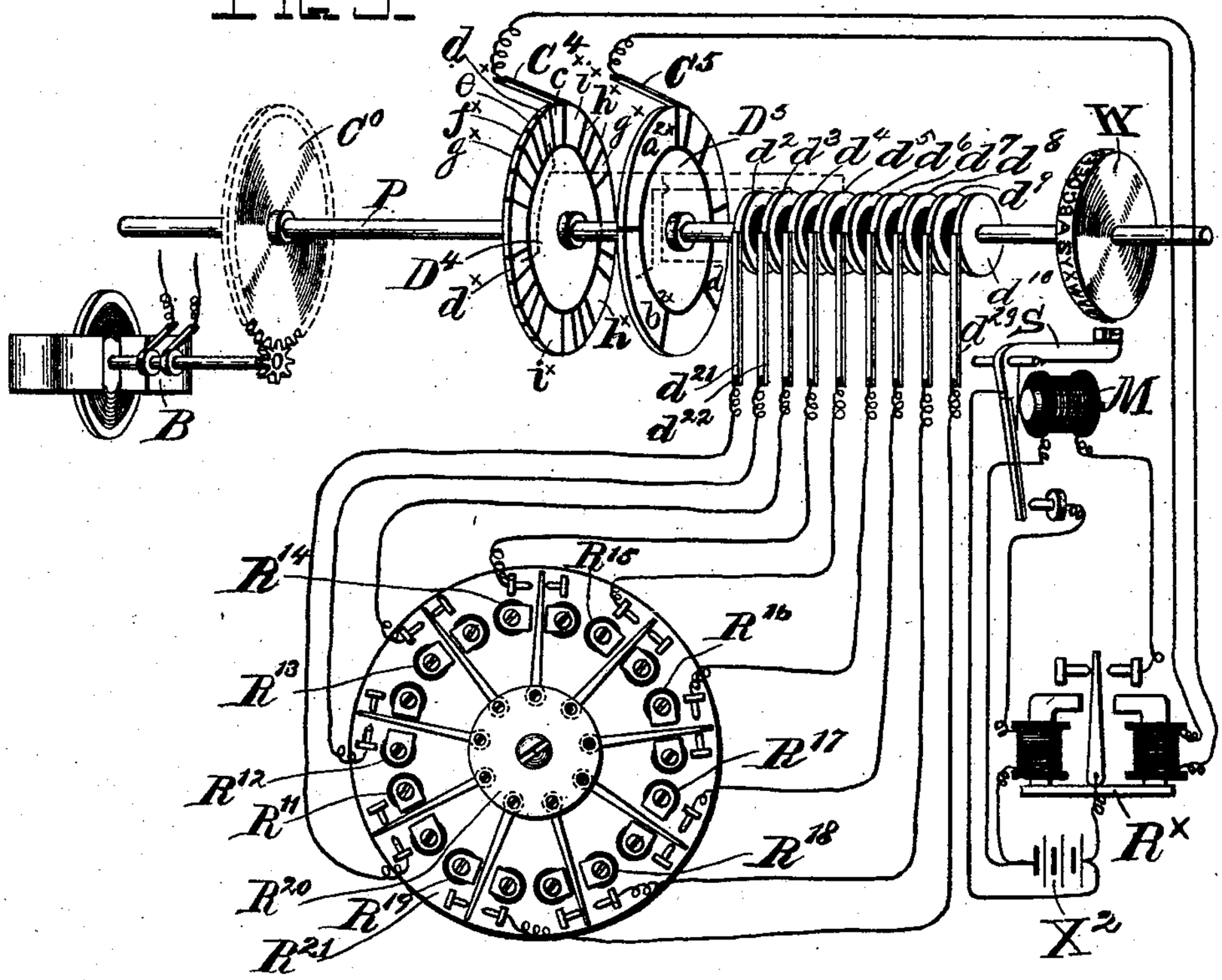
H. A. ROWLAND.

MULTIPLEX PRINTING TELEGRAPH.

(Application filed July 26, 1897.)

(No Model.) 8 Sheets—Sheet 4.

FIG. 9.



Witnesses
John N. Holt,
Percy C. Brown.

Inventor
Henry A. Rowland,
by Whitman & Wilkinson,
Attorneys.

No. 689,753. Patented Dec. 24, 1901.

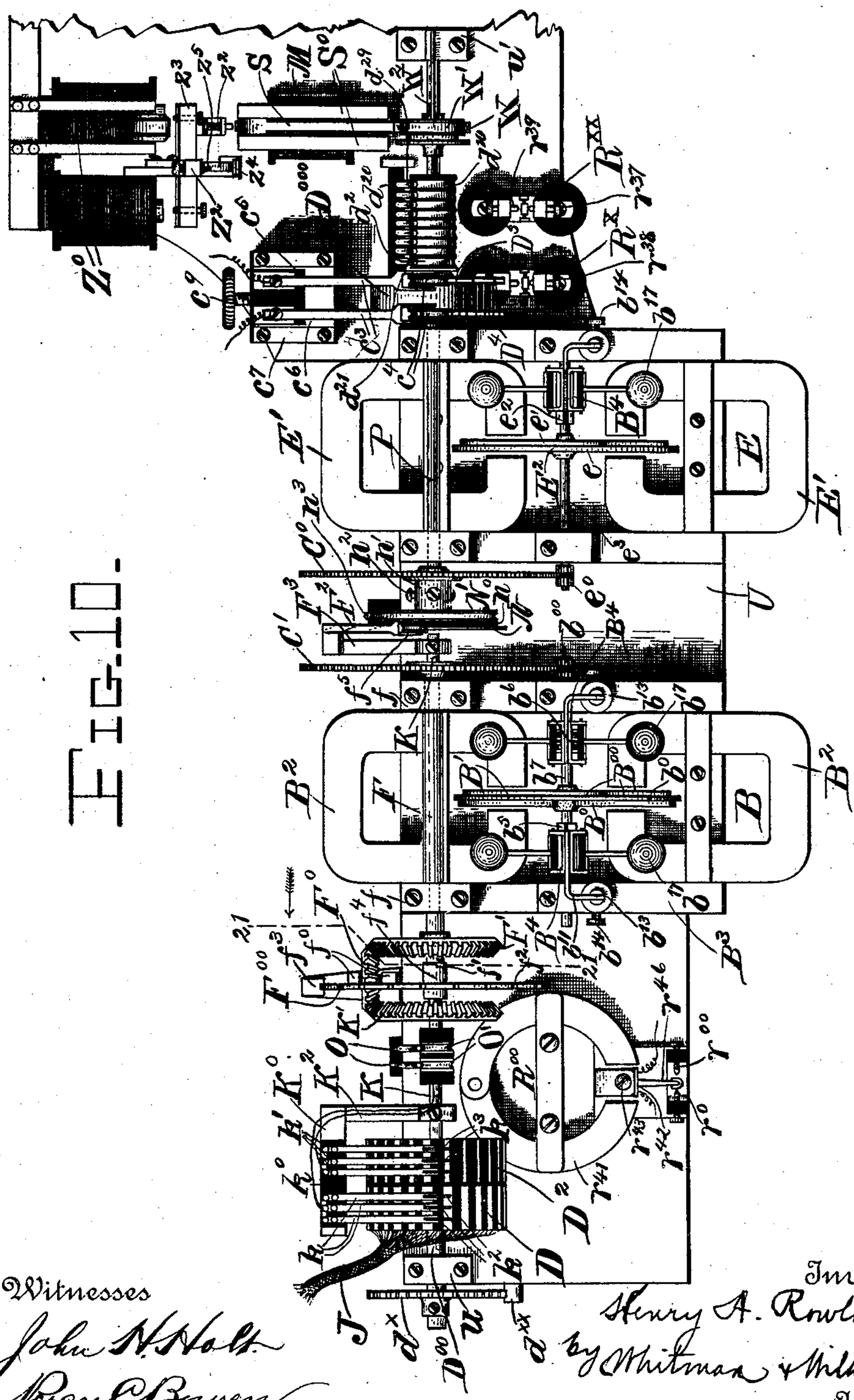
H. A. ROWLAND.

MULTIPLEX PRINTING TELEGRAPH.

(Application filed July 26, 1897.)

(No Model.) 8 Sheets—Sheet 5.

FIG. 10.



Witnesses
John N. Holt
Percy C. Bowen

Inventor
Henry A. Rowland
by Whitman & Wilkinson,
Attorneys.

No. 689,753. Patented Dec. 24, 1901.

H. A. ROWLAND.

MULTIPLEX PRINTING TELEGRAPH.

(Application filed July 26, 1897.)

(No Model.) 8 Sheets—Sheet 6.

FIG. 11.

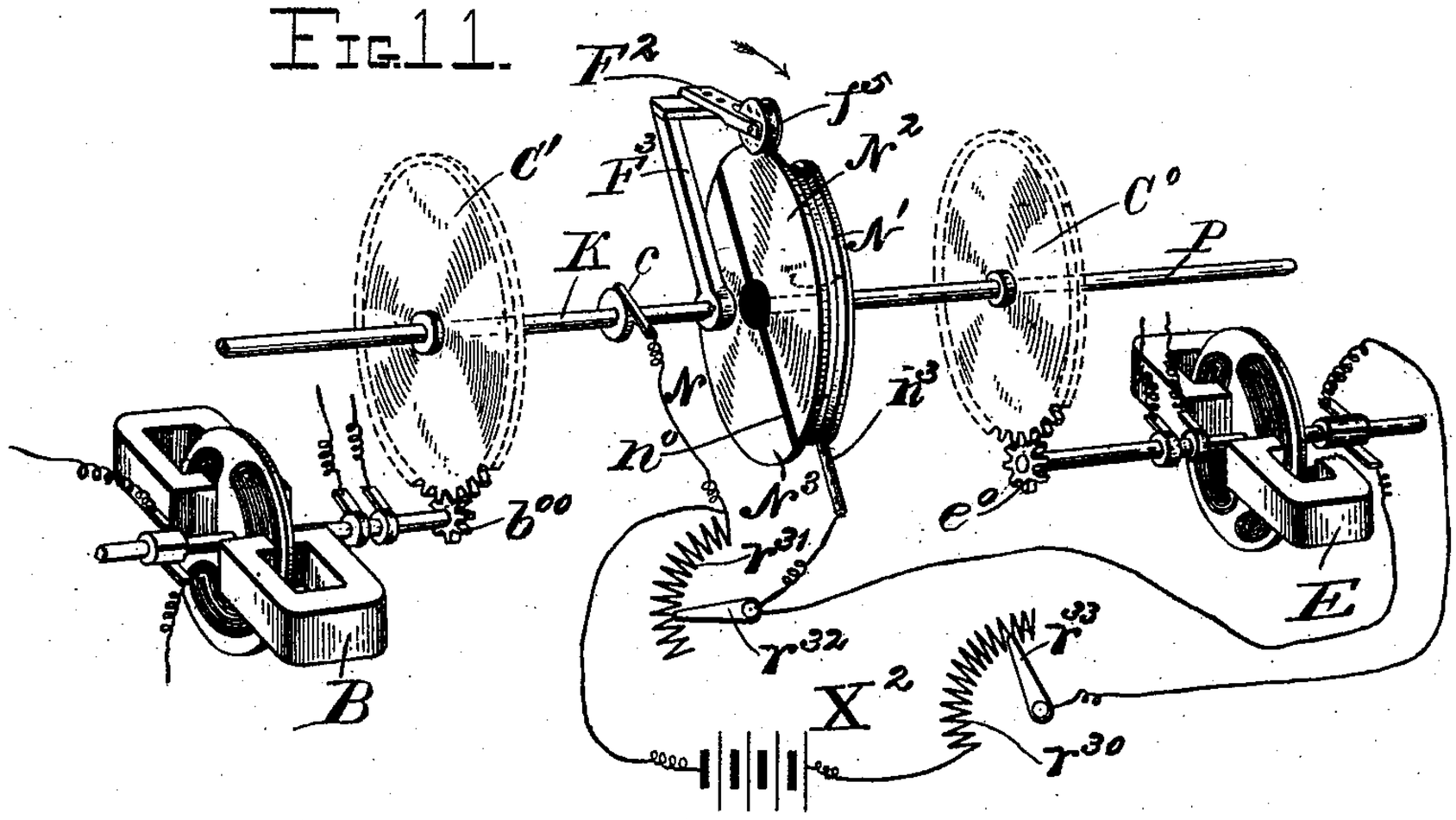


FIG. 12.

