

March 31, 1931.

G. S. VERNAM

1,798,235

PRINTING TELEGRAPH SWITCHING SYSTEM

Filed March 16, 1929

5 Sheets-Sheet 1

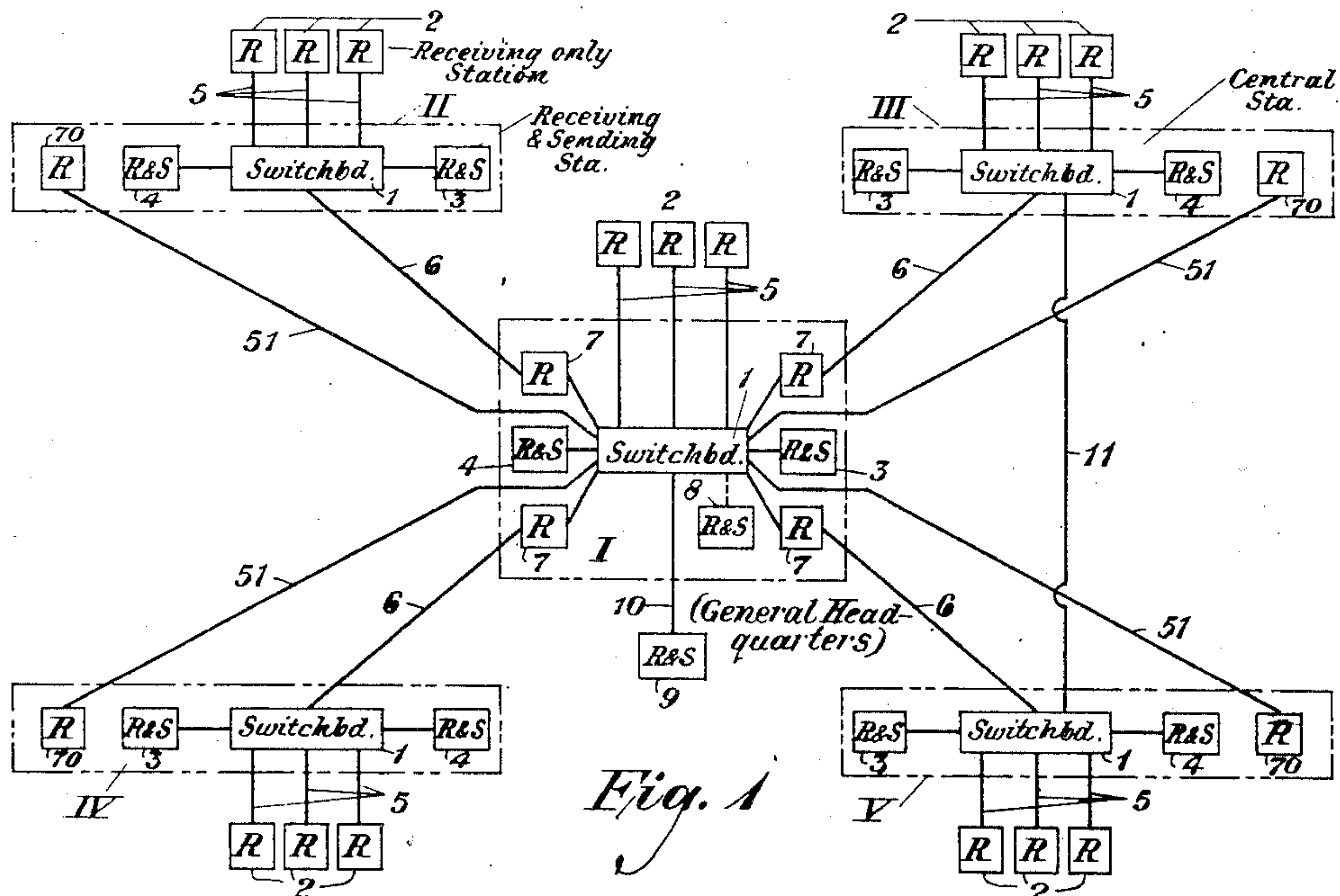


