

March 30 , 1926.

1,578,299

G. S. VERNAM

PRINTING TELEGRAPH SYSTEM

Original Filed June 10, 1918

6 Sheets-Sheet 1

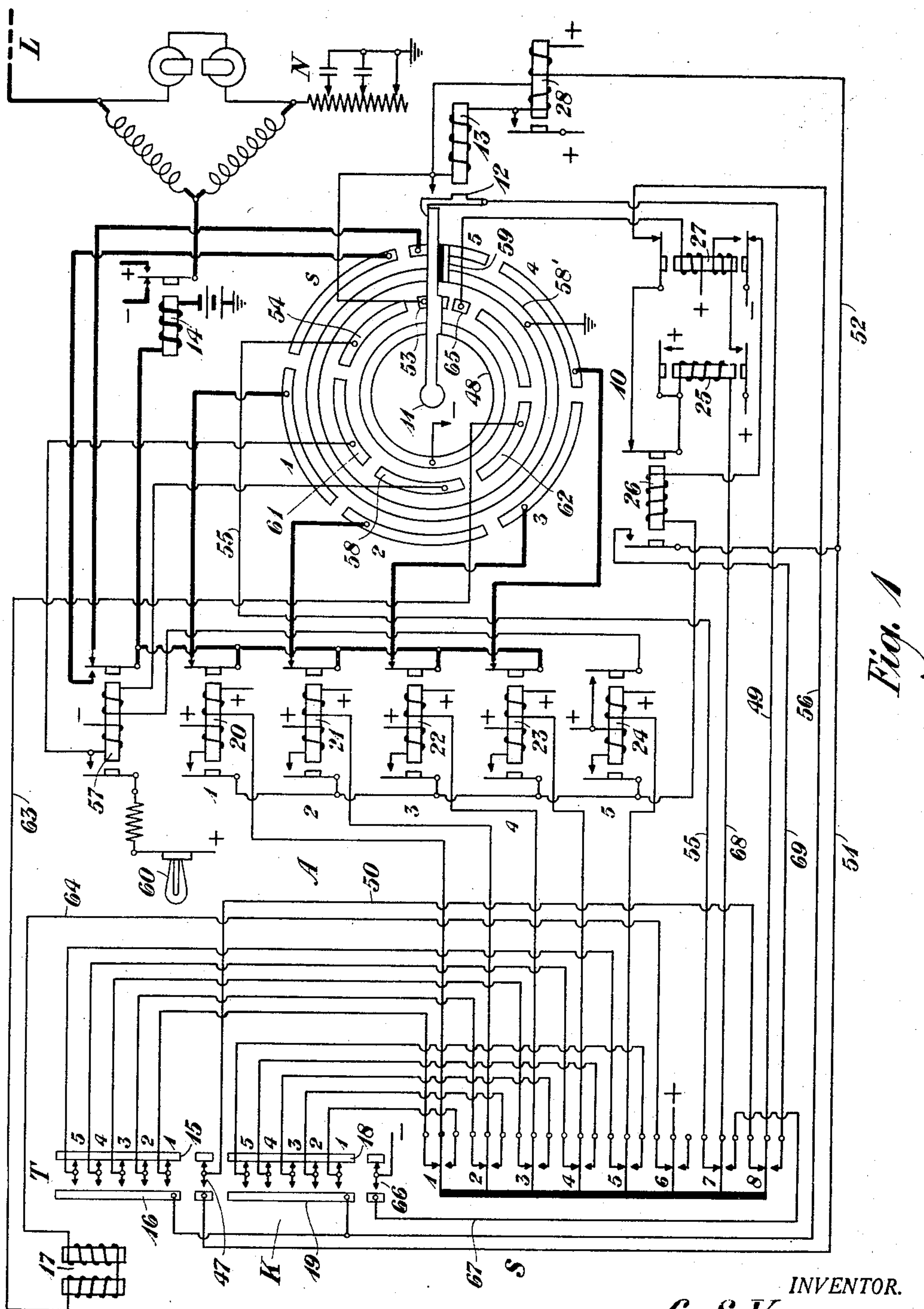


Fig. 1

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PRINTING TELEGRAPH SYSTEM

Original Filed June 10, 1918

6 Sheets-Sheet 2

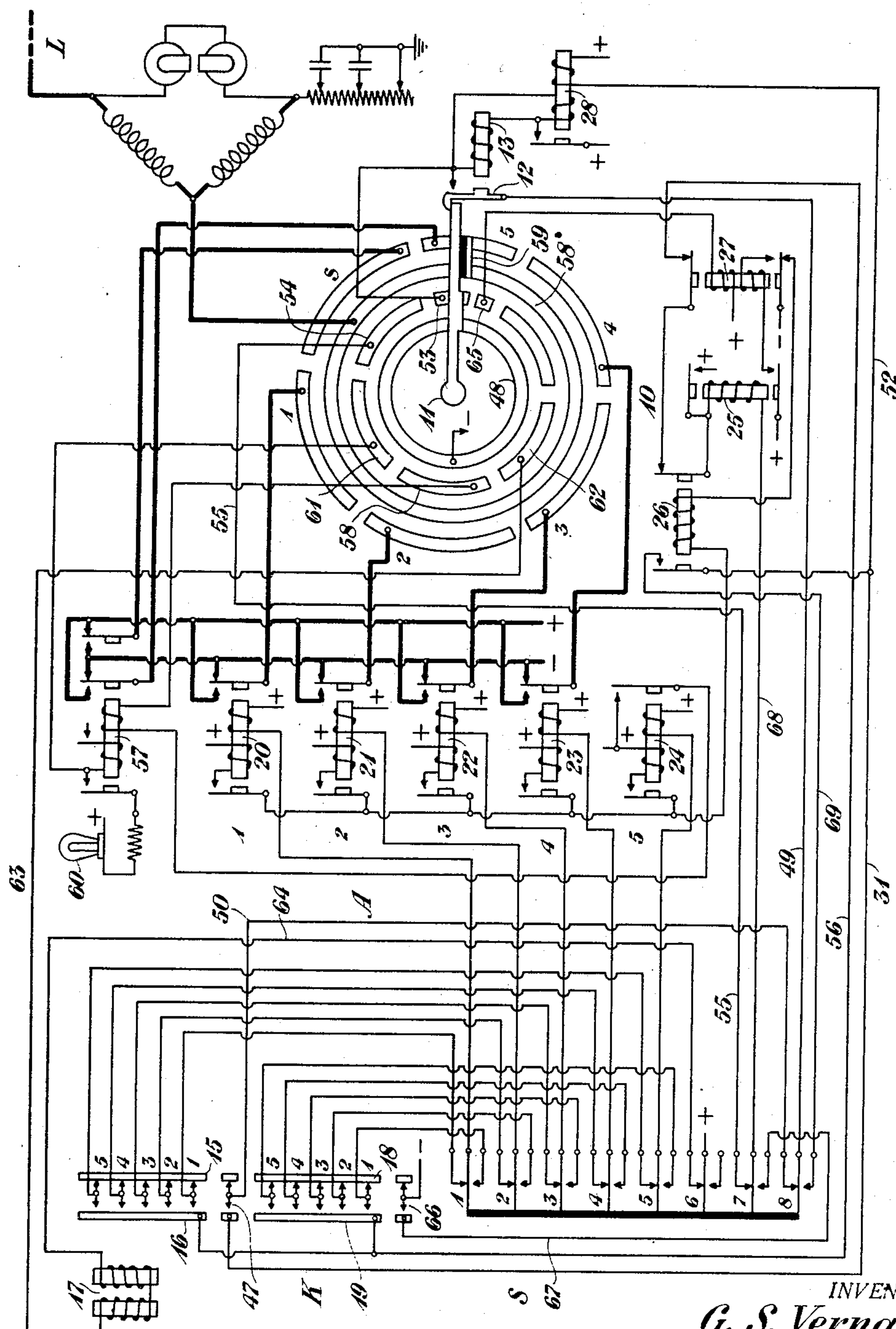


Fig. 2

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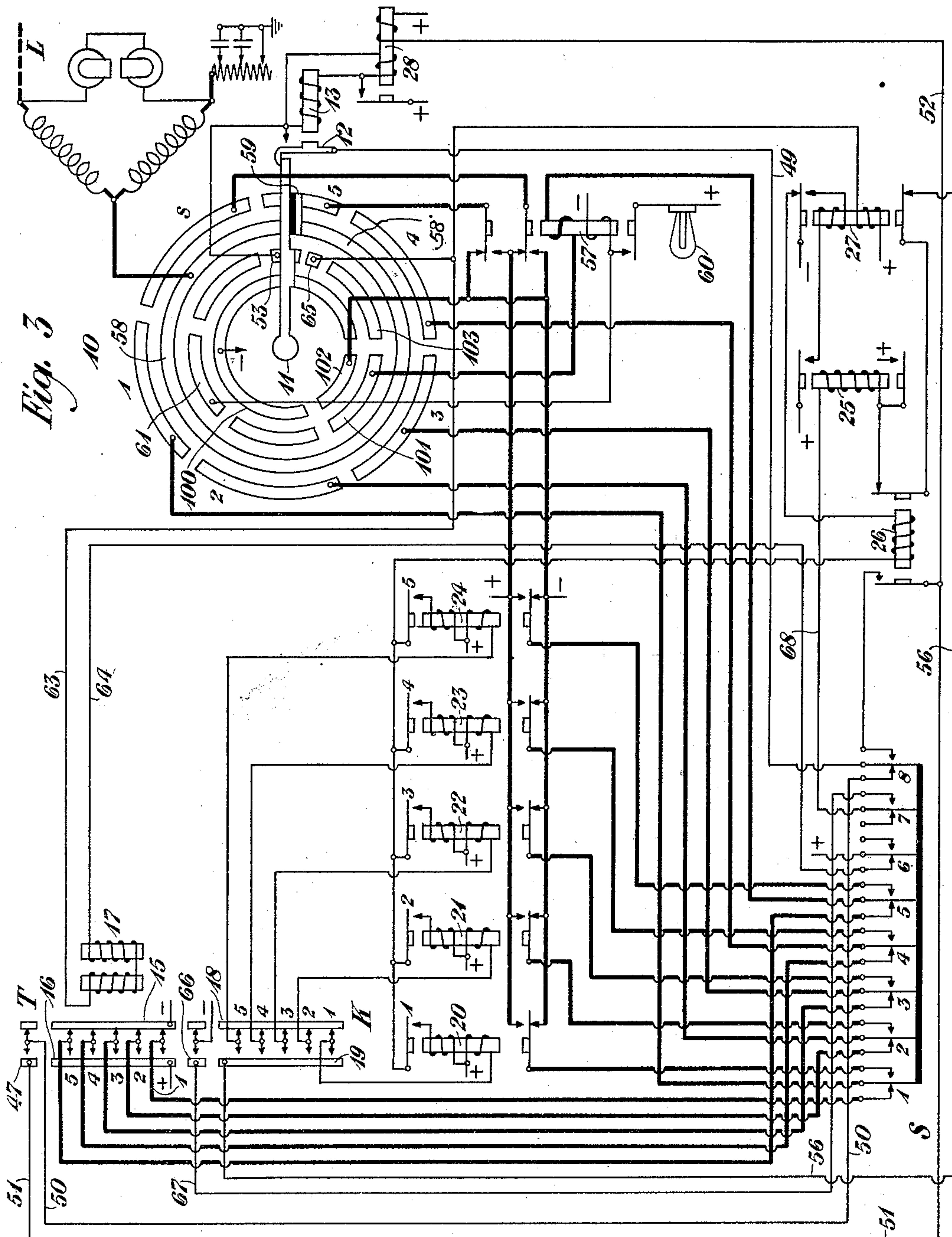
1,578,299

