Dec. 15, 1925. 1,565,343

G. S. VERNAM ET AL

PRINTING TELEGRAPH EXCHANGE SYSTEM

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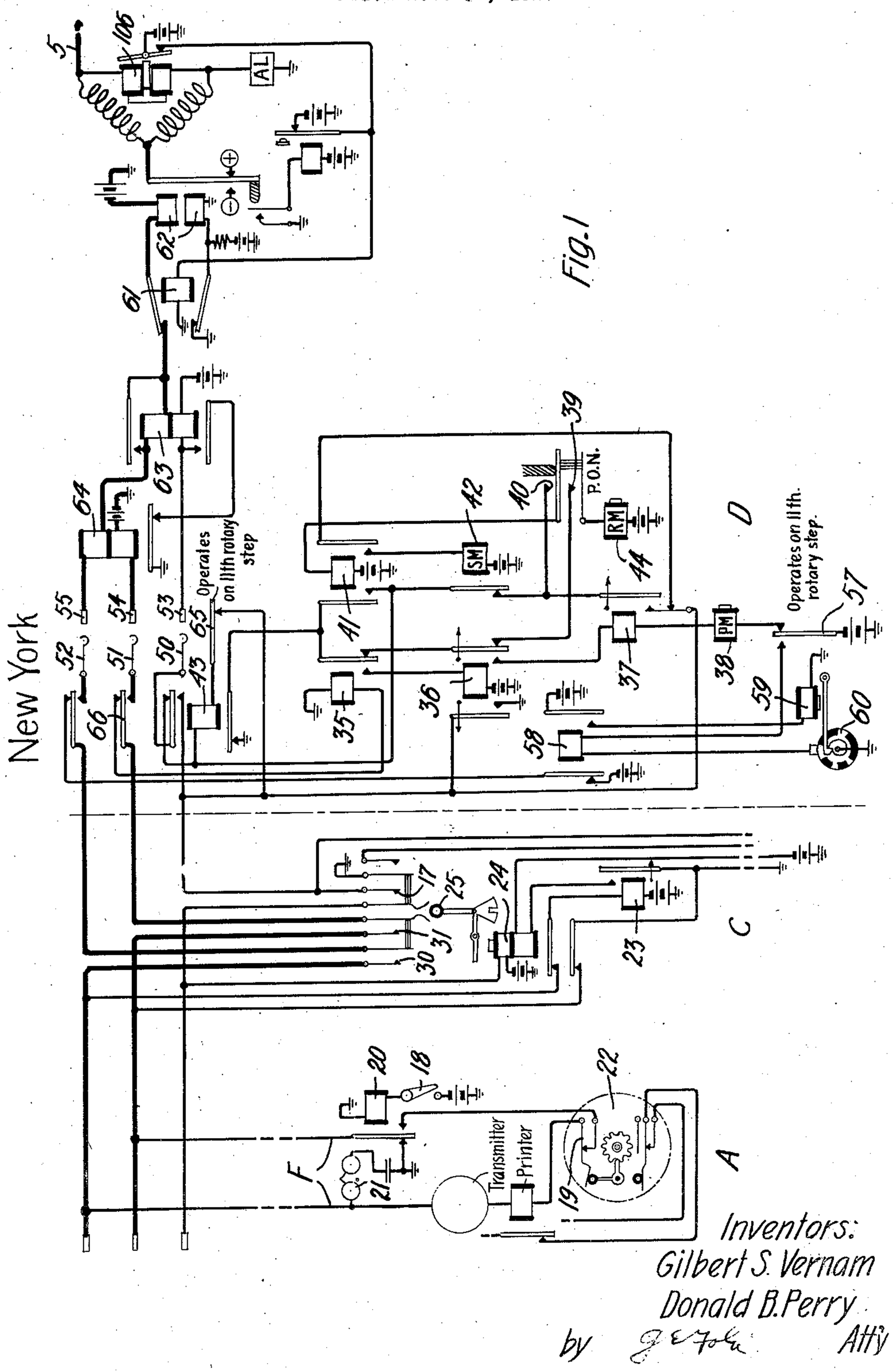

