

March 8, 1927.

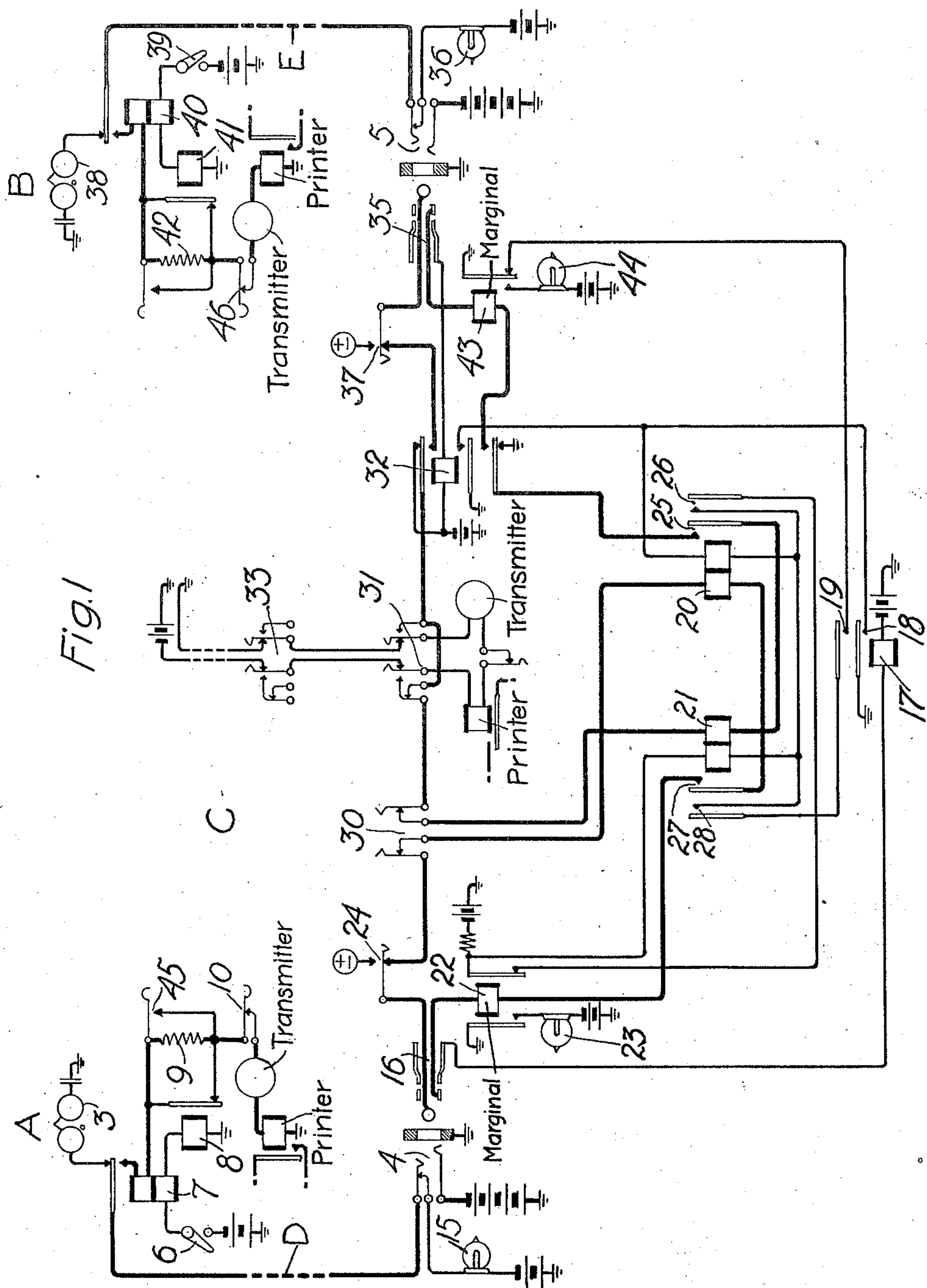
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PRINTING TELEGRAPH EXCHANGE SYSTEM