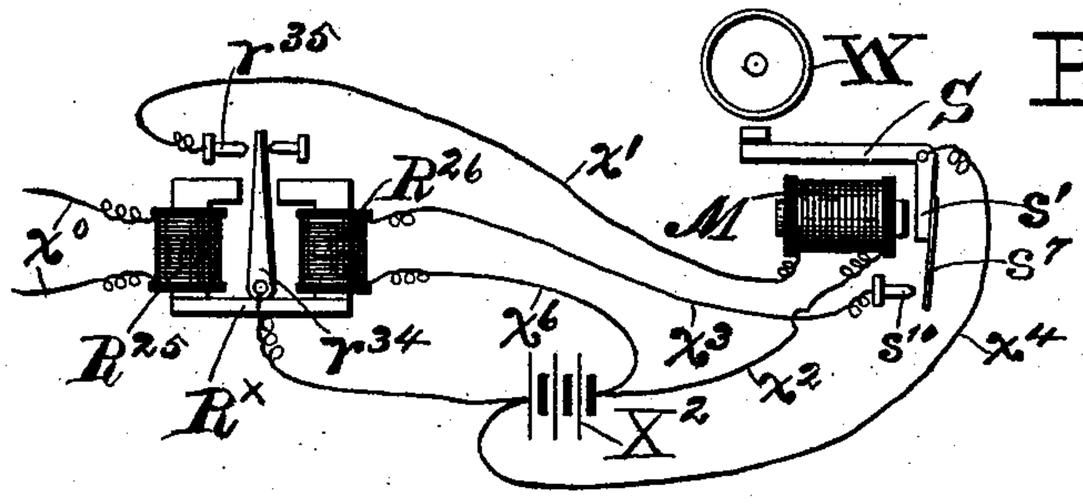
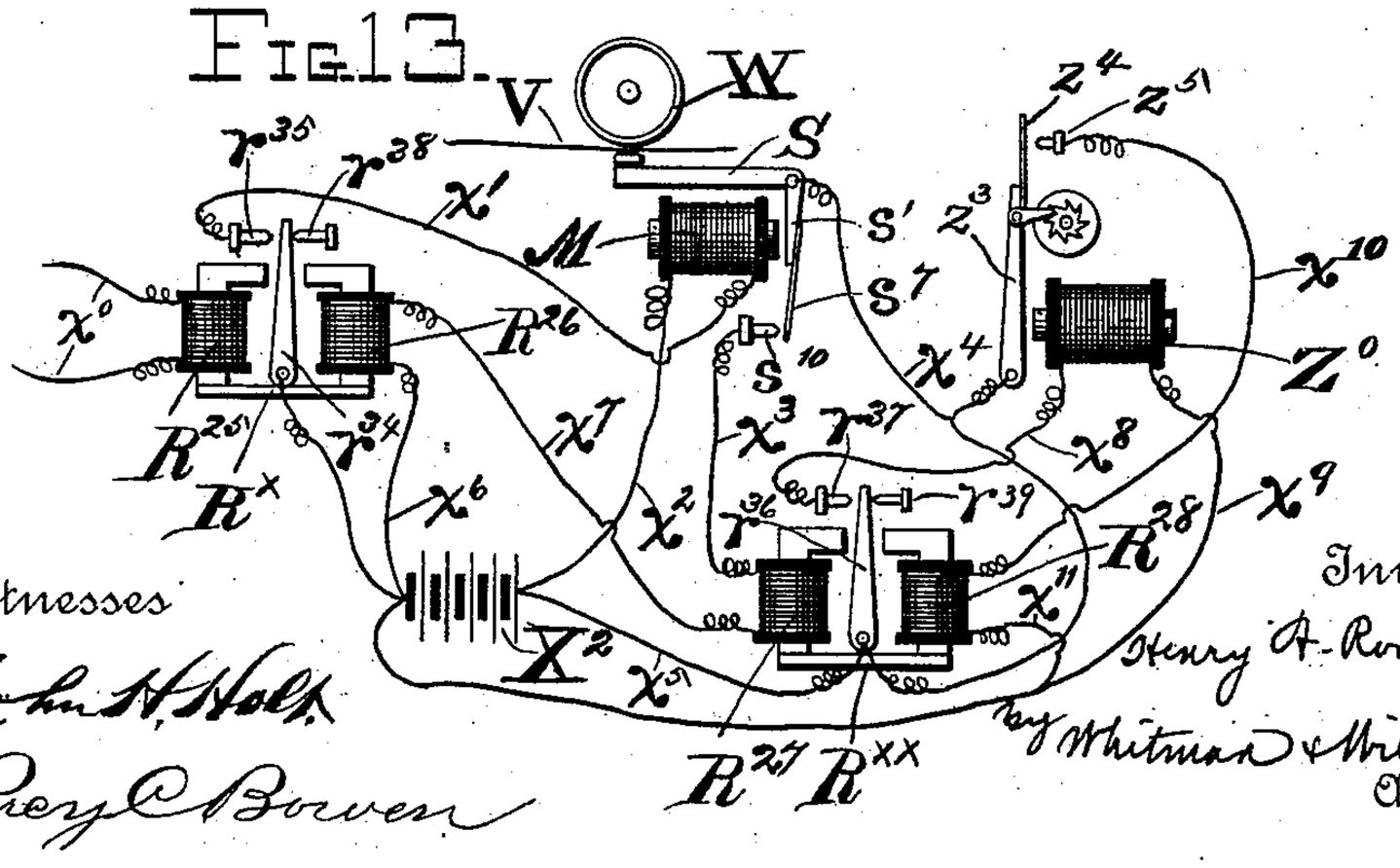


FIG. 13.



Witnesses
John A. Holt.
Percy C. Bowen

Inventor
Henry A. Rowland,
by Whitman & Millinson.
Attorneys.

No. 689,753. Patented Dec. 24, 1901.

H. A. ROWLAND.

MULTIPLEX PRINTING TELEGRAPH.

(Application filed July 26, 1897.)

(No Model.) 8 Sheets—Sheet 7.

FIG. 14

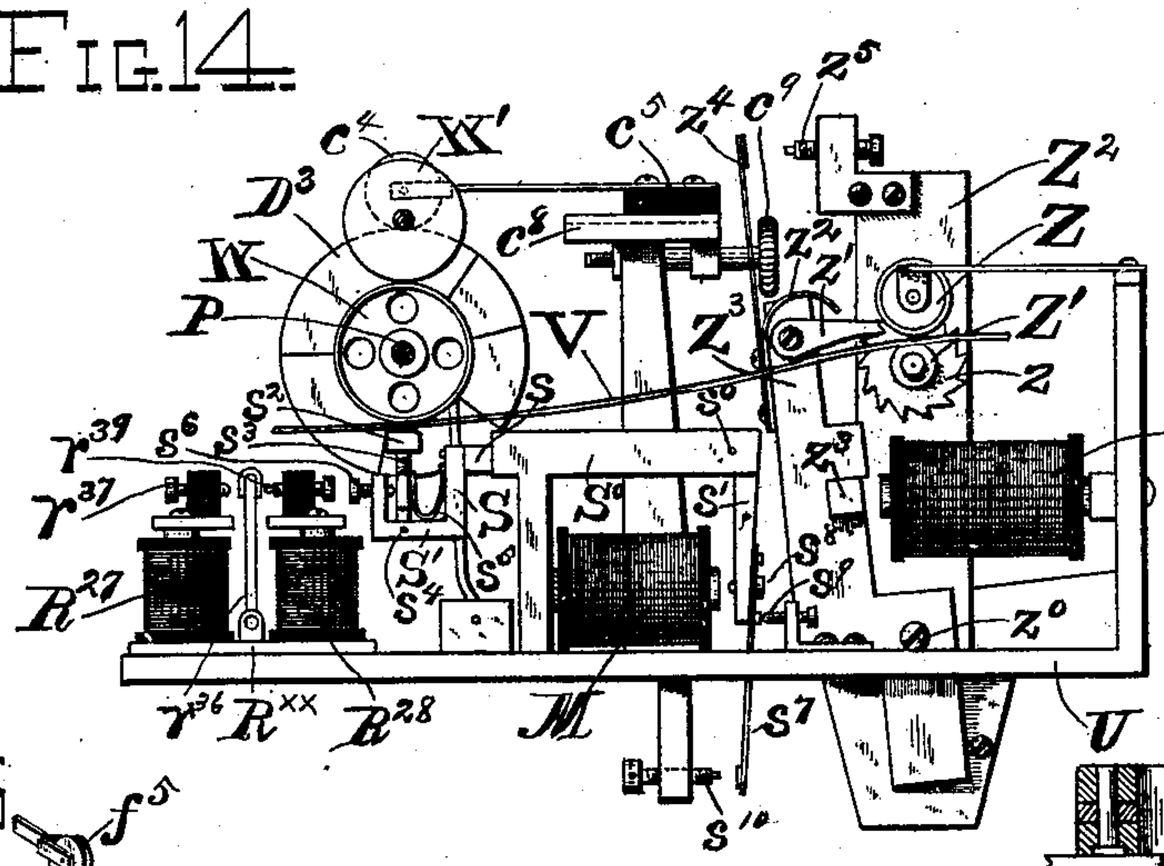


FIG. 21a

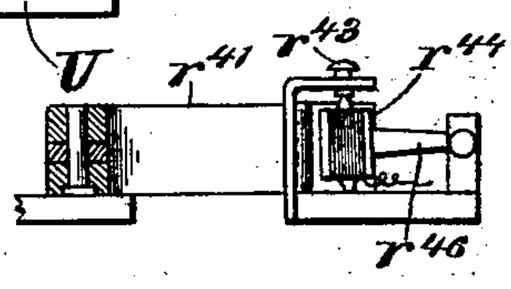


FIG. 15

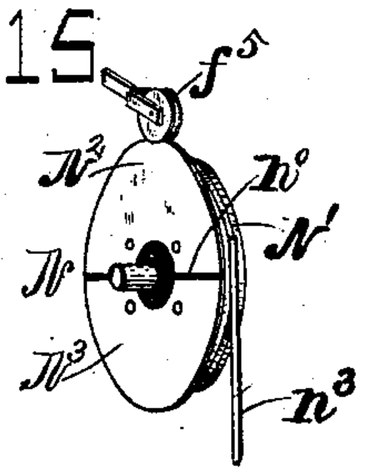


FIG. 16

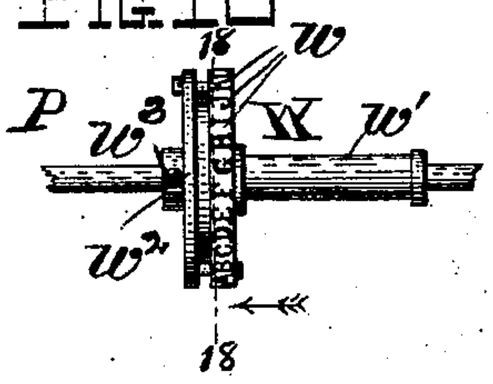


FIG. 17.

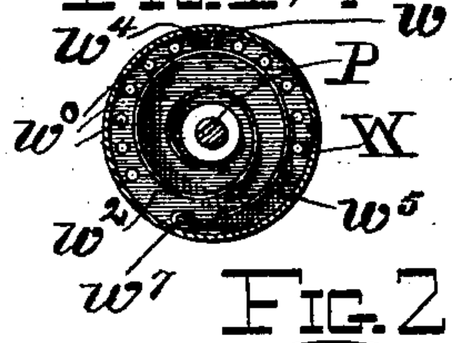


FIG. 18.

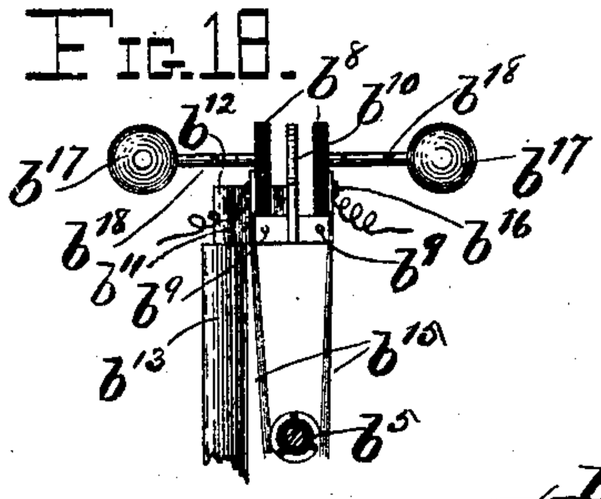


FIG. 21.

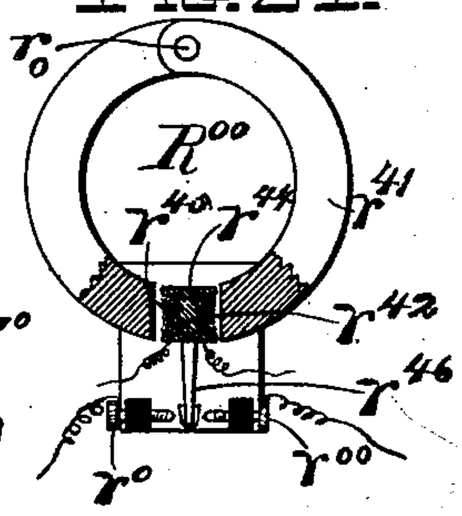


FIG. 20.

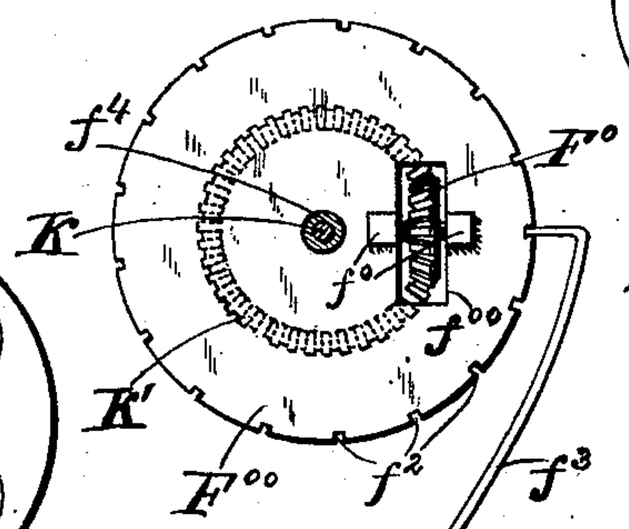
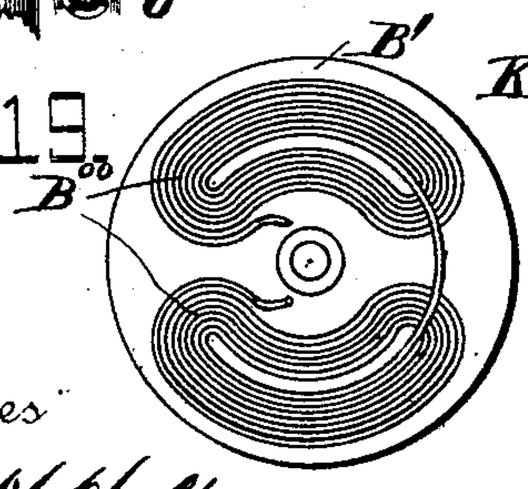


FIG. 19.



Witnesses
John A. Holl,
Percy C. Bowen

Inventor
Henry A. Rowland,
by Whitman & Wilkinson,
Attorneys

No. 689,753. Patented Dec. 24, 1901.

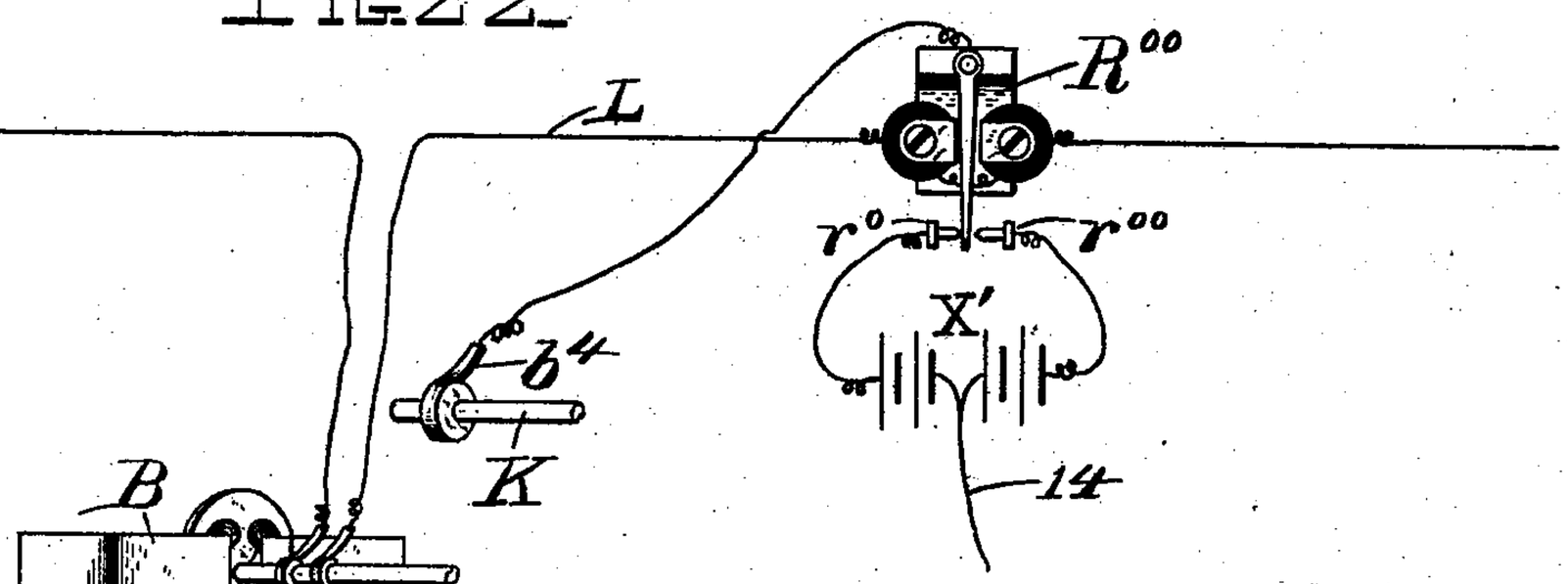
H. A. ROWLAND.

