

Oct. 21, 1924.

1,512,070

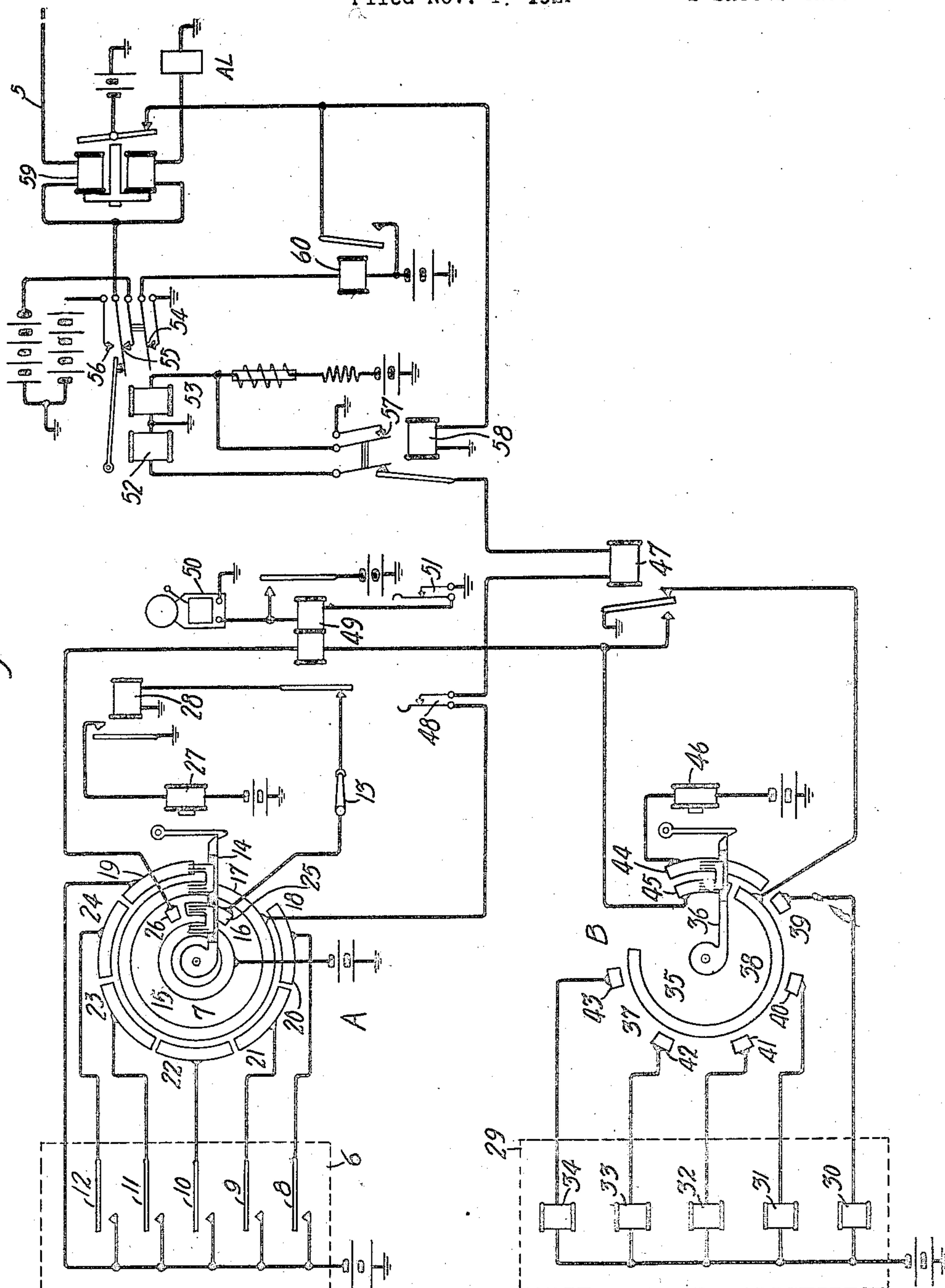
G. S. VERNAM

PRINTING TELEGRAPHY

Filed Nov. 4, 1921

2 Sheets-Sheet 1

Fig. 1.