Filed Dec. 23, 1922

2. Sheets-Sheet 1



Inventor:
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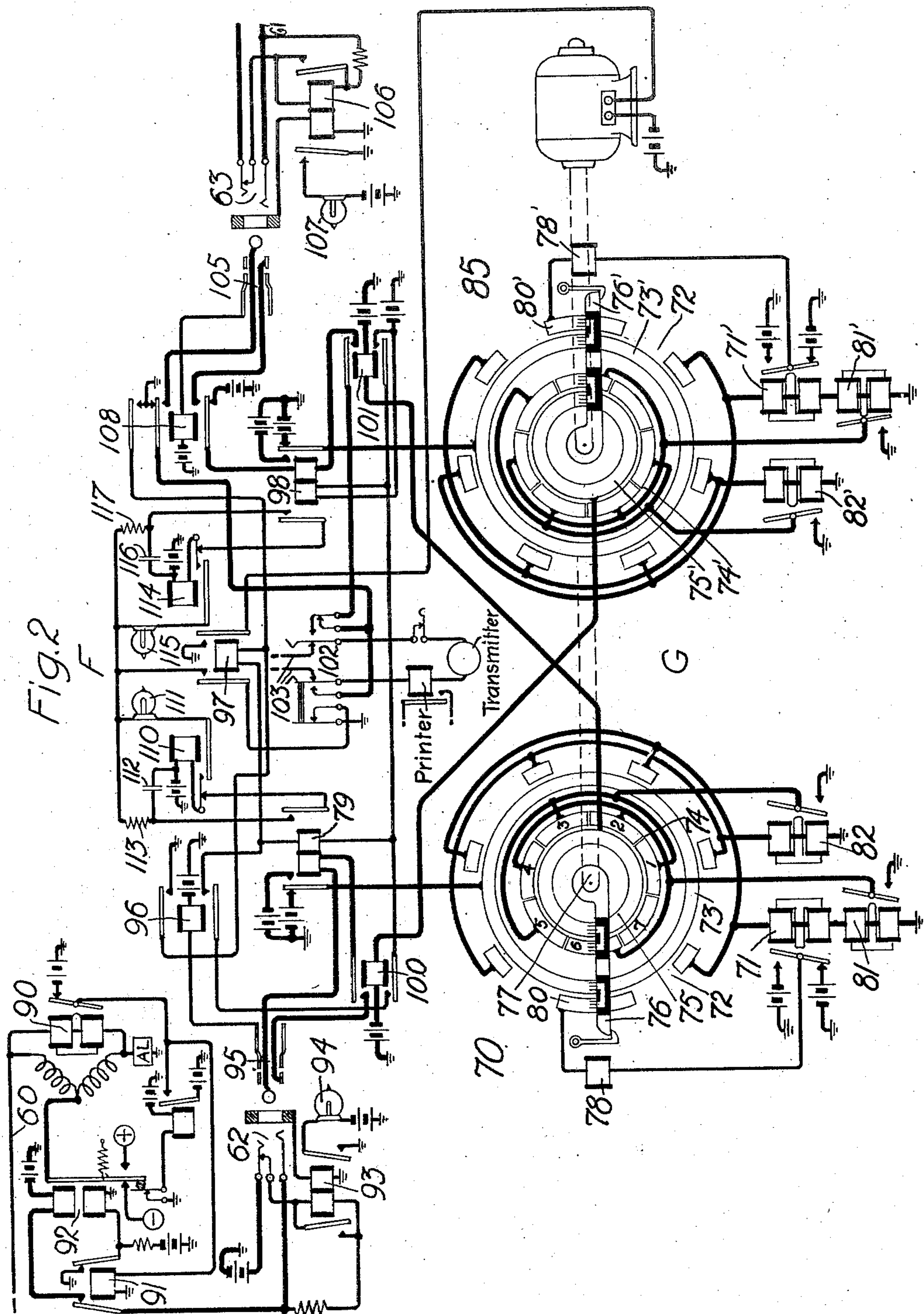
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PRINTING TELEGRAPH EXCHANGE SYSTEM

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2 Sheets-Sheet 2



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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-EXCHANGE SYSTEM.

Application filed December 23, 1922. Serial No. 608,727.

This invention relates to printing telegraphy, and particularly to printing telegraph exchange systems.

Its object is a printing telegraph exchange system wherein repeating means is associated with the link circuits for repeating impulses between connected lines.

The invention according to its preferred form provides a printing telegraph exchange system in which a plurality of printing telegraph subscribers' lines terminate at a central office where link circuits are located for establishing connections between the subscribers' lines. In each of the link circuits there is arranged repeating means whereby the impulses from one line will be transmitted accordingly to the connected line, thus permitting the use of the equipment in conjunction with lines in which the associated stations are located at remotely separated points.