MULTIPLEX PRINTING TELEGRAPH.

(Application filed July 26, 1897.)

(No Model.) 8 Sheets—Sheet 8.

FIG. 22.



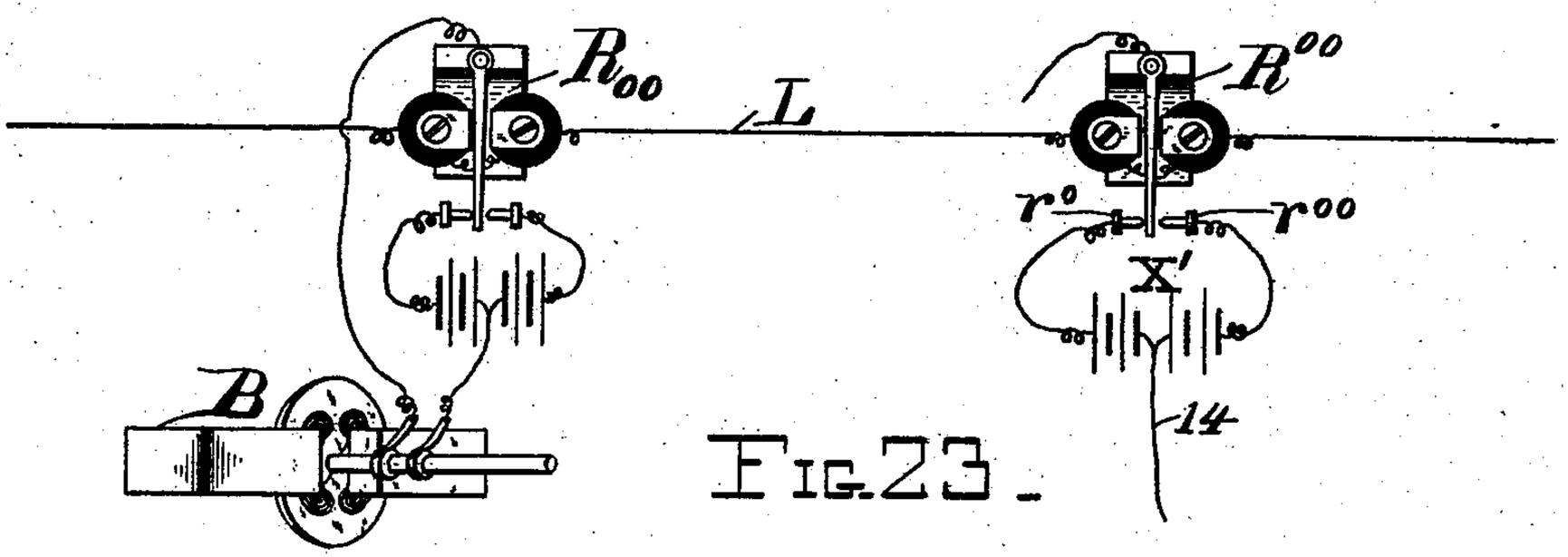


FIG. 23.

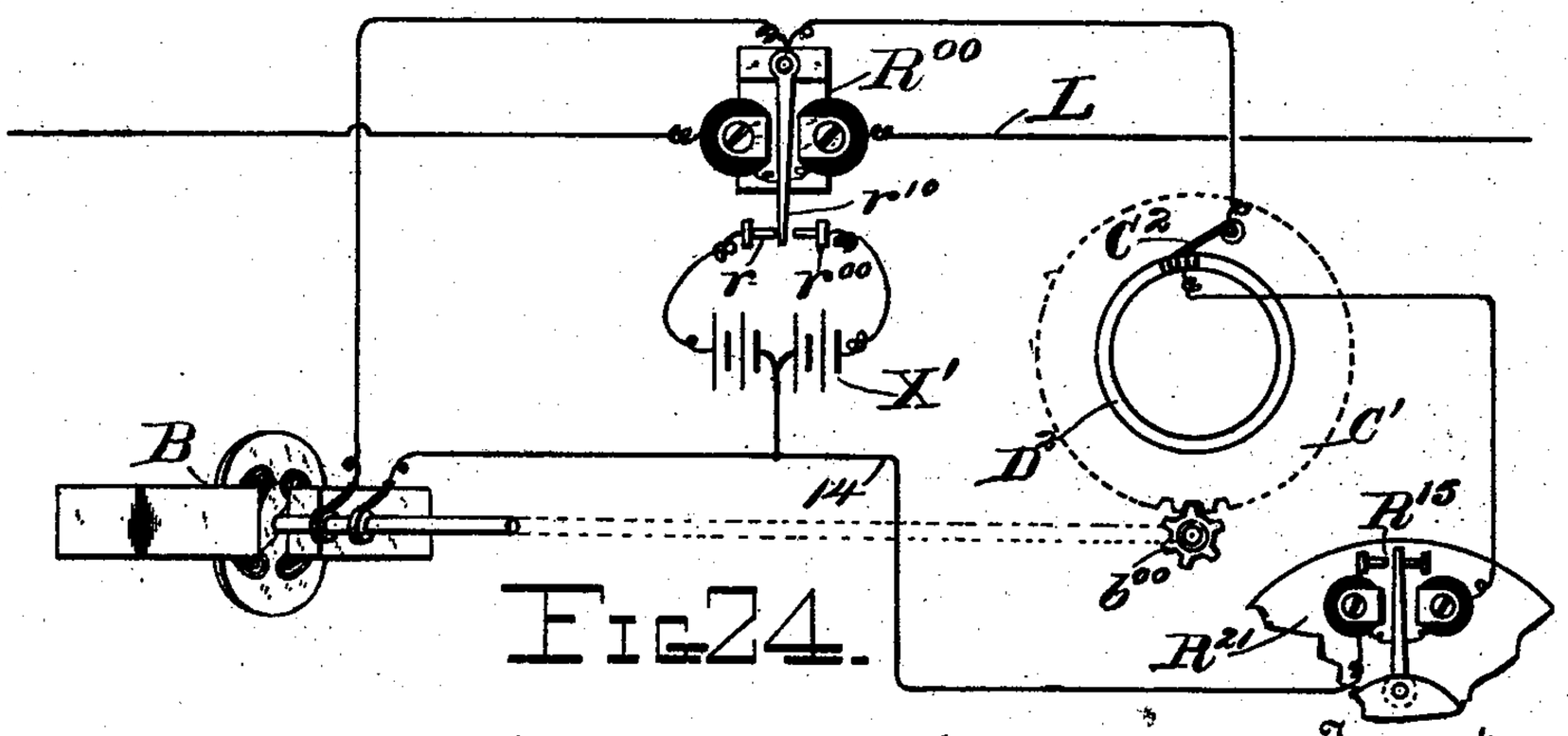


FIG. 24.

Witnesses
John J. V. Kalb
J. Stephen Kinsler.

Inventor
Henry A. Rowland,
by Wilkinson & Fisher,
Attorneys.

UNITED STATES PATENT OFFICE.

HENRY A. ROWLAND, OF BALTIMORE, MARYLAND, ASSIGNOR TO THE ROWLAND TELEGRAPHIC COMPANY, OF BALTIMORE, MARYLAND, A CORPORATION OF NEW JERSEY.

MULTIPLEX PRINTING-TELEGRAPH.

SPECIFICATION forming part of Letters Patent No. 689,753, dated December 24, 1901.

Application filed July 26, 1897. Serial No. 646,017. (No model.)

To all whom it may concern:

Be it known that I, HENRY A. ROWLAND, a citizen of the United States, residing at Baltimore, State of Maryland, have invented certain new and useful Improvements in Multiplex Printing-Telegraphs, (Case B;) and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same.

My invention relates to improvements in multiplex printing-telegraphs, and more especially to those of the synchronous type or those in which the local transmitting and receiving instruments are controlled by synchronously-operating mechanism.

This invention further consists in adapting a system of the above character to use with an alternating or other periodically-varying electric line-current and employing this current both for transmitting signals and producing synchronous motion. The advantages to be derived from such an adaptation of the alternating current are many. An alternating current may be sent over a line to a greater distance without any change of form of its waves or impulses than any other current. Hence it enables me to transmit messages to much greater distances without relaying or repeating them than has been hitherto practicable. Moreover, in such a case there would be practically no diminution of speed with increase of distance, and, furthermore, such a current is admirably adapted to my code of signals and method of synchronizing.

This invention, moreover, relates to a synchronous telegraph system in which synchronous motion is produced by and maintained between continuously moving or rotating parts as contradistinguished from the intermittent motion of the so-called "step-by-step" synchronous telegraphs. According to the present invention the inertia of the moving parts is utilized in steadying their motion and in maintaining synchronism, whereas in the case of the step-by-step devices the inertia is entirely gotten rid of, so that if for any reason the current which operates the step-by-step devices should be interrupted the motion of these devices will be arrested accordingly. For these reasons, as well as others, there is a fundamental difference between the two systems.

The present invention constitutes an improvement upon the system of telegraphy shown and described in Letters Patent of the United States No. 622,636, granted to me on April 4, 1899, and to this end comprises the novel features hereinafter described, and pointed out in the claims.

Referring to the accompanying drawings, Figure 1 is a diagram illustrating the principle of transmitting a message according to this invention. Fig. 2 represents a form of transmitter for modifying the line-current by impressing an extra current upon the modified line-current. Fig. 3 represents a tape transmitter embodied in the present invention and adapted to operate with this system. Fig. 4 represents a somewhat-different form of tape transmitter also embodied in the present invention and adapted to operate with this system. Fig. 5 is a diagram illustrating a principle of receiving messages according to this invention. Fig. 6 represents a form of line-relay and connections which may be substituted for the line-relay and connections shown in Fig. 5. Fig. 7 represents a sine or approximately sine curve of an alternating current. Fig. 8 is a diagram showing the electrical connections between the several parts of the circuit combining or combination device. Fig. 9 is a diagram further illustrating the combination device and its related parts. Fig. 10 is a plan view representing the working apparatus, including the printer, motor-dynamo, motor-regulating device, synchronizer, sending and receiving sunflower and trailer, device for setting the said sunflower, and the receiving line-relay. Fig. 11 shows a means for regulating the speed of one shaft or its driving-motor by means of a contact operated by a shaft having a steady motion. Fig. 12 is a diagram showing circuits. Fig. 13 is a diagram illustrating a further application of the principle shown in Fig. 12, showing the electrical connections between the several electromagnetic parts of the printer herein described. Fig. 14 represents in side eleva-

tion the printer and a part of the circuit-combining device. Fig. 15 is a detail perspective view of the motor-regulating contact-maker. Fig. 16 represents in side elevation a detail view of the type-wheel. Fig. 17 represents a section taken along the line 18 18 of Fig. 16 and looking in the direction of the arrow. Fig. 18 represents in side elevation a detail view of one of the brush-holders of the synchronizer or motor-dynamo. Fig. 19 represents in side elevation the armature of the synchronizer, showing the arrangement of the synchronizing-current coils. Fig. 20 represents a sectional view of the device for setting the sending and receiving brushes or trailers, taken along the line 21 21 of Fig. 10 and looking in the direction of the arrow. Fig. 21 represents a plan view, partly in section, of the line polarized receiving-relay. Fig. 21^a represents the line receiving-relay, partly in section and side elevation, showing the manner of pivoting the armature. Fig. 22 is a diagram showing the synchronizer connected directly in the main line. Fig. 23 is a diagram showing the synchronizer connected to an independent main-line relay, and Fig. 24 is a diagram showing the synchronizer and current-distributer connected to the receiving line-relay abreast or in multiple.

Similar letters and numerals refer to similar parts throughout the several views.

The transmitting apparatus.—Referring first to Fig. 1, which is a diagram illustrating the principle of sending a message according to the present invention, A represents an alternating-electric-current generator of any approved form delivering its current to a single main line L.

It will be assumed for the purpose of the following description that the current of the generator A is produced by an electromotive force of sine or approximately sine wave form, though it is not to be understood that this invention is limited to any special form of alternating or pulsating current—as, for example, such a current as that produced by the Wheatstone transmitter or, in fact, by a vibrating current-changer of any kind used for changing a direct into an alternating or pulsating current may be used. Moreover, the line-current in any case may be derived directly from the generator or from some secondary source, such as a transformer.

Referring again to Fig. 1, R^0 represents the transmitting line-relay or what will hereinafter be designated the "transmitter." This transmitter is preferably a neutral relay having the main-line circuit connected to its contact r^0 and tongue r'. D represents a transmitting current distributer or sunflower having its segment-circuits connected to the magnet-coil of the transmitter and supplied with current from a local source, such as the battery X. The principal transmitting-segments of this sunflower comprise three groups of nine segments in each group. In the diagram Fig. 1 only one of these groups is shown connected to the transmitter, as the multiplicity of connections would tend to confuse the drawings. I locate in each group of segment-circuits a suitable apparatus for making and breaking or otherwise altering them in the proper combinations to effect the transmission of the messages. This apparatus may be any suitable form of keyboard—such, for example, as shown in my Patent No. 622,636, above referred to, or improvements thereon—or it may be a perforated tape, or indeed any suitable means for altering the electric condition of the segment-circuits for the actuation of the transmitter. In the drawings I simply represent a series of contacts or keys 1′ to 9′.

C represents a trailer moving in synchronism with the generator A. This trailer may be driven in any suitable way and is herein shown as mounted upon a toothed disk C′, which meshes with a pinion b^{00}, carried by the shaft b^7 of a snychronizer B, which is driven in synchronism with the generator A, as hereinafter described. If, however, the generator and trailer C are at the same station, the trailer may be driven directly by the generator. The trailer is connected to the source of local current X through the disk C′, shaft K, and contact-brush b^4.