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PRINTING TELEGRAPH SYSTEM

Original Filed June 10, 1918

6 Sheets-Sheet 3



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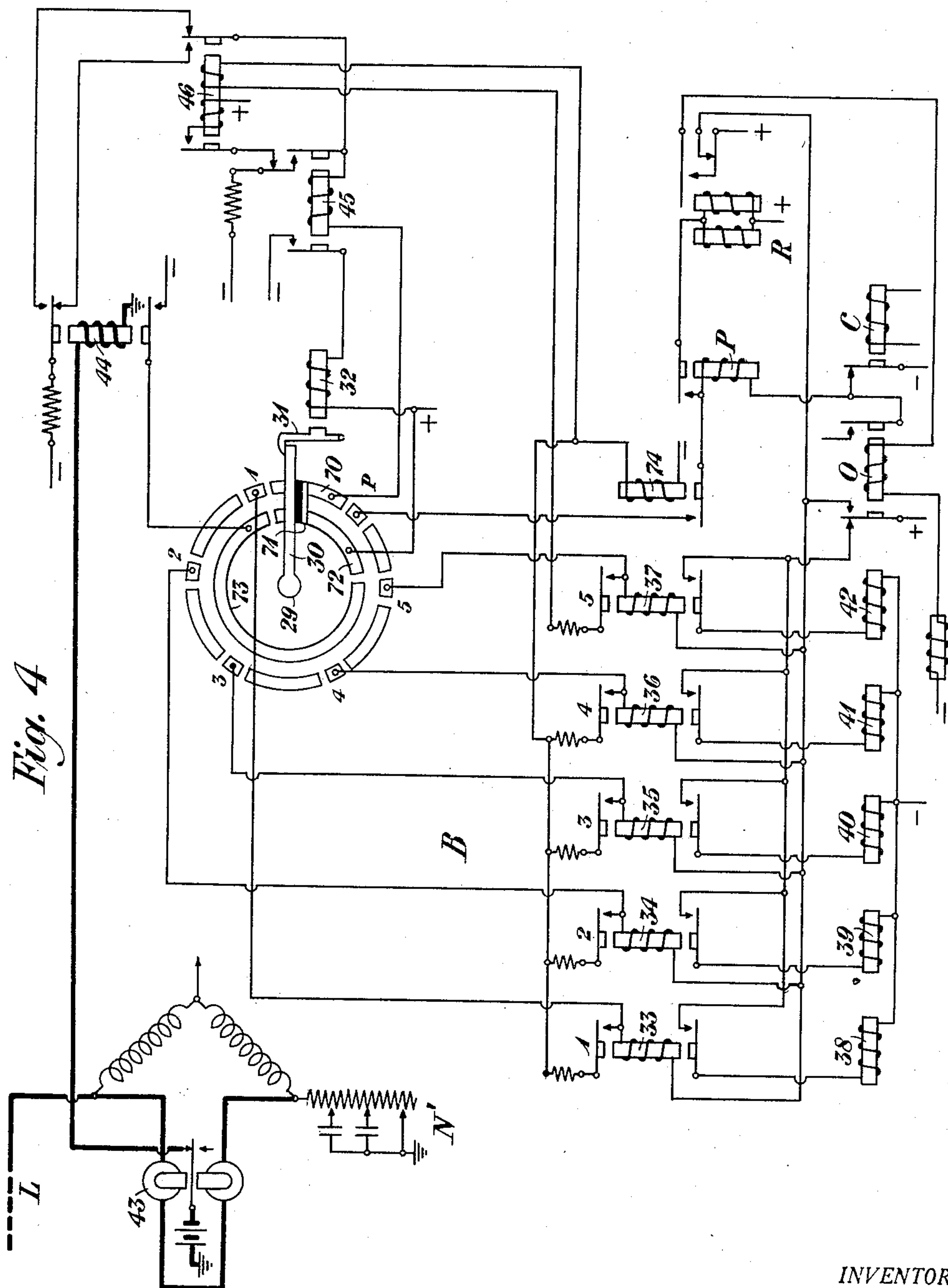
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1,578,299

PRINTING TELEGRAPH SYSTEM

Original Filed June 10, 1918 6 Sheets-Sheet 4



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PRINTING TELEGRAPH SYSTEM

Original Filed June 10, 1918

6 Sheets-Sheet 5

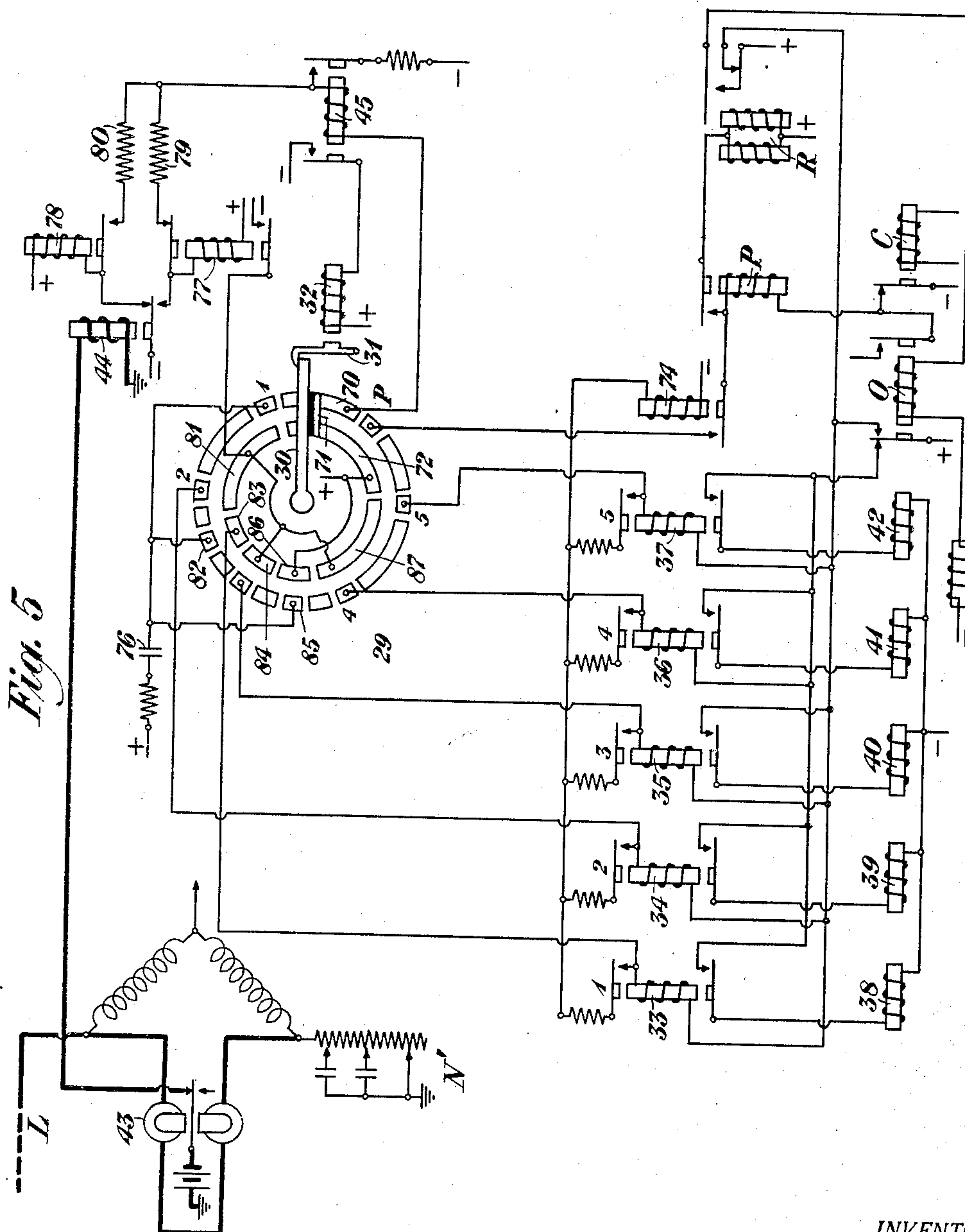


Fig. 5

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1,578,299

PRINTING TELEGRAPH SYSTEM

Original Filed June 10, 1918 6 Sheets-Sheet 6

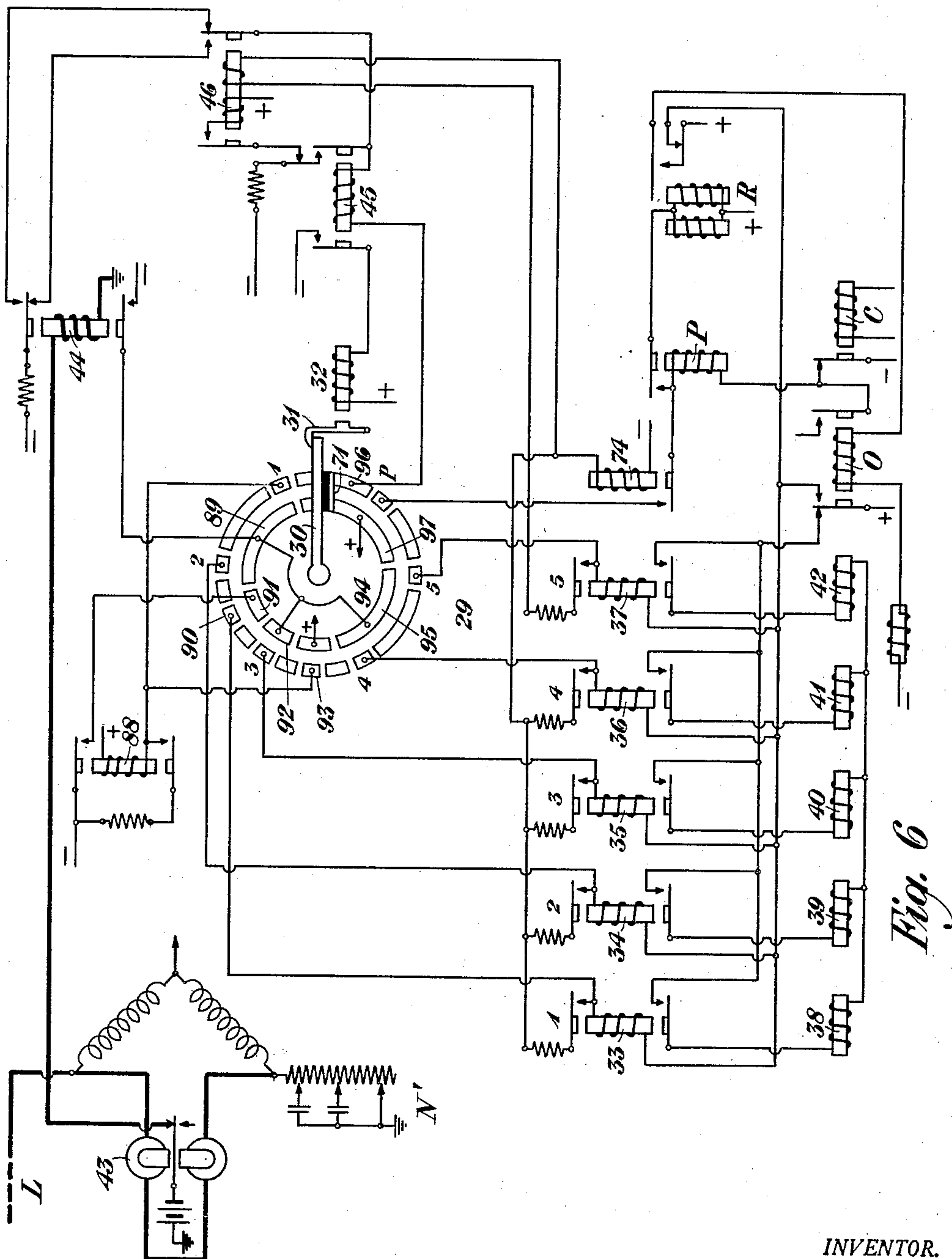


Fig. 6

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Patented Mar. 30, 1926.