A better understanding of the invention may be had from the following description, taken in conjunction with the accompanying drawings which illustrate the invention.

Referring to the drawings, Fig. 1 illustrates one embodiment of the invention, while Fig. 2, represents a modification of the arrangement shown in Fig. 1.

Referring now to Fig. 1, there are shown two printing telegraph subscribers' stations, A and B, having telegraph lines, D and E, respectively, connecting the stations with a central office C. It will be understood, of course, that in actual practice many other lines similar to D and E may terminate at the same central office, and that a plurality of link circuits similar to C are employed and each of the link circuits is arranged with direct point repeating means for repeating directly the impulses received from one line to another line with which it is associated through the link circuit.

Assume for the purpose of illustration, that the subscriber A desires to communicate telegraphically with the subscriber B. The subscriber A would thereupon actuate switch 6, which establishes an energizing circuit for relays 7 and 8. Obviously, however, this switch 6 may be used for other purposes, such as the closure of the power circuit extending to the motor of the printing telegraph equipment. For the sake of clearness, the latter has not been shown. Relay 7 in opening its contact disconnects call bell

3 from the telegraph line D and connects the upper winding thereof to this line. Relay 8, in attracting its armature, opens at its contact a short circuit about resistance 9 which is now included in the locking circuit of the relay 7, the transmitter and printer, the latter two having been shown diagrammatically. A printer of a type suitable for use in connection with the system now under consideration is disclosed in U. S. Patent to H. Pfannenstiehl No. 1,583,365 granted May 4, 1926. It is understood, of course, that other types of printing telegraph equipment may be used with equally good results.

The closure of the front contact of relay 7 completes an operating circuit for line lamp 15 extending from battery, through the lamp 15, tip contact of the jack 4, armature and front contact and upper winding of relay 7, resistance 9, contact of break key 10, and the printing telegraph equipment to ground. Line lamp 15 is thereupon lighted for indicating to the operator that subscriber A desires to be connected with another subscriber.

The operator at the central office in observing the lighted condition of lamp 15, inserts plug 16 into jack 4, whereupon the circuit including the lamp 15 is severed, due to the movement of the tip contact of the jack 4. The insertion of the plug 16 into the jack 4 also establishes an energizing circuit for sleeve relay 17 extending from grounded battery, through the winding of relay 17 and the sleeve contacts of plug 16 and jack 4 to ground. Relay 17 in closing contact 18 establishes an energizing circuit for the right and left hand windings of repeater relays 20 and 21, respectively. This circuit may be traced from grounded battery, through the left hand winding of repeater relay 21, right hand winding of repeater relay 20 and contact 18 to ground. The establishment of the circuit just traced causes the operation of the armatures of the respective repeater relays for closing their associated contacts. Each of the repeater relays closes at one of its contacts the operating circuit of the other repeater relay, that is, repeater relay 20 in closing contact 25 establishes an operating circuit for repeater relay 21, extending from battery through the upper armature and back contact of relay 32, normal contact of printer

key 31, right hand normal contact of release key 30, right hand winding of repeater relay 21, contact 25 of repeater relay 20 and lower armature and back contact of sleeve relay 32 to ground. The operating circuit for repeater relay 20 may be traced from grounded battery, ring contacts of jack 4 and plug 16, winding of supervisory relay 22, contact 27 of repeater relay 21, left hand winding of repeater relay 20, left hand normal contact of release key 30, normal contact of ringing key 24, tip contact of plug 16 and jack 4, out over the line D to the subscriber's station A and thence through the locking winding of relay 7, resistance 9, break key 10 and the printer set to ground.

Contacts 25 and 27 of repeater relays 20 and 21, respectively, being now closed, these relays will remain operated. Following the closure of contacts 25 and 27, the repeater relays 20 and 21 cause the closure of contacts 26 and 28. Contact 19 of sleeve relay 17 being now closed, a short circuit for the right hand and left hand windings respectively of repeater relays 20 and 21 is established. This latter circuit may be traced from grounded battery, through the right hand back contact of supervisory relay 22, contact 26 of repeater relay 20, contact 28 of repeater relay 21, contact 19 of sleeve relay 17 and the back contact of supervisory relay 43 to ground. Accordingly no current flows through the right and left hand windings of repeater relays 20 and 21, respectively.

It is to be noted that for the condition just described current flows through the winding of supervisory relay 22, which current is not of sufficient strength to energize the same for the lighting of supervisory lamp 23. The operation of supervisory relay 22 will be described more fully hereinafter.

