

(No Model.)

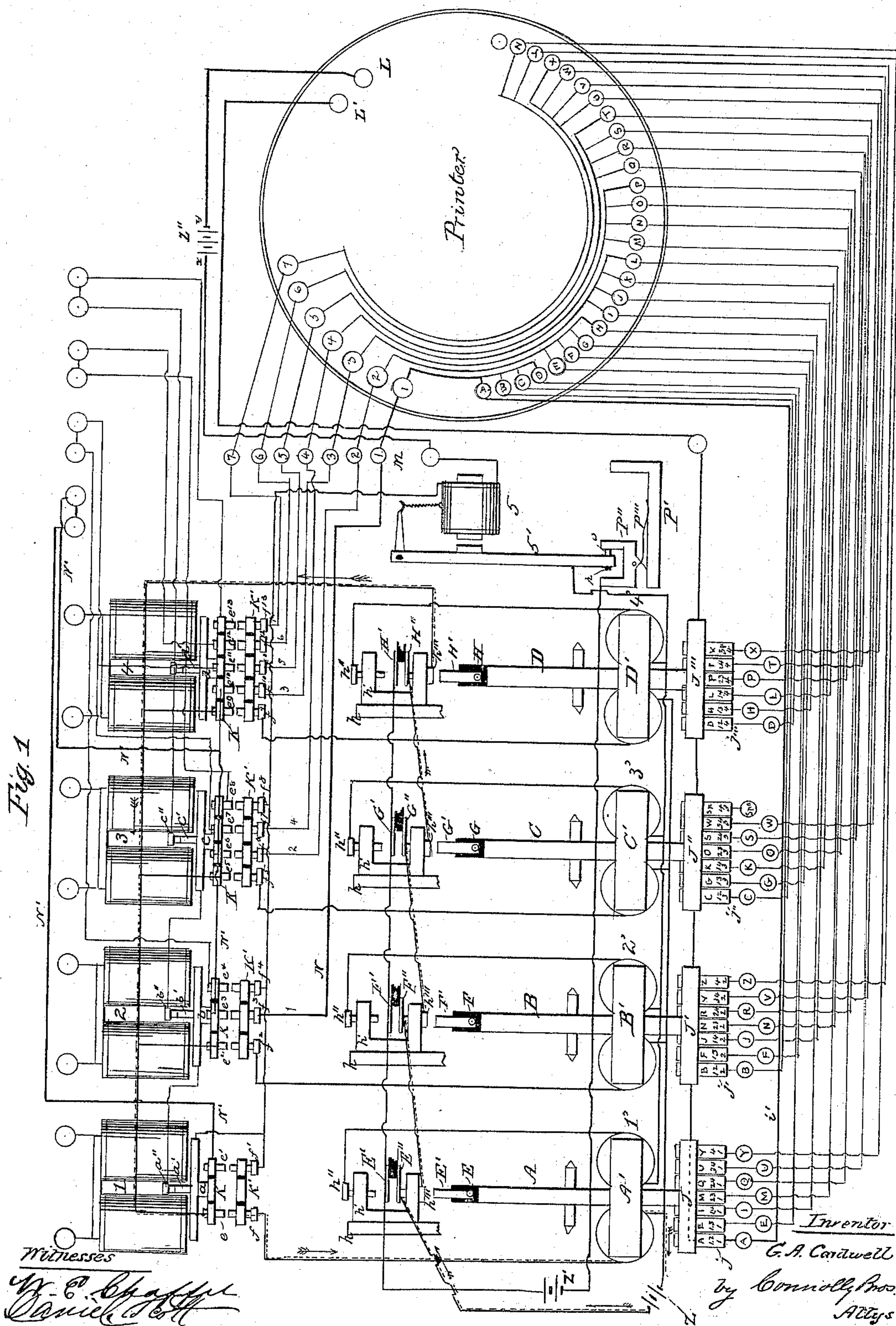
2 Sheets—Sheet 1.