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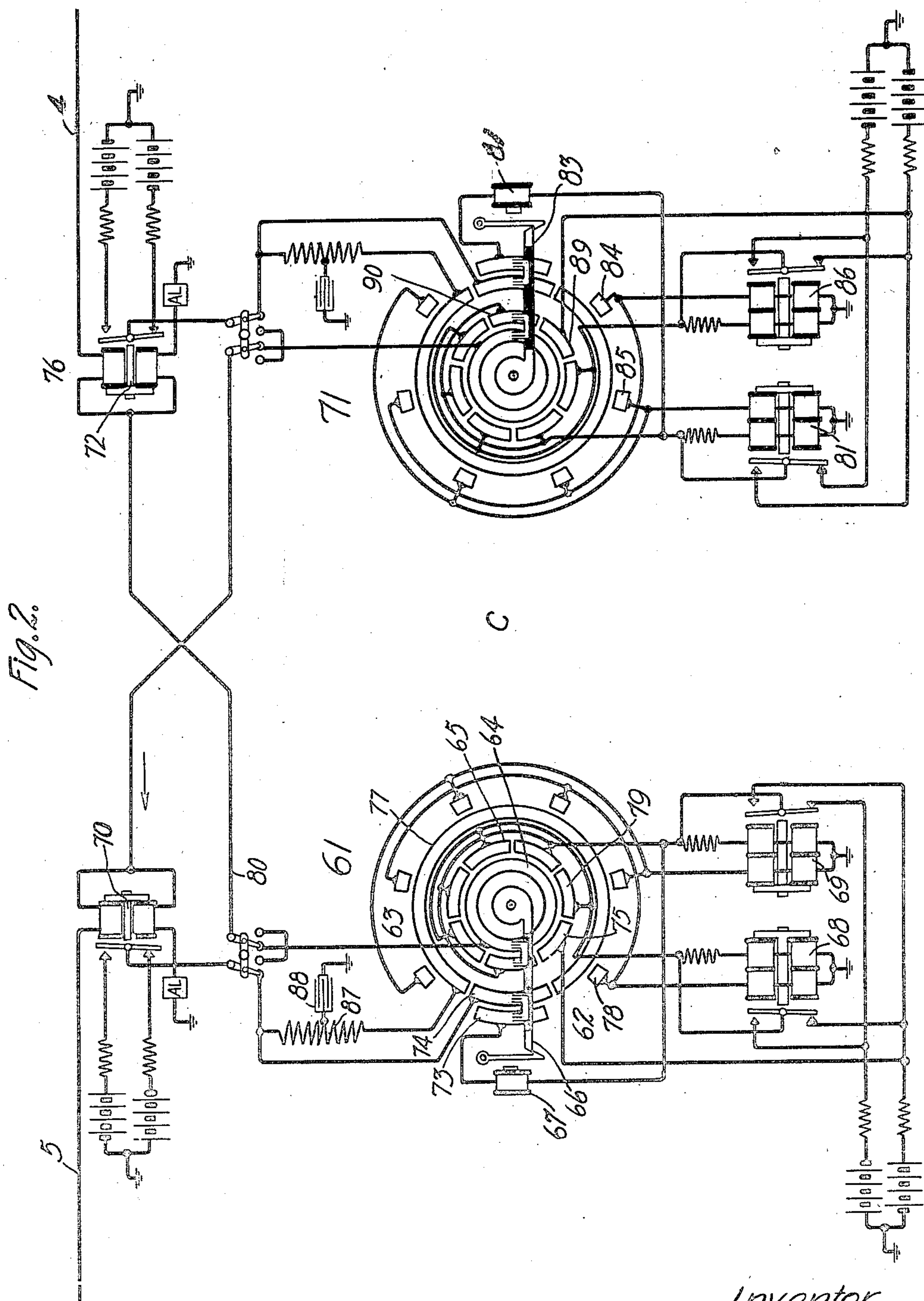
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PRINTING TELEGRAPHY

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2 Sheets-Sheet 2



Inventor
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By *John* Att'y.