The plug 16 having been inserted in the jack 4, the operator is now in connection with the subscriber A. The operator thereupon actuates a printer key 31, which connects the printing telegraph equipment, which is common to a plurality of cord circuits and which may be associated with the other cord circuits upon the operation of printer key 33 or other keys associated with other cord circuits serially with the tip conductor of the link circuit. The operator may now actuate the transmitting mechanism for communicating with subscriber A to ascertain the number of the called for line. The subscriber A now operates his transmitter to send a series of impulses for causing the operation of the printer equipment at the central office for indicating to the operator the number of the line desired. For the case chosen for illustration the subscriber A would transmit a character or number designating the line E which ex-

tends from the central office to the subscriber's station B.

The operator having ascertained the number of the called for line inserts the calling plug 35 in the jack 5 for extending the line D to the line E. The insertion of the plug 35 in the jack 5 causes the disconnection of the line lamp 36 which is prevented from lighting when the subscriber B responds to the call. Also the insertion of the plug 35 into the jack 5 causes the operation of sleeve relay 32 over a circuit extending from battery through the winding of sleeve relay 32 and the sleeve contacts of plug 35 and jack 5 to ground. Sleeve relay 32 in operation opens at its contacts the operating circuit of the repeater relay 21, which is released and remains deenergized until the subscriber B responds by the connection of the printer set thereat with the line E, as will be described hereinafter. Repeater relay 21 opens at its contact 27, the energizing circuit for the operating winding of repeater relay 20, but owing to the establishment of the locking circuit for repeater relay 20, this relay does not open its contacts, but remains energized until the transmitter at station A is operated, at which time it responds to the impulses thus transmitted for repeating such impulses to the connected line after the connection has been established.

The plug 35 being inserted in the jack 5, the supervisory relay 43 is connected with the ring conductor of the associated line. The supervisory relay 43 will, however, not be energized for causing the lighting of supervisory lamp 44, on account of the call bell 38 and a condenser being connected serially with the tip conductor of the line E. If the operator desires to supervise the connection the printer set associated with the link circuit should remain connected in the link circuit until the called for station responds. The operator may now actuate ringing key 37 for impressing on the line E ringing current. The ringing current impressed on the line E traverses the armature and back contact of relay 40 the call bell 38 and associated condenser to ground, the call bell 38 thus responds for indicating to the subscriber B that another party desires to communicate with him telegraphically.

The subscriber B being thus informed actuates switch 39 for completing the energizing circuit for relays 40 and 41. It is to be understood, of course, that the switch 39 may serve a purpose similar to that described in connection with switch 6 at station A. Relay 40 in operating, disconnects the call bell 38 from the tip conductor of the line E, and connects the latter through the upper winding of relay 40 and through resistance 42, break key 46 and the printer

set associated therewith to ground. The short circuit about the resistance 42 having been removed upon the operation of relay 41, the printing telegraph equipment in station B is now operatively associated with the line E extending to the central station C. The establishment of the circuit just traced also completes an energizing circuit for the repeater relay 21 extending from grounded battery through the ring contacts of jack 5 and plug 35, winding of supervisory relay 43, lower front contact and armature of sleeve relay 32, auxiliary contact 25 of repeater relay 20, right hand winding of repeater relay 21, right hand contact of release key 30, through operators printing telegraph set, upper armature and front contact of sleeve relay 32, contact of ringing key 37, tip contacts of plug 35 and jack 5 and thence over the line E, through the upper winding of relay 40, resistance 42, break key 46 and the printer set to ground.

The subscriber B now operates his transmitter for transmitting to the station A through the link circuit C, a series of impulses, which upon being received on the printer set at station A informs such subscriber that B is now ready to receive the communication from the former station. The printer key 31 at the central station being actuated, the impulses transmitted from station B to station A will accordingly be received on the printer equipment thereat, indicating to the operator that the called-for subscriber has answered at which time the printer key thereat may be restored to normal.

Following the completion of the communication between stations A and B, the subscriber at station B opens key 39, whereupon the circuit extending from grounded battery, through the lower winding of relay 40 and the winding of relay 41, is broken. Relay 40, however, does not release its armature, owing to current flowing through its upper winding. Relay 41, however, does release its armature for short-circuiting resistance 42. The short circuiting of resistance 42 causes a change in the current flowing through the supervisory relay 43 which is such that this relay operates.