The contact breadth of each of the transmitting sunflower-segments is such that the time consumed by the trailer in passing over one segment is equal to the time consumed in a line-current impulse or semicycle in passing from one zero-point to the next—that is to say, for each segment that passes beneath the trailer C a corresponding semicycle of the line-current passes the contact of the transmitter R^0. Therefore for every group of nine segments that the trailer passes over there will at the same time be a group of nine semicycles of the line-current that will pass the transmitter-contact. Then by causing the transmitter to break the line through its contact for the length of time that a segment is in contact with the trailer one complete semicycle of the line-current may be cut out or suppressed for each break. This is accomplished by operating the contacts 1′ to 9′. If, for example, contacts 1′ and 3′ are closed, segments 1 and 3 will cause the transmitter to cut out the first and third semicycles of a corresponding group of line semicycles by energizing the transmitter for the length of time that the trailer is in contact with those segments. Likewise the operation of any of the other contacts will cause the transmitter to similarly modify the corresponding line impulses. This arrangement is therefore well adapted to my general method of transmission, which, as described in the Patent No. 622,636, above referred to, consists, briefly, in suppressing or otherwise modifying a preselected number of the semicycles or impulses of the line-current for each character or signal and transmitting these signals to a distant point, where they are recorded. The code

herein employed consists in suppressing two semicycles out of a group of nine for each signal, as it may readily be assumed that at the time that a group of nine segments of the sunflower are being swept over by the trailer a corresponding group of nine line semicycles are passing the transmitter-contact. I do not, however, confine myself to these exact numbers. In operating these transmitting-sunflowers it is quite important that they should be so adjusted that they will cause the transmitter to break the line-circuit at the non-sparking point or as near it as possible, which has been found to be at or near the point of zero-current. This is readily accomplished by adjusting the sunflower around its axis until no sparking is observed at the contacts of the transmitter when it breaks the line-circuit. When the proper adjustment is made, the trailer will begin to pass onto one of the sunflower-segments at the instant that a semicycle of the line-current begins to flow past the transmitter-contact. While it is important thus to begin to break the line-circuit at the point of zero-current or the non-sparking point, it is not, however, essential to establish the circuit again at the zero-point of the current with the receiving apparatus herein described, though this may be done, if desired. The reason for this is that with the principal form of receiving apparatus herein shown the semicycle next succeeding the suppressed one is not used as a modified semicycle in the combination of semicycles composing a signal. For example, suppose the first and third semicycles, Fig. 7, were suppressed and the line-circuit reëstablished at a point somewhere in the fourth semicycle. A polar line receiving-relay would not be affected by the incomplete fourth semicycle, for this semicycle is of the same sign (negative) as the last semicycle which had acted to throw the relay-tongue—that is, the second semicycle. This will be more apparent after the description of the receiving apparatus. Nor do I confine myself to the suppression of individual semicycles, for instead of causing the transmitter to suppress one semicycle at each time that it breaks the line-circuit it may be made to suppress two, three, or more semicycles, and, furthermore, while it will be assumed for the purpose of this description that the semicycles are modified by suppressing or cutting them out I have herein shown means for otherwise modifying the current. Thus by connecting the resistance r^3 to the contact and tongue of the transmitter the semicycles which would otherwise be cut out upon the breaking of the contact will be reduced in intensity and may be made to accomplish the same result as suppressing them entirely.

A third way of modifying the line-current is shown in Fig. 2, where means is employed for superimposing an extra current upon the suppressed impulse.

In Fig. 2, R^{00} represents the electromagnet of a relay, and r^5 its armature, having a contact-spring r^6 and contact-screws r^7 and r^8, the former being insulated from the armature and the latter held rigid. Normally the line-current would pass through contact r^7 into the spring r^6 and conductor r^9; but if the magnet R^{00} attracts the armature r^5, which is pivoted at r^{10}, the end of the spring r^6 will be thrust against the contact r^8, which will break the connection at r^7 and introduce the current from the battery X, which battery may obviously be replaced by any other desired source of current. This arrangement may be substituted for the transmitter of Fig. 1.

Referring again to Fig. 1, it will be seen that the operator using the contacts 1′ to 9′ will have the exclusive use of the line-transmitter, and hence the main line, just as long as the sunflower-segments to which his contacts are connected are being swept over by the trailer, and likewise with the operators using the other groups of segments, so that the operators in no way interfere with each other, though all are sending messages at the same time. The sunflower may thus be divided into any number of groups of segments, depending upon the number of separate persons using the line. One of the segments of the transmitting-sunflower not included in the three groups is permanently connected, as by wire 10′, to the transmitter, so that each time the trailer C comes in contact with the segment so connected the transmitter will modify a line-current impulse. The object of this is to effect the proper setting of the receiving-sunflower, as hereinafter fully described.

The synchronizer B is substantially the same in principle as the "synchronous device" described and claimed in my aforesaid patent, being regulated directly by the line-current passing through certain of its coils, as shown in Fig. 1, or indirectly by the said current, as hereinafter shown and described, and in either case driven by an independent source of power. The line L represents the metallic leg of the circuit connecting the station Fig. 1 with the receiving-station, Fig. 5.

In Fig. 3 is shown an arrangement of the transmitting apparatus in which the messages are sent by means of a perforated tape. In this case G represents the transmitting-tape, provided with a series of perforations g', representing the message to be transmitted. The tape is driven at a uniform speed over a metal contact-roller H by means of the synchronizer or by any other suitable means in synchronism with the alternator. This may be done in one way by causing the teeth of a small wheel c^0 to engage a row of perforations g of the tape and driving this wheel through the gear c^0 and pinion b^{00} of the synchronizer. The local-battery circuit 12 is connected at one side to a brush or stylus h, which rests upon the surface of the tape G above the cylinder H and in the path of the perforations g'. The other side of the local circuit is electrically connected to the cylinder H by

means of the brush h^0. Thus it will be seen that the transmitter R^0 will be energized at each time that a perforation g' passes beneath the brush h and will cause the transmitter to modify an amount of line-current depending upon the length of the perforation. By making the perforations each equal to the length of a semicycle as each perforation passes the brush h the transmitter will suppress a semicycle. Then by arranging these perforations according to a code—such, for example, as that herein described—such a form of transmitter becomes readily adapted to my system of receiving.

In punching the tape G for multiplex transmission the perforations representing several messages would naturally alternate, just as in the case of the sunflower, where the signal of the first operation is transmitted by connecting in the local circuit a certain combination of segments of the first group, the signals of the second operation by connecting in the local circuit a certain combination of segments of the second group, and so on.

In Fig. 4 is shown a form of transmitting apparatus in which the line-transmitter and sunflower are used, but in which the sunflower-segment circuits are made and broken by means of a transmitting-tape somewhat different from that shown in Fig. 3. In this case G′ represents such a tape passing over a metal contact-roller H′ and driven by a wheel or disk c^{00}, mounted upon the shaft K and having a lug upon it which engages the teeth of the wheel c^{000} once in each revolution of the sunflower-trailer. The teeth of the wheel c^{000} engage the perforations g^3 of the tape, and thus impart motion thereto. The synchronizer B drives the trailer C by means of the gear C′, mounted upon the shaft K. Upon the tape G′, above the contact-piece H′, rest a series of brushes h' to h^8, and each of these brushes is connected to a segment of the sunflower of the group of segments to be operated by this particular tape. The electric circuit passes through the coil of the transmitter R^0 to the sunflower and contact-brushes h' to h^8 through the brushes b^4 and h^0. By completing the local circuit through combinations of the brushes h' to h^8 the same effect is produced upon the transmitter R^0 as by operating the contacts of Fig. 1. This is accomplished in the present case as follows: The tape G′ is perforated at intervals upon transverse lines, as $o\ o$, $o'\ o'$, and $o^2\ o^2$, and these perforations are arranged upon each line in such a position that two brushes h' to h^8 will complete the local circuit through the perforations for each combination of perforations coming beneath the brushes, a different combination of said perforations being brought beneath the brushes for each revolution of the trailer by the forward movement of the tape. Thus two perforations upon the line $o\ o$ will complete the circuit through the brushes of the group h' to h^8 and cause the transmitter to suppress corresponding impulses of the line-current. A differently-disposed pair of perforations upon the line $o'\ o'$ will cause the transmitter to suppress another pair of the line impulses, and so on. The perforations in each transverse line may thus be made to represent a character, and obviously the arrangement is not confined to two perforations in each line. If a polarized receiving-relay is used in connection with this form of transmitter, the number of brushes or segment-circuits would be increased to nine, as in the case of the apparatus shown in Fig. 1. The reason for this will hereinafter more fully appear. Furthermore, in multiplex transmission, or, in other words, if the receiving-sunflower operating in conjunction with the apparatus shown in Fig. 4 is divided into groups of segments—three, for example—such as shown in Fig. 5, and it is desired to receive messages on each group, obviously the trailer of the transmitting device, Fig. 4, would be driven three times as fast as the receiving-trailer, since the transmitting apparatus sends only one signal or combination of signals for one character upon each revolution, whereas the receiving apparatus can receive three upon each revolution of its trailer.

The receiving apparatus.—Passing next to the receiving apparatus, reference will be had particularly to Fig. 5, where R^{00} represents the receiving line-relay. This is a polar relay having its coils traversed by the main-line current and having one contact r connected to the outer plus pole of a split battery X′ and its other contact r^{00} connected to the outer negative pole of the same battery.

The receiving apparatus other than the line-relay is worked on a local relayed circuit, so that the said main line will not be affected by any accident that might occur to the local apparatus. This relayed circuit includes a conductor connected to the line-relay tongue, a synchronizer B, a trailer C^2, and its sunflower D^2, the various segment-circuits of the said sunflower, polar selecting-relays R^{11} to R^{19}, located in said segment-circuits, and a common wire 14, which connects the said relay-circuits with the battery. The trailer C^2 is mounted on the disk or gear wheel C′ and is driven in synchronism with the transmitting-trailer by the synchronizer B, as shown and as described relative to the transmitting-trailer. The sunflower D^2 is composed of groups of segments corresponding to those of the transmitting-sunflower, except that the segments of the latter are broader than those of the former. Also the insulation between the segments of the receiving-sunflower is made broader than that between those of the transmitting-sunflower. In each of the local receiving-sunflower segment-circuits is a polar selecting-relay forming the group R^{11} to R^{19}—that is, the coils of these relays are traversed by the segment-circuits. It will thus be seen that when the line-current is flowing interruptedly the line-relay tongue r^{10} will be kept in a state of vibration between its

contacts. Then as the receiving-trailer passes from one segment to the next in unison with said current and with the transmitting-trailer the adjacent selecting-relays will receive local current impulses from the battery X′ of opposite polarity—that is to say, the relays indicated by the reference-letters with even-numbered exponents—such as R^{12}, R^{14}, R^{16}, and R^{18}—will normally receive, for example, plus impulses, while the relays R^{11}, R^{13}, R^{15}, R^{17}, and R^{19} will normally receive negative impulses. These relays are so wound, however, that the impulses distributed in this manner send their tongues against their back-stops. These are the conditions that exist when no signal is being received.

For each signal that is received the selecting-relays corresponding to the signals will receive impulses of opposite polarity to the normal impulse and will send their tongues against their forward contacts, the object of which is to complete certain printer-circuits hereinafter described. This is accomplished in the following way: It will be assumed that the signal was sent from the transmitter by operating contacts 1′ and 3′—that is, the first and third semicycles of a group corresponding to the nine segments of the sunflowers supposed to be in use. At the time that the first semicycle is suppressed the receiving-trailer C^2 will be in contact with the segment connected to wire l^2, and in this case a negative impulse would normally be transmitted down the wire l^2 to the relay R^{11}; but as a semicycle of the line-current has been suppressed the tongue of the line-relay R^{00} will not make contact with that pole of the battery which sends a negative impulse to the relay R^{11}, but will remain against the contact r^{00}, where the preceding semicycle had attracted it. The obvious effect of this will be to cause a positive impulse to traverse the relay R^{11}, and being an impulse opposite to the normal one will send the tongue of that relay against its forward contact. Likewise the suppression of the third semicycle, as above assumed, will cause the relay R^{13} to send its tongue against its forward contact. When the receiving-trailer again comes around to the sunflower-segments connected to the relays R^{11} and R^{13}, impulses will be sent through them from the battery X′ in the normal direction, which will cause their tongues to return to the back-stops, thereby avoiding the use of any extra circuits or apparatus for accomplishing this result. Operating as above described two different selecting-relays act to close their forward contacts, and thereby partly close two printer-circuits for each signal received. A group of selecting-relays similar to the group R^{11} to R^{19} would be connected to each group of the receiving-sunflower segments, and as these groups of segments of the transmitting and receiving sunflowers correspond and the trailers move in synchronism messages sent upon group No. 1 of the transmitter-segments will be received upon group No. 1 of the receiving-sunflower segments only, and so with the second and third groups. Therefore there will be no interference on the line, though several of the operators are sending and receiving messages at the same time.

Before passing to the description of the operation of printing the messages reference will be had to the means for indicating the proper adjustment of the sunflowers and also to the way in which the synchronizer is operated which regulates the speed of the trailers.

Adjusting the sunflowers and trailers.—The object of this arrangement is to indicate when the receiving trailer or sunflower is so adjusted with relation to the trailer and sunflower at the station from which the signals are sent that the trailers will rest simultaneously upon corresponding segments. This is accomplished in the following way: At the sending end (see Fig. 1) I permanently connect one or more of the odd segments of the sunflower to the transmitter-coil circuit, as by wire 10′, so that once in each revolution of the trailer C one or more of the line impulses will be modified, whether the keyboard or other local transmitting apparatus is operated or not. At the receiving-station one or more odd segments of the sunflower corresponding to those at the transmitting-station are connected, as by wire 15, to the coils of a relay R^{000} or other magnetic signaling device, which is again connected to the common battery-wire 14. If the receiving-sunflower is properly set so that its trailer arrives upon a predetermined segment at the same time that the transmitting-trailer arrives upon a corresponding segment, then at each time that the transmitter modifies a line impulse corresponding to these predetermined segments of the transmitting-sunflower the relay R^{000} will receive a local current impulse of a given polarity, and if this continues its tongue will remain continually against one of its contacts; but now if this adjustment of the sunflowers is altered the relay R^{000} will not receive an impulse of the same sign upon every revolution of the trailer. Hence its tongue will be sent over against its other contact. This action of the relay may be made to indicate the proper adjustment of the sunflower in a number of ways—as, for example, by audible signals produced by the relay in acting, as described. The same result may be effected by adjusting the trailers instead of the sunflowers, and I have provided means, hereinafter shown, for accomplishing this.