Patented Oct. 21, 1924.

1,512,070

UNITED STATES PATENT OFFICE.

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

PRINTING TELEGRAPHY.

Application filed November 4, 1921. Serial No. 512,830.

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 Telegraphy, of which the following is a specification.

This invention relates to telegraph systems.

An object of this invention is the provision of means at a point intermediate the ends of a signaling conductor for repeating and regenerating signaling current impulses, and while it is particularly adapted for use in systems of the start-stop type, it is clearly not limited to this field.

Another object is to provide means whereby an operator at a receiving station may effect the operation of an auxiliary signaling device at the transmitting station and stop the transmitting apparatus.

In accomplishing the above objects, the invention contemplates a system of relays and connections interposed between sections or branches of a line conductor whereby each signal impulse may be regenerated and repeated to the adjoining line section, besides the provision in such a system of means whereby a change in line conditions at the receiving station, an auxiliary receiving device at the transmitting station may be actuated to communicate a "break in" signal to the operator thereat, and stop the transmitting apparatus.

Referring to the drawing:

Fig. 1 shows diagrammatically circuit and apparatus employed at one terminal station.

Fig. 2 shows diagrammatically circuits and apparatus employed at a repeating or re-generating station.

The invention, in general, comprises sending equipment A including an auxiliary signaling mechanism operative upon a change in line conditions at the receiving station and receiving equipment B located at a terminal station, and re-generative repeating equipment C located at an intermediate station, all stations being connected by duplex line conductors 4 and 5.

The term "re-generative repeater" as used herein, refers to repeating mechanism in which the signaling current impulses are regenerated at a point intermediate the ends of the signaling conductor to correct for distortion which the signals may have suf-

fered in the transmission thereof over the first line section, as distinguished from a repeater in which the signals are not regenerated but merely repeated to the adjoining line section.

The sending equipment A includes a current control means 6 such as a tape transmitter or any well-known type of transmitter, which selects the impulses to be transmitted subsequently over the line conductor 5, by means of a start-stop or intermittently rotating distributor 7, to the receiving equipment B.

The sending distributor 7 comprises an arm 14 which intermittently rotates over a plurality of continuous and segmented rings 15, 16, 17 and 18, the continuous and segmented rings being arranged in pairs. The segments 20 to 24 of the outer ring 18 are connected to contacts 8 to 12 inclusive of the transmitter 6 and serve to complete the circuits from a source of battery associated with the transmitter through a brush carried by the distributor arm 14. Forming a part of the ring 16 is a start segment 25 which when the brush arm 14 is held against rotation, will be bridged to the ring 15 so that battery is connected with the winding of a release relay 28 when the start or cutoff key 13 is closed. The brush arm 14 is arranged to be released by a release magnet 27 under the control of the release relay 28, the energizing circuit of which is completed as previously described.

The receiving equipment B includes a receiving instrument, such as a printer diagrammatically represented at 29 which comprises a plurality of selecting magnets 30, 31, 32, 33 and 34 and a start-stop distributor 35.

The receiving distributor 35 comprises a pair of segmented distributor rings 37 and 38 and an intermittently rotating brush arm 36 which is adapted to associate the distributor segments 39, 40, 41, 42 and 43 with the ring 38. The outer ring 37 of the distributor also includes a start segment 44 which, when the brush arm 36 is held against rotation, is bridged by the brush carried thereby with the segment 45 forming a part of the inner ring 38. The brush arm 36 is arranged to be released by a release magnet 46 under the control of a line relay 47 which responds to incoming impulses.

Associated with the receiving equipment

is a break key 48 which is arranged to effect a change in the electrical condition of the line 5 thereby causing the line relay at the distant station to be released. Upon the
 5 deenergization of the line relay 47 a condition will be created whereby this relay establishes, upon the passage of the inner brush carried by the brush arm 14 over the segment 26, an energizing circuit for a break
 10 relay 49. This break relay 49 controls the operation of a signaling device 50 and opens the energizing current of the start relay 28.