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UNITED STATES PATENT OFFICE.

GILBERT S. VERNAM, OF BROOKLYN, NEW YORK, ASSIGNOR TO AMERICAN TELEPHONE AND TELEGRAPH COMPANY, A CORPORATION OF NEW YORK.

PRINTING-TELEGRAPH SYSTEM.

Original application filed June 10, 1918, Serial No. 239,257. Divided and this application filed March 28, 1922. Serial No. 547,592.

To all whom it may concern:

Be it known that I, GILBERT S. VERNAM, residing at Brooklyn, in the county of Kings and State of New York, have invented certain Improvements in Printing-Telegraph Systems, of which the following is a specification.

This application is a division of application Serial No. 239,257 filed June 10, 1918.

10 This invention relates to printing telegraphy, and more particularly to printing telegraph systems employing a distributor for distributing outgoing impulses to the line in predetermined and definite order, and
15 for distributing successively received impulses to selective printing mechanism in the order received. In its more specific aspects the invention relates to a system in which instead of continuously operating
20 synchronized distributors at the sending and receiving stations, a distributor is provided at each station, whose operation is intermittent, i. e., each distributor is started at each station, completes one operation, and then
25 stops preparatory to executing another cycle of operations, the starting and stopping of the distributors securing the same result as the synchronizing of the usual continuously operating distributors.

30 The invention has for one of its objects the provision of means whereby the time utilized for each cycle of operations may be reduced, thereby increasing the speed of operation.

35 Another object of the invention has reference to the provision of means whereby, instead of employing both a starting and a stopping impulse in addition to the usual code impulses, but a single impulse in addition
40 to the code impulses will be required.

45 A further object of the invention has reference to means whereby one of the impulses which would normally be of longer duration than the others may be shortened in order to compensate for the time during which the distributor is at rest between operations.

50 A further object of the invention relates to the provision of arrangements whereby the first or starting impulse of each series of impulses will always be different in character from the last preceding code impulse, thereby insuring that the distributor will only be set in operation when such a change in the character of the impulse takes place.

Another object of the invention has reference to the provision of means whereby when a code forming apparatus such as a tape transmitter or sending key sets up a given code group, the code group thus set up will be transferred to a suitable storing mechanism which will control the transmission of the code impulses, thus permitting of the setting up of a second code group while the first code group is being transmitted.

Another object of the invention has reference to the provision of means whereby if the sending key or other code forming mechanism be held operated for a period longer than that necessary to transmit the code group so formed, said code group will not be repeated.

Still another object of the invention has reference to the provision of means at the receiving station whereby one or more of the first impulses of a code group may be stored up until the printing operation resulting from the reception of a preceding code group has been completed.

Other and further objects of the invention will appear in connection with the detailed description to be hereinafter given. In the systems heretofore known employing a rotary distributor whose rotation is intermittent, it has been customary to send a starting impulse to set the distributor into motion, then send the code impulses making up a group corresponding to a given character, and finally send a stopping impulse to restore the apparatus to normal and prepare it for the succeeding group of impulses. Thus, with a Baudot code of five impulses to determine the character to be printed, it would be necessary to transmit seven impulses for each character. The time necessary to transmit these impulses would be further increased by the period during which the distributor is at rest between successive rotations so that altogether a time period equal to about seven and one half impulses would be necessary for the transmission of each character.

In order to reduce the time period necessary for the transmission of each character, means are provided in accordance with this invention whereby the distributor will always be brought to rest upon the transmission of the last impulse of a code group regardless of the character of said impulse,

thereby eliminating the extra stopping impulse, the organization being so arranged that the first or starting impulse of each group will be opposite to or different in character from the last impulse in the preceding set. In order to still further reduce the time period, the last impulse, which would normally be longer than the others, because of the period of rest between rotations, may be somewhat shortened in accordance with this invention, by making the corresponding segment of the sending distributor shorter than the others thereby compensating for the period of rest.

In order to permit of setting up a new combination upon the tape transmitter, controlling key or other means used to set up the code group for each character before the transmission of the preceding group has been completed, arrangements are provided whereby the code group set up will be stored by means of a set of relays which will then control the transmission of the code group, while the code forming means may be restored. This gives more time to advance the tape because of the overlap in the time periods and permits of a correspondingly more rapid operation of a keyboard transmitter. Means are also provided so that if a key is held operated for a period longer than that necessary to transmit the corresponding group of impulses, the distributor will not be caused to rotate a second time and repeat the previous character. In connection with the receiving end, after the last impulse of a group has been received a certain length of time is necessary to complete the printing operations. In order to eliminate this time period from the total time period necessary for the reception and printing of each character, the apparatus is so arranged that one or more of the first impulses of each code group is stored up and held ineffective until sufficient time has been given for operations connected with the printing of the preceding character, so that the selecting and printing operations overlap each other.

The invention may now be more fully understood by reference to the following description taken in connection with the accompanying drawings, Figures 1, 2 and 3 of which respectively illustrate three different forms of transmitting arrangements embodying the present invention, while Figs. 4, 5 and 6 respectively illustrate three forms of receiving arrangements embodying the invention. It will be understood, of course, that any one of the three forms of receiving arrangements illustrated may be used in connection with any one of the three forms of transmitting arrangements shown.

Referring now to Figs. 1 and 4, which, when placed end to end, constitute a circuit diagram of one form of the invention ar-

ranged for duplex operation, two stations A and B are shown interconnected by a line L terminating at each end in the usual duplex arrangement. At station A only the details of the transmitting apparatus are shown, while at station B only the details of the receiving apparatus are shown. The transmitting apparatus comprises a rotary distributor 10, having a plurality of segments over which an arm 11 is adapted to rotate. The segments are arranged in the form of four concentric rings, there being six segments in the outer ring, five of which correspond to the five impulses constituting the usual Baudot code, and the other of which corresponds to a starting impulse. The fifth segment of the five segments corresponding to the impulses of the code, is made somewhat smaller than the other segments in order to compensate for the increased length of the impulse sent from said segment due to the fact that the arm 11 remains at rest upon said contact for a brief period between successive revolutions, as will more fully appear hereafter.

The rotating arm 11 is normally held stationary by means of a releasing device 12 under the control of a starting magnet 13, and upon the energization of the latter, the releasing device 12 is tripped, permitting the arm 11 to rotate over the successive segments of the distributor, until it returns to its normal position, when it again engages the releasing device 12, the magnet 13 having in the meantime been deenergized. A pole changer 14 is provided which sends out to the line L successive positive or negative impulses as the arm 11 rotates over the segments of the distributor.

In order to control the formation of the sets or groups of code impulses corresponding to the various characters to be printed, a tape transmitter T is provided, said transmitter comprising five sets of contacts which normally rest upon an idle bus-bar 15, but which are adapted, as a perforated tape passes over suitable controlling means, to be shifted into contact with a bus-bar 16, so that circuits are completed corresponding to the perforations in the tape. The tape is advanced by means of a magnet 17 in a well-known manner.

An alternative means for setting up the groups of impulses corresponding to the characters is provided, said means comprising a key-controlled transmitter K consisting of five contacts normally resting against an idle bus-bar 18, but adapted to be moved into contact with the bus-bar 19 in various combinations, depending upon the key depressed. As the details of these code-forming mechanisms are well-known in the art and form no part of the present invention, they need not be further described.

In order to shift the control of the sending

apparatus from the tape transmitter T to the keyboard transmitter K, a gang switch S is provided having eight sets of contacts. Five of these sets of contacts control circuits leading to storing relays 20, 21, 22, 23, and 24 whereby the code combinations set up on the transmitter T or K as the case may be, is stored up so that the transmitter may be restored to normal for the purpose of setting up a second code group while the first group is being transmitted. An overlap relay 25, a keyboard relay 26, a lockout relay 27 and a starting relay 28 are provided, the purpose of these relays more fully appearing hereinafter.

The receiving apparatus illustrated at station B includes a distributor 29 comprising a plurality of segments arranged in two concentric rings over which an arm 30 is adapted to rotate. The arm 30 is held normally stationary by means of a catch 31 under the control of releasing magnet 32, which when energized permits the arm 30 to rotate over the segments of the distributor until it returns to its normal position where it again engages the catch 31, the magnet 32 having been in the meantime deenergized.

There are five segments in the outer ring corresponding one to each of the impulses constituting a code group, and an additional segment for the purpose of sending a printing impulse to the printing apparatus. In order to register the received selecting impulses, selecting relays 33, 34, 35, 36 and 37 are provided, said relays controlling the circuit of selecting magnets 38, 39, 40, 41 and 42, to control selecting devices whereby the character to be printed is determined in a manner well known in the art. A polarized line relay 43 is bridged between the line L and the artificial line N', said line relay 43 being arranged to control the circuit of a relay 44 in such a manner that when current of one polarity is flowing over the line, the relay 44 will be maintained energized, but when an impulse of opposite polarity is sent over the line the relay 44 will be deenergized.

The starting magnet 32 is under the control of starting relay 45, whose circuit is so arranged that it is under the joint control of relay 44 and a control relay 46, and said circuit is only completed when, after the last impulse of a given group has been received, a starting impulse of opposite polarity to said last impulse, is sent over the line to actuate the line relay 43. A printing relay P, an overlap relay O, a clearout relay C and a release magnet R are provided for purposes more fully hereinafter appearing.

The apparatus of Figs. 1 and 4 may now be fully understood from a description of the operation.