G. A. CARDWELL.

MULTIPLE HARMONIC PRINTING TELEGRAPH.

No. 335,681.

Patented Feb. 9, 1886.



Witnesses
W. C. Chaffee
Daniel S. Holt

Inventor
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(No Model.)

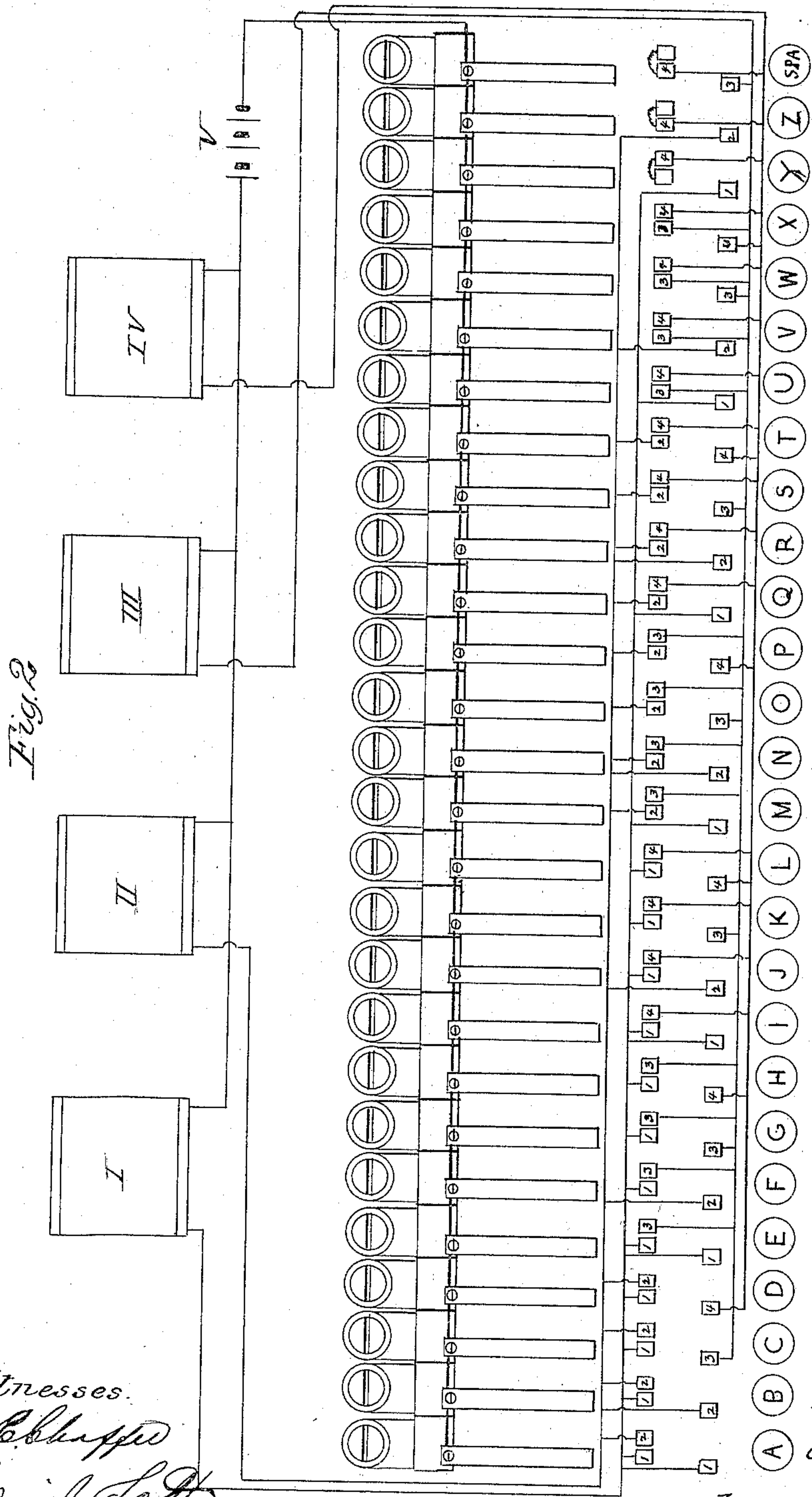
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Witnesses.