Responsive to the operation of the sending distributor 7 and the actuation of the re-
 15 spective contacts of the transmitter 6, a pole-changing relay having an operating winding 52 and a locking winding 53 is provided for applying to the apex of the ratio arms, which have included therein the windings of a
 20 receiving relay 59, impulses of a polarity depending upon the actuation of the transmitter contacts. The relay 59 is so constructed and connected that it responds only to incoming impulses and is non-responsive
 25 to outgoing impulses.

The apparatus so far described constitutes the equipment of one station but it will be understood that any desired number of sta-
 30 tions may be associated with the line conductors 4 and 5 in the same manner as the station above described so that the normally closed line circuit will extend serially through the several stations.

The repeating or regenerating equipment
 35 C which is interposed intermediate the line conductors 4 and 5 comprises a distributor 61 including a plurality of rings 62, 63, 64 and 65 and a brush arm 66. The brush arm 66 is released upon the energization of a re-
 40 lease magnet 67 under the control of the brush carried by the brush arm 66 which bridges segments 73 and 74 of the rings 62 and 63 respectively, and the receiving relay 70 which is connected to the ratio arms forming
 45 a part of the line conductor 5 and terminating at the repeater station C. The segments of the ring 65, there being seven in number, one corresponding to each unit of the five unit code for which the system is especially
 50 designed, the sixth serving as a stop segment while the seventh serving to effect the transmission of a starting impulse to the distant or receiving station upon the passage of the brush carried by the brush arm 66 thereover.
 55 Alternate ones of the segments forming the ring 65, are connected with an armature of the polarized storing relay 68 which serves for storing the impulses subsequently to be transmitted while the remaining ones thereof
 60 are connected with the armature of a similar storing relay 69 serving the same purpose as relay 68. These relays 68 and 69 are provided with locking windings for retaining the armatures thereof in the position set.
 65 The outer ring 62 comprises a plurality of

segments, the length of which are approximately one-quarter the length of the segments forming the ring 65 so that only the center portion of each segment is used for
 70 operating the printer and which are connected with the left hand winding of the respective storing relays. With this arrangement, the characters will be recorded correctly even though the received signals are somewhat distorted.
 75

Equipment similar to that designated by the numeral 61 is shown at 71 for regenerating and repeating signals to be transmitted in the direction of the arrow. Inasmuch as
 80 such equipment is identical to that just described, a detail description thereof is considered unnecessary here.

The operation of the system is as follows:

Assuming now that the station A, as shown in Fig. 1, is sending, the transmitter 6 will
 85 be actuated thereby closing certain ones of the contacts 8 to 12 inclusive depending upon the code impulses to be transmitted, the start or cutoff key 13 also being operated. The closure of the contact controlled by the
 90 key 13 completes a circuit from battery through the ring 15 of the distributor 7, the inner brush secured to the brush arm 14, segment 16, switch 13, left-hand normal contact of relay 49, and the winding of start control
 95 relay 28 to ground. The start relay 28, when energized, establishes an energizing circuit for release magnet 27 extending from battery through the winding of release magnet 27 and the contact and armature of start
 100 relay 28 to ground. Release magnet 27 thereupon operates and releases the brush arm 14 which begins to rotate whereby the brushes carried thereby pass over the respective rings. Immediately after the pas-
 105 sage of the inner brush carried by the brush arm 14 over segments 16, the energizing circuit for the start relay is broken and the armature of this relay is thereby released for causing the deenergization of the release
 110 magnet 27 in order to stop the brush arm 14 at the end of its cycle.