Fig. 1

Inventors:
Gilbert S. Vernam
Donald B. Perry
by J. E. Yoke Atty

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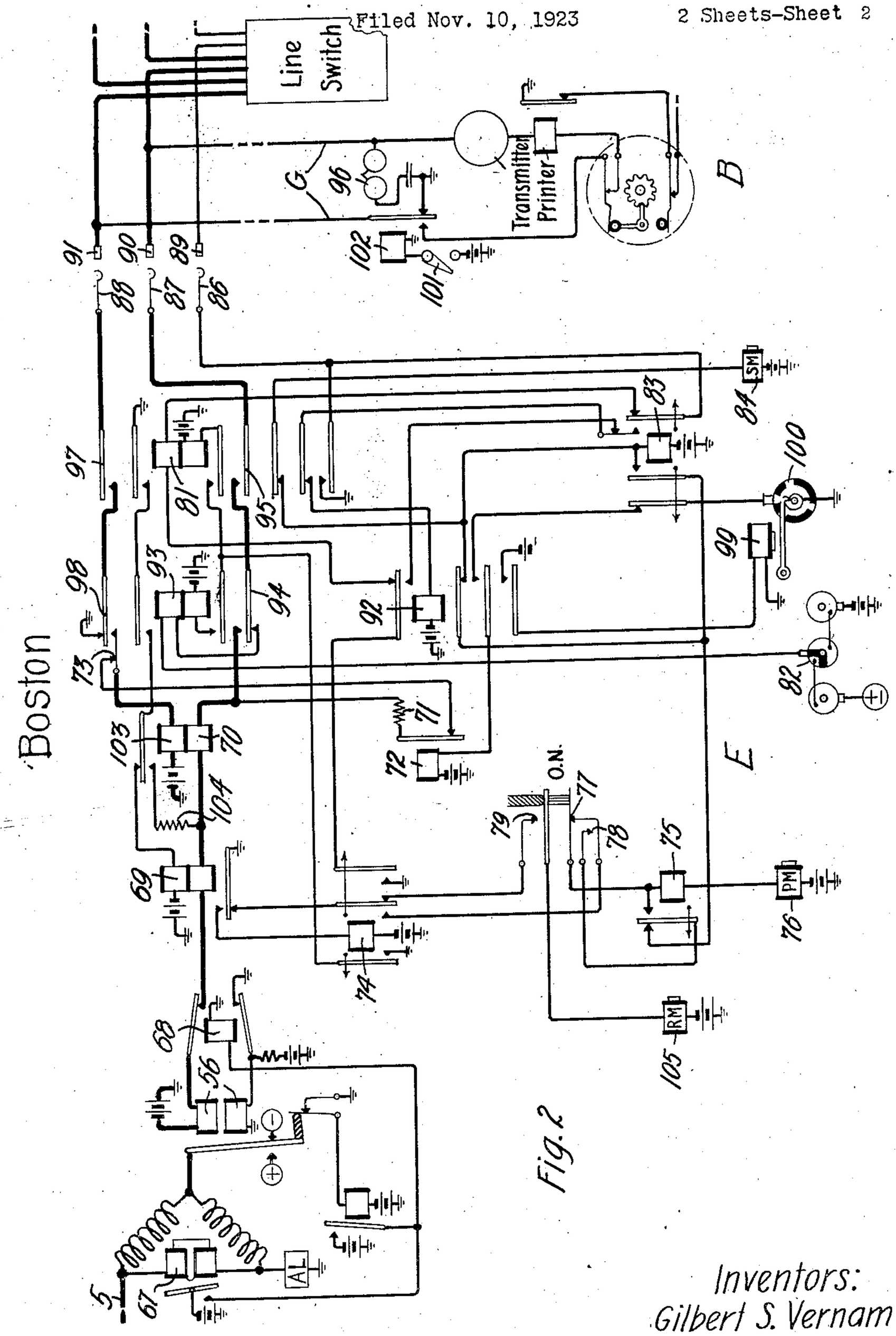

Fig. 2

Inventors:
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Patented Dec. 15, 1925. 1,565,343

UNITED STATES PATENT OFFICE.