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Daniel Scott

Inventor

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UNITED STATES PATENT OFFICE.

GEORGE A. CARDWELL, OF BROOKLYN, NEW YORK, ASSIGNOR OF TWO-THIRDS TO FREDERICK K. FITCH, OF NEW YORK, N. Y., AND JOSEPH T. MURRAY, OF NEWARK, NEW JERSEY; SAID MURRAY ASSIGNOR OF ONE-HALF OF HIS RIGHT TO WILLIAM PHILIP ARNOLD, OF ELIZABETH, NEW JERSEY.

MULTIPLE HARMONIC PRINTING-TELEGRAPH.

SPECIFICATION forming part of Letters Patent No. 335,681, dated February 9, 1886.

Application filed December 17, 1884. Serial No. 150,583. (No model.)

To all whom it may concern:

Be it known that I, GEORGE A. CARDWELL, a citizen of the United States, residing at Brooklyn, in the county of Kings and State of New York, have invented certain new and useful Improvements in Multiplex-Telegraph Systems and Apparatus; and I do hereby declare the following to be a full, clear, and exact description of the invention, reference being had to the accompanying drawings, which form part of this specification, in which—

Figure 1 is a plan view or diagram of a telegraphic receiving apparatus embodying my improvements. Fig. 2 is a diagram representing a key-board transmitter.

This invention has relation to certain improvements in that peculiar system of multiple telegraphic transmission outlined in an application filed by me September 4, 1883, Serial No. 105,525. In said application I have detailed a method and means for effecting what I have termed a "permutation or multiple telegraphic transmission," and I have shown how, for instance, the Gray harmonic system of sending different currents simultaneously over a single line, when applied to the printing or recording of separate signals, may be permuted by employing the different pulsatory currents or "tones" in couples, thereby causing certain receiving devices to respond to two simultaneously-transmitted currents and produce a definite signal in response to the conjoint action of such currents.

Previous to the invention of the system of permutation described in my said application, the harmonic system had been employed in printing-telegraphy to the extent of causing a given character to be printed in response to a single tone-current, and likewise in causing a series of characters to be printed from a succession of intermissions in a single tone-current, through the medium of a rheotome-transmitter and a type-wheel controlled by an escapement. According to the first method—that is, the recording of a character in response to each tone-current—the number of different characters was limited to the number of different currents. Thus, supposing that six tone-currents were available, but six different

characters could be printed. According to the second method, involving the rheotome transmission, each current required a number of impulses corresponding to the alphabetical order or position of each letter, and hence the speed of transmission was very much limited.

My system of permutation contemplated the printing of a large number of different characters by the use of a limited number of tone or equivalent currents, but differed from the second method alluded to, in that each character was to be printed in response to a single act of transmission or impulse, instead of in response to a succession of impulses corresponding to the alphabetical order or position of the character; and I accomplished this object by a peculiar combination of relays in the receiving-instrument, these being so arranged that, while each responded to a single tone-current and effected the printing of a corresponding character, any two relays, when made to respond to two currents transmitted by a single impulse—as by the depression of a key controlling two different currents—would effect the printing of another character. Thus, there may be as many different characters printed as there may be permutations in couples of the different currents, each character being printed in response to a single impulse of the proper key.

In carrying out the system described in my application I made use of six tone currents, and a corresponding number of combining-relays. I have found, however, that I can reduce the number of combining-relays, and that I can still further enlarge or extend the permutation principle, so as to operate effectually with less than six tone-currents, and the improvement constituting the subject of the present application has for its object the provision of suitable devices for this purpose.