As soon as the outer brush of the brush arm 14 passes off of the segment 19 forming
 115 a part of the outer ring 18, the circuit extending from battery through the segment 19, outer brush of the brush arm 14, ring 17, normal contacts of the break key 48, line relay 47 armature and off-normal contact of
 120 relay 58 and the winding 52 of the pole-changing relay, is opened whereby the armature of the pole-changing relay is released for applying to the apex of the ratio arms a current the polarity of which is opposite to that which is normally applied to the line.
 125 In order to insure the continued operation of relay 58, upon the release of the armature of the pole-changing relay for opening contact 55 and closing contact 56, relay 60 is provided which is normally energized for
 130

establishing an auxiliary energizing circuit for this relay through its back contact. The purpose of relay 60 is to maintain relay 58 energized whereby the pole-changing relay 52 is retained in its released position regardless of incoming impulse should the break key 48 be opened at the transmitting station. This impulse, in passing over the line conductor 5, causes the energization of the receiving relay 70 located at the repeater station, and the battery connections under the control of this relay and the relay 69 are connected so as to be in series aiding, thus causing the energization of the release magnet 67 of the distributor 61. Release magnet 67 upon being energized releases the brush arm 66 which thereupon begins its rotation and when the inner brush carried thereby passes on to segment 75 forming a part of the ring 65, reverses the polarity of the battery applied to the line 4 to cause the operation of the receiving relay 59 at the distant station. Receiving relay 59 thereupon opens its contact and causes the deenergization of relay 58 which controls through its contact the energizing circuit of the line relay 47 and establishes an energizing circuit for winding 53 for preventing the release of the pole-changing relay 52. Line relay 47 then releases its armature which completes an energizing circuit for release magnet 46 of the receiving distributor 35 extending from battery through the winding of release magnet 46, segment 44, brush carried by the arm 36, segment 45 and the back contact and armature of relay 47 to ground. The brush arm 36 is thereby released for rotation.

Assuming that the contacts 8, 10 and 12 are closed, as the brush arm 14 rotates over the segment 20, battery is again applied to the operating winding 52 of the pole changing relay thereby causing the energization thereof and the application to line of an impulse representing one unit forming a part of the desired character. This impulse passes over the line conductor 5 to the windings of the receiving relay 70 which responds to reverse the position of its armature and connect negative battery to the segment 77 which forms a part of the ring 63. Brush arm 66 then bridges the segment 77 with the segment 78 which is connected to the left-hand winding of storing relay 68 but since this relay is already positioned to connect positive battery with the armature thereof, the position of its armature will thereby be reversed. As the brush arm passes over segment 79, an impulse of negative polarity will be applied to the line 4. Such a circuit may be traced from grounded battery, upper contact and armature of storing relay 68, segment 79, inner brush carried by the brush arm 66, the conductor 80 to the apex of the ratio arms 76 and from there on over the adjoining line section 4 to the re-

ceiving station. As brush arm 14 passes from the segment 20 to the second selecting segment 21, the energizing circuit for the coil 52 of the pole-changing relay is open whereby this relay releases its armature for closing contact 56 and applies positive potential to the apex of the ratio arms which is connected with the line conductor 5. The receiving relay 70 at the repeater station will respond to this impulse for reversing the position of its armature and consequently affect the operation of storing relay 69 and the subsequent transmission through the distributor 61 of a similar impulse to the adjoining line section 4. The brush arm 14 now passes over the third selecting segment 22 and inasmuch as the contact 10 for the case selected is closed, winding 52 of the pole-changing relay is connected with battery whereby the desired impulse is transmitted. The repeater equipment will respond in a manner similar to that previously described. Conditions similar to those just described depending upon the position of the transmitter contacts 11 and 12 will be created upon the passage of brush arm 14 over the corresponding segments 23 and 24.

The operation, of the receiving apparatus Fig. 1 will be described, it being understood that the operation of all receiving apparatus along the line will be identical. As previously described, the reversal of the normal line conditions caused the energization of the release magnet 46 whereby brush arm 36 is caused to rotate. Immediately upon the passage of the brush arm off of the segment 45 the energizing circuit of the release control magnet 46 is opened thereby causing the deenergization of this magnet for releasing the stop arm to stop the brush arm at the completion of its rotation.