Relay 43 in operating, closes at its front contact, an operating circuit for supervisory lamp 44 which is thereupon lighted for indicating to the operator that the plug 35 may be disconnected from the jack 5. Similarly, when the subscriber at station A opens switch 6, the resistance 9 being now short circuited, supervisory relay 22 is accordingly energized for lighting the supervisory lamp 23, the purpose of which is the same as that described in connection with supervisory lamp 44. Supervisory relay 43, in opening its back contact, removes the short circuit

about the right hand winding of repeater relay 20, whereupon this relay is maintained energized over a circuit extending from grounded battery, right hand armature and contact of relay 22, contact 26 and right hand winding of repeater relay 20 to ground at either the uppermost contact and armature of relay 17 or the middle contact and armature of relay 32. Now should the subscriber A operate his transmitting mechanism, impulses will not be repeated to line E as repeater relay 20 is now held energized over the circuit just traced.

Likewise when supervisory relay 22 is energized the short circuit about the left hand winding of repeater relay 21 is removed, accordingly preventing it from responding to the actuating of the transmitting equipment at station B. Such a condition also insures that the supervisory lamps 23 and 44 will be maintained lighted until the operation of release key 30 or the removal of the plugs 16 and 35 from their associated jacks. If the locking circuit for the repeater relays was not established upon the operation of the supervisory relays, then upon the operation of switches 6 and 39 at the respective stations for associating the printing telegraph equipment with the line, the supervisory relays would be deenergized and the lamps controlled thereby extinguished. Accordingly the operator would not receive the disconnect signal unless it happened to be observed upon its initial operation, that is, immediately following the opening of the switches 6 and 39 at stations A and B, respectively. Before disconnecting the plugs from the associated jacks, release key 30 should be operated momentarily by the operator to open the circuit of both answering and calling plugs, thus releasing relays 7 and 40 and restoring the subscribers' circuits to normal.

Assume, for example, that the subscriber A desires to recall the operator before the connection has been broken down. Subscriber A thereupon operates repeatedly flashing key 45 for short-circuiting the resistance 9. Resistance 9, being short circuited, the current now flowing through the winding of supervisory relay 22 is such that this relay is operated for causing the illumination of the supervisory lamp 23. The operator C, observing the flashing of the supervisory lamp 23 is informed that the subscriber A desires to be connected with another subscriber. Accordingly the operator actuates printer key 31 for connecting the printer set thereat with the cord circuit. The operation of the system from this point is identical to that previously described.

During the period that any of the subscribers is receiving impulses from any other subscriber, such subscriber may interrupt the transmission by actuating a break

key located at each of the subscribers' stations. For example, should the subscriber B desire to interrupt the sending of the subscriber A, it would only be necessary to actuate break key 46, thereby opening the energizing circuit for repeater relay 21 for producing a condition which informs the subscriber A that subscriber B desires to reverse the direction of the sending.

Referring now to Fig. 2 there are shown trunk circuits 60 and 61 which extend from distant stations and terminate at a central office F in jacks 62 and 63 respectively. Each of the trunk circuits has associated therewith duplex equipment for permitting half duplex service between the connected stations. The equipment for one line only has been shown in detail as the equipment for the other line is identical to that shown in the upper left hand corner of Fig. 2. In order that lines terminating at the central office F may be extended to other lines as desired link circuits are provided. Each of the link circuits is provided with regenerative repeating means for repeating the signals received from one line to another which will be free from bias and distortion. There is also arranged with such repeating means switching relays for performing desired functions as will be described more fully hereinafter.

The repeating or regenerating equipment G which is associated with the link circuit comprises a distributor 70 including a plurality of rings 72, 73, 74 and 75 and a brush arm 76, the latter being frictionally mounted on a continuously rotating shaft 77. The brush arm 76 is released upon the energization of a release magnet 78, under the control of the brush carried by the brush arm 76, the start control relay 71 and the line relay 79. The segments of the ring 74 are 7 in number, one corresponding to each unit of the five-unit code for which the system is established, 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 arm 76 thereover. Alternating ones of the segments forming the ring 74 are connected with the armature of polarized storing relay 81 which serves for storing the impulses sequentially to be transmitted while the remaining ones thereof are connected with the armature of a similar storing relay 82 serving the same purpose as storing relay 81. These relays 81 and 82 are of the polarized type and thereby when either is energized their armatures are maintained in the position set until an impulse is received of a polarity opposite to that which previously caused their operation. The outer ring 72 comprises a plurality of segments the length of which are approximately $\frac{1}{4}$ the length of the segments form-

ing the inner ring 74 so that only the center portion of each signal unit is used.