GILBERT S. VERNAM, OF RIVER EDGE, NEW JERSEY, AND DONALD B. PERRY, OF YONKERS, NEW YORK, ASSIGNORS TO AMERICAN TELEPHONE AND TELEGRAPH COMPANY, A CORPORATION OF NEW YORK.

PRINTING-TELEGRAPH-EXCHANGE SYSTEM.

Application filed November 10, 1923. Serial No. 674,009.

To all whom it may concern:

Be it known that we, GILBERT S. VERNAM and DONALD B. PERRY, residing at River Edge and Yonkers, in the counties of Bergen and Westchester and States of New Jersey and New York, respectively, have invented certain Improvements in Printing-Telegraph-Exchange Systems, of which the following is a specification.

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

An object of the invention is a printing telegraph system which is flexible and one wherein a printing telegraph subscriber located in one city may extend his line automatically to a subscriber located in a distant city.

In accordance with the preferred form of the invention, it contemplates a plurality of printing telegraph stations located at remote cities which are connected by a plurality of telegraph lines and which have located thereat machine switching apparatus for automatically establishing a connection between a calling and a called subscriber.

Referring to the drawings, a complete system is shown diagrammatically when Figures 1 and 2 are placed end for end with Fig. 1 to the left of Fig. 2.

In the drawings there are shown two printing telegraph stations A and B whose lines F and G respectively extend to central offices where suitable machine switching apparatus is located. At the office in which the line F terminates, there is arranged a line switch C and a selector switch D which serve to extend the line F to one of a plurality of telegraph lines such as 5 which extend between New York and Boston, or any other desired city, and which as illustrated, is provided with duplex equipment. As will be described hereinafter, the telegraph lines extending between the two cities are, however, not capable of the simultaneous transmission in both directions but are arranged for giving what is commonly referred to as half duplex service. Associated with the end of the telegraph line 5 terminating at the city of Boston is a connector switch E operative to connect the telegraph line 5 with the line of the called for subscriber. It is understood, of course, that many other lines similar to F and G extend from subscribers' stations to the offices at which telegraph lines similar to 5 terminate, and so for convenience but two of the lines are shown in the present case. Each of the printing telegraph subscribers' stations is provided with an impulse sending device and printing telegraph equipment, the latter comprising the usual transmitter and receiving printer for performing their respective functions.

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

Assume for the sake of illustration, that the subscriber A at New York desires to communicate with the subscriber B located at Boston. Accordingly the subscriber A operates switch 18 which establishes an energizing circuit for relay 20. Relay 20 disconnects the call bell 21 from the transmitting circuit and connects the impulse sender 22 with the tip and ring conductors. The closure of the circuit at the contacts of relay 20 completes an energizing circuit for line relay 23, the circuit of which may be traced from grounded battery, through the winding of relay 23, upper armature and contact of relay 24, thence over the line to the subscriber's station through the transmitter and printer in series, contact 19 of the impulse sending device 22, front contact and armature of relay 20, and over the line to the central office and through the lowermost contact and armature of cut-off relay 24 to ground. Line relay 23, in operating closes at its contact an operating circuit for cut-off relay 24. Cut-off relay 24 is thereupon energized and opens at its lowermost contact, the operating circuit of line relay 23 and moves plunger 25 to a position where contacts 17, 30 and 31 are closed. Relay 23 being of the slow-to-release type, does not release until relay 36 has operated as described later.

At the closure of contact 30, a circuit is completed for causing the energization of line relay 35. The energizing circuit of relay 35 may be traced from battery, left-hand contact and armature of relay 58, uppermost contact and armature of relay 43 over the line and through the transmitter and printer, contact 19 and the front con-