After passing over segments 44 and 45, the brush arm bridges segment 38 and 39. At this moment, the first selecting unit, as previously described, is being received from the line. At each of the receiving stations, the first selecting impulse, being of such character as to cause the operation of the receiving relay 59, causes the consequent energization of relay 58. This relay in energizing closes the energizing circuit of line relay 47. Line relay 47 thereupon closes its front contact so that upon the passage of the brush over the segments 38 and 39, the energizing circuit of selecting magnet 30 will be closed and consequently movement of the selecting bar controlled thereby will result. As the brush arm continues its rotation, it passes over the second selecting segment at the moment the second selecting impulse is received which is of a polarity sufficient to cause the energization of receiving relay 59 whereby relay 58 is deenergized and consequently, line relay 47 is deenergized for closing its back

contact. Ground is thereupon not connected with the segment 38 so that upon the passage of the brush carried by the brush arm 36, thereover, the selecting magnet 31 will not be energized. The brush arm 36 continues to rotate passing in succession over segments 41, 42 and 43 of the receiving distributor thereby closing circuits for corresponding ones of the selecting magnets of the printer depending upon the position of the armature of the line relay 47. The five selecting impulses which determine the character to be printed have now been received. As the brush arm passes over the segments 44 and 45, the energizing circuit for the release magnet 46 is not completed owing to the position of the armature of the line relay 47, and the brush arm 36 comes to rest. The apparatus is now ready to respond to another series of code impulses.

Assuming now that a receiving operator desires to "break in" for any purpose, the operator will operate break key 48 at his station. Inasmuch as the contacts of this key are serially connected in a manner to effect a change in the electrical conditions of the line by causing the deenergization of the pole-changing relay at such station, and consequently the application of a source of battery of a positive polarity with the line 4. Receiving relay 72 which is connected in the ratio arms 76 is operated whereby the batteries under the control of this relay and the polarized storing relay 81 at the repeater station C are connected in series aiding for causing the energization of release magnet 82 of the distributor 71. The receiving relay 72 will remain in this position until the break key 48 is released when it will return to its normal position as shown in the drawings.

When the brush arm 83 of the distributor 71 passes over the receiving segments 84 and 85, polarized storing relays 81 and 86 will be operated so as to connect positive battery with their contacts, and will remain in this position while the brush arm 83 passes over the remaining receiving segments. The brush arm 83 will be stopped upon the completion of this rotation and remain in this position until the line condition is reversed. Under the conditions just described, a current impulse of positive polarity will be transmitted to the adjoining line section 5 immediately upon the passage of the inner brush of the arm 83 over the segment 89 and such impulse will continue while the brush crosses the remaining sending segments and as long as it remains on segment 90, which is the normal position of the brush arm 83. The transmission of an impulse of this character causes the operation of receiving relay 59 whereby the energizing circuit for

relay 58 is opened thereby causing the release of this relay as previously described. The pole-changing relay is retained in its normal position with negative potential applied to the line conductor 5, as the locking winding 53 of this pole changing relay is now energized due to the opening of contact 57 under the control of relay 58. The deenergization of relay 58 as previously described also opens the energizing circuit of line relay 47 which is likewise deenergized and remains in such position until the relay 58 is again energized. Upon the passage of the inner brush on the brush arm 14 of the transmitting distributor 7 over segment 26, an energizing circuit is completed for break relay 49 extending from battery through ring 15, inner brush of the brush arm 14, segment 26, left-hand winding of break relay 49 and the back contact and armature of line relay 47 to ground whereupon this relay is energized to open the energizing circuit of the start relay 28 and thereby prevent the brush arm 14 again starting. At the right-hand contact of break relay 49, a holding circuit for this relay is completed upon the operation thereof extending from battery through the armature and contact and right-hand winding of this relay and the contacts of release key 51 to ground. This relay is thereby retained energized independent of the distributor 7 and will remain in this position until the release key 59 is operated for opening the locking circuit just traced. Also, upon the closure of the right-hand contact of break relay 49, an energizing circuit is completed for operating the signaling device 50 which may be a bell or any well-known means for giving an indication to the transmitting operator that the receiving operator desires to reverse the direction of sending.