Equipment similar to that designated by the numeral 70 is shown at 85 for regenerating and repeating signals to be transmitted in the opposite direction. Inasmuch as such equipment is identical to that just described, a detailed description thereof is considered unnecessary here.

The operation of the system is as follows:

Assume that a party to whose station the trunk circuit 60 extends desires to communicate telegraphically with a party whose printing telegraph equipment is operatively associated with the trunk circuit 61. The calling party will thereupon operate his transmitting equipment or may for the purpose of signaling the operator merely open the line circuit for causing the energization of the line relay 90 at the central office F to reverse the position of its armature. Line relay 90 responding to the alteration of the normal line condition causes the deenergization of control relay 91. This control relay at its left hand contact opens the circuit of the pole changer relay 92 while at its right hand contact a short circuit about the lower winding of the pole changer relay 92 is removed. Accordingly, pole changer relay 92 will not reverse the position of its armature due to the establishment of an energizing circuit through the lower winding thereof. The control relay 91 upon being deenergized also opens the operating circuit of line relay 93 which becomes deenergized causing the lighting of line lamp 94. Relay 93 closes at its left hand contact a short circuit about its left hand winding whereby lamp 94 is maintained lighted.

The operator at the central office observing the lighted condition of the line lamp 94 inserts plug 95 into jack 62. The insertion of plug 95 into jack 62 opens at the tip contact of the latter the operating circuit of line relay 93 whereby the original energizing circuit of this relay is severed. However, a circuit is established for operating this relay extending from grounded battery through the winding of sleeve relay 96, sleeve contacts of plug 95 and jack 62 and the right hand winding of line relay 93 to ground. Both sleeve relay 96 and line relay 93 are thereby energized. Line relay 93 opens the operating circuit of the line lamp 94 which is thereupon extinguished. Sleeve relay 96 on the other hand closes at its upper contact an operating circuit including the winding of control relay 97 and the locking windings of line relays 79 and 98. The circuit for operating the relays just described may be traced from grounded battery through the left hand windings of line relay 98 right hand winding of line relay 79, winding of control relay 97, and the upper contact and armature of sleeve relay 96 to

ground. Control relay 97 in closing its right hand contact closes the power circuit extending to the motor which drives the shafts upon which the distributor brush arms are mounted. Line relays 79 and 98 in energizing connect negative battery with the continuous rings 73 and 73' respectively. Due to the fact that negative battery is now connected with the continuous rings in each case, and since the brush arms 76 and 76' are at rest, an operating circuit is established for release magnets 78 and 78'. The energizing circuit for the release magnet 78 may be traced from negative battery at the contact of line relay 79, continuous ring 73, outer brush carried by the brush arm 76, segment 80, winding of release magnet 78, armature and lower contact of start control relay 71 to the positive terminal of the battery. Likewise, the energizing circuit of the release magnet 78' may be traced from the negative pole of battery by the contact of the line relay 98, continuous ring 73', outer brush carried by the brush arm 76', segment 80', winding of release magnet 78' and the armature and lower contact of start control relay 71' to the positive pole of the battery. Both of the release magnets 78 and 78' are accordingly energized for removing the latches controlled thereby out of the path of the respective brush arms. As previously described, the brush arms 76 and 76' are frictionally mounted on continuously rotating shafts. When the release latches are withdrawn the brush arms thereupon are free to rotate.

As the brush arms rotate the brushes carried thereby travel over the receiving segments whereby negative impulses will be transmitted through the storing relays 81 and 82 and relay 71. The armatures of relays 81 and 82 will thus be moved to engage their lower contacts thus connecting ground with the transmitting segments while the armature of relay 71 engages its upper contact. When the sending brush of each distributor reaches segment #1 the sending relays 100 and 101 will be operated and will remain operated until the brush completes its cycle of rotation. Following the passage of the brush arm over segment #5 the brush arms in each case will be arrested and will be held against rotation until the receipt of a start impulse from either of the stations to which the circuits 60 and 61 extend. Release magnets 78 and 78' will not be energized upon the engagement of the outer brush with the segments 80 and 80' as negative battery is now connected to the armature of start control relay 71. Both of the sending relays 100 and 101 close at their lower contacts short circuits about the locking windings of the line relays 79 and 98, but these line relays are not released at this time. Line relay 79 is held energized by current