In an application of even date herewith I have, conjointly with Frederick K. Fitch, shown and described a special construction of key-board or transmitter, adapted for use in connection with my receiver, and comprising a set of keys, each of which is so contrived that its depression will control the transmission of certain impulses of tone or equivalent cur-

rents in a definite and determinate order. I will therefore only describe this transmitter in such specific terms as may be necessary to clearly describe the system. The apparatus which embodies my present invention I term a "distributor," its function being to select and relay the proper currents for each printing or recording operation, and to distribute such relayed currents through their proper courses.

My invention consists in the novel construction, combination, and arrangement of devices for carrying my invention into effect, as hereinafter described and specifically claimed.

In order to fully comprehend the nature of the distributor and its mode of operation, let it be assumed that the harmonic transmitter has a capacity of four tone-currents—for instance, C E G B. The receiving apparatus is furnished with "analyzers," so that when any of these tone-currents are sent over a single line it will be so diverted as to act upon its own relay, and upon no other.

In Fig. 1 of the drawings, which shows the distributor, 1 2 3 4 designate, respectively, the four receiving-relays, which are normally closed, the armature-tongues *a b c* of relays 1 2 3 having contact-points *a' b' c'*, closing circuits from a local battery through opposing contacts *a'' b'' c''*, while no circuit whatever is made through parts *d' d''* of relay 4, such parts merely serving as mechanical stops to limit the movement of the armature-tongue.

1' 2' 3' 4', represent four double-coil electro-magnets having pivotal tongues A B C D to their armatures A' B' C' D'. Each tongue terminates at its rear end in a block of insulating material, E F G H, respectively. To these blocks are attached, on opposite faces, the contact-springs E' E'' F' F'' G' G'' H' H'', respectively. In the rear of each tongue stands a post, *h*, supporting a bracket, *h'*, of insulating material, through the arms of which pass the upper and lower contact-screws, *h'' h'''*, opposing the spring-contacts E' E'' F' F'', &c., as shown. When the armatures are raised from the poles, the springs E' F' G' H' rest upon the lower contact-screws, *h'''*, and when the armatures are attracted this contact is broken and a contact made between the upper springs, E' F' G' H', and the upper contacts, *h''*. The forward ends of the armature-tongues carry metallic bars J J' J'' J''' opposed to the ends of insulated contact-springs *j*, &c., which respectively lead to the different printing-magnets, and thence to a battery or batteries, adjusted as hereinafter more fully described. The armature-tongues of the magnets 1 2 3 4 each carries a block of insulating material, K, with insulated contacts *e e'*, &c., opposing contacts *f f'*, &c., in stationary blocks K', of insulating material. The block on armature-tongue of magnet 1 carries two contacts, *e e'*, opposing contacts *f f'*. That of magnet 2 carries three contacts, *e² e³ e⁴*, opposing contacts *f² f³ f⁴*, while those of magnets 3 and 4 carry, respectively, four and five con-

tacts, the opposing stationary blocks having corresponding points.

When an armature is released, the contacts of the moving block touch those of the opposing stationary block; but while the armature is against the poles or attracted the contact-points are separated. 5 designates a supplementary magnet having a pivotal tongue, 5', to its armature. At its forward extremity this tongue carries a platinum stud, *o*, on its under side and a stud of insulating material, *p*, on its upper side. A standard, P', facing this end of the tongue, carries a pivotal U-shaped bracket, P'', against which bears a spring, P''', and between the ends of this bracket the ends of the tongue extend.

While the armature is unattracted, as when the distributor is inactive, the platinum point *o* rests upon the lower arm of the bracket P'', so as to complete a circuit through the same from the tongue.

The printing-instrument, it may be here briefly stated, consists of a series of magnets mounted in a frame, the armatures being connected to levers which are adapted to strike a common center, as in a type-writing machine.