When the break key at the receiving station is released, the pole changer relay at such station will be energized in a manner to connect a potential of a negative polarity to the adjoining line section for causing a similar movement of the receiving relay 72 connected in the ratio arms 76. Negative battery will thereby be connected to the winding of the release magnet 58 which will operate and release the brush arm 83. When the brush arm 83 crosses receiving segments 84 and 85, relays 81 and 86 will be operated again in the opposite direction, as previously described, to connect negative potential with the adjoining line section 5 when the brush arm 83 reaches sending segment 89 and which will continue to be applied until the brush arm 83 is again released for rotation.

From the previous description, it will be seen that when the break key is operated at a receiving station, a steady impulse of a positive polarity will be transmitted over

the line and through the repeater equipment to the sending station. This will cause the deenergization of the line relay at such station whereby the transmitting distributor at such station is stopped and a signaling device is operated to give an indication to the operator that the receiving operator has interrupted the sending.

As shown in Fig. 2, a resistance 87 is connected in series between the contacts of the receiving relay 70 and the receiving ring 77 of the distributor 61. A condenser 88 is connected from this resistance to ground. The polarity of the charge on this condenser is reversed every time the receiving relay 70 reverses, and it serves the purpose of bridging over the interval while the tongue or armature of the receiving relay is passing from one contact to another.

What is claimed is:

1. In combination, a line conductor divided into sections, relaying apparatus interposed between adjacent sections comprising a plurality of storing relays to be selectively operated, intermittently rotating distributing apparatus for distributing the signals from one of said line sections to said storing relays, a source of signaling current, and circuit connections also established by said distributing apparatus for connecting said source of current with the adjoining line section in accordance with the operation of the storing relays.

2. In combination, a line conductor divided into sections, relaying apparatus interposed between adjacent sections comprising a pair of relays associated therewith to be selectively operated, an intermittently rotating distributor for consecutively connecting said relays with one of said line sections, a source of signaling current, and circuit connections extending between said source of current and the adjoining line section completed directly by said distributor in accordance with the operation of said relays.

3. Retransmitting apparatus comprising a start-stop distributor having receiving and transmitting sections, storing means selectively operated by impulses distributed thereto through said receiving section, a line circuit, a source of current associated with said storing means, and circuit connections established by said distributor for connecting said source of current to said line circuit through said transmitting section as determined by the storing means.

4. In a printing telegraph system, a line circuit, a plurality of printing telegraph stations, repeating apparatus intermediate the ends of said line circuit for regenerating signaling current impulses, comprising a rotary distributor and signal storing means, transmitting apparatus associated with said line circuit at one of said stations, receiving

apparatus associated with said line circuit at another of said stations, means at the receiving station for effecting a change in the electrical conditions of said line circuit to cause the operation of said distributor and said signal storing means whereby a prolonged impulse is transmitted over said line, and a signal at the transmitting station responsive to such prolonged impulse but unresponsive to impulses for operating the receiving apparatus.

5. In a printing telegraph system, a line circuit, a plurality of printing telegraph stations, repeating apparatus intermediate the ends of said line circuit for regenerating the signaling current impulses, a plurality of stations along said line, transmitting apparatus associated with said line circuit at one of said stations, a receiving printer associated with said line circuit at another of said stations, a key for effecting a change in the conditions of said line circuit to cause the operation of the repeating apparatus to transmit a prolonged impulse, a signaling device at the transmitting station responsive to such prolonged impulse but unresponsive to impulses for operating the receiving printer.

6. In a printing telegraph system, a line circuit, a plurality of printing telegraph stations, repeating apparatus intermediate the ends of said line circuit for regenerating the signaling current impulses, transmitting apparatus associated with said line circuit at one of said stations, a receiving printer associated with said line circuit at another of said stations, means at said last mentioned station to change the electrical condition of said line circuit, means at said first mentioned station responsive to impulses transmitted to operate the receiving printer, a special signaling device controlled by said last mentioned means and unoperated by the response of said means to said transmitted impulses but operated by said means when the condition of the line circuit is changed due to the operation of said means at the receiving station which causes the operation of said repeating apparatus to transmit a prolonged impulse.