furnished from the trunk circuit over the ring contacts of jack 62 and plug 95, upper contacts of relay 100 and the left hand winding of line relay 79 out over the tip contacts of plug 95 and jack 62 to the terminal of the battery. The current for line relay 98 is, however, furnished from battery on the lower armature and contact of sleeve relay 108, the circuit of which extends through the right hand windings of line relay 98, upper contact and armature of sending relay 101, right hand contact of printing key 102, middle armature and contact of sleeve relay 108 to ground. Accordingly, these line relays will remain energized even though short circuits are placed about the holding windings thereof. The operator may now actuate printer key 102 which disconnects the conductors 103 extending to the other cord circuits where a key similar to key 102 is located and also connects the printer set located thereat in series with the operating circuit of line relay 98. As sending relay 101 is now energized any signals transmitted by the operator will be repeated by line relay 98 through the distributor 85 to the storing relays 81' and 82'. Similar signals will then be retransmitted by the sending brush and repeated by sending relay 100 over the trunk circuit to which the plug 95 is connected. The signals transmitted by the sending relay 100 will pass through the operating windings of line relay 79 but the latter relay will not be affected as it is held operated by its holding winding during the intervals when the circuit in its main winding is open.

The party initiating the call will after receiving the response of the operator operate the transmitting equipment for the transmission of a series of character signals for informing the operator the number of the trunk circuit to which connection is desired. In this case the line relay 79 responds upon the receipt of a starting impulse to cause the application of a positive battery to the continuous ring 73 and accordingly the energization of the release magnet 78 and the release of the brush arm 76. As the brush arm 76 travels over the receiving segments and since receiving relay 79 responds to the operation of the receiving relay 90, in accordance with the transmitted signals, impulses will be stored in the storing relays 81 and 82. Thus, upon the passage of the sending brush over the sending segments, sending relay 101 will be operated for opening and closing the operating circuit of the printer set located at the central office. This printer set will thereby respond for recording the number or designating character of the called for line.

The operator having ascertained the number of the called for line it being for the particular case chosen for illustration the

trunk circuit 61, inserts plug 105 into jack 63. The insertion of the plug 105 into jack 63 causes the opening of the main operating circuit of line relay 106. This line relay
 5 however is not deenergized as the insertion of the plug 105 into jack 63 establishes an energizing circuit for sleeve relay 108 and the left hand winding of line relay 106. Accordingly, line lamp 107 is not lighted.
 10 Sleeve relay 108 also connects the operating winding of the line relay 98 and the repeating equipment 85 with the tip and ring conductors of the cord circuit. The system is now in a condition for normal operation.

15 The operator may now actuate his transmitter for transmitting to the calling and called for subscribers characteristic characters for informing such parties that connection has been established and the transmission of messages may be proceeded with.
 20 In case the plug 105 is inserted in the jack 63 when the plug 95 is pulled down, sleeve relay 108 will be operated and sleeve relay 96 accordingly released. In this case

25 the locking circuit for the line relays 79 and 98 will be completed through the control relay winding and the upper front contact of sleeve relay 108 and the circuit for the auxiliary contacts of sending relay 100 will
 30 be open at the lower armature and contact of sleeve relay 96. Under this condition line relay 79 will be held operated by its locking winding although there is no current in its operating winding. If the printing key 102
 35 is now operated the operator's printer set will be connected directly in series with the plug 105 for communication over the connected trunk circuit.

40 The transmission of impulses in either direction causes the operation of the line relays for releasing the associated distributor, storing the impulses in accordance with those transmitted and retransmitting such impulses to the connected trunk circuit
 45 which will be free from bias and distortion.

In order that either party may inform the operator when the transmission of the message has been completed supervisory signals in each end of the cord circuit are provided. For example, associated with the
 50 plug 95 is a supervisory relay 110 which controls the lighting of a supervisory lamp 111. Supervisory relay 110 is controlled through auxiliary contacts on line relay 79
 55 and by slow charging condenser 112. This condenser 112 is connected to a high resistance 113 which limits the current to such a value that condenser 112 requires several
 60 seconds to become charged to approximately full potential of the battery. When line relay 79 is operated supervisory relay 110 which is of comparatively low resistance is shunted around the condenser 112 which prevents the condenser from receiving any appreciable charge. Resistance 113 also lim-