The synchronizer-circuit.—From Fig. 5 it will be seen that the synchronizer operates upon a local relayed circuit and is shown in that figure as connected in series with the receiving-sunflower. It is, however, not best to connect the synchronizer and sunflower in series, but in multiple, as shown in Fig. 24. This, though, is an obvious alternative. Moreover, the synchronizer may be governed by the line-current direct, while the receiv-

ing-sunflower and other receiving apparatus is operated upon a relayed circuit. The connections for such an arrangement are shown in Fig. 22. Also the local synchronizing-current may be relayed from the main-line current by a separate relay R_{00}, located in the main-line circuit and making the local synchronizing-current independent of the local signaling-current, as shown in Fig. 23. If in this case the line impulses should be modified by simply reducing them in intensity, this second line-relay R_{00} may be more sensitive than the line signaling-relay R^{00}, so that it will respond to every impulse and work constantly, thereby producing a better synchronizing-current than relay R^{00}.

Neutral line receiving-relay and circuits.—With slight changes in the receiving apparatus the neutral line receiving-relay R and its connections, as shown in Fig. 6, may be substituted for the polar relay R^{00} of Fig. 5. In this case the armature of the relay R, vibrated by the line-current, is sent against the contact *r* for each unmodified impulse of the line-current and will normally—that is, as long as no signal is received—transmit through the conducting-segments of the sunflower device positive currents only. I assume in the description that these currents are positive, though they may be either positive or negative. The tongue of the relay R is caused to strike the contact *r* under the influence of a plus line impulse at each time that a conducting sunflower-segment comes beneath the brush and will strike the same contact—that is, contact *r*—under the influence of negative line-waves at such times as the insulation between the sunflower-segments comes beneath the brush or trailer, thus normally transmitting to each receiving-relay a positive current. The local selecting-relays are therefore in this case so wound that plus currents cause them to open their local circuits, while negative currents cause them to close them. Now if an impulse of the line-current arriving at the relay R is modified, as herein described, the effect will be to cause its armature to remain against the contact r^{00} for the length of time that the modified current is passing the relay-coils, and while thus against the contact r^{00} a negative current will be sent through one of the local receiving-relays, the effect of which will be to cause the particular local relay which receives the current to close its local circuit. The tongues of the local receiving-relays are brought back in a reverse direction when the line-relay tongue turns to the contact *r*. In the event that the relay R is employed one of the relays of the group R^{11} to R^{19} may be dispensed with, using eight instead of nine selecting-relays. The reason for this is the relay R being a neutral relay its tongue will be drawn back by the spring r^2 and will act for each line impulse and therefore operate each selecting-relay successively; but where the line-relay is a polarized relay only alternate selecting-relays with respect to the order in which they receive their current can be operated together, as the tongue of the polarized line-relay will remain against the contact to which it is attracted until an impulse of opposite polarity to that which last actuated it arrives. Hence the use of a greater number of selecting-relays when the line receiving-relay is polarized.

The selecting-relays and system of combination.—The function of these selecting-relays is to close or partly close (in the case of the apparatus herein described) nine local branch printer-circuits in combinations corresponding to the combinations of line impulses suppressed or otherwise modified—that is to say, for each combination of modified line impulses representing a character a corresponding combination of selecting-relays will be acted upon and close their contacts through two local printer-circuits, and thereby cause the printer to print the corresponding character. The contacts thus closed by the selecting-relays, though, only partly close the local circuits to the printer. The completion of these circuits in combinations to form a part of the main printer-circuit is effected by means of a novel form of circuit combining and distributing device based upon the following system of combinations, which is but a special case out of many which may be devised from my general system of combining circuits.

In explaining the present system of combinations it will be assumed that we have nine circuits, represented by *a b c d e f g h i*, respectively, being the nine circuits to be closed in combinations through the selecting-relay contacts. In this series circuit *a* may be combined with *b c d e f g h i*, *b* with *c d e f g h i*, *c* with *d e f g h i*, *d* with *e f g h i*, *e* with *f g h i*, *f* with *g h i*, *g* with *h i*, and *h* with *i*, thus obtaining thirty-six separate combinations. Then by not counting contiguous combinations—that is, such combinations as *ab bc cd de ef fg gh hi*—there will be left from nine circuits twenty-eight combinations, as follows: (*a*) *c d e f g h i*, (*b*) *d e f g h i*, (*c*) *e f g h i*, (*d*) *f g h i*, (*e*) *g h i*, (*f*) *h i*, and (*g*) *i*. Contiguous combinations are not counted, for the reason that contiguous selecting-relays do not act in combinations, as hereinbefore explained. Thus it will be seen that these combinations may be arranged in seven groups. In the first *a* combines with seven others, in the second *b* combines with six others, and so on through the series. The practical application of this grouping will be readily seen in the following description of the circuit-combining device. This device will first be described with reference to Fig. 8, where D^4 represents a ring made up of twenty-eight insulated metallic segments $c^\times d^\times e^\times f^\times g^\times h^\times i^\times$, $d^\times e^\times f^\times g^\times h^\times i^\times$, &c., with all of the segments represented by like letters electrically connected together and each of these groups connected to the wires $c'^\times$ to $i'^\times$. D^5 represents a ring made up of seven insulated segments

$a^{2\times}$ $b^{2\times}$ $c^{2\times}$ $d^{2\times}$ $e^{2\times}$ $f^{2\times}$ $g^{2\times}$, the breadth or contact-surface of the segment $a^{2\times}$ corresponding to that of seven of the segments of the ring D^4, the breadth of the segment $b^{2\times}$ corresponding to that of six of the segments of the ring D^4, and so on to the segment $g^{2\times}$, which corresponds in size to any of those of the ring D^4. The wires $c'^{\times}$ $d'^{\times}$ $e'^{\times}$ $f'^{\times}$ $g'^{\times}$ are connected to the segments of the ring D^5, and all of the wires $a'^{\times}$ to $i'^{\times}$ are connected, respectively, to the contact-disks d^2 to d^{10}, and these contact-disks are electrically connected to the forward contacts $a^{3\times}$ to $i^{3\times}$ of the selecting-relays.

C^4 and C^5 represent brushes resting upon the rings D^4 and D^5 and occupying corresponding angular positions relative to their respective rings. These brushes are connected in circuit with a local battery or other source of local current X^2 and with a magnet $R^{\times}$, which actuates the printer.

The rings D^4 and D^5 are preferably mounted upon the same shaft and are driven at a constant speed in synchronism with the alternator and sunflower devices by the driving mechanism hereinafter described. Obviously the same result may be accomplished if the brushes C^4 and C^5 are made to rotate and the rings D^4 and D^5 are held stationary, the object being simply to produce relative motion between the brushes and rings.

The operation of the combination device.—The operation of this circuit-combining device is as follows: Assuming that a signal has been sent and that the relays R^{11} and R^{13} are the ones which are affected by the signal, as described in reference to Fig. 5, these relays will close the contacts $a^{3\times}$ and $c^{3\times}$. Tracing the circuit from the battery X^2 at the instant that the brushes C^4 and C^5 occupy the positions relative to the segments under them such as shown in the drawings, it will be seen that this circuit is complete, passing through magnet $R^{\times}$, brush C^5, segment $a^{2\times}$, disk d^2, contact $a^{3\times}$, then through contact $c^{3\times}$ into disk d^4, and back to battery through line $c'^{\times}$, segment $c^{\times}$, and brush C^4. This will cause the printer actuated by the relay $R^{\times}$ to print the character representing the signal received; but if any of the contacts at $a^{3\times}$ $b^{3\times}$ to $i^{3\times}$ are closed singly the relay $R^{\times}$ will not be affected, for the circuit through it will not be completed. Upon the reception of another signal we will suppose the relays R^{12} to R^{14} to close the contacts $b^{3\times}$ and $d^{3\times}$. A current will then flow through the coils of the magnet $R^{\times}$, as will be obvious, when the segments in the rings D^4 and D^5, which correspond to the closed circuits $b^{3\times}$ $d^{3\times}$, come in contact with the brushes C^4 and C^5, and in like manner two other circuits of the group $a^{3\times}$ to $i^{3\times}$ may be closed for another signal. With the nine circuits thus combined the printer may be made to print all of the letters of the English alphabet and such other symbols as may be selected.

Printing a character.—The principal steps in the operation of printing a character may be better described in connection with Fig. 9, where the printer type-wheel W is shown mounted on a shaft P, with the circuit-combining device, and where S represents the printer hammer or platen actuated by a magnet M which is magnetized by a local circuit controlled by the relay $R^{\times}$. The type-wheel is so set that any character upon its periphery corresponds to a prearranged combination of the segments of the rings D^4 and D^5, so that the instant the selecting-relays close the circuits through the combination of segments representing the signal received the character to be printed for that combination will be in front of the printer hammer or platen. It will, however, be seen that the magnet which actuates this platen is not excited directly from the relay-circuit, but by a separate circuit controlled by a relay $R^{\times}$. The detail operation of the printer will be described later, when the object of employing the relay $R^{\times}$ will be fully stated.

Having thus described the general principle of my invention, some of the apparatus by which the system is put into operation will next be described.

Reference will be had first to Fig. 10, which is a plan view showing the synchronizer, auxiliary motor, means for regulating the speed of the motor, the printer, "combination device," transmitting and receiving sunflower devices and device for setting them, and the line-relay, all mounted on one base, which may be extended to accommodate more printers, when necessary.

The synchronizer.—This device comprises, among other parts, a disk armature B', mounted to rotate between the poles of two permanent magnets B^2. The armature B' consists of a non-magnetic disk b^0, preferably metallic, carrying upon one of its faces three or more coils B^0, adapted to carry a continuous current and connected with the commutator b^5. Upon the other face of the disk b^0 (see Fig. 19) are mounted two coils B^{00} for the synchronizing-current and are connected to the collector-rings b^6. Obviously these two coils may be replaced by four, six, or a greater number of coils, if desired. The armature-disk, collector-rings, and commutator are all mounted on the shaft b^7, which is journaled in the frame B^3.

B^4 B^4 represent the brush-holders, which are most clearly shown in the detail view, Fig. 18. They consist of two plates of insulating material b^8, pivotally mounted, as at b^9, on each side of a central plate b^{10}, which is bent, as at b^{11}, and there secured to a rod b^{12}, which rod is adapted to be held in a central opening in the upright b^{13} and secured by the set-screw b^{14}. The brushes b^{15} are secured to each of the plates b^8, where they may be connected to the terminal wires, as at b^{16}. The pressure of the brushes against the commutator or collector-rings is secured by means of the weights b^{17}, connected by the arms b^{18}

to the upper portion of the plates b^8. The coils carrying the continuous current, revolving between the magnet-poles and supplied with the proper commutator b^5, constitutes a continuous or direct current motor from which the necessary power to drive the synchronizing-coils B^{00} is derived. I do not, however, wish to limit the driving power to a direct-current electric motor, as this power may be a small water-motor, clockwork, a falling weight, or, in fact, any suitable source of power may be employed. The armature of the synchronizer—that is, the synchronizing-coils—will not do work or absorb work as long as the motor keeps them in step with the current; but when the motor tends to get out of step the said synchronizer-coils or the current in them will do or absorb work, as the case may be, and thus keep the motor in step or in synchronism.

On one end of the armature-shaft b^7 of the synchronizer is mounted a pinion b^{00}, which meshes with a large gear C', mounted fast on a shaft F, which latter is journaled in the bearings f. This shaft F only extends from the gear C' to the point f', is made hollow, and receives the shaft K, which revolves loosely within it. Motion is transmitted from the shaft F to the shaft K by means of the beveled gears F', F^0, and K'. The gear F', being mounted on the shaft F, meshes with the intermediate gear F^0, and that in turn meshes with the gear K', mounted fast on the shaft K. The gear F^0 is mounted in the lugs or bearings f^0, which are mounted on a disk F^{00} on each side of a slot f^{00}, through which the gear F^0 passes. (Shown most clearly in the detail view, Fig. 20.) This disk F^{00} is provided with a plurality of notches or slots f^2 around its periphery, which are adapted to engage a spring set-piece f^3, by means of which the disk may be set in any desired position around the shaft K, the disk F^{00} being mounted on the loose collar f^4. The object of this method of gearing will be presently described.

Other details of the working apparatus.—The transmitting and receiving sunflower trailers consist of the metal strips k and k', respectively, carrying at their free ends the metal rollers k^2 and k^3. These strips are mounted upon a right-angled extension K^0 of an arm K^2 and insulated therefrom, as at k^0, and the arm K^2 is adjustably mounted on the shaft K. The rollers k^2 and k^3 rest, respectively, upon the sunflowers D and D^2, which latter are mounted fast upon a hollow shaft D^{00}, which receives the end of the shaft K. The shaft D^{00} is secured at its other end in the upright u.

The sunflowers D and D^2 may be adjusted around the shaft K as an axis by means of the toothed disk $d^\times$, and when so adjusted may be held in the desired position by the set-piece $d^{\times\times}$. J represents a cable made up of the wires which connect the sunflower-segments, and b^0 represents the terminal connections from which the current passes into the strips k k' through the rings O' O'.

The angular position of the trailers may be adjusted or varied without in any way affecting the rotation of the shaft F. This is done by means of the arrangement of the gears K', F^0, and F', and the operation is as follows: The set-spring f^3 is withdrawn from engagement with the teeth of the disk F^{00}, which disk is then advanced or turned back, as the case may require, carrying with it the gears F^0 and K', until the rollers k^2 and k^3 rest upon the proper segments. This done, the set-spring f^3 may be allowed to again engage the disk F^{00}, which will retain the said disk in position. The slots f^2 around the periphery of the disk F^{00} are equidistant and correspond to every alternate segment of one of the sunflowers—that is, there are half as many slots as segments in one of the sunflowers.

The receiving line-relay.—In Figs. 10 and 21 is shown a special form of line receiving-relay, having a circular permanent magnet r^{41}, between the poles of which is mounted an oscillating armature r^{42}, being pivoted, as at r^{43}, and consisting of core r^{44}, (see Fig. 21,) of such form as to be in unstable equilibrium when in the center of its motion—that is to say, the armature is so mounted that the pivoted points of its supporting pins or lugs will be out of vertical alinement with each other. (See Fig. 21^a.) The armature proper consists of an I-shaped piece of iron r^{44}, upon which is wound a coil of wire r^{45}, and has a tongue r^{46}, which is adapted to vibrate between the contact-screws r^0 and r^{00}. The proximity of the magnet-poles to the armature may be varied at will, as the magnet may be made in two parts pivotally connected, as at r^0.

The printer-driving motor and speed-regulating device.—E represents the direct-current motor for driving the printers and combination devices. This motor is provided with field-magnets E', and a disk armature E^2, similar to the armature B' of the synchronizer, except that it is provided with the direct-current coils e' only. The motor E is provided with the commutator e^2 and brush-holder B^4, similar to those of the synchronizer. The shaft e^3 carries a pinion e^0, which gears with the toothed disk C^0, mounted on the shaft P.