Assuming that it is desired to transmit by means of the tape transmitter T of Fig. 1, in response to the movement of the tape, the

contacts of the transmitter corresponding to the perforations in the tape will be moved into contact with the bus-bar 16. If the tape controlled lever contact 47 is closed a circuit will be completed from the negative pole of the battery over ring 48 of the distributor, arm 11, catch 12, conductor 49, over the eighth normal contact of the gang switch S, over conductor 50, switch 47, conductors 51 and 52, and through the right hand winding of starting relay 28 to the positive pole of the battery. Relay 28 is thereby energized and its front contact completes a circuit from the positive pole of the battery through its left hand winding in parallel with the winding of starting magnet 13, to segment 53, over arm 11 and ring 48 to the negative pole of the battery. Starting magnet 13 is now energized and withdraws the catch 12 from the arm 11 which now rotates over the various segments of the distributor. As soon as the arm 11 leaves the segment 53, the circuit through the locking winding of relay 28 and magnet 13 is broken, and the magnet 13 is restored to normal.

The arm 11 now passes over the starting segment S of the outer ring. At this time, assuming that the first, third and fifth contacts of the tape transmitter have been actuated, a circuit is completed from the negative pole of the battery over the inner ring 48 of the distributor, arm 11, segment 54, conductor 55, the seventh normal contact of the gang switch S, winding of overlap relay 25, right hand contact of keyboard relay 26, upper back contact of lockout relay 27, conductor 56, bus-bar 16, first, third and fifth contact of the tape transmitter, the upper first, third and fifth contacts of the gang switch, and through the right hand windings of storing relays 20, 22 and 24 to battery. The overlap relay 25 at its upper front contact completes a locking circuit from the positive pole of the battery through the winding of the overlap relay, over the seventh contact of gang switch, conductor 55, segment 54, arm 11 and ring 48, to the negative pole of the battery, said locking circuit remaining closed until the arm 11 leaves the starting segment of the distributor. Storing relays 20, 22 and 24 are also energized, thereby completing locking circuits from positive battery through their left hand windings and over their front left hand contacts in parallel, and thence through winding of keyboard relay 26 and over the lower back contact of lockout relay 27 to the negative pole of the battery. Keyboard relay 26 is thereby energized and at its right hand contact opens the initial energizing circuit previously traced through the overlap relay and the contacts of the tape transmitter for the storing relays. The storing relays are now removed from the control of

the tape transmitter so that the tape may be advanced and the contacts reset for another group of code impulses.

As the arm 11 passes over the starting segment of the distributor, a starting impulse will be sent to the line L, whose character depends upon the character of the last impulse of the code group previously transmitted. Assuming that in setting up the previous group of impulses the fifth contact of the tape transmitter had been actuated, thereby actuating the storing relay 24, a circuit would have been completed from the positive pole of the battery over the front right hand contact of relay 24, through the right hand winding of controlling relay 57, over segment 58, arm 11 and ring 48 of the distributor, to the negative pole of the battery, thereby energizing the relay 57 which is locked up over its left hand winding and over its left hand front contact. Consequently as the arm 11 in transmitting the code group now set up, passes over the starting segment S, a circuit is completed from ground over the second ring 58' of the distributor, insulated contact 59 carried by arm 11, starting segment S, front right hand contact of relay 57, winding of pole changing relay 14, to battery. Pole changing relay 14 is thereby energized, and a negative starting impulse is sent over its front contact to the line L. It will be noted that the fifth impulse of the preceding group was positive, due to the fact that while the contact 59 was resting upon the fifth segment of the distributor, the circuit of the relay 14 was held open at the right hand contact of the relay 57. Had the last impulse of the preceding group been negative, as would have been the case if the fifth contact of the tape transmitter T had been unactuated, the storing relay 24 would not have been energized, and consequently the circuit of relay 57 would not have been completed. Consequently as the arm 11 passed over the starting segment S, the circuit of pole changing relay 14 would not have been completed, as the right hand armature of relay 57 would be resting upon its back contact. The armature of the relay 14 would then rest upon its back contact so that a positive starting impulse would have been transmitted to the line L.

As soon as the arm 11 leaves the segment 54, the locking circuit of the overlap relay 25 is broken, and said relay is restored to normal. The arm 11 now passes over the first segment of the outer ring of the distributor, so that the control of the pole changing relay 14 has now passed from the starting segment S to the first segment. Inasmuch as storing relay 20 is now energized, the circuit of the pole changing relay is broken, and a positive impulse is sent to the line. At the same time the locking winding of the relay 57 is short circuited from the positive pole of the

battery through the pilot lamp 60, over the left hand front contact of relay 57, segment 61, arm 11 and ring 48 of the distributor, to the negative pole of the battery. Relay 57 is now deenergized and restored to normal.

The arm 11 now passes to the second segment of the commutator, the circuit of the pole changing relay 14 being now transferred to said segment. As storing relay 21 is not operated, a circuit for the pole changing relay is now completed from ground, over ring 58', insulated contact 59 carried by arm 11 and the second segment of the outer ring of the distributor, over the back contact of relay 21, through the winding of relay 14 to battery. Relay 14 now operates to send a negative impulse over the line L. At the same time, owing to the fact that storing relay 24 was locked up upon the formation of the code group now being transmitted, a circuit is completed from the negative pole of the battery over ring 48, arm 11 and segment 58 of the distributor, through the right hand winding of relay 57, over the front right hand contact of storing relay 24, to the positive pole of the battery. Relay 57 is now locked up, thereby determining that the starting impulse of the next group shall be negative, and that the last impulse of the present group shall be positive, as will appear later.

As the contact 59 carried by the arm 11 leaves the second segment and passes over the third segment of the outer ring of the distributor, the circuit of the pole changing relay 14 is broken by reason of the fact that the storing relay 22 is energized. A positive impulse is therefore sent to the line L over the back contact of the pole changer. At the same time a circuit is completed from the negative pole of the battery over ring 48, arm 11 and segment 62 of the distributor, over conductor 63, through the winding of the transmitter magnet 17, over conductor 64, and over the sixth contact of the gang switch, to the positive pole of the battery. The magnet 17 of the transmitter is now actuated to advance the tape another step and set up a different combination upon the transmitter T. The new combination thus formed does not at this time produce any result, as the initial energizing circuits of storing relays 20 to 24 inclusive are held open at the right hand contact of the keyboard relay 26 as already described.

The arm 11 now leaves the third segment of the outer ring of the distributor and passes over the fourth segment. As the arm 11 leaves the segment 62, the circuit of the transmitter magnet 17 is broken, and as the contact 59 carried by the arm 11 leaves the third segment of the outer ring and passes over the fourth segment, the circuit of the pole changing relay 14 is again completed at the right hand back contact of storing

relay 23, thereby sending a negative impulse to the line L.

The arm 11 now leaves the fourth segment of the outer ring of the distributor and passes over the fifth segment, which it will be noted is shorter than the other segments. As the contact 59 carried by the arm 11 passes over the fifth segment, the control of the circuit of the pole changing relay 14 is transferred from the storing relay 23 to the relay 57 which, it will be remembered was energized over the front right hand contact of the storing relay 24. As relay 57 is now energized, the circuit of the pole changing relay 14, which would extend from ground over the ring 58, contact 59 and fifth segment of the outer ring of the distributor, and thence over the right hand contact of relay 57 through the winding of pole changing relay 14 to battery, is now open at the right hand contact of relay 57. Consequently a positive impulse is transmitted over the line L. At the time the arm 11 started in its travel over the fifth segment of the commutator, a circuit was completed from the negative pole of the battery, over ring 48, arm 11 and segment 65 of the distributor, through the upper winding of the lockout relay 27 to the positive pole of the battery. Relay 27 is thereby energized and at its lower contact opens the locking circuits of the storing relays 20, 22 and 24 which, it will be recalled, passed through the winding of the keyboard relay 26. The storing relays and the relay 26 are thereby deenergized. The initial energizing circuit of the storing relays is not completed, however, by the closure of the right hand contact of the keyboard relay 26, as said circuit is now held open at the upper contact of the lockout relay 27. As soon, however, as the arm 11 leaves the segment 65, the relay 27 is deenergized, and the circuit through the transmitter contacts and the storing relays is prepared by the falling off of the upper armature of the relay 27. Upon leaving the segment 65 the arm 11 passes on and comes into contact with the catch 12 just after making contact with the segment 53. The apparatus is now in condition for another cycle of operations, and if, as would normally be the case, a new combination has already been set up by the tape transmitter and if contact 47 is closed, the initial energizing circuit of the starting relay 28 will be completed as soon as the arm 11 comes into engagement with the catch 12, thereby initiating the next cycle of operations.

If, instead of using the tape transmitter, it is desired to send by means of the keyboard transmitter K, the gang switch S will be shifted to its lower position, thereby transferring the control of the storing relays 20 to 24 inclusive from the contacts of the tape transmitter T to the correspond-

ing contact of the keyboard transmitter K. Upon operating a key of the keyboard, a code combination will be set up whereby certain of the contacts of the transmitter K are shifted from the idle bus-bar 18 into contact with bus-bar 19. The common keyboard contact 66 is also closed, said contact remaining closed so long as the key is depressed. The closure of this contact, assuming that the code combination set up has resulted in the shifting of the first, second and fourth contacts of the key transmitter, completes the following circuit: from the negative pole of the battery, over contact 66, conductor 67, lower seventh contact of the gang switch, conductor 68, through the winding of the overlap relay 25, back contact of the keyboard relay 26, back contact of lockout relay 27, conductor 56, bus-bar 19 of the transmitter K, first, second and fourth contacts of said transmitter, lower first, second and fourth contacts of the gang switch, and in parallel through the windings of relays 20, 21 and 23 to positive pole of the battery. Overlap relay 25 and storing relays 20, 21 and 23 are energized over the circuit just traced, overlap relay 25 completing a locking circuit from positive pole of the battery over its upper front contact, through the winding of said relay, over conductor 68, lower seventh contact of the gang switch, over conductor 67 and common keyboard contact 66, to the negative pole of the battery. The overlap relay will therefore be maintained energized so long as the key is held depressed. Relays 20, 21 and 23 upon being energized, at their front left hand contacts complete locking circuits from the positive pole of the battery, in parallel through their left hand windings, and over their left hand front contacts through the winding of keyboard relay 26, and over the lower back contact of lockout relay 27, to the negative pole of the battery. Keyboard relay 26 is thereby energized and at its right hand contact opens the initial energizing circuit of the overlap relay 25 which it will be recalled, was traced through the right hand windings of the storing relays. Consequently the storing relays are now rendered independent of the keyboard transmitter contacts and a new combination may be set up by depressing another key without affecting the storing relays which now control the transmission of the code combination already set up. The keyboard relay 26 at its left hand front contact completes a circuit from the negative pole of the battery, over ring 48, arm 11 of the distributor, catch 12, conductor 49, lower eighth contact of the gang switch, conductor 69, front contact of keyboard relay 26, conductor 52 and right hand winding of starting relay 26, to the position pole of the battery. Starting

relay 28 is thereby energized and at its front left hand contact completes a circuit from the positive pole of the battery through its left hand winding in parallel with the winding of starting magnet 13, over segment 53, arm 11 and ring 48 of the distributor, to the negative pole of the battery. Magnet 13 is thereby energized, and withdraws the catch 12 from the arm 11, which begins to rotate over the segments of the distributor.