tact and armature of relay 20 at station A, contact 31 of the line switch C, upper middle armature and contact of relay 43, and the winding of relay 35 to ground. Line relay 35 in energizing, completes an energizing circuit for slow-to-release relay 36 extending from grounded battery through the winding of relay 36, front contact and armature of relay 35 and the lowermost armature and contact of relay 43 to ground. Relay 36 in closing its contacts, conditions an energizing circuit for series relay 37 and the vertical magnet 38 which respond to the closure of the back contact of relay 35 in response to the operation of the impulse sending device 22. At the left-hand contact and armature of relay 36, there is established a locking circuit for relay 24 of the line switch C. This locking circuit may be traced from grounded battery, through the upper winding of cut-off relay 24, contacts 17, and the left armature and contact of relay 36 to ground. As previously stated, relay 23 is of the slow-to-release type and remains operated after its circuit has been opened by relay 24 and until relays 35 and 36 have been energized to maintain relay 24 energized after which relay 23 releases its armature.

The subscriber A now actuates the impulse sending device 22 to send the impulses of the first digit for selecting a particular level allotted to a designated city to which a plurality of telegraph lines similar to 5 are connected and which extend between New York and Boston, thereby interrupting the circuit of line relay 35. On the operation of the impulse sending device 22, contact 19 is opened thereby opening the loop circuit. Upon the first retraction of the armature of relay 35, a circuit is completed from grounded battery, switch member 57, vertical magnet 38, series relay 37, right-hand front contact and armature of relay 36, back contact and armature of relay 35, and the lowermost armature and contact of relay 43 to ground. Due to the energization of the vertical magnet 38, the wipers 50, 51 and 52 will be lifted to a level in the bank of contacts in which the contacts 53, 54 and 55 are located. It is, of course, understood that these contacts 53, 54 and 55 are connected to the telegraph line 5, there of course, being other similar contacts of this level likewise connected to other telegraph lines extending between the two cities. The first upward step of the shaft on which the wipers 50, 51 and 52 are mounted, closes the off-normal contacts 39 and 40. Through one of these contacts, an energizing circuit for the release magnet 44 is prepared, while through the other off-normal contact, an energizing circuit for the interrupter relay 41 is conditioned. Upon the energization of relay 37, which as previously described is energized at the same time as vertical magnet 38, the interrupter relay 41 will be energized over a circuit which extends from grounded battery, through the winding of relay 41, off-normal contact 40, armature and contact of relay 37 and the left-hand armature and contact of relay 36 to ground. Following the closure of the left-hand contact of relay 41, a locking circuit is established therefor extending from grounded battery, through the winding of relay 41, off-normal contact 40, back contact and armature of stepping magnet 42, left-hand contact and armature of relay 41 and the lowermost armature and contact of relay 43 to ground.

When the series of impulses end, line relay 35 is again energized thereby maintaining relay 36 energized. Owing to this operation, the series relay 37 is deenergized closing the circuit of stepping magnet 42. The energizing circuit of stepping magnet 42 may be traced from grounded battery, through the winding of said magnet, right armature and contact of interrupter relay 41, back contact of relay 37, and the left-hand armature and contact of relay 36 to ground. It is to be noted here that the interrupter relay 41 depends for its energization on the ground established at the lowermost armature and contact of relay 43, while the stepping magnet 42 depends for its energizing circuit on the closure of the left-hand front contact of relay 36. The stepping magnet 42 now operates moving the wipers 50, 51 and 52 on to the first set of contacts such as 53, 54 and 55. If the telegraph line which is connected to this set of contacts is free, there will be an absence of ground on the wiper 50. However, if the telegraph line happens to be busy, there will be a ground on this particular contact. Assume the latter to be the case. This ground on the contact 53 is now connected through wiper 50 and the armature and back contact of relay 43 to the contacts of the stepping magnet 42 and the interrupter relay 41. Near the end of its stroke, the stepping magnet 42 opens its contact, thereby opening the locking circuit of interrupter relay 41. Accordingly relay 41 is deenergized opening the energizing circuit of stepping magnet 42. Stepping magnet 42 closes its back contact again closing the circuit of the interrupter relay 41 to the wiper 50 and the contact 53. At this time, the interrupter relay 41 depends solely upon the wiper 50 for a circuit because its own circuit to ground at the switching relay 43 is open. If wiper 50 rests on a grounded contact, the interrupter relay 41 will again energize and again cause the energization of the stepping magnet 42 causing it to rotate the wipers to the next set of contacts. So long as the wiper 50 finds ground, the interrupter relay 41 and the stepping magnet 42 will vibrate.