Fig. 1

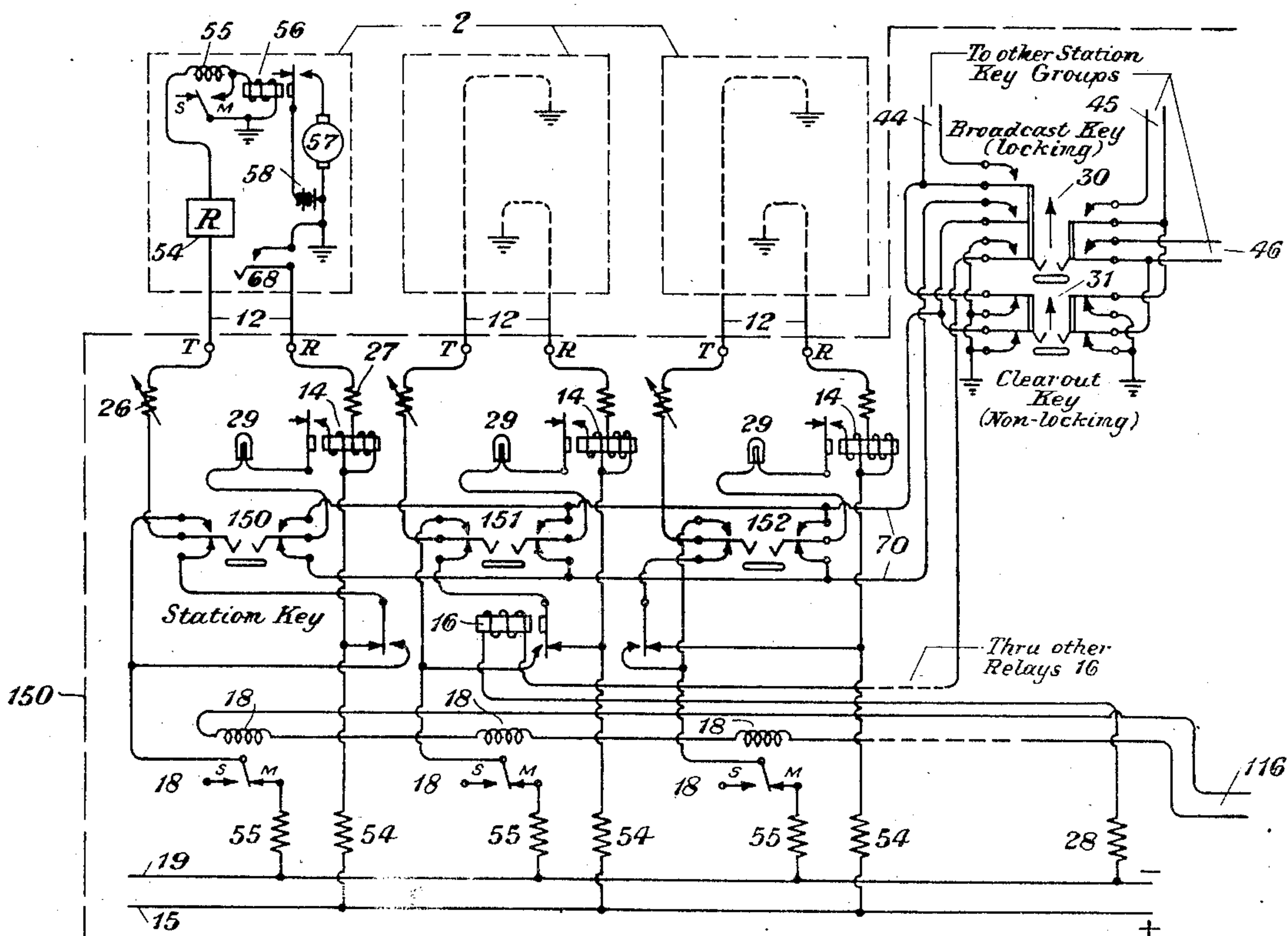


Fig. 3

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5 Sheets-Sheet 2