Assuming that, as a result of the combination previously transmitted, the relay 57 had not been energized, the pole changing relay 14 would have been maintained energized, while the arm 11 remained upon the fifth segment of the distributor, so that the last impulse transmitted over the line L would have been negative. As the arm 11 passes from the fifth segment of the distributor to the starting segment, the control of the circuit of relay 14 is transferred to the starting segment, and said relay is now deenergized, so that a positive starting impulse is sent over the line L. The arm 11 then passes to the first segment of the outer ring of the distributor, thereby transferring the control of the pole changing relay 14 to the storing relay 20. As this relay is energized, pole changing relay 14 remains deenergized, and the first code impulse is therefore positive. During the transmission of the first selecting impulse, as the arm 11 passes over the segment 61, the locking winding of the relay 57 would have been short circuited to deenergize said relay in the manner already described, had it been energized.

The arm 11 now passes over the second segment of the outer ring of the distributor, thereby transferring the control of the pole changing relay 14 from storing relay 20 to storing relay 21. As this relay is also energized, pole changing relay 14 remains deenergized, and the second selecting impulse sent to the line L will be positive. During the transmission of this impulse, the arm 11 passes over the segment 58 to complete the circuit of the right hand winding of the relay 57. As said circuit is controlled by the right hand contact of storing relay 24, which relay it will be remembered is not energized during the transmission of the code combination now being transmitted, the circuit of the relay 57 will not be completed, and said relay will not be energized. The arm 11 now passes to the third segment of the outer ring of the distributor, thereby transferring the control of the pole changing relay 14 to storing relay 22. As this relay is deenergized at this time, relay 14 is energized, and the third selecting impulse sent to the line L will be negative. The arm 11 then passes to the fourth segment of the outer ring of the distributor, thereby transferring the con-

trol of the pole changing relay to the storing relay 23. As this relay is energized, the relay 14 will be deenergized, and the fourth selecting impulse will be positive. The arm 11 now passes to the fifth segment of the outer ring of the distributor. The control of the pole changing relay is thereby transferred from the storing relay 23 to the relay 57. Relay 57 is not energized at this time, owing to the fact that the storing relay 24 was not energized by the code combination now being transmitted. Accordingly the circuit of the pole changing relay is completed, and the last selecting impulse sent to the line will be negative.

As the arm 11 passed to the fifth segment of the outer ring of the distributor, said arm passed over the segment 65, thereby completing a circuit from the negative pole of the battery, over ring 48, arm 11 and segment 65 of the distributor, and through the upper winding of the lockout relay 27 of the positive pole of the battery. Relay 27 is now energized, opening at its lower contact the locking circuit already traced through the left hand windings of the storing relays, and through the winding of the keyboard relay 26. The storing relays are thereby deenergized, and the keyboard relay 26 is restored to normal, thereby preparing the initial energizing circuits of the keyboard relays at its right hand back contact. Said circuits are held open, however, at the upper contact of the lockout relay 27. If now the key is still held depressed, and the common keyboard contact 66 maintained closed, the overlap relay 25 will still remain locked up, so that a locking circuit is completed from the positive pole of the battery over the lower front contact of relay 25, through the lower winding and lower front contact of a lockout relay 27 to the negative pole of the battery. Consequently lockout relay 27 will be maintained energized until the key is released. This arrangement prevents the possibility of a false operation due to the continued depression of the transmitter key which, were it not for the fact that the upper contact of the relay 27 is held open, would result in again setting up the same combination upon the storing relays, so that the same code group would be again transmitted.

As soon as the arm 11 leaves the segment 65, the initial energizing circuit of the lockout relay 27 is broken, and if the key of transmitter K has already been restored, with the consequent deenergization of the overlap relay 25, the lockout relay 27 is deenergized. If the key is not restored this result does not take place until the key is released. The arm 11 in the meantime comes into engagement with the catch 12, and rests upon the segment 53, so that the apparatus is now ready for another cycle of operations.

Referring now to Fig. 4, which shows a form of receiving apparatus adapted to co-operate with the transmitting apparatus just described, it will be noted that the receiving apparatus is under the control of a relay 44 whose circuit is controlled by polarized line relay 43. Assuming now that a series of five selecting impulses is being received over the line L, the first, third and fifth selecting impulses being positive and the second and fourth being negative, and further assuming that the last selecting impulse of the preceding code group was negative, it will be evident from the preceding description of the apparatus in Fig. 1 that the group of selecting impulses now being received will be preceded by a positive starting impulse. The last selecting impulse of the preceding group being negative, resulted in holding the armature of the polarized relay 43 against its upper contact, so that the circuit of relay 44 is completed. As soon, however, as the positive starting impulse is received, the armature of the line relay 43 is shifted to its lower contact, thereby opening the circuit of relay 44 which is deenergized and closes at its upper contact a circuit from the negative pole of the battery, over the upper back contact of relay 44, right hand back contact of relay 46, winding of starting relay 45, segment 70, contact 71 and segment 72 of distributor 29, to the positive pole of the battery. Relay 45 is thereby energized, and at its right hand contact completes a locking circuit from the negative pole of the battery over the right hand front contact and through the winding of relay 45 and over segment 70, contact 71 and segment 72 of the distributor to positive pole of the battery. Relay 45 at its left hand front contact completes the circuit of starting magnet 32 which withdraws the catch 31 from the arm 30 of the distributor, permitting the arm to rotate over the segments of the distributor. As soon as the contact 71 of the distributor leaves the segment 70, the starting relay 45 is deenergized, thereby deenergizing starting magnet 32.

As the arm 30 rotates, contact 71 passes over the first segment of the outer ring of the distributor. Segment 73 of the inner ring of the distributor, it will be noted, is connected to the lower contact of relay 44. At the instant that the contact 71 passes over the first segment of the outer ring of the distributor, the first selecting impulse will be received from the line, and as said impulse is positive, relay 44 will remain deenergized so that a circuit is completed from the negative pole of battery over the lower back contact of relay 44, segment 73, contact 71 and the first segment of the outer ring of the distributor, and thence through the winding of selecting relay 33 and over the normal contact of the release magnet R

to the positive pole of the battery. Relay 33 is locked up over a circuit from the negative pole of the battery, through the winding of relay 74, upper front contact of relay 33, and normal contact of release magnet R, to the positive pole of the battery. The relay 74 which is energized over said circuit is ineffective at this time.

The arm 30 now continues to rotate until the contact 71 passes over the second segment of the outer ring of the distributor, at which instant the second selecting impulse is being received over the line. This impulse being negative the polarized relay shifts its armature to its upper contact, completing the circuit of relay 44 which at its lower contact holds open the circuit extending from the second segment of the outer ring of the distributor to the relay 34. Accordingly selecting relay 34 is not operated. The arm 30 now continues rotating, and as the contact 71 passes over the third segment of the outer ring of the distributor, the third selecting impulse is received over the line. This impulse being positive, relay 44 is deenergized, thereby completing a circuit from the negative pole of the battery over the lower back contact of relay 44, segment 73, contact 71, and third segment of the outer ring of the distributor, through the winding of relay 35 and over the normal contact of the release magnet R to the positive pole of the battery. Relay 35 is thereby energized and completes a locking circuit similar to that already traced for relay 33. Similarly as the arm continues to rotate, a negative impulse is received as the contact 71 passes over the fourth segment of the outer ring of the distributor, and the positive impulse is received as it passes over the fifth segment. The negative impulse received as the contact passes over the fourth segment, produces no effect upon the selecting relay 36, but the positive impulse received as the contact passed over the fifth segment, results in the deenergization of relay 44, with the consequent closure of a circuit from the negative pole of the battery, over segment 73, contact 71 and fifth segment of the outer ring of the distributor, through the winding of selecting relay 37, and over the normal contact of release magnet R, to the positive pole of the battery. Relay 37 closes a locking circuit from the negative pole of the battery, through the winding of the relay 74, through the right hand winding of relay 46, over the upper front contact and winding of relay 37, and over the normal contact of release magnet R, to the positive pole of the battery. Selecting relays 33, 35 and 37 are now energized, thereby completing at their lower contacts, circuits from the negative pole of the battery, through the windings of selecting magnets 38, 40 and 42, over the lower front contacts of the corresponding selecting

relays, and over the left hand back contact of overlap relay O to the positive pole of the battery. The selecting magnets shift the disks of the selector, not shown, to determine the character to be printed.

The circuit just traced through the right hand winding of the relay 46, results in the energization of said relay, which thereupon completes a locking circuit from the positive pole of the battery, through left hand winding and over the left hand contact of said relay, over the right hand normal contact of relay 45, to the negative pole of the battery. Relay 46 now remains energized until the starting relay 45 is energized in response to the next starting impulse. Relay 46 at its right hand front contact, shifts the control of the starting relay circuit from the upper back contact of relay 44 to the upper front contact of said relay. As the last selecting impulse just received was positive, relay 44 is at this time deenergized, so that the circuit of the relay 45 will not now be completed until a negative starting impulse is received.

In the meantime, while the operations just described have been taking place, the arm 30 has continued to rotate, so that the contact 71 passes over segment P of the outer ring of the distributor, thereby closing a printing circuit from the positive pole of the battery, over segment 72, contact 71 and segment P of the distributor, over the lower front contact of relay 74, through the winding of the printing relay P, and over the back contact of the clearout relay C, to the negative pole of the battery. The printing relay is thereupon energized, and completes a locking circuit from the positive pole of the battery through the windings of release magnet R, the upper front contact of printing relay P and back contact of relay C, to the negative pole of the battery. The release magnets R being actuated, shift the stop bar, not shown, into the aligned slots of the selector disks, and the printing operation proceeds. The release magnets R also operate to open their normal contact, thereby disconnecting the positive pole of the battery from the windings of the selecting relays, which are thereupon restored to normal. At the same time, the front contact of the release magnet is closed, completing a circuit from the positive pole of the battery through the overlap relay O to the negative pole of the battery. The overlap relay O is thereupon energized, and at its left hand contact opens the circuit of the selector magnets, restoring them to normal, and at its front left hand contact connects the positive pole of the battery with the windings of the now restored selecting relays which are again in condition to receive the new set of selecting impulses while the printing operation resulting from the preceding set proceeds. At the end of the

printing operation, the clearout relay C is operated, thereby opening the circuit of the printing relay P and the release magnet R, and restoring the circuits to the normal condition.

While the printing operation is being started, the arm 30 continues to rotate until it engages with the catch 31, whereupon it comes to rest until a starting impulse is again received. As already pointed out, the last selecting impulse received being positive, the relay 44 is deenergized, so that no circuit is completed through the starting relay 45, but as soon as a negative starting impulse is received the relay 44 will be energized, thereby completing a circuit from the negative pole of the battery over the upper front contact of relay 44 and the right hand front contact of relay 46, through the winding of the starting relay 45 and over segment 70, contact 71 and segment 72 of the distributor. The starting relay functions as before to release the arm 30, and at its right hand front contact opens the locking circuit previously traced for the relay 46, which is now restored to normal. Relay 46 will not again be energized until the last selecting impulse of a received code group, is passed. It will thus be seen that the receiving distributor will only be released when the last impulse of any code group is followed by a starting impulse of opposite polarity.