7. In a printing telegraph system, a line circuit, a plurality of printing telegraph stations, repeating apparatus intermediate the ends of said line circuit for regenerating the signaling current impulses, a receiving printer associated with said line circuit at one of said stations, transmitting apparatus associated with said line circuit at another of said stations, means at the receiving station for effecting a change in the conditions of said line circuit, a relay at the transmitting station responsive to impulses transmitted to operate the receiving printer, a special signaling device controlled by said relay and unoperated by the response of said

relay to such transmitted impulses but operated by said relay when the condition of said line circuit is changed whereby said repeating apparatus is operated to effect the transmission of a prolonged impulse.

8. In a printing telegraph system, a line circuit, a plurality of printing telegraph stations associated with said line circuit, repeating apparatus intermediate the ends of said line circuit for regenerating the signaling current impulses, a rotary distributor at each station comprising a brush rotatable over a plurality of segments, a transmitter associated with the distributor at one station, a receiving printer associated with the distributor at a second station, means responsive to the operation of the transmitter to transmit an impulse to release the brush of the distributor at the second station, whereby the brushes rotate in synchronism to transmit impulses from the transmitter to the receiving printer, a special signal at said first station non-responsive to said impulses, and means at the second station to so change the electrical conditions at said line circuit during the transmission of impulses whereby said repeating apparatus is operated to transmit a series of impulses of a predetermined character to operate said special signal.

9. In a printing telegraph system, a line circuit, a plurality of printing telegraph stations associated with said line circuit, repeating apparatus intermediate the ends of said line circuit for regenerating the signaling current impulses, intermittently rotating distributors at each of said stations, a transmitter associated with the distributor at one station, a receiving printer associated with the distributor at a second station, means responsive to the operation of the transmitter to transmit an impulse by means of said distributor at the first station to cause the operation of the distributor at the second station whereby said distributors operate to transmit impulses from the transmitter to the receiving printer, a special signal at said first station unresponsive to said impulses, and means at the second station to alter the electrical conditions of the line circuit whereby said repeating apparatus is operated to effect the transmission of a series of impulses of a predetermined character to operate said special signal and stop one of said distributors.

10. In a telegraph system, a line circuit joining two stations, repeating apparatus intermediate the ends of said line circuit for regenerating the signaling current impulses, transmitting and receiving distribut-

ing apparatus associated with said line circuit at the ends thereof, and means at the receiving station for altering the electrical conditions of said line circuit whereby said repeating apparatus is operated to transmit a series of impulses of a predetermined character to cause the stoppage of said transmitting distributing apparatus.

11. In a telegraph system, a line circuit, a plurality of telegraph stations associated with said line circuit, repeating apparatus intermediate the ends of said line circuit for regenerating the signaling current impulses, and intermittently rotary distributor at each station, transmitting apparatus associated with the distributor at one station, a receiving apparatus associated with the distributor at a second station whereby signals may be transmitted by the transmitting apparatus over the line and distributed to the receiving apparatus, and means to change the electrical conditions of the line circuit whereby said repeating apparatus is operated to transmit a prolonged impulse of a predetermined polarity to stop one of said transmitters.

12. In combination, a line conductor divided into sections, relaying apparatus interposed between adjacent sections comprising a distributor which is stopped once for each cycle of rotation, a plurality of relays associated therewith to be selectively operated, holding circuits for said relays for maintaining said relays energized in accordance with the character of the preceding impulse until the character of the impulse is changed, a source of signaling current, and circuit connections established by said distributor for connecting said source of current with the adjoining line section.

13. In combination, a line conductor divided into sections, relaying apparatus interposed between adjacent sections comprising a distributor which is arranged to be stopped once for each cycle of its rotation, a pair of relays associated therewith to be selectively operated, holding circuits for said relays for maintaining said relays energized in accordance with the character of the preceding impulse until the character of the impulse is changed, a source of signaling current, and circuit connections established by said distributor for connecting said source of current with the adjoining line section.

In testimony whereof, I have signed my name to this specification this 2nd day of November, 1921.

GILBERT S. VERNAM.