During this time, the switching relay 43 has had a ground at each end of its winding. Therefore, it remains deenergized. When the wiper 50 engages an undergrounded contact as, for example 53, the interrupter relay 41 fails to energize. Switching relay 43 immediately energizes over a circuit extending from battery through the lower winding of release relay 63, contact 53, wiper 50, armature, back contact and winding of switching relay 43, operating member 65, and the armature and front contact of relay 36 to ground.

The energization of switching relay 43 disconnects the line relay 35 and extends the subscriber's line through the contacts 54 and 55 to the telegraph line 5. It also removes at its lowermost armature, the ground connection through which the series relay 37 and the vertical magnet 38 were previously energized, thereby preventing the actuation of either the series relay 37 or the vertical magnet 38. Switching relay 43 also extends the sleeve conductor through the wiper 50 and contact 53 to the lower winding of release relay 63. Prior to the deenergization of release relay 36, ground is connected to the sleeve conductor through the lowermost armature and contact of release relay 63. Following this operation, release relay 36 deenergizes but the continuity of ground on the sleeve conductor is maintained. During this operation, the switching relay 43 remains energized thereby holding the selector switch D in its selected position. The holding circuit for this relay may be traced from grounded battery, winding of relay 41, off-normal contact 40, back contact and armature of magnet 42, winding of relay 43, contact 65 and the left-hand armature and front contact of relay 36 to ground. Relay 41 does not energize over the circuit just traced on account of the insufficiency of current.

If all of the telegraph lines connected to contacts corresponding to 53, 54 and 55 in the selected level are busy, the wiper 50 will be unable to find absence of ground. The wipers will therefore take eleven rotary steps. At this point in the operation, operating members 57 and 65 will be operated cutting off the switching relay 43 and the vertical magnet 38 and closing an energizing circuit for the busy relay 58. The energizing circuit for the busy relay 58 extends from battery, through the operating element 57 and left contact thereof, winding of busy relay 58 of the conducting segments of the interrupter 60 to ground. The interrupter 60 is provided with suitable conducting and insulating segments so arranged as to effect the transmission of impulses designating the character "B" or in some cases, it may be desired to transmit a number of groups of impulses representing the word "Busy". The energization of the busy relay 58 closes through its right-hand contact and armature a circuit for release magnet 59. The release magnet 59 controls the starting of the interrupter 60 for transmitting to the station A characteristic signals to indicate that the called for line is busy. The impulses transmitted by the left-hand armature and contact of relay 58 due to the operation of the interrupter 60 pass over the line to the subscriber's station A and cause the operation of the printer mechanism for recording a symbol which indicates that the line is busy and the calling subscriber should abandon the call and wait a few minutes before again attempting to establish the connection.

If an idle telegraph line is seized the closure of the two uppermost contacts of the switching relay 43, establishes a circuit for pole changer relay 62 which may be traced from grounded battery, through the upper winding of the pole changer relay 62, upper armature and contact of control relay 61, upper armature and contact of relay 63, upper winding of relay 64, contact 55, wiper 52, uppermost contact and armature of switching relay 43, back over the circuit extending to the subscriber's station A and thence through contact 31 of the line switch C, armature 66 and front contact of switching relay 43, wiper 51, contact 54, lower winding of relay 64 to the opposite pole of the battery. It is to be noted that relay 64 is of the differential type and does not pull up its armature upon the completion of the circuit just traced. Due to the establishment of the energizing circuit for the pole changer relay 62, the armature controlled thereby is caused to engage the contact to which the negative pole of the battery is connected for transmitting over the telegraph line 5 a marking impulse. This impulse upon being received at the other end of the telegraph line 5 operates relay 67 which in turn causes the operation of control relay 68. Control relay 68 in closing its upper contact, establishes the following circuit: positive pole of battery through the upper winding of relay 70, contact 73 controlled by relay 93, back contact and armature of relay 72, resistance 71, lower winding of relay 70, lower winding of relay 69, front contact and upper armature of relay 68, and the upper winding of pole changer relay 56 to the negative pole of the battery. Relay 70 is not energized at this time due to the differential connection of its windings. The value of the resistance 71 is chosen so that it equals the resistance of a normal subscriber's line circuit to maintain a current of approximately 60 milliamperes flowing therein. Due to the establishment of the circuit just traced, line relay 69 is energized and establishes an ener-