its the current to a value such that supervisory relay 110 will not be energized except when line relay 79 is deenergized to open the auxiliary contacts associated therewith for an appreciable period of time, that is,
 70 for a time longer than the time occupied in the normal transmission of impulses. Thus, if the party at the station of the trunk circuit 60 desires to advise the operator of the completion of the communication with
 75 the connected trunk circuit, it only becomes necessary to cause the transmission of a long open impulse. This open impulse upon being received at the central office causes the opening of the auxiliary contacts of line
 80 relay 79 allows condenser 112 to charge slowly to approximately the full potential of the battery. At the end of the long open impulse, line relay 79 will operate to close its auxiliary contact, thus allowing con-
 85 denser 112 to discharge through the winding of relay 110. Relay 110 will now be energized and will close a locking circuit for itself from grounded battery through its winding and front contact, through lamp
 90 11 and through the left hand contacts of control relay 97 and key 102 to ground. This will cause the illumination of supervisory lamp 111.

There is also associated with the plug 105
 95 a supervisory relay 114 which controls the operation of supervisory lamp 115 and which is also controlled by a slow charging condenser 116 and a high resistance 117. Supervisory relays 110 and 114 are also
 100 released upon the actuation of key 102 and the withdrawal of the plugs 95 and 105.

It is apparent from the previous description that the present invention provides an arrangement whereby a number of trunk
 105 circuits extending from various subscriber's stations to a central office may be established between the various lines by means of cord circuits, such cord circuits being equipped with repeating means for repeating the im-
 110 pulses from one line to another which are free from bias and distortion.

Although the invention has been disclosed and described in conjunction with a particular type of system it is, of course, obvious that various departures may be made without departing from the spirit and scope of the present invention.

What is claimed is:

1. A printing telegraph system comprising a plurality of printing telegraph subscribers' lines terminating at a central office, link circuits at the central office for connecting any of the subscribers' lines with any
 120 other subscriber's line, relay means in each link circuit operative in accordance with the transmitted impulses for repeating impulses between connected lines, and other means in each link circuit cooperating with said relay
 125 means for reforming received impulses to

insure the repetition thereof in the same form as originally transmitted.

2. A printing telegraph system comprising a plurality of printing telegraph subscribers' lines terminating at a central office, a plurality of link circuits at the central office for establishing connections between any of the subscribers' lines, relay means in each link circuit for repeating impulses between connected lines, and means in each link circuit cooperating with said relay means for reforming the received impulses to insure their repetition in their original form between connected lines.

3. In a printing telegraph exchange system, a plurality of printing telegraph subscribers' lines terminating at a central office, link circuits at the central office for connecting any of the subscribers' lines with any other subscriber's line, and means in each link circuit comprising distributing apparatus, a plurality of relays associated with said distributing apparatus and arranged to be selectively operated, and circuit connections established by said distributing apparatus for repeating to a connected line impulses in accordance with the operation of said relays.

4. In a printing telegraph exchange system, a plurality of printing telegraph subscribers' lines terminating at a central office, interchangeable link circuits at the central office for establishing connections between any of the subscribers' lines, means in each link circuit comprising an intermittently rotating distributor, a pair of relays associated therewith to be selectively operated in accordance with the impulses transmitted, a source of signaling current, and circuit connections established by said distributor

for connecting said source of current with the connected line as determined by the operation of said relays.

5. In a printing telegraph exchange system, a plurality of printing telegraph subscribers' lines terminating at a central office, interchangeable link circuits at the central office for establishing connections between any of the subscribers' lines, means in each link circuit comprising a start-stop distributor having receiving and transmitting sections, storing means selectively operated by current impulses received from one of the connected lines, a source of signaling current adapted to cooperate with the transmitting section of said distributor, means to retransmit to the other connected line from said current source corresponding impulses, the cooperation being controlled by said storing means whereby signaling current impulses will be originated.

6. A printing telegraph exchange system comprising a plurality of printing telegraph subscribers' lines terminating at a central office, a plurality of operator's cord circuits at the central office for establishing connections between any two of the subscribers' lines, means in said cord circuits for repeating impulses between connected lines, said last mentioned means comprising means for insuring that the impulses as repeated are of the same form as those transmitted, and means in each of said cord circuits for enabling an operator to supervise a connection after it has once been established.

In testimony whereof, I have signed my name to this specification this 22nd day of December, 1922.

GILBERT S. VERNAM.