For the purpose of governing the speed of the motor E the shaft P carries at one end a disk N, and near this a second disk N', insulated from the first disk, as at n, and secured on the shaft P by the collar n' and set-screws n^2. The disk N is divided, as shown most clearly in the detail view Fig. 15, into two or more parts N^2 and N^3, and each half of the disk is insulated from the other, as at n^0. The part N^2 is electrically connected to the disk N', hereinafter more fully described. The contact-roller f^5, carried by the strip F^2, which is mounted on the arm F^3 and rotated by the

shaft K, makes contact with the half of the disk N^2 or N^3 or rests upon the insulation dividing them, according as the speed between the said roller and disk N varies, as will be explained more fully in connection with a subsequent figure. The current is conveyed to or from the disk N' through the brush n^3. In order to fully describe the operation of this governing apparatus, reference will be had to Fig. 11, which shows the arrangement of the motor-circuits in addition to the other governing apparatus. It being assumed that the motor E gets its power from the battery X, which obviously may be any other suitable source, and that the arm F^3 rotates in the direction of the arrow and that the disk N, driven by the motor E, rotates in the same direction, the operation is as follows: The resistances of the rheostats r^{30} and r^{31} are so adjusted that when the course of the current is from the battery X^2 through resistance r^{30}, motor-resistance r^{31}, and back to battery X^2 again the motor E will be driven at about the same speed as the synchronizer B; but when the circuit is completed through the contact-maker f^5 and disk N^2 the current will be short-circuited around the resistance r^{31} and will cause the motor to accelerate its speed. Therefore it will be seen that if the disk N and arm F^3 are rotating in the same direction and at the same speed the contact-maker f^5 will rest either on the insulation between the segments N^2 and N^3 or on the segment N^3; but as soon as the disk N commences to lag in its speed the contact-maker f^5 will run over onto the segment N^2 and by this will complete the short circuit around the resistance r^{31}, and thereby cause the motor to increase its speed, which it will continue to do until the disk catches up and the contact-maker is again brought back to the insulation n^0, which breaks the short circuit around the resistance. The shafts F and P will thus be caused to maintain the same speed.

The combination device.—The theory and operation of this combination device having been described and illustrated with reference to Figs. 8 and 9, a practical working form of the same is shown in Figs. 10 and 14, where the segmental rings D^4 and D^5 are shown mounted upon an insulating-collar D^{000}, which is in turn mounted on the shaft P. d^2 to d^{10} represent the rotating contact-rings in contact with as many brushes $d^{2'}$ to d^{29}, which latter are mounted on the insulated support d^{20}. These brushes instead of being of the form shown may be provided with small rollers, such as those that make contact with the sunflowers D and D^2. The spring-metal arms C^4 C^5, having contact-rollers c^4, which engage the rings D^4 and D^5, are mounted upon an insulating-plate c^5, carried upon a plate c^6, which is adapted to slide between the sides c^7 of a support c^8, being actuated by a milled screw c^9. By turning the screw c^9 either one way or the other the position of the rollers on the rings D^4 and D^5 may be adjusted.

The printer.—It will be understood from what has gone before that at such times as an electric circuit is made complete through the combination device I may cause the current in this circuit, which corresponds at any particular instant to a signal sent over the line, to operate magnetic devices in various ways and of various kinds; but for the purpose of making these signals manifest in an intelligible form I preferably cause them to be represented by printed characters, and to this end have devised the automatic printer, (shown most clearly in Figs. 10 and 14,) the electrical connection between the several electromagnetic parts being shown in the diagram Fig. 13.

W represents the type-wheel, mounted on the shaft P, and therefore rotating in synchronism with the combination device and with the line-current. This type-wheel (most clearly shown in the detail views Figs. 16 and 17) consists of a wheel W, having the type w arranged around its periphery and is also provided with a long collar w', which extends from one side of the wheel only. This collar and wheel are mounted loosely on the shaft P, and on the opposite side of the type-wheel from the collar is a disk w^2, held fast on the shaft by the set-screw w^3. This disk is provided with a plurality of small holes w^0, into any of which is inserted a small pin w^4, against which a pin w^6 on the type-wheel rests, the type-wheel being driven against the pin w^4 by means of a coil-spring w^5, one end of the spring being secured to the hub of the type-wheel, while the other end is secured to the disk w^2. By this arrangement the speed of the shaft is not affected by the repeated blows given to the type-wheel by the printing-hammer, owing to the fact that the type-wheel is loose upon the shaft P, and whenever the type-wheel is struck it will give way and the shaft P will continue to revolve, the spring bringing the wheel back to its initial point when the hammer releases it. This arrangement also secures greater clearness in the printing, as the wheel momentarily stops when struck. Were the type-wheel rigid on the shaft, it would continue to move when struck, which would cause a blur. The type-wheel is inked by the roller W', mounted on the rod W^2, which latter is secured to the upright u'. The characters are printed from this type onto a strip of paper V, which passes between the periphery of the type-wheel and a printing-hammer S. This printing-hammer S consists of an arm s, preferably of magnetic metal and pivoted, as at s^0, in the frame S^0, and at the pivoted end is bent at right angles to form the downwardly-extending arm s'. The hammer-head consists of a frame S', secured to the end of the arm

s and carrying a striker s^2, mounted on the stem s^3, which is pivoted, as at s^4, to the frame S'.

s^5 represents a spring secured to the frame S' and in engagement with the stem s^3, and s^6 represents a set-screw for adjusting the position of the striker s^2. The spring s^5 allows the striker s^2 to give way with the type-wheel, which will also obviate blurring in the printing. The downwardly-extending arm s' of the printing-hammer forms the armature of the electromagnet M, so that whenever the magnet M is excited the arm s' will be attracted and will obviously send the striker s^2 against the paper. This arm also carries a contact-spring s^7, which when the arm s' is attracted, as stated, will be sent into engagement with the contact-screw s^{10}. When the magnet is deënergized, the hammer rebounds quickly from the type-wheel, being assisted in this operation by the spring s^7.

The paper V passes between the rollers Z and Z' and is advanced the proper distance after the printing of each letter by the spacing mechanism, comprising, among other parts, the ratchet z, mounted on the same spindle with the roller Z' upon the upright Z^2. This ratchet is rotated the distance of one tooth for each letter by the pawl z', carried by the arm Z^3, which is pivoted at z^0. The pawl z' is held in the proper position by the spring z^2.

The rocking arm Z^3 carries an armature z^3, which after each letter has been printed is adapted to be attracted by the electromagnet Z^0, thus causing the pawl z' to advance the ratchet-wheel and therefore the paper V. A metal strip z^4, secured to the upper end of the arm Z^3, makes contact with a screw z^5 every time the magnet Z^0 attracts the armature z^3, and thus completes a circuit, which instantly causes the magnet Z^0 to release the armature z^3, when the contact at z^5 is again broken and the arm Z^3 returns to its normal position, as shown most clearly in Fig. 15.

The circuits through the electromagnets M and Z^0 are opened and closed by the magnetic devices or distributing-relays $R^\times$ and $R^{\times\times}$, which are provided with freely-moving vibrating tongues r^{34} and r^{36}, which are adapted to vibrate between the contacts r^{35} r^{38} and r^{37} r^{39}, respectively. The relay $R^\times$ acts to close a circuit which operates the printer for each combination on the combination device, before described.

To more fully describe the action of the printer, reference will be had to the diagram of the printer-circuits, Fig. 13. The wires x^0 are connected with the brushes or contacts C^4 C^5 of the combination device, and with the source of local current, so that whenever a signal is received the magnet R^{25} of the relay $R^\times$ becomes excited. This causes the tongue r^{34} to be attracted by the magnet R^{25}, the said tongue thus making contact at r^{35} and completing the circuit from the battery X^2 through the wires x' and x^2 and the magnet M. This instantly causes the magnet M to attract its armature s', which in turn causes the printing-hammer S to print a letter on the strip V; but at the instant that the magnet M attracts the armature s' the strip s^7 makes contact with the point s^{10}, and this completes the circuit from the battery X^2 through the magnets R^{27} and R^{26} by way of the wires x^3, x^4, x^5, x^6, and x^7, which causes the magnet R^{26} to attract the tongue r^{34}. This breaks the contact at r^{35} and releases the printing-hammer and also causes the magnet R^{27} to attract the tongue r^{36} and make contact at r^{37}. The effect of making the contact at r^{37} is to complete the circuit through the magnet Z^0 by way of the wires x^8 and x^9, which magnet then attracts its armature z^3 and makes contact between z^4 and z^5, the effect of this being to close the circuit through the magnet R^{28} by way of the wires x^{10} and x^{11}, causing the magnet to attract the tongue r^{36}, breaking the contact at r^{37} and therefore breaking the circuit through the magnet Z^0, and thus restoring all of the parts to the initial position. This cycle of operations takes place every time a letter is printed, but the action of all the parts is so rapid that while following each other in perfect order they appear to act simultaneously.

The simple case of operating the printer-magnet without the spacing mechanism is shown in Fig. 12. In this instance when a signal is received the magnet R^{25} becomes excited by the current from the wires x^0 and attracts its tongue r^{34}, which makes contact at r^{35} and closes the circuit through the magnet M and causes that magnet to attract its armature s' and print a letter. At the same time contact is made between the strip s^7 and point s^{10}, which completes the circuit through the magnet R^{26}, causing that magnet to attract the tongue r^{34} and breaking the contact at r^{35}, which causes the current through the magnet M to cease to flow, thus allowing the printing-hammer to return to its normal position.

It will be observed that the character is not necessarily printed as soon as the signal which represents it arrives. Thus a signal representing the letter "A," for example, will cause the relay $R^\times$ to send its tongue against the contact r^{35}, and when this takes place the printing-hammer may either operate immediately or it may be held back, but as soon as released will operate nevertheless, as the tongue of the relay is freely moving and will remain against the contact r^{35} until the printer-hammer operates and energizes the magnet R^{26}, which will draw the tongue away from the contact r^{35}. This action renders the operation of the hereindescribed printer essentially different from those printers where the contact-maker taking the place of the tongue r^{34} is drawn back by a spring immediately after it makes the contact for operating the printer-hammer. In the case of the

printers having the spring-controlled or actuated contact-makers it is necessary for the printer-hammer to act instantly that the said contact is made or else it will not print the character. What has been said about the relay $R^{\times}$ and the printer-hammer applies to the relay $R^{\times\times}$ and spacing mechanism. The latter may act any time after the contact r^{37} has been completed.

While I have herein shown and described my transmitting apparatus as used in connection with a type-printing receiver, I do not wish to be understood as limiting myself to such use. Thus, for example, my system of transmission may be readily used with a Morse recorder or Bain chemical receiver, and I propose to so use the system at such times as it becomes desirable to do so. Moreover, there are many obvious modifications which may be made in the herein-described system without departing from the spirit of my invention; but

What I claim, and desire to secure by Letters Patent of the United States, is—

1. In a system of telegraphy, the combination with a main-line conductor carrying a signaling and synchronizing electric current, a transmitter for altering the electrical condition of said main-line current, a continuously-moving synchronizer regulated by the said current, a sunflower and trailer regulated by the said synchronizer and in which there is a continuous relative motion between said sunflower and trailer, and a transmitting-tape located in the segment-circuits of said sunflower for operating said transmitter, substantially as described.

2. In a system of telegraphy, the combination with a main-line conductor carrying a signaling and synchronizing electric current, of a transmitter with the main-line circuit normally closed through one of its contacts, a continuously-rotating synchronizer regulated by the said electric current, a sunflower and trailer regulated by and moving in unison with said synchronizer, the segment-circuits of said sunflower passing through the coil of said transmitter, and a source of local current connected to said segment-circuits, substantially as described.

3. In a system of telegraphy, the combination with a main-line conductor carrying an electric current, of a transmitter with the main-line circuit normally completed through one of its contacts, a continuously-rotating synchronizer regulated by the said current, a sunflower and trailer regulated by and moving in unison with said synchronizer, the segments of said sunflower being divided into groups and their circuits passing through the coil of said transmitter, and a source of local current connected to the said segment-circuits, substantially as described.

4. In a system of telegraphy, the combination with a main-line conductor carrying an electric current, of a transmitter with the main-line circuit normally completed through one of its contacts, a continuously-rotating synchronizer regulated by the said current, a sunflower and trailer regulated by and moving in unison with said synchronizer, the segments of said sunflower being divided into groups and their circuits passing through the coil of said transmitter, means for altering the electrical condition of each group of said segment-circuits separately, and a source of local current connected to the said segment-circuits, substantially as described.

5. In a system of telegraphy, the combination with a main-line conductor carrying an alternating signaling and synchronizing current of electricity, of a transmitter with the main-line circuit normally closed through one of its contacts, a continuously-rotating synchronizer regulated by the alternating current, a sunflower and trailer regulated by the said synchronizer and in which there is a continuous relative motion between said sunflower and trailer, and the segment-circuits of said sunflower passing through the coil of said transmitter, substantially as described.

6. In a system of telegraphy, the combination with a main-line conductor carrying an alternating signaling and synchronizing current of electricity, of a transmitter with the main-line circuit normally closed through one of its contacts, a continuously-moving synchronizer regulated by the said alternating current, a sunflower and trailer regulated by and moving in unison with said synchronizer, the segment-circuits of said sunflower passing through the coil of said transmitter, and means for altering the electrical condition of said segment-circuits whereby the said relay is caused to modify the alternating current, substantially as described.

7. The combination with a conductor carrying an alternating signaling and synchronizing electric current, of a shaft having a continuous steady motion regulated by said alternating current, a sunflower and trailer driven in unison with said shaft, a transmitter operated by the sunflower-circuits with the alternating line-current passing through its contact side, whereby the said transmitter may be made to vary the electrical properties of the line conductor and thus modify the waves of the alternating current, substantially as described.

8. The combination with a main-line conductor carrying an alternating electric current, a sunflower and trailer in which there is a continuous relative motion between the sunflower and trailer, a transmitter operated by the sunflower-circuits with the line-current passing normally through its contact side, and properly-adjusted resistances connected from the tongue of said transmitter to said contact whereby the said transmitter is caused to reduce the intensity of the wave impulses of said current at such times as it is actuated by said sunflower-circuits, substantially as described.

9. In a system of telegraphy, the combina-

tion with a main-line conductor carrying an alternating current of electricity, of a transmitter with the main-line circuit normally closed through one of its contacts, a continuously-rotating synchronizer regulated by the alternating current, a sunflower and trailer regulated by and moving in unison with the said synchronizer, the segment-circuits of said sunflower passing through the coil of said transmitter, and a source of local current connected to the segment-circuits, substantially as described.