gizing circuit for release relay 74 which is of the slow-to-release type. Release relay 74 prepares through its innermost armature and front contact the energizing circuit of the series relay 75 and the vertical magnet 76.

When the subscriber A dials the tens digit, pole changer relay 62 is operated in accordance with such operation for causing the transmission of impulses to operate receiving relay 67, whereby line relay 69 vibrates its armature and establishes alternately the circuit for the release relay 74 and for the series relay 75 and vertical magnet 76. During the operation of relay 68 pole changer relay 56 does not follow such operation owing to its working circuit. The release relay 74 remains energized but the vertical magnet 76 is quick acting and follows the impulses and lifts the wiper shaft upon which the wipers 86, 87 and 88 are mounted. The series relay 75 operates on the first impulse and remains energized to the end of the series of impulses impressed on the vertical magnet 76.

On the first upward movement of the wiper shaft, contact 77 is opened while contacts 78 and 79 are closed. The closure of contact 78 extends the energizing circuit of the vertical magnet 76 through the armature and front contact of the series relay 75, while the closure of contact 79 prepares a circuit for the energization of the release magnet 105. Inasmuch as the release relay 74 and the series relay 75 are at this time energized, the movement of the wiper shaft produces no changes.

When the impulses cease, line relay 69 remains energized and the series relay 75 is accordingly deenergized. The impulse circuit is now transferred to the stepping relay 83 and the stepping magnet 84. When the subscriber dials the last digit, the line relay 69 again vibrates sending pulsations through the stepping relay 83 and the stepping magnet 84 in parallel. The stepping magnet 84 rotates the wipers 86, 87 and 88 over the bank of contacts in which contacts 89, 90 and 91 individual to the called for subscriber, are located. No interference with other connected lines is caused due to the movement of the wipers 86, 87 and 88 over the bank of contacts as the line wipers are opened at the contacts of switching relay 81.

During the rotation of the wipers 86, 87 and 88, the wiper 86 may pass over one or more busy lines, the wiper contacts of which are grounded. Busy relay 92 may be energized while the wiper is passing over such contacts but this will not interfere with the operation of the stepping magnet 84 as the circuit for this magnet is controlled through the contacts of the stepping relay 83 which remains energized and holds the circuit closed until the last series of impulses has been received. When this occurs, the stepping relay 83 will also be released and if the called for line is not busy, busy relay 92 will be released due to the absence of ground on the contact to which wiper 86 is now engaged.

If the called for line is not busy, the wiper 86 on engaging contact 89 connects battery through one of the relays of the line switch to the upper winding of switching relay 81 for causing the energization of this relay. The energizing circuit for the switching relay 81 may be traced from grounded battery at the line switch, contact 89, wiper 86, right-hand armature and contact of relay 83, upper winding of relay 81, uppermost contact and armature of busy relay 92 and the outermost armature and contact of relay 74 to ground. Following the closure of the contacts of the switching relay 81, a locking circuit therefor is established from grounded battery through the lower winding, armature and front contact thereof, and the left-hand armature and front contact of relay 74 to ground. Ground is also connected to the wiper 86 due to the energization of the switching relay 81 making the called for line busy. Relay 81 also opens the circuit of the stepping magnet 84 and of the busy relay 92.