A modified form of receiving arrangement is shown in Fig. 5, said arrangement differing from that of Fig. 4 in that the distributor has certain additional segments to which circuits are connected whereby the first received selecting impulse may be stored up on the condenser 76 without at once affecting the first selecting relay 33. This arrangement allows sufficient time for the release magnets R and the overlap relay O to be energized, to prepare the circuit for the actuation of the selecting relays. The arrangement shown in Fig. 5 also differs from that in Fig. 4 in that a somewhat different means for controlling the circuit of the starting relay 45 is provided. This controlling means will be more fully understood from a description of the operation.

Assuming that the last received selecting impulse was negative so that the relay 44 is energized, upon receiving a positive starting impulse from the line L the polarized relay 43 will shift its contact, thereby opening the circuit of relay 44. Relay 44 thereupon at its lower back contact completes a circuit from the negative pole of the battery, over back contact of relay 44 and through the winding of relay 77, to positive pole of the battery, and in parallel with the winding of relay 77, over the upper back contact of said relay, through resistance coil 79, through the winding of start-

ing relay 45 and over segment 70, contact 71 and segment 72 of the distributor, to the positive pole of the battery. Relays 77 and 45 are thereupon energized, the latter closing a locking circuit over its right hand front contact through its winding and thence over the circuit previously traced, to maintain said relay energized until the contact 71 leaves segment 70. Starting relay 45 at its left hand contact closes the circuit of starting magnet 32, which withdraws the catch 31 from the arm 30, permitting it to rotate. As the arm 30 rotates, the contact 71 passes over the first segment of the outer ring of the distributor. At this moment the first selecting impulse is being received over the line L, and assuming this impulse to be positive, the relay 44 remains deenergized so that the circuit of the relay 77 is completed over its lower back contact. Relay 77 being energized connects the negative pole of the battery over its lower front contact, over segment 81, contact 71, the first segment of the outer ring of the distributor, to the condenser 76, thereby charging said condenser. As the arm 30 continues to rotate, the contact 71 passes over the second segment of the outer ring of the distributor. At this time, a second selecting impulse is being received, and assuming this impulse to be negative, relay 44 is energized, thereby opening the circuit of relay 77 and closing the circuit of relay 78. The deenergization of relay 77 opens a circuit which would otherwise be completed from the negative pole of the battery and over segment 61, contact 71 and the second segment of the outer ring of the distributor to the winding of selecting relay 34. Accordingly, selecting relay 34 is not operated.

As the arm 30 continues to rotate, it passes over a segment 82 located midway between the second and third segments of the outer ring of the distributor. A circuit is thereby completed from the condenser 76, over segment 82, contact 71, segment 83, through the winding of selecting relay 33 and over the normal contacts of the release magnet R, to the positive pole of the battery. The condenser 76 is thereby discharged through this circuit, energizing the selecting relay 33 which is locked up through the winding of relay 74, and completes the circuit of selecting magnet 38. Upon further rotation of the arm 30, the contact 71 passes over the third segment of the outer ring of the distributor at the same instant that the third selecting impulse is being received. Assuming this impulse to be positive, the relay 44 is deenergized, completing a circuit for the relay 77 which in turn connects the negative pole of the battery over its lower front contact and over segment 84, contact 71 and the third segment of the outer ring of the distributor, through the winding of

selecting relay 35, to the positive pole of the battery. Selecting relay 35 is thereupon energized, closing its locking circuit, and completing the energizing circuit of selecting magnet 40. The arm 30 now carries the contact 71 over a segment 85, midway between the third and fourth segments of the outer ring of the distributor. A circuit is thereby completed from the condenser 76 over the segment 85, contact 71 and segment 86 of the distributor, to the positive pole of the battery, thereby completely discharging the condenser 76, if said condenser had not already been completely discharged through the winding of selecting relay 33. As the fourth selecting impulse is being received, the contact 71 passes over the fourth segment of the outer ring of the distributor. If this impulse is negative, the relay 44 is energized, completing the circuit of relay 76 and opening the circuit of relay 77. As a result, no circuit is completed over the fourth segment, through selecting relay 36. The arm 30 now carries the contact 71 over the fifth segment of the outer ring of the distributor, as the last selecting impulse is being received. Assuming this impulse to be positive, a circuit would be completed from the negative pole of the battery, through the lower front contact of relay 77, over segment 87, contact 71, and fifth segment of the outer ring of the distributor, through winding of selecting relay 37, to the positive pole of the battery. Relay 37 is thereupon locked up and completes the circuit of selecting magnet 42. The contact 71 is then carried over the segment P, thereby completing the printing circuit from the positive pole of the battery, over segment 72, contact 71, segment P, lower front contact of relay 74, winding of the printing relay P and back contact of the clearout relay C, to the negative pole of the battery. The printing operation now proceeds as described in connection with Fig. 4, and need not be further considered.

As the arm 30 continues to rotate it comes into engagement with the catch 31 and is brought to rest awaiting the starting impulse. As the last received selecting impulse was positive, the starting impulse must now be negative. The last positive selecting impulse it will be remembered, resulted in the deenergization of the relay 44, with the consequent energization of the relay 77. Relay 78 is now deenergized and as soon as a negative starting impulse is received the relay 44 will be energized, thereby completing the circuit of the starting relay 45 over the lower front contact of relay 44, back contact of relay 78, resistance coil 30, winding of relay 45, segment 70, contact 71 and segment 72 of the distributor, to the positive pole of the battery. The

distributor will thereupon be released by the release magnet 32, and the operation proceeds as already described.

A still further modification of the receiving apparatus is illustrated in Fig. 6. In this arrangement the control of the starting relay 45 is the same as in Fig. 4. The arrangement for storing up the first received selecting impulse to allow sufficient time for the printing operation to proceed, in this form consists of a storing relay 88, whose action will be more fully understood from a description of the operation.

Assuming that a starting impulse has been received so that the relay 45 is energized to complete the circuit of the starting magnet 32, the catch 31 will be withdrawn from the arm 30 as before, permitting the arm 30 to carry the contact 71 over the first segment of the outer ring of the distributor. At this instant, as a positive selecting impulse is being received, the relay 44 will be deenergized, thereby completing a circuit from the negative pole of the battery, over the lower back contact of relay 44, segment 89, contact 71, and first segment of the outer ring of the distributor, through the winding of the relay 86 to the positive pole of the battery, thereby energizing the relay 88. Relay 88 thereupon closes a locking circuit from the positive pole of the battery, through the winding and over the lower front contact of said relay, to the negative pole of the battery.

As the arm 30 continues in its travel, the contact 71 passes over the second segment of the outer ring of the distributor. Assuming that the selecting impulse received at this moment is negative, relay 44 will be energized, and no circuit will be completed for the selecting relay 34 over the second segment of the outer ring of the distributor. The arm 30 now carries the contact 71 over a segment 90 midway between the second and third segments of the outer ring of the distributor, whereupon a circuit is closed over the upper front contact of relay 88, and over segment 91, contact 71 and segment 90 of the distributor, through the winding of selecting relay 33, over the normal contact of release magnets R, to the positive pole of the battery. It will thus be seen that the first selecting impulse is stored up by the relay 88 and is not effective to actuate the selecting relay until after the second selecting impulse has been received.

The arm 30 now continues rotating, thereby carrying the contact 71 over the third segment of the outer ring of the distributor, whereupon, assuming that a positive impulse is at this moment being received over the line, a circuit is closed from the negative pole of the battery over the lower back contact of relay 44, segment 92, contact 71 and third segment of the outer ring of the dis-

tributor, through the winding of selecting relay 35, to the positive pole of the battery. Selecting relays 33 and 35 when actuated, are locked up in the manner described in connection with Figs. 4 and 5, and close the circuits of the selecting magnets 38 and 40. The contact 71 now passes over a segment 93, midway between the third and fourth segments of the outer ring of the distributor, thereby short-circuiting the winding of relay 88 over a circuit from the positive pole of the battery, over segment 94, contact 71 and segment 93 of the distributor, over the lower front contact of relay 88, to the negative pole of the battery. Relay 88 is thereupon deenergized and restored to normal.

The distributor now continues its rotation, passing over the fourth and fifth segments of the outer ring of the distributor, and assuming that the corresponding impulses are negative and positive respectively, the selecting relay 36 is unactuated, but the positive impulse results in the deenergization of relay 44, whereupon a circuit is closed from the negative pole of the battery, over the lower back contact of relay 44 and over segment 95, contact 71 and fifth segment of the outer ring of the distributor, through the winding of selecting relay 37, to the positive pole of the battery. Relay 37 closes a circuit for selecting magnet 42 at its lower contact, and at its upper contact closes a locking circuit from the positive pole of the battery through the normal contact of the release magnets R, through the winding and over the upper front contact of relay 37, through the right hand winding of relay 46 and through the winding of relay 74, to the negative pole of the battery. Relay 74 had already been energized over the locking circuits of the other selecting relays, but the circuit just traced results in the energization of relay 46, which completes a locking circuit through its left hand winding and over its left hand contact, and through the normal contact of starting relay 45 as already described. The relay 46 at its right hand contact, shifts the control circuit of the starting relay 45 from the back contact of relay 44 to the front contact of said relay. As the last selecting impulse was positive, relay 44 is at this time deenergized, and the circuit of the starting relay 45 cannot be closed until a negative impulse is received.

In the meantime the arm 30 has carried the contact 71 over the printing segment P of the outer ring of the distributor, thereby completing a circuit for the printing magnet P, whereupon the sequence of printing operations already described takes place. The arm 30 continues its rotation until it engages with the catch 31, whereupon it comes to rest. The apparatus is now in condition to receive a new series of code impulses. As soon as a negative starting

impulse comes over the line, relay 44 is energized, thereby completing the circuit of starting relay 45 from negative pole of battery over the upper front contact of relay 44, right hand front contact of relay 46, winding of relay 45 and over segment 96, contact 71 and segment 97, to the positive pole of the battery. The energization of relay 45 over this circuit, releases the brush arm for its next cycle of operations, and at the front right hand contact of said relay opens the locking circuit of relay 46, which is restored to normal.

It will be understood, of course, that any one of the receiving arrangements shown in Figs. 4, 5 and 6 may be used with the sending arrangement illustrated in Fig. 1. Fig. 2 illustrates a modified form of sending arrangement which involves the same principles as that of Fig. 1, and which may be used in connection with the receiving arrangements shown in Figs. 4, 5 or 6. In the arrangement of Fig. 2 the pole changing relay 14 is eliminated and the positive and negative selecting impulses are sent over the line directly under the control of the storing relays. In order to accomplish this result, the line L is connected directly to the ring 58 of the distributor, while the starting and selecting impulse segments of the distributor are connected to contacts of the first four storing relays, and to contact of the controlling relay 57. The contacts of these relays determine the polarity of the impulses sent to the several segments.