10. In a system of telegraphy, the combination with a main-line conductor carrying an alternating current of electricity, of a transmitter with the main-line circuit normally closed through one of its contacts, a continuously-rotating synchronizer regulated by the alternating current, a sunflower and trailer regulated by and moving in unison with the said synchronizer, the segment-circuits of said sunflower passing through the coil of said transmitter, means for altering the electrical condition of said segment-circuits, and a local source of current connected to said segment-circuits, substantially as described.

11. In a system of telegraphy, the combination with a main-line conductor carrying an alternating current of electricity, of a transmitter with the main-line circuit normally closed through one of its contacts, a synchronizer having a steady continuous motion regulated by the alternating current, a sunflower and trailer regulating by and moving in unison with the said synchronizer, the segments of said sunflower being divided into independent groups, the circuits of said segments passing through the coil of said transmitter, and a source of local current connected to said segment-circuits, substantially as described.

12. In a system of telegraphy, the combination with a main-line conductor carrying an alternating current of electricity, of a transmitter with the main-line circuit normally closed through one of its contacts, a synchronizer having a steady continuous motion regulated by the alternating current, a sunflower and trailer regulated by and moving in unison with the said synchronizer, the segments of said sunflower being divided into groups, the circuits of said segments passing through the coil of said transmitter, means for altering the electrical condition of each group of segment-circuits separately, and a source of local current connected to the said segment-circuits, substantially as described.

13. In a system of telegraphy, the combination with a main-line conductor carrying an alternating electric current, of a transmitter with the circuit of the said alternating current passing normally through the contact side thereof, a series of conducting-strips, a contact-maker moving continuously over and in contact with said conducting-strips and having its motion regulated by said alternating current, conducting-wires connected to said strips, means for altering the electrical condition of said conducting-wires, and a source of local current with its circuit passing through the coil of said relay and through the said conducting-wires, substantially as described.

14. In a system of telegraphy, the combination with a main-line conductor, of an alternating current carried by said main-line conductor, a transmitter with the circuit of said alternating current passing normally through the contact side thereof, a series of conducting-strips, a brush adapted to move continuously over and in contact with said conducting-strips, conducting-wires connected to said strips, with the circuit through them normally open, means for closing the circuit through any of said conducting-wires, and a source of local current with its circuit passing through the coil of said transmitter and through the said conducting-wires, substantially as described.

15. In a system of telegraphy, the combination with a main-line conductor, of an alternating current carried by said main-line conductor, a transmitter with the circuit of said alternating current passing normally through the contact side thereof, a series of conducting-strips, a brush adapted to move continuously over and in contact with said conducting-strips, conducting-wires connected to said strips, a perforated tape for making or breaking the electric circuit through said wires, and a source of local current with its circuit passing through the coil of said transmitter, substantially as described.

16. In a system of telegraphy, the combination with a main-line conductor carrying an alternating current varying gradually in intensity, of a transmitter with the main-line circuit passing normally through the contact side thereof, a perforated tape adapted to travel in synchronism with the said alternating current, an actuating-coil forming a part of the transmitter, a local source of electric current with its circuit passing through the coil of said transmitter, which circuit is adapted to be made and broken through the said perforated tape, substantially as described.

17. The combination with a main-line conductor carrying an alternating electric current gradually rising and falling in strength, of a transmitter with the circuit of the said main-line conductor normally passing through its contact side, a perforated tape adapted to travel in synchronism with said line-current, a synchronizer operating in synchronism with said line-current and governing the speed of said tape, an actuating-coil forming a part of said transmitter, a local source of electric current with its circuit passing through the coil of said relay, which circuit is adapted to be made or broken through the said perforated tape, substantially as described.

18. The combination with a main-line conductor carrying an alternating electric current varying gradually and continuously in

intensity, of an electromagnetic transmitter with the main-line circuit normally passing through the contact side thereof, a plurality of conducting-strips, a brush adapted to move in synchronism with the said alternating current over and in contact with said strips, conducting-wires connected to said strips, a local source of electric current with its circuit adapted to pass through any of said conducting-wires, through said strips, brush and transmitter magnet-coil for operating said transmitter, and a perforated tape interposed in the circuits of said conducting-wires and making and breaking the continuity of the electric circuit through the said conducting-wires, substantially as described.

19. The combination with a main-line conductor carrying an alternating electric current varying gradually and continuously in intensity, an electromagnetic transmitter with the main-line circuit, normally passing through the contact side thereof, a plurality of conducting-strips, a brush adapted to move in synchronism with the said alternating current over and in contact with said strips, conducting-wires connected to said strips, a local source of electric current, with its circuit passing through said conducting-wire, through said strips, brush, and the magnet-coil of said transmitter for operating the same, and a perforated tape interposed in the circuits of said conducting-wires and making and breaking the continuity of the electric circuit through combinations of said conducting-wires, substantially as described.

20. The combination with a main-line conductor carrying an alternating electric current varying gradually and continuously in intensity, of an electromagnetic transmitter with the main-line circuit normally passing through the contact side thereof, a plurality of conducting-strips, a brush adapted to move in synchronism with said alternating current over and in contact with said strips, conducting-wires connected to said strips, a local source of electric current with its circuit passing through any of said conducting-wires, through said strips and brush, and through the magnet-coil of said transmitter for operating the same, a traveling perforated tape interposed in the circuits of said conducting-wires and making and breaking the continuity of the electric circuit through combinations of said conducting-wires, and a synchronizer adapted to govern the speed of said brush and tape in synchronism with the line alternating current, substantially as described.

21. The combination with a source of alternating electric current, of a main-line conductor carrying said current, an electromagnetic transmitter with the circuit of said main-line conductor normally passing through the contact side thereof, a plurality of conducting-strips, a brush moving in synchronism with said alternating current over and in contact with said strips, electrical conductors connected to said strips, a source of local current with its circuit adapted to pass through any of said conductors and through the magnet-coil of said transmitter for operating the same, means for making or breaking the continuity of the electric circuit through any of said conductors, one or more of said strips permanently connected to the magnet-coil of said transmitter whereby said transmitter is operated at regularly-recurring intervals for effecting the adjustment of the apparatus for receiving the signals, substantially as described.

22. In a system of telegraphy, the combination with a main-line conductor carrying an alternating signaling and synchronizing current of electricity, of a relay with the main-line circuit passing through its coils, a sunflower and trailer device operating in synchronism with the line alternating current, the segment-circuits of said sunflower passing through the contacts of said relay and through the tongue thereof, a local source of current connected in said segment-circuits having its polarity changed by said line-relay, substantially as described.

23. In a system of telegraphy, the combination with a main-line conductor carrying an alternating signaling and synchronizing current of electricity gradually rising and falling in intensity, of a relay with the main-line circuit passing through its coils, a sunflower and trailer device operating in synchronism with the line alternating current, the segment-circuits of said sunflower passing through the contacts of said relay and through the tongue thereof, a local source of current connected in said segment-circuits and having its polarity changed by said line-relay, substantially as described.

24. In a system of telegraphy, the combination with a main-line conductor carrying an alternating current of electricity, gradually rising and falling in strength, of a relay with the main-line circuit passing through its coils, a synchronizer regulated by said alternating current, a sunflower and trailer device regulated by said synchronizer, a local source of current connected in the segment-circuits of said sunflower and having its polarity changed by said line-relay, substantially as described.

25. In a system of telegraphy, the combination with a main-line conductor carrying an alternating signaling and synchronizing current of electricity, of a relay with the main-line circuit passing through its coils, a synchronizer regulated by said alternating current, a sunflower and trailer device, regulated by said synchronizer, the segment-circuits of said sunflower passing through the contacts of said relay and through the tongue thereof, a local source of current connected in said segment-circuit and having its polarity changed by said line-relay, substantially as described.

26. In a system of telegraphy, the combination with a main-line conductor carrying an alternating signaling and synchronizing cur-

rent of electricity, of a relay with the main-line circuit passing through its coils, a sunflower and trailer device operating in synchronism with the line alternating current, the segments of said sunflower being divided into groups, a local source of current connected in said segment-circuit and having its polarity changed by said line-relay, substantially as described.

27. In a system of telegraphy, the combination with a main-line conductor carrying an alternating signaling and synchronizing current of electricity, of a relay operated by the main-line current, a sunflower and trailer device operating in synchronism with said line alternating current, a local source of current connected in the segment-circuits of said sunflower and having its polarity changed by the main-line relay, a synchronizer located in the circuit with said current and regulating the said sunflower and trailer device, substantially as described.

28. In a system of telegraphy, the combination with a main-line conductor carrying an alternating electric current gradually increasing and diminishing in strength, a local circuit relayed from the main-line circuit, a sunflower and trailer device, with the segment-circuits of said sunflower connected in said local circuit, and a synchronizer regulated by the local relayed current, substantially as described.

29. In a system of telegraphy, the combination with a main-line conductor carrying an alternating signaling and synchronizing current of electricity, of a relay with the main-line circuit passing through its coils, a sunflower and trailer device operating in synchronism with the line alternating current, the segments of said sunflower being divided into groups and the segment-circuits of said sunflower passing through the contacts of said relay and through the tongue thereof, a local source of current connected in said segment-circuits and having its polarity changed by said line-relay, substantially as described.

30. In a system of telegraphy, the combination with a main-line conductor carrying an alternating signaling and synchronizing current of electricity, of a relay with the main-line circuit passing through its coils, a synchronizer regulated by said alternating current, a sunflower and trailer device, regulated by said synchronizer, the segments of said sunflower being divided into groups, and the segment-circuits of said sunflower passing through the contacts of said relay and through the tongue thereof, a local source of current connected in said segment-circuits and having its polarity changed by said line-relay, substantially as described.

31. In a system of telegraphy, the combination with a main-line conductor carrying an alternating signaling and synchronizing current of electricity, of a relay with the main-line circuit passing through its coils, a synchronizer regulated by said alternating current, a sunflower and trailer device regulated by the said synchronizer the segments of said sunflower being divided into groups, a group of selecting-relays connected in each group of segment-circuits, a local source of current connected in said segment-circuits and having its polarity changed by said line-relay, substantially as described.

32. In a system of telegraphy, the combination with a main-line conductor carrying an alternating signaling and synchronizing current of electricity, of a relay with the main-line circuit passing through its coils, a synchronizer regulated by the alternating current, a sunflower and trailer device regulated by the said synchronizer, the segments of said sunflower being divided into groups, selecting-relays located in said circuits, the circuits of said sunflower passing through the contacts of said relay and through the tongue thereof, a local source of current connected in said segment-circuits and having its polarity changed by said line-relay, substantially as described.

33. In a system of telegraphy, the combination with a main-line conductor carrying an electric current, of a relay with the main-line circuit passing through its coils, a synchronizer regulated by the alternating current, a sunflower and trailer device regulated by the said synchronizer, the segments of said sunflower being divided into groups, a group of selecting-relays connected in each group of segment-circuits, a plurality of printers, one being operated by each of said groups of relays and a local source of current connected in said segment-circuits and having its polarity changed by said line-relay, substantially as described.

34. In a system of telegraphy, the combination with a main-line conductor carrying an alternating electric current, a local circuit relayed from the main-line circuit, a sunflower and trailer device, the segments of said sunflower being divided into groups and having their circuits connected in said local relayed circuit, a group of local relays, connected in each group of segment-circuits, and a synchronizer regulated by the relayed current and regulating the said sunflower and trailer device, substantially as described.

35. In a system of telegraphy, the combination with a main-line conductor carrying an alternating electric current, a local circuit relayed from the main-line circuit, a sunflower and trailer device, the segments of said sunflower being divided into groups and having their circuits connected in said local relayed circuit, a group of local relays connected in each group of segment-circuits, a plurality of printers, one being operated by each group of said relays, and a synchronizer regulated by the relayed current and regulating the said sunflower and trailer device, substantially as described.

36. The combination with a source of alternating electric current, of a main-line con-

ductor adapted to carry said current, a relay operated by the main-line current, a plurality of conducting-strips, a brush adapted to move in synchronism with said alternating current over and in contact with said strips, a series of polarized relays, a local source of electric current with the circuit therefrom passing through the coils of said polarized relays, through the said conducting-strips and brush, through the armature of the line-relay and either of the contacts thereof, back to the said source, substantially as described.

37. The combination with a source of alternating electric current, of a main-line conductor adapted to carry said current, a relay operated by the main-line current, a plurality of conducting-strips, a brush adapted to move in synchronism with the said alternating current over and in contact with said strips, a series of polarized relays, a local source of electric current with its circuit adapted to pass through the coils of said relays, through the said conducting-strips and brush and to have the direction of the current therein changed by the said line-relay, substantially as described.

38. The combination with a source of alternating electric current, of a main-line conductor adapted to carry said current, a relay operated by the main-line alternating current, a plurality of conducting-strips, a brush adapted to move in synchronism with said alternating current over and in contact with said strips, a series of polarized relays, a local source of electric current with its circuit adapted to pass through the coils of said series of relays, through the said conducting-strips and brush and through either of the contacts of said line-relay, a relay with the circuit through its coil passing through one of the said conducting-strips and through the local source of current and adapted to indicate the proper adjustment of the said conducting-strips, substantially as described.

39. The combination with a source of alternating electric current, of a main-line conductor adapted to carry said current, a relay operated by the main-line alternating current, a plurality of conducting-strips, a brush adapted to move in synchronism with said alternating current over and in contact with said strips, a series of polarized relays, a local source of electric current with its circuit adapted to pass through the coils of said series of relays, through the said conducting-strips and brush and through either of the contacts of said line-relay, a synchronizer regulated by the said alternating current and adapted to regulate the motion of the said brush, and a relay with the circuit through its coil passing through one of the said conducting-strips and through the local source of current, the said relay being adapted to indicate the proper adjustment of said conducting-strips, substantially as described.

40. In a system of telegraphy, the combination with a main line and a periodically-varying electric current carried thereby, of a transmitting sunflower and trailer, and means operated thereby for suppressing one or more of the impulses of the line-current at regularly-recurring intervals, a main-line relay receiving the signals thus transmitted, a receiving sunflower and trailer, an auxiliary receiving-relay, a source of local current, connected thereto and to the segment-circuits of said sunflower and to said main-line relay, said auxiliary relay normally receiving local impulses of a given polarity, and acting to indicate the proper adjustment of said receiving-sunflower and giving a signal when said sunflower is out of adjustment.

41. In a system of telegraphy, the combination with a main-line conductor carrying an alternating current of electricity, of a relay with the main-line circuit passing through its coils, a synchronizer regulated by the alternating current, a sunflower and trailer device regulated by the said synchronizer, a group of selecting-relays connected in the segment-circuits, a signaling device connected to one of the segments and adapted to make a signal when the segments occupy a prearranged position relative to others on the line, a local source of current connected in said segment-circuits and having its polarity changed by said line-relay, substantially as described.