The paper is in the form of a strip or ribbon supplied from a reel and fed by means of an electro-magnetic feeding device, similar to that employed in "stock-printers."

As the printing-instrument does not constitute a part of the invention to which this application relates, it will not be more particularly described or illustrated than is necessary to show its relation to the distributor.

The connection wires or conductors are shown in the diagram, and will be specifically traced as the description of the operation proceeds.

Let it now be supposed that the letter A is to be printed. As will be inferred, the allotment of the letters to the keys and the relation of any given letter to any particular succession of impulses is arbitrary, since any letter may be assigned to any operative combination. The depression of a single key controls several current-impulses—that is, during its depression it controls certain magnets, the energizing of which bring the tone-currents into play. The keys are so constructed that when depressed each closes a circuit from a local battery through such of the four magnets as have lines or branches leading to the key, and thus effect the transmission of the tone-currents depending on the energized magnets.

In the diagram, Fig. 2, I have shown the four magnets I II III IV, by which the tone-current circuits are closed and opened, and I have also shown the courses of the branches leading from said magnets to the key-board and their terminals through which circuit is made in depressing the keys. If, now, the key bearing the letter A be depressed, a circuit is first closed from the local battery V through the key, and through the contact 1 into and through magnet I. Instantly mag-

net I produces the transmission of a tone-current, which may be C, and as a result, following the well-understood action of such a current, the armature of "distributor-magnet" 1 is released, and the contacts $e f e' f'$ brought together. A current from a local battery, Z, now flows through the points $e f$ in the course of the dotted lines and in the direction of the arrows thereon, and passes through one bobbin of the electro-magnet 1', whence the circuit is to one pole of the battery Z, which may be the negative pole. From the positive pole the circuit is through each of the lower spring-contacts, E' F' G' H', and the contact-screws h'' , as seen, thence to the contacts $e f$. The armature of magnet 1' is thus attracted. Immediately, however, the circuit through the first bobbin is broken by the separation of the contact-spring E' from its opposing contact-screw h'' ; but a circuit is at once established through the second bobbin by way of contacts E' h'' , the current flowing from battery Z', first through said contacts, then through the second bobbin to the bracket P'', to armature-tongue 5' of said magnet, and back again to the battery Z'. This current now retains the armature of magnet 1' against its poles. While this change of circuit is taking place, the magnet 1 has been restored to its normal position, and the contacts $e f$ separated, the key A of the transmitter having broken circuit through the magnet I, the making and breaking of such circuit being almost simultaneous, and being performed by the partial depression of the key. When the key is still further depressed, it closes circuits from the battery V through the points 1 2, and immediately magnets I II are energized. Two tone-currents, C E, are now sent over the line, and magnets 1 2 affected so as to release their armatures and make contacts between the points in front thereof.

The action of the magnet 1 under the first impulse was preparatory—that is, it effected an adjustment or preparation of the distributor for the performance of its principal function—namely, the direction of a current to the proper printing-magnet. Now, under the two new impulses, the circuit in the distributor is as follows: To the copper pole x of battery Z'', through contacts $e' f'$ of magnet 1, by way of magnet 5, and from zinc pole y to binding-post L, from which leads a line to the magnet of the paper-feed in the printing-instrument, and thence returns to binding-post L'. From the latter the circuit continues through the bars J J' J'' J''' until it reaches the spring-contact j , which is in circuit with the printing-magnet of letter A. The circuit is then by way of the spring j and the connecting-wire i' to said printing-magnet, and finally back to the contact e' by way of binding-post M and line N, through contacts $e^3 f^3$ and line N'. The letter A is now printed and the printing-circuit immediately broken by the automatic elevation of the transmitter-key. Simultaneously the armature of magnet 5, which was drawn

down by the operation of the current, rises, and in so doing the contact o leaves the lower arm of the bracket P'' and breaks the local circuit, which was originally made through the second bobbin of the magnet 1', thereby allowing the armature of the latter to rise and assume its normal position; but the insulated piece p , coming in contact with the upper arm of the bracket P'', lifts the bracket and again completes the circuits through the same and the point o , thus restoring these devices to their normal positions.