The operation of the modified features of this arrangement is the same, whether the tape transmitter T or the keyboard transmitter K is used, and consequently it will be unnecessary to describe the operation with both transmitters. Assuming that the keyboard transmitter is to be used, the depression of a key of the keyboard shifts a certain combination of the five keyboard selecting contacts and closes the common keyboard contact 66 thereby completing the circuit of the overlap relay 25, said circuit being the same as that already traced in connection with the description of the apparatus in Fig. 1. Assuming that the first, third and fifth selecting contacts are operated, the overlap relay 25 and storing relays 20, 22 and 24 will be energized over this circuit. The overlap relay 25 is locked up as described in connection with Fig. 1, and the storing relays 20, 22 and 24 complete locking circuits through their left hand windings and the winding of the keyboard relay 26 as already described. Keyboard relay 26 as before opens the initial energizing circuit of the storing relays, thereby rendering them independent of the keyboard transmitter, so that a new combination may be set up by the depression of another key, without affecting said storing relays. Key-

board relay 26 at its left front contact, completes the circuit of starting relay 28 as described in Fig. 1. Relay 28 is energized and completes at its left hand front contact the circuit of the starting magnet 13, whereupon the catch 12 is withdrawn from the arm 11, and the arm 11 rotates over the segments of the distributor. Assuming that the last impulse of the previous code group was negative, the relay 57 will be unactuated and as the arm 11 carries the contact 59 over the starting segment S of the outer ring of the distributor, a positive starting impulse is sent to the line over a circuit from the positive pole of the battery, over the right hand back contact of relay 57, over starting segment S, contact 59 and ring 58' of the distributor to the line L.

The arm 11 now leaves the starting segment S and passes over the first segment of the outer ring of the distributor. As storing relay 20 is actuated, a positive selecting impulse is sent over the line from the positive pole of the battery, over the front right hand contact of storing relay 20, first segment of the outer ring of the distributor, contact 59 and ring 58' of the distributor, to the line L. At the same time the left hand winding of the relay 57 is short circuited over the segment 61 in the manner described in Fig. 1, to deenergize said relay, had it been previously energized. The arm 11 now carries the contact 59 over the second segment of the outer ring of the distributor. Storing relay 21 being deenergized, a negative impulse is sent to the line from the negative pole of the battery, over the back contact of storing relay 21, over the second segment of the outer ring of the distributor, contact 59 and ring 58' of the distributor, to the line L. At the same time a circuit is completed from the negative pole of the battery, over ring 48, arm 11, segment 58 of the distributor, through the ring hand winding of the relay 57, over the right hand front contact of storing relay 24, to the positive pole of the battery. Relay 57 is energized over this circuit, and thereupon completes its locking circuit and shifts the connections of the fifth and starting segments of the outer ring of the distributor.

The arm 11 now rotates over the third and fourth segments of the outer ring of the distributor, thereby transmitting positive and negative impulses over the front contact of storing relay 22, and over the back contact of storing relay 23 respectively. As the arm 11 leaves the fourth segment, and passes over the fifth segment of the outer ring of the distributor, the fifth selecting impulse is sent to the line. The circuit for this impulse may be traced from the positive pole of the battery, over the middle front contact of relay 57, and over the fifth segment of the outer ring of the distributor,

contact 59 and ring 58' of the distributor to the line L. At the beginning of this impulse, a circuit is completed from the negative pole of the battery, over the ring 48, arm 11 and segment 66, through the upper winding of the lockout relay 27. Lockout relay 27 operates as described in connection with Fig. 1 to open at its lower contact the circuit of the keyboard relay 26 and at its upper contact to hold open the initial energizing circuit of the storing relays through the contacts of the keyboard transmitter. Said lockout relay 27 at its lower front contact completes a locking circuit for itself, so long as the overlap relay 25 is maintained locked up by the continued depression of the key of the keyboard transmitter K. If the key K has already been restored, or as soon as said key is restored, the overlap relay 25 is deenergized, and the locking circuit of the relay 27 is opened, so that said relay is restored to normal and the apparatus is ready for a second cycle of operations as soon as the arm 11 engages with the catch 12.

It will now be noted that the last impulse sent to the line was positive, and said positive impulse continues so long as the arm 11 remains upon the fifth segment of the distributor. As soon as the arm 11 is released by the depression of another key, thereby passing over the starting segment S, a negative impulse will be sent to the line over the front right hand contact of the relay 57. It will thus be seen that the starting impulse is at all times opposite in character to the last selecting impulse, the character of said impulses being determined by the relay 57.

A third form of transmitting apparatus which may be used with any one of the receiving arrangements shown in Figs. 4, 5 and 6, is illustrated in Fig. 3. This arrangement differs from that of Fig. 2 in that the selecting contacts of the tape transmitter T normally rest upon a bus-bar 15 connected to the negative pole of the battery, the first four of said contacts being connected through the gang switch, directly to the first four selecting segments of the outer ring of the distributor, while the last contact is connected through the gang switch to relay 57 which functions in a manner analogous to that of the relay 57 in Fig. 2 to determine the polarity of the last selecting impulse and the starting impulse. Said selecting contacts of the tape transmitter are adapted to be moved in accordance with the perforations of the tape into contact with the bus-bar 16 connected to the positive pole of the battery. By this arrangement the first four selecting impulses are transmitted to the line directly over the contacts of the tape transmitter, without the interposition of storing relays, while the last

selecting impulse operates a storing relay 57 so that the transmitter magnet 17 may be actuated to shift the tape during the transmission of the last selecting impulse.

A keyboard transmitter is so arranged that the combination set up upon said transmitter is transferred to the storing relays 20 to 24 inclusive, said storing relays controlling the connections to the selecting and starting segments of the outer ring of the distributor in a manner similar to that of Fig. 2, so that the polarity of the selecting and starting impulses are determined directly by said relays. The arrangement differs from that of Fig. 2, however, in that the connections from the contacts of the storing relays to the selecting and starting segments of the distributor, pass through the contacts of the gang switch, so that said connections may be shifted from the control of the storing relays to the tape transmitter contacts or vice versa, as desired.

Assuming that the tape transmitter is being used, and that the first, third and fifth contacts of said transmitter have been shifted to the bus-bar 16, the closure of the tape control lever contact 47 completes a starting circuit from the negative pole of the battery over segment 100 of the inner ring of the distributor, arm 11, catch 12, conductor 49, eighth contact of the gang switch, conductor 50, contact 47, conductors 51 and 52 and through the right hand winding of starting relay 28, to the positive pole of the battery. Starting relay 28 completes the circuit of starting magnet 13 in the manner described in connection with Fig. 1. The catch 12 is therefore withdrawn from the arm 11, which rotates over the segments of the distributor. The polarity of the starting impulse to be sent to the line will now depend upon the polarity of the last selecting impulse previously transmitted. Assuming said last selecting impulse to have been negative, the relay 57 will be unactuated, and at the time the catch 12 was withdrawn the circuit for said last selecting impulse might have been traced from the negative pole of the battery over the upper back contact of relay 57, over the fifth selecting segment of the distributor and over contact 59 and ring 58' of the distributor, to the line L. As the arm 11 leaves the fifth segment of the distributor and passes over the starting segment S, a positive impulse is sent to the line from the positive pole of the battery, over the middle back contact of the relay 57, and over the starting segment S, contact 59 and ring 58' of the distributor, to the line L.

The arm 11 now leaves the starting segment S and passes over the first selecting segment of the distributor, whereby the first

selecting impulse is transmitted over a circuit from the positive pole of the battery, bus-bar 16, first selecting contact of the tape transmitter T, first contact of gang switch S, and over the first selecting segment of the distributor, contact 59, ring 58', to the line L. At the same time a short circuit for the lower of locking winding of the relay 57 is closed, from the positive pole of the battery, through the lamp 60, over the lower front contact of relay 57 and over segment 61, arm 11, and segment 100 of the distributor, to the negative pole of the battery. Had the relay 57 been at this time energized, the short circuiting of its lower winding would have restored it to normal.

The arm 11 now passes over the second selecting segment of the distributor, whereupon a negative selecting impulse is transmitted from the negative pole of the battery, over bus-bar 15, second contact of the tape transmitter, second contact of the gang switch, second selecting segment of the distributor, contact 59 and ring 58' of the distributor, to the line L. The arm 11 of the distributor now passes over the third selecting segment of the distributor, thereby transmitting a positive selecting impulse from the positive pole of the battery, over the bus-bar 16, third contact of the tape transmitter, third contact of the gang switch, third selecting segment of the distributor, contact 59 and ring 58 of the distributor, to the line L. At the same time, since the fifth contact of the tape transmitter is shifted into contact with the positive bus-bar 16, a circuit for relay 57 is completed from the positive pole of the battery, over the bus-bar 16, fifth contact of the tape transmitter, fifth contact of the gang switch, upper winding of relay 57, segment 101, arm 11, segment 102 of the distributor, to the negative pole of the battery. Relay 57 is energized over this circuit, and completes a locking circuit through its lower winding and over its lower front contact, through the lamp 60. The energization of this relay shifts the connections of the fifth selecting segment and the starting segment of the outer ring of the distributor. Had the fifth contact of the tape transmitter been unactuated, so that it rested against the negative bus-bar 15, the relay 57 would not have been actuated, as both terminals of its upper winding would have been connected to the negative pole of the battery.

The arm 11 now continues its rotation and passes over the fourth selecting segment of the distributor, thereby transmitting a negative impulse to the line from the negative pole of the battery over the bus-bar 15, fourth contact of the tape transmitter, fourth contact of the gang switch, fourth selecting segment of the distributor,

contact 59 and ring 58' of the distributor, to the line L. At the same time a circuit is completed for the transmitter magnet 17; from the negative pole of the battery, over segment 100, arm 11 and segment 103 of the distributor, over conductor 63, winding of transmitter magnet 17, conductor 64, and sixth contact of the gang switch, to the positive pole of the battery. The transmitter magnet is now actuated to shift the tape which may be done at this time without affecting the impulses transmitted, as the first four selecting impulses have already been transmitted and the fifth impulse is stored up by the relay 57.

The arm 11 now passes over the fifth selecting segment of the distributor, thereby transmitting a positive selecting impulse to the line from the positive pole of the battery, over the upper front contact of relay 57, over the fifth selecting segment, contact 59 and ring 58' of the distributor, to the line L. At the beginning of this impulse a circuit is also completed from the negative pole of the battery, over the segment 100, arm 11 and segment 65 of the distributor, through the lower winding of the lockout relay 27, to the positive pole of the battery. Lockout relay 27 is energized, but its actuation at this time is without effect. The arm 11 continues its rotation until it engages the catch 12, whereupon it comes to rest. The last selecting impulse which is now being transmitted being positive, should the arm 11 again be released, thereby passing over the starting segment 3, a negative starting impulse will be transmitted to line from the negative pole of the battery, over the middle front contact of relay 57, starting segment S, contact 59 and ring 58' of the distributor, to the line L.