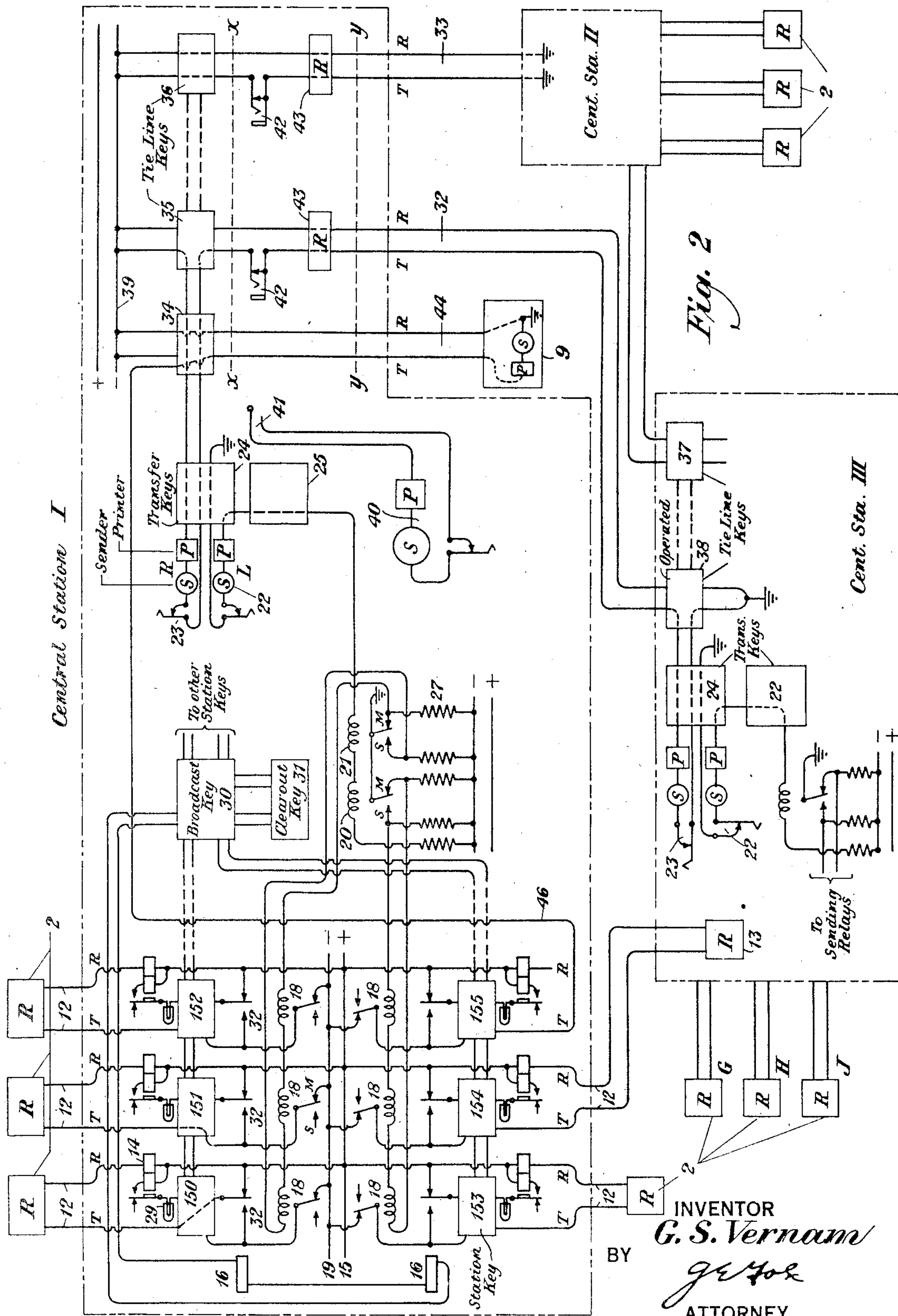


Fig. 2

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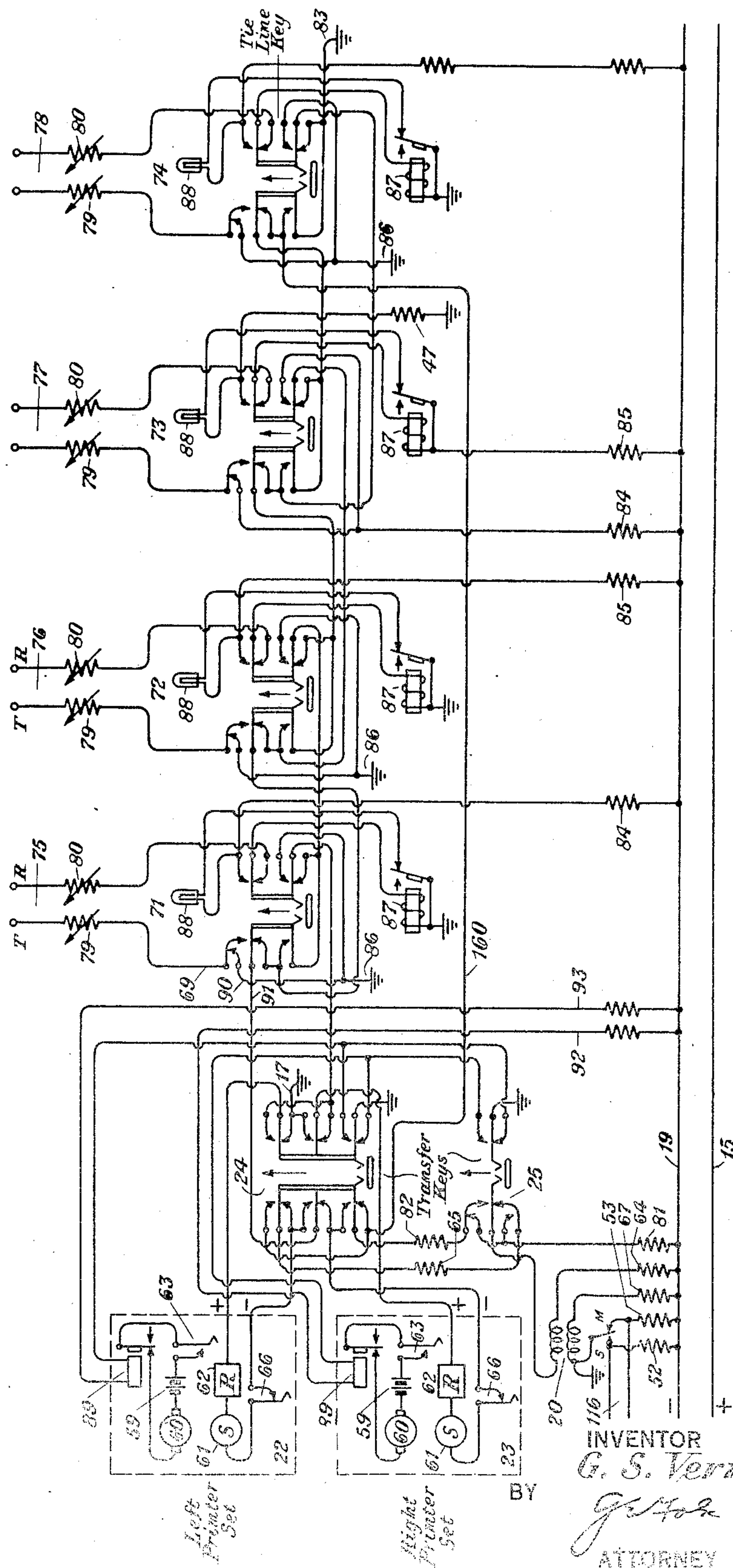
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5 Sheets-Sheet 3

Fig. 4



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