I have arranged the key-board for the transmission of twenty-seven signals, constituting a complete alphabet and a spacing-mark or "space." Thustwenty-seven sets of impulses in the order arbitrarily adopted will effect the printing of twenty-seven different characters by the establishment of twenty-seven distinct circuits leading from the distributor through as many different printing-magnets. The key-board may, however, have greater or less capacity. I have already stated in a preliminary portion of this specification that each key makes and breaks three contacts—or, in other words, produces three electrical impulses. For further example, I will refer now to the key marked K. It will be seen that the contacts are designated, *seriatim*, 3 1 4, which indicates that in depressing the key circuits are made from battery V first through the transmitting-magnet III, that this circuit is immediately broken, and that the circuit is divided and completed through transmitting-magnets I and IV. The effect of this operation on the distributor is to first energize receiving-magnet 3, complete a local circuit through the first bobbin of magnet 3', immediately break said circuit, and produce a circuit in the second bobbin, which will maintain the armature attracted by the first bobbin down upon the poles; second, the energizing of the receiving-magnets 1 4 and the production of a circuit through the contacts which these magnets govern in the distributor, and the diversion of the current from one pole of a local battery through the magnet 5 into the magnets controlling the paper-feed, thence back to the bar I'', thence through one of the spring-contacts upon which this bar impinges, thence to the printing-magnet of letter K, and back to the other pole of the battery.

The order of contacts or impulses is different for each key, and the letters by which these contacts are designated refer to the commutations or permutations which are correspondingly produced in the transmitting and receiving magnets. The directions of the currents produced in the distributor by these permutations can be readily traced on the diagram, and need not be further specified.

In describing the action of the keys I have referred to the making and breaking of three contacts at each depression, and I have also suggested that the two contacts upon which the actual printing operation depends are to be made simultaneously. There are, however,

several exceptions to these peculiarities in the action of the keys. By reference to the diagram of the key-board it will be seen that the keys Y Z Sp have each but two operative
 5 contacts—thus, 1 4, 2 4, 3 4. This indicates that each of these keys, after first making and breaking the preparatory circuit, then establishes its printing-circuit in response to a single tone-current. When the keys make and
 10 break three contacts, the printing-circuit is established through contact-points in the distributor, closed or controlled by two receiving-relays, whereas when the keys make but two contacts the printing-circuit is formed at
 15 the distributor through contacts controlled by only one receiving-relay, the first contact made by the key being used to produce the usual preparatory circuit in the distributor.

The operation of the distributor in directing the currents to the printing-magnet does not depend on the absolute simultaneous completion of the two operative circuits. One part of the circuit may be formed slightly in advance of the other, but the printing-circuit
 20 will not be complete until both receiving-relays have responded; hence, where two tone-currents are transmitted, one of them may slightly anticipate the other. The term "simultaneous" is therefore to be understood
 25 with reference to the two receiving-relays as indicating that both their armatures must lie retracted and the proper contacts be made thereby at the same time.

In some cases—as where the receiving-relay
 35 4 is employed as one of the elements of a permutation or combination—it is even necessary, in order to insure certainty, that the corresponding contact through the key be made after the one with which it combines, so that
 40 the contacts between the armature-tongue and opposing stop of the receiving-relays 1, 2, or 3 may be separated before relay 4 is brought into requisition, in order to avoid the formation of a circuit by the latter through the con-
 45 tacts, and the consequent feeding of a space in the printer between the letters of a word.