In case keyboard transmitter K should be used for transmission, the gang switch S will be thrown to the right, thereby disconnecting the transmitter and connecting the controlling contacts of the storing relays to the distributor. Upon depressing a key of the transmitter, a combination of the selecting contacts will be shifted into contact with the bus-bar 19, and the common keyboard contact 66 will be closed. Assuming that the first, third and fifth selecting contacts are shifted, a circuit will now be closed from the negative pole of the battery over contact 66, conductor 67, seventh contact of the gang switch, conductor 68, winding of overlap relay 25, back right hand contact of the keyboard relay 26, lower back contact of the lockout relay 27, conductor 56, bus-bar 19, first, third and fifth contacts of the keyboard transmitter, and through the lower winding of storing relays 20, 22 and 24, to the positive pole of the battery. Overlap relay 25 is energized, and completes a locking circuit from the positive pole of the bat-

tery over its lower front contact, and through its winding, over the seventh contact of the gang switch, and over conductor 67 and contact 66, to the negative pole of the battery. The overlap relay will therefore be maintained energized so long as the key now actuated is held depressed. Storing relays 20, 22 and 24 are also energized, thereby completing locking circuits from the positive pole of the battery, through their upper locking windings and upper front contacts, through winding of relay 26, and over the upper back contact of the lockout relay 27, to the negative pole of the battery. Keyboard relay 26 is energized over this circuit, and at its right hand contact opens the initial energizing circuits of the storing relays, so that a new key may be depressed without affecting the combination now being transmitted. At its left hand front contact relay 25 completes a starting circuit from the negative pole of the battery, over segment 100, arm 11, catch 12, conductor 49, eighth contact of the gang switch, front left hand hand contact of keyboard relay 26, conductor 52 and right hand winding of starting relay 28, to the positive pole of the battery. The actuation of starting relay 28 results in the withdrawal of the catch 12 from the arm 11, which now proceeds to rotate over the segments of the distributor. The starting impulse will be transmitted as soon as the contact 59 passes over the starting segment S, and its polarity will be determined by the polarity of the last selecting impulse preceding. Assuming that the last selecting impulse was positive, relay 57 would have been actuated and the circuit of the last selecting impulse might have been traced from the positive pole of the battery over the upper front contact of relay 57, through the fifth selecting segment of the distributor contact 59 and ring 58', to the line. As soon as the arm 11 leaves the fifth selecting segment and passes over starting segment S a negative starting impulse will be transmitted from the negative pole of the battery over the front middle contact of relay 57, over segment S, contact 59 and ring 58' of the distributor to the line L.

The selecting impulses are now under the control of the storing relays 20 to 24 inclusive, and as the arm 11 passes over the first selecting segment of the distributor, a selecting impulse is transmitted from the positive pole of the battery, over the lower front contact of storing relay 20, over the first contact of the gang switch, first selecting segment of the distributor, contact 59, ring 58', to the line L. At the same time a short circuit is completed for the lower locking winding of the relay 57 from the negative pole of the battery, over segment 100, arm 11, segment 61, lower front contact of relay 57, lamp 60, to the positive pole of the bat-

tery. Relay 57 is now deenergized and restored to normal, thereby shifting the battery connections of the fifth selecting segment, and the starting segment of the distributor.

The arm 11 now passes over the second selecting segment of the distributor, thereby transmitting a negative impulse from the negative pole of the battery, over the lower back contact of starting relay 21, second contact of the gang switch, second selecting segment of the distributor, contact 59 and ring 58' to the line L. The arm 11 next passes over the third selecting segment of the distributor, thereby transmitting a positive selecting impulse from the positive pole of the battery, over the lower front contact of storing relay 22, third contact of the gang switch, third selecting segment of the distributor, contact 59, arm 58' of the distributor, to the line L. At the same time, inasmuch as the fifth storing relay 24 is now energized, a circuit is completed for the relay 57 from the positive pole of the battery, over the lower front contact of the relay 24, fifth contact of the gang switch, through the upper winding of relay 57, segment 101, arm 11 and segment 102 of the distributor, to the negative pole of the battery. Relay 57 is thereby energized and locked up as before, again shifting the connections of the selecting segment and the starting segment S of the distributor. Had the storing relay 24 been unactuated, the relay 57 would not have been energized, as both terminals of its upper winding would have been connected to the negative pole of the battery.

The arm 11 now passes over the fourth selecting segment of the distributor, thereby transmitting a negative impulse to the line from the negative pole of the battery, lower back contact of storing relay 23, fourth contact of the gang switch, fourth selecting segment of the distributor, contact 59, ring 58', to the line L. As the arm 11 continues in its rotation, it passes over the fifth selecting segment of the distributor, thereby transmitting the last positive selecting impulse from the positive pole of the battery, over the upper front contact of relay 57, fifth selecting segment of the distributor, contact 59 and ring 58', to the line L. At the beginning of this impulse a circuit was also completed from the negative pole of the battery, over the segment 100, arm 11 and segment 65 of the distributor, to the lower winding of the lockout relay 27. Said relay is thereby energized and at its upper contact opens the locking circuit previously traced through the storing relays and the keyboard relay 26. The storing relays and the keyboard relay are thereby restored to normal. At its lower contact relay 27 holds open the initial energizing circuit of the storing re-

lays, so that the actuation of a key of the keyboard transmitter cannot affect said relays until the relay 27 is deenergized. If now the key of the keyboard transmitter which was actuated to formulate the code group just transmitted still remains depressed, so that the contact 66 is closed, the overlap relay 25 will remain actuated and a locking circuit will be completed over the upper front contact of the relay 27, through the winding of said relay and over the upper front contact of overlap relay 25, to the positive pole of the battery. Relay 27 will thereby remain energized so long as the key remains depressed, so that the continued depression of said key will not again set up the same combination on the storing relays, and repeat the transmission of the same group of selecting impulses. If, however, the key had already been restored, or as soon as the key is restored, overlap relay 25 being deenergized, the relay 27 is deenergized and the apparatus is restored to normal as soon as the arm 11 of the distributor engages the catch 12. If the catch 12 is withdrawn in response to the depression of another key, since the last impulse now being transmitted is positive, a negative starting impulse will be transmitted over the middle front contact of the relay 57 as soon as the arm 11 passes over the starting segment S of the distributor.

It will be seen that by means of the arrangements herein disclosed, it is possible to control the operation of an intermittently actuated distributor by the transmission of a single impulse in addition to the selecting impulses necessary to determine the character to be printed. It is also possible to transmit selecting and controlling impulses of substantially the same length, so that where a code of five selecting impulses is used, the time period necessary for each character is reduced from the time necessary to transmit about seven and a half impulses to that necessary to transmit six impulses. It will further be seen that by means of these arrangements the distributor is controlled by transmitting a starting impulse different in character from the last selecting impulse previously transmitted. It will further be seen that by means of these arrangements the code group set up upon a transmitting mechanism may be stored in an auxiliary mechanism during the actual transmission of the code, thus permitting the setting up of a new code group or combination while the preceding combination is being transmitted. Moreover it is possible by means of the arrangements already described, to delay the selecting operations due to the first selecting impulses in order to permit of the completion of certain printing operations before the next set of selecting operations takes

place. Furthermore, while for purposes of illustration the invention has been shown as disclosed in certain forms which have been found most desirable in practice, it will be understood that it is capable of embodiment in many other different and widely varied organizations, without departing from the spirit of the invention as defined in the appended claims.

What is claimed is:

1. In a signaling apparatus, an intermittently operating distributor, means to set said distributor into operation, means responsive to all received impulses of a group regardless of their character, and a relay energized when the last impulse of a group is of one character only, said first mentioned means being under the joint control of said responsive means and said relay.

2. In a signaling apparatus, an intermittently operating distributor, means to set said distributor into operation, a circuit for said means having two branches, a relay to extend said circuit over one of said branches, said relay being energized only when the last received impulse of a group is of a particular character, and means to complete the circuit over said branch upon receiving the first impulse of the next group.

3. In a signaling system, an intermittently operating distributor, means to set said distributor into operation, a circuit for said means having two branches, a relay energized when the last received impulse of a group is of one character only and controlling the extension of said circuit over one of said branches, means acting in response to the last received impulse of a group to hold open said branch and responding to the first impulse of the succeeding group to complete said circuit over said branch.

4. In a signaling system, an intermittently operating distributor, means to set said distributor into operation, a circuit for said means under the control of said distributor and having a plurality of branches, a relay responsive to all impulses of a group of impulses of different character and operating to close one or the other of said branches depending upon the character of the received impulse, a second relay energized when the last impulse of a group is of one character only and controlling the extension of said circuit over one of said branches, said first mentioned relay operating in response to said last impulse to hold open said branch and operating in response to the first impulse of the succeeding group to close said circuit over said branch, whereby the distributor is set into operation, and means to open said circuit upon the initiation of the operation of said distributor and hold said circuit open until the distributor completes its cycle of operations, whereby the actua-

tion of said first mentioned relay in response to impulses other than the first is ineffective to actuate said first mentioned means.

5. In a signaling system, a receiving distributor for distributing successive groups of impulses, means responsive to a starting impulse differing in character from the last impulse of the preceding group to set said distributor into operation, indicating mechanism, means responsive to the receiving impulses of a group to control the action of said indicating mechanism, and means to temporarily prevent said responsive means from responding to certain of the impulses of a group.

6. In a signaling system, a receiving distributor for receiving successive groups of impulses, means responsive to a starting impulse differing in character from the last impulse of the preceding groups to set said distributor into operation, indicating mechanism, means responsive to the received impulses of a group to control the action of said indicating mechanism, and means to store certain of the impulses of a received group until the indicating mechanism has been actuated in response to a preceding group.

7. In a signaling system, an intermittently operating distributor for receiving successive groups of impulses, translating devices, means responsive to a starting impulse differing in character from the last impulse of the preceding group to set said distributor into operation to distribute the received impulses of a group to said translating devices, and means to temporarily prevent the distribution of certain of said impulses to the corresponding translating devices.

8. In a signaling system, an intermittently operating distributor for receiving successive groups of impulses, translating devices, means responsive to a starting impulse differing in character from the last impulse of the preceding group to set said distributor into operation to distribute the received impulses of a group to said translating devices, means to store the first impulse dis-

tributed, and means to transfer the stored impulse to the corresponding translating devices.

9. In a signaling system, an intermittently operating distributor for receiving successive groups of impulses, translating devices, means responsive to a starting impulse differing in character from the last impulse of the preceding group to set said distributor into operation to distribute the received impulses of a group to said translating devices, means to store the first impulse distributed, and means controlled by said distributor to transfer the stored impulse to the corresponding translating device.

10. In a signaling apparatus, an intermittently operating distributor, means to set said distributor into operation, a circuit for controlling said means, a relay responsive to all received impulses of the group regardless of their character, means under the control of said relay for momentarily closing said circuit at one point each time the character of the received impulses is changed, and means to prevent said circuit from being completed at another point except when said distributor is at rest.

11. In a signaling apparatus, an intermittently operating distributor, means to set said distributor into operation, a circuit for said means having two branches, a relay for controlling one of said branches and a relay for controlling the other branch, one of said relays responding to impulses of one character and the other relay responding to impulses of another character, a third relay responding to impulses of either character, said relay cooperating with the other two relays to close one or the other of said branches each time the character of the received impulses is changed, and means to complete said circuit at another point only when the distributor is at rest.

In testimony whereof, I have signed my name to this specification this 27th day of March, 1922.

GILBERT S. VERNAM.