42. In a system of telegraphy, the combination with a main-line conductor carrying an alternating current of electricity, of a relay with the main-line circuit passing through its coils, a synchronizer regulated by the alternating current, a sunflower and trailer device regulated by the said synchronizer, the segments of said sunflower being divided into groups, a group of selecting-relays connected in such groups of segment-circuits, a signaling device electrically connected to one of the segments of said sunflower and adapted to make a signal when the said sunflower occupies a prearranged position relative to others on the line, a local source of current connected in said segment-circuits and having its polarity changed by said line-relay, substantially as described.

43. A combination device which consists of a series of conducting-segments moving under a number of brushes, a plurality of circuits connected to said conducting-segments, means for closing certain of said circuits in combinations, a source of electric-current supply connected with said circuits, the current being allowed to flow through said circuits when in the forward movement of said conducting-segments, a prearranged combination of the same come beneath said brushes and a relay connected to the said segments and brushes, and adapted to break its own circuit and means for closing the said circuit so broken, substantially as described.

44. In a combination device, the combination with a set of conducting-segments of uniform width, said segments being divided into groups, a second set of conducting-segments

with each segment corresponding in width to a group of segments in the first set, brushes electrically connected together and passing over and in contact with said segments, a source of electric current connected in the circuit with said brushes, conductors connecting the group of segments of the first set with the segments of the second set so that an electric current can flow from one of said brushes to the other when the circuits are closed through said segments in prearranged combinations, substantially as described.

45. In a combination device, the combination with a set of conducting-segments of uniform width, said segments being divided into groups, a second set of conducting-segments with each segment corresponding in width to a group of segments in the first set, brushes electrically connected together and passing over and in contact with said segments, a source of electric current connected in the circuit with said brushes, conductors connecting the group of segments of the first set with the segments of the second set so that an electric current can flow from one of said brushes to the other when the circuits are closed through said segments in prearranged combinations, an electromagnet connected in the circuit with said brushes, and a printer operated by said magnet for each of the aforesaid combinations, substantially as described.

46. In a circuit-combining device of the character described, the combination with a plurality of segments mounted upon a shaft and representing combinations of circuits, of a plurality of contact-rings electrically connected to the said segments, a plurality of circuits electrically connected to the said contact-rings, a plurality of polarized relays adapted to close the said circuits in combinations, brushes in contact with the said segments and a source of electricity connected to the said brushes the said brushes being adapted to convey a current of electricity to and from the said segments during their forward movement for each combination of the said plurality of circuits, an electromagnet in electrical connection with said brushes and said source of current, and a printer adapted to be operated through the said magnet for each combination of the aforesaid plurality of circuits, substantially as described.

47. The combination with an electromagnet having two separate coils, an armature and contacts between which said armature is vibrated by said magnet, a second electromagnet provided with an armature and contact, said armature being vibrated in and out of engagement with said contact by said magnet, one coil of the first electromagnet being connected in series with the armature and contact of the second magnet, and the coil of the second magnet connected in series with the armature and contact of the first magnet, a source of electric current connected with said circuits; and means for passing a current through the coil of the first magnetic device not connected with the second magnetic device, substantially as described.

48. The combination with an electromagnet having two separate coils, an armature and contacts between which said armature is vibrated by said magnet, a second electromagnet provided with an armature and contact, said armature being vibrated in and out of engagement with said contact by said magnet, a printer operated by said second magnet and armature, one coil of the first electromagnet being connected in series with the armature and contact of the second magnet and the coil of the second magnet connected in series with the armature and contact of the first magnet, a source of electric current connected with said circuits, and means for passing a current through the coil of the first magnetic device not connected with the second magnetic device, substantially as described.

49. In a printer of the character described, the combination with a type-wheel, of a printing-hammer pivoted near said type-wheel; an electromagnet adapted to actuate said printing-hammer; a contact-maker carried by the printing-hammer arm; an upright, a ratchet, roller and contact-maker mounted on said upright; a rocking arm; a pawl, contact-maker and armature carried by said rocking arm; an electromagnet adapted to actuate said rocking arm, said arm adapted to advance a strip of paper passing in front of said type-wheel; electromagnetic circuit-closing devices for actuating the said printer, the said contact-makers and circuit-closing devices making and breaking the electric circuits through the electromagnet-coils of the printer in prearranged order upon the printing of each character, substantially as described.

50. A printing-hammer which consists of a pivoted arm carrying at one end an armature and at the other end a bracket; an upright pivoted stem carried by said bracket; a striker mounted on the upper end of said stem and a spring and set-screw carried by said bracket for controlling the said stem and striker, substantially as described.

51. In a printing-telegraph, the combination with a main-line alternating signaling and synchronizing current, of a synchronizer regulated thereby, a shaft operated by said synchronizer, an independently-driven shaft regulated to synchronism with the first shaft by means of the said synchronizer and a printer operated by said second shaft, substantially as described.

52. In a telegraph system, the combination with a synchronizer and a shaft operated thereby, of a second shaft, a motor driving said second shaft, means for varying the electrical condition of the motor-circuit from one of said shafts to the other as the two shafts are or are not revolving in synchronism, whereby the said motor is regulated to synchronism with said synchronizer, substantially as described.

53. In a telegraph system, the combination with a synchronizer and a shaft operated thereby, of a second shaft, a motor driving said second shaft, a conductor carried by the second shaft and connected to the motor-circuit, a conductor carried by the first shaft and connected to the motor-circuit, suitable resistances in said motor-circuit, said conductors making contact with each other and altering the resistance of the motor-circuit when the shafts are not in synchronism and occupying a prearranged position with relation to each other and with the electric circuit through them broken when the shafts are in synchronism, substantially as described.

54. In a printing-telegraph, the combination with a synchronizer and a shaft operated thereby, of a second shaft, a motor driving said second shaft, a disk carried by one of said shafts having a portion thereof insulated from the rest of the disk, said portion being connected to said motor-circuit, a contact-maker carried by the other shaft adapted to make contact with said disk and connected in said motor-circuit, suitable resistance in said motor-circuit, the resistance of said circuit being increased or diminished as the speed between said contact-maker and disk varies, substantially as described.

55. In a device for regulating the speed of an electric motor from a revolving shaft, the combination with a revolving shaft, of a contact-maker carried by and revolving with said shaft, a disk mounted on a second shaft and composed of a plurality of conducting members insulated from each other and adapted to be brought in contact with said contact-maker, an electric motor and a source of electric current from which said motor is driven with its circuit passing through the said contact-maker and through one or more of the said conducting members, through said motor and then through a variable resistance back to the source, and a variable resistance connected in shunt with said circuit, substantially as described.

56. The combination with a main-line conductor, of a periodically-varying electric current carried by said conductor, an electromagnetic transmitter with the circuit of the said main-line conductor normally passing through its contact side, a perforated tape adapted to travel in synchronism with said line-current, a synchronizer operating in synchronism with said line-current and governing the speed of said tape, a local source of electric current with its circuit passing through the magnet-coil of said transmitter, which circuit is adapted to be made or broken through the said perforated tape, substantially as described.

57. The combination with a main-line conductor, of an electric current carried by said main-line conductor, an electromagnetic transmitter with the main-line circuit normally passing through the contact side thereof, a plurality of conducting-strips, a brush adapted to move in synchronism with the said current over and in contact with said strips, conducting-wires connected to said strips, a local source of electric current with its circuit adapted to pass through any of said conducting-wires, strips, and through the magnet-coil of said transmitter and a perforated tape interposed in the circuits of said conducting-wires and making and breaking the continuity of the electric circuit through the said conducting-wires, substantially as described.

58. The combination with a main-line conductor, of an electric current carried by said main-line conductor, an electromagnetic transmitter with the main-line circuit normally passing through the contact side thereof, a plurality of conducting-strips, a brush adapted to move in synchronism with the said current over and in contact with said strips, conducting-wires connected to said strips, a local source of electric current, with its circuit passing through said conducting-wires, through said strips and brush, and through the magnet-coil of said transmitter and a perforated tape interposed in the circuits of said conducting-wires and making and breaking the continuity of the electric circuit through combinations of said conducting-wires, substantially as described.

59. In a system of telegraphy, the combination with a main-line conductor carrying an alternating current of electricity, of a relay with the main-line circuit passing through its coils, a synchronizer regulated by said alternating current, a sunflower and trailer device regulated by said synchronizer, a local source of current connected in the segment-circuits of said sunflower and having its polarity changed by said line-relay, substantially as described.

60. In a system of telegraphy, the combination with a main-line conductor carrying an alternating electric current, a local circuit relayed from the main-line circuit, a sunflower and trailer device, with the segment-circuits of said sunflower connected in said local circuit, and a synchronizer regulated by the local relayed current, substantially as described.

61. In a printing-telegraph, the combination with a main-line alternating signaling and synchronizing current, of a synchronizer regulated thereby, a shaft operated by said synchronizer, an electrical contact-maker controlled by the synchronizer, an independently-driven shaft regulated to synchronism with the first shaft by means of the said contact-maker, and a printer operated by said second shaft, substantially as described.

62. The combination with a shaft having a steady motion, of a second shaft, an electric motor driving the said second shaft, and means controlled by said shafts for varying the electrical condition of the motor-circuit as the speed between the said shafts varies, substantially as described.

63. The combination with a shaft having a

steady motion, of a second shaft, a printer driven by the second shaft, an electric motor driving said second shaft, and means controlled by said shafts for varying the electrical condition of the motor-circuit as the speed between the shafts varies, substantially as described.

64. The combination with a shaft having a steady motion, of a second shaft, an electric motor driving the second shaft, electrical contacts operated by said shafts and varying the electrical condition of the motor-circuit as the speed between the shafts varies, substantially as described.

65. The combination with a shaft having a steady motion, insulated contact-segments carried by said shaft, an independently-driven shaft, a contact-maker carried by the independently-driven shaft and engaging the segments on the first shaft, a motor driving the second shaft and having its circuit connected to said segments and contact-maker whereby the electrical condition of said circuit is varied to the variation in speed between the said shafts, substantially as described.

66. The combination with a circuit-combining device, comprising a series of conducting-segments and a plurality of contact-brushes in engagement therewith, with relative motion between the said brushes and segments, of a plurality of circuits connected to said conducting-segments, means for closing said circuits in combinations, a source of electric-current supply connected to said circuits, the current being allowed to flow through certain of said circuits when a prearranged combination of the said segments is brought into engagement with said brushes, and a distributing-relay connected to said brushes, substantially as described.

67. The combination with the circuit-combining device, of a series of selecting-relays closing the circuits through their contacts to said device in combinations, and a current-distributing relay connected to said circuit-combining device and acting for each combination of the circuits closed through said circuit-combining device, substantially as described.

68. A circuit-combining device, comprising a series of conducting-segments and a plurality of contact-brushes with relative motion between the two, the length of said segments in contact at one time with said brushes varying as between the segments, the greater length being a multiple of the lesser, substantially as described.

69. The combination with a circuit-combining device, comprising a series of conducting-segments and a plurality of contact-brushes with relative motion between the two, the length of said segments in contact at one time with said brushes varying as between the segments, the greater length being a multiple of the lesser, a plurality of circuits connected to said conducting-segments, means for closing said circuits in combinations, a source of current-supply connected to said circuits, the current being allowed to flow therefrom through certain of said circuits when a prearranged combination of said segments come in contact with said brushes, substantially as described.

70. The selecting-relays and circuit-combining device, substantially as herein described, in combination with a telegraphic printer having the current-distributing relays operated by or from said selecting-relays and circuit-combining device, substantially as described.

71. In a telegraphic printer having the printing and spacing magnets, substantially as described, in combination with a circuit-combining device and current-distributing relays adapted to combine a plurality of local circuits for each combination of signals received and to distribute the current to the electromagnetic parts of the printer during each cycle of operations accompanying the printing of a character, and a plurality of selecting-relays connected to said circuit-combining device and closing circuits therethrough in combinations for each character to be printed.

72. In a telegraphic printer, the combination with a circuit-combining device and current-distributing relays adapted to combine a plurality of local circuits for each combination of signals received and to distribute the current to the electromagnetic parts of the printer during each cycle of operations accompanying the printing of a character, and a plurality of selecting-relays connected to said circuit-combining device, and closing circuits therethrough in combinations for each character printed, substantially as described.

73. In a telegraphic printer, the combination with a type-wheel, of a printing-hammer, an electromagnet operating said printing-hammer, spacing mechanism and an electromagnet operating said mechanism, current-distributing relays having freely-moving tongues, one of said relays completing the circuit through the printer-hammer magnet for each character printed and allowing the circuit to remain closed until the said character is printed, a second current-distributing relay actuated from the first and completing the circuit through the spacing-magnet after the printing of each character and allowing said circuit to remain closed until the spacing mechanism has acted, substantially as described.

74. In a telegraphic printer, the combination with a type-wheel, of a printing-hammer mounted near said type-wheel and carrying a contact-maker, an electromagnet actuating said printing-hammer, a current-distributing relay having a freely-moving tongue, an electric circuit passing through one of the tongue-contacts of said relay and through the coil of the printing-hammer magnet, means for sending the said relay-tongue against one of its

contacts and completing the circuit through the printing-hammer magnet-coils and means operated by the contact-maker of the printing-hammer for sending the relay-tongue away from the said contact and thus breaking the circuit through the printing-hammer magnet, substantially as described.

75. In a telegraphic printer, the combination with a circuit-combining device, of a current-distributing relay comprising two independently-excited coils and a freely-moving tongue operated thereby, one of said coils being connected to said circuit-combining device, a type-wheel, a printing-hammer carrying an electrical contact-maker, an electromagnet for operating said printing-hammer, an electric circuit passing through the tongue and one contact of said relay and through the coil of the printing-hammer magnet, a second circuit passing through one of the coils of said relay and through the contact-maker of said printing-hammer, and a source of electric current connected to said circuits, substantially as described.

76. In a telegraphic printer, the combination with an electromagnet and printing-hammer actuated thereby, of a type-wheel rotating near said printing-hammer, a current-distributing relay having two independently-excited coils and a freely-moving tongue, the tongue and one of the contacts of said relay connected in the circuit with said printing-hammer magnet, a contact-maker carried by said printing-hammer magnet and connected in the circuit with one of the coils of said distributing-relay and a source of electric current connected in said circuits, substantially as described.

77. In a telegraphic printer, the combination with an electromagnetically-operated printing-hammer, of a circuit-combining device, and a current-distributing relay operated by said circuit-combining device, completing the circuit through the coils of the printing-hammer magnet for each character to be printed and allowing the said circuit to remain completed until the character is printed, and means for automatically breaking the said circuit directly after the printing of a character, substantially as described.

78. In a telegraphic printer, the combination with the printing-hammer magnet, of a distributing-relay connected in circuit with said magnet, means for operating said relay whereby the printing-hammer is operated, and means for preventing any further action of said relay until the printing-hammer has acted, substantially as described.

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

HENRY A. ROWLAND.

Witnesses:

S. A. TERRY,

JOHN H. HOLT.