The wipers 87 and 88 are now closed through to the ringing cut-off relay 93 and ringing current will be transmitted intermittently through the upper winding of ringing cut-off relay 93 and over the ring side of the line through the call bell 96 and associated condenser to ground. The ringing cut-off relay 93 is designed so that it will not operate on the alternating ringing current but when the subscriber B responds to the call by the operation of switch 101 which corresponds to switch 18 at station A, the disconnection of the call bell 96 and the completion of the circuit through the front contact of relay 102 permits direct current to flow through the upper winding of ringing cut-off relay 93 to effect this operation. Ringing cut-off relay 93 in operating disconnects the source of ringing current from the line and establishes a locking circuit for itself extending from grounded battery, through the front contact and armature thereof, and the left-hand armature and front contact of relay 74, to ground. It also removes the ground connection from the tip conductor and disconnects the resistance 71 from in bridge of the signaling circuit. A locking circuit is also completed for relay 69 upon the energization of ringing cut-off relay 93. Relay 69 is thus prevented from following the printed signals and causing the false release of the switching mechanism.

A channel of communication is now established between the subscriber A located

at New York and the subscriber B located at Boston and the transmission of messages between these two stations may now be commenced. In many cases, however, it would first be necessary for the subscriber B to operate his transmitter for the transmission of suitable symbols to the subscriber A to advise such subscriber of the completion of the connection and that the subscriber B is in readiness to receive any messages which the subscriber A may desire to transmit.

Should the called for subscriber's line be busy, busy relay 92 will be energized over a circuit completed through the wiper 86 and the contact 89 to ground at the line switch. Busy relay 92 opens at its back contact the energizing circuit of switching relay 81 thereby preventing the energization of this relay. Busy relay 92 on the release of relay 83 will be locked up over a circuit extending through its upper front contact and the right-hand armature and contact of relay 74 to ground. Likewise the energizing circuit of the stepping relay 83 is opened and consequently any subsequent energization of this relay by further dial impulse or printer signals from the calling station is prevented. There is also completed due to the energization of the busy relay 92 an energizing circuit for the release magnet 99 of the interrupter 100 which is similar to that described in connection with the interrupter 60 and which controls the energization of relay 72. On the operation of the interrupter 100, relay 72 is caused to open and close its contacts in accordance with the conducting and insulating segments on the interrupter 100 and accordingly opening the line circuit for effecting the operation of the pole changer relay 56. The pole changer relay 56 responds to the operation of relay 72 and transmits over the telegraph line 5 impulses which effect the operation of receiving relay 106. The receiving relay 106 controls the energization of control relay 61 which in responding to the operation of this relay, causes the transmission of impulses to the subscriber's station A corresponding to those transmitted due to the operation of the interrupter 100. Accordingly, the printer at the subscriber's station A will be operated for giving a printer record that the called for subscriber's line is busy and that the call should be abandoned for the time being.

When the transmission of messages between the connected stations has been completed, the release of the switching mechanism is controlled jointly by both stations. If the called subscriber disconnects his printer equipment first by the opening of switch 101, the differential relay 103 will be operated over the tip side of the loop circuit. Differential relay 103 in energizing opens the locking circuit of line relay 69 and connects the resistance 104 in circuit with the winding of the pole changer relay 56, whereby the pole changer and the line relay 69 are maintained energized over a circuit extending from battery, through the upper winding of pole changer relay 56, upper armature and contact of control relay 68, lower winding of line relay 69, resistance 104, upper armature and front contact of relay 103, middle contact and armature of relay 93 and the middle contact and armature of relay 81 to ground.

When the subscriber A disconnects, the pole changer relay 62 is caused to assume the position shown in the drawing for effecting the transmission of a spacing impulse and the corresponding operation of receiving relay 67. Consequently, control relay 68 is deenergized whereupon line relay 69 releases its armature followed after a short interval by the deenergization of release relay 74. Switching relay 81 releases quickly opening the line wipers and removing the ground from the wiper 86. Release magnet 105 will now be energized over a circuit extending from battery, through the winding of release magnet 105, off-normal contact 79, back contact and innermost armature of relay 74, back contact and armature of relay 69 to ground. The release magnet 105 will restore the switch mechanism E to its normal condition. The ringing cut-off relay 93 is slower to release than the switching relay 81 so that the wipers 87 and 88 will not have any ringing current on them while they are rotating to their normal position.