I have described the distributor in its application to printing-telegraphy; but I do not limit myself to such application, as it may
 50 be used in switching operations, so that, instead of relaying currents through printing-magnets it will relay sounders or recorders at any distance on lines radiating or diverging from the distributor—as from a central
 55 switching-station—the keys being so manipulated as to send Morse or other signals through a given line after the completion of the preparatory adjustment of the distributor.

I have suggested the employment of tone-currents—that is, rythmical undulations; but such currents are not essential, as any two currents of different characteristics as commonly employed in multiplex telegraphy are available, the transmitting and receiving devices
 60 being constructed in keeping with the special requirements. So, too, instead of using a

single trunk main line, I may use two or more.

I claim—

1. In a receiving and distributing instrument for that class of multiplex printing-telegraphs wherein the transmission of electric
 70 signals is effected by the conjoint action of two different electric currents, the combination of the following instrumentalities, viz: first, receiving-relays and printing-circuit relays which partially complete the printing-
 75 circuit under the action of the first electrical impulse of the sending-key; second, a supplementary electro-magnetic device which temporarily maintains the preparatory closure or
 80 completion of said printing-circuit; third, a series of circuits, batteries, and contacts, which, when two impulses are sent by the key, fully completes said printing-circuit to the exclusion of all others.
 85

2. In a current-distributor or switching apparatus, the combination, with receiving-relays and means, substantially as described, for controlling the action of the same separately and conjointly by currents of various
 90 characteristics transmitted through a main or trunk line, of one or more electro-magnetic devices constructed and adapted to relay circuits through diverging or radiating lines and operate printing, sounding, or recording mag-
 95 nets in response to special combinations of the transmitted currents on the main line.

3. In a current-distributor or switching device, the combination, with receiving-relays which respond to currents of various characteristics sent over a main or trunk line and conjointly establish normally-open circuits,
 100 of an electro-magnetic device or devices constructed and adapted to complete radiating or diverging circuits through given radiating or diverging lines in response to permutations or conjoint operations of the receiving-relays.
 105

4. In a current-distributor or switching apparatus, the combination of permutable receiving-relays and electro-magnetic translating devices, from which lines proceed to printing, recording, or sounding magnets, substantially as described, said translating devices
 110 being constructed and adapted to respond to initial or preparatory currents relayed by one of the receiving-relays, and close and maintain closed normally-open contacts in the printing, recording, or sounding lines during the
 115 conjoint action of two relays in completing the working-circuit.
 120

5. In a current-distributor or switching apparatus, the combination of three or more permutable receiving-relays constructed and adapted to close normally-open circuits through any two of said relays in response to
 125 currents of different characteristics passing simultaneously through a main or trunk line, and to effect the relaying of different circuits in response to the different combinations of permutations of the receiving-relays.
 130

6. In a current-distributor or switching apparatus, the combination of receiving-relays

and electro-magnetic circuiting or translating devices, the latter being constructed and adapted to respond to initial or preparatory currents completed by any one of said relays, and
5 close contacts between a conductor common to all the translators and given outgoing lines in circuit with printing or working magnets, substantially as described.

7. In a current-distributor or switching device, the combination, with permutable receiving-relays and electro-magnetic translating devices for directing currents into different diverging or radiating lines, and means, substantially as described, whereby the translating-magnets are energized through one local
15 circuit, and such energization maintained through a different circuit, of a supplementary electro-magnetic device, substantially as described, for restoring the translating devices

to normal condition after each printing, recording, or sounding operation.

8. The combination, with a current-distributor or switching device constructed and adapted to respond to combined currents and complete a separate local circuit for different
25 permutations, of a transmitter comprising a series of keys adapted to control the transmission of two or more currents of different characteristics, one of said currents being initial or preparatory, substantially as described. 30

In testimony that I claim the foregoing I have hereunto set my hand this 9th day of December, 1884.

GEORGE A. CARDWELL.

Witnesses:

THOS. A. CONNOLLY,
GEORGE F. ESCHBACH.