If the subscriber A disconnects first, the line switch C and the switch mechanism D will release, but the switch mechanism E will not release as the line relay 69 will remain locked up through the back contact of differential relay 103 and the front contact of ringing cut-off relay 93. When a subscriber A disconnects the transmitter and receiving printer by opening switch 18 thereby causing the deenergization of relay 20 and the closure of its back contact, an energizing circuit is established for differential relay 64. This relay, in operating, opens the holding circuit of relay 63 and the switching relay 43. The latter relay in releasing its armature, closes at its lowermost armature and back contact a circuit for release magnet 44 which may be traced from grounded battery winding of release magnet 44, off-normal contact 39, right-hand back contact and armature of relay 63, back contact and armature of relay 35 and the lowermost armature and back contact of relay 43 to ground. The operation of the release magnet 44 restores the selector switch D to normal. The selector switch D is now in a position to be selectively operated by the subscriber A for extending the lines individual to such subscriber to any

one of a plurality of printing telegraph subscribers located in distant cities. However, when the called subscriber disconnects, the differential relay 103 is energized and effects the release of line relay 69 which as previously described controls the energization of release magnet 105 for restoring the switch mechanism E to normal.

Although the invention has been disclosed with reference to a particular type of system, it is obvious that various modifications may be made without departing from the spirit and scope of the present invention.

What is claimed is:

1. In a telegraph system, a plurality of printing telegraph stations located at distant cities, printing telegraph and impulse sending devices at each of the stations, a plurality of telegraph lines extending between said cities, machine switching apparatus responsive to the operation of said impulse sending device for seizing one of said telegraph lines, machine switching apparatus at the other end of said line, means responsive to the seizure of said telegraph line for sending a preliminary impulse thereover to condition said second mentioned machine switching apparatus for operation, and means operated due to the further operation of said impulse sending device for operating said machine switching apparatus to extend the connection to another of said printing telegraph stations.

2. In a telegraph system, a plurality of printing telegraph stations located at distant cities, telegraph lines for interconnecting said stations, printing telegraph and impulse sending devices, a machine switching apparatus for seizing one of said telegraph lines, and means operated upon the failure of said machine switching apparatus to seize one of said telegraph lines for transmitting to the calling station characteristic impulses for operating the printing telegraph apparatus thereat to record the busy condition of the telegraph lines.

3. In a telegraph system, a plurality of printing telegraph stations located at distant cities, printing telegraph and impulse sending devices at each of the stations, a plurality of telegraph lines extending between said cities, machine switching apparatus responsive to the operation of said impulse sending device for seizing one of said telegraph lines, and start-stop interrupter means effective upon the failure of said machine switching apparatus to seize one of said telegraph lines for transmitting to the calling station characteristic impulses to effect the operation of the printing telegraph apparatus thereat to record the busy condition of said telegraph lines.

4. In a telegraph system, a plurality of stations, a number of central offices having automatic switches therein, telegraph lines interconnecting said offices and appearing in said switches, each of said lines comprising a single conductor, printing and impulse sending devices at each of said stations, said switches being responsive to said impulse devices for selecting a telegraph line, and means responsive to one of said switches when all lines are found busy for sending signals to a calling station to operate the printing device thereat.

5. In a telegraph system, a plurality of stations each having a printing device thereat, a central office, a plurality of telegraph lines outgoing from said office, automatic switches in said office for connecting said stations to said telegraph lines, means at said stations for operating said switches to select a group of said lines, and an interrupter associated with said switches and responsive to one of said switches when all desired lines are found busy for transmitting signals to the calling station to operate the printing device thereat.

6. In a telegraph system, a plurality of printing telegraph stations located at distant points, printing and impulse sending devices at each of said stations, a plurality of telegraph lines, an automatic switch controlled by said impulse devices for selecting said lines to establish a connection between two of said stations, release means for said switch, a differential relay having two windings for controlling the operation of said release means, said relay being included in said lines in such a manner as not to respond to the opening thereof when telegraph signals are being sent, and means controlled from said stations for causing said relay to operate.

In testimony whereof, we have signed our names to this specification this 8th day of November, 1923.

GILBERT S. VERNAM.
DONALD B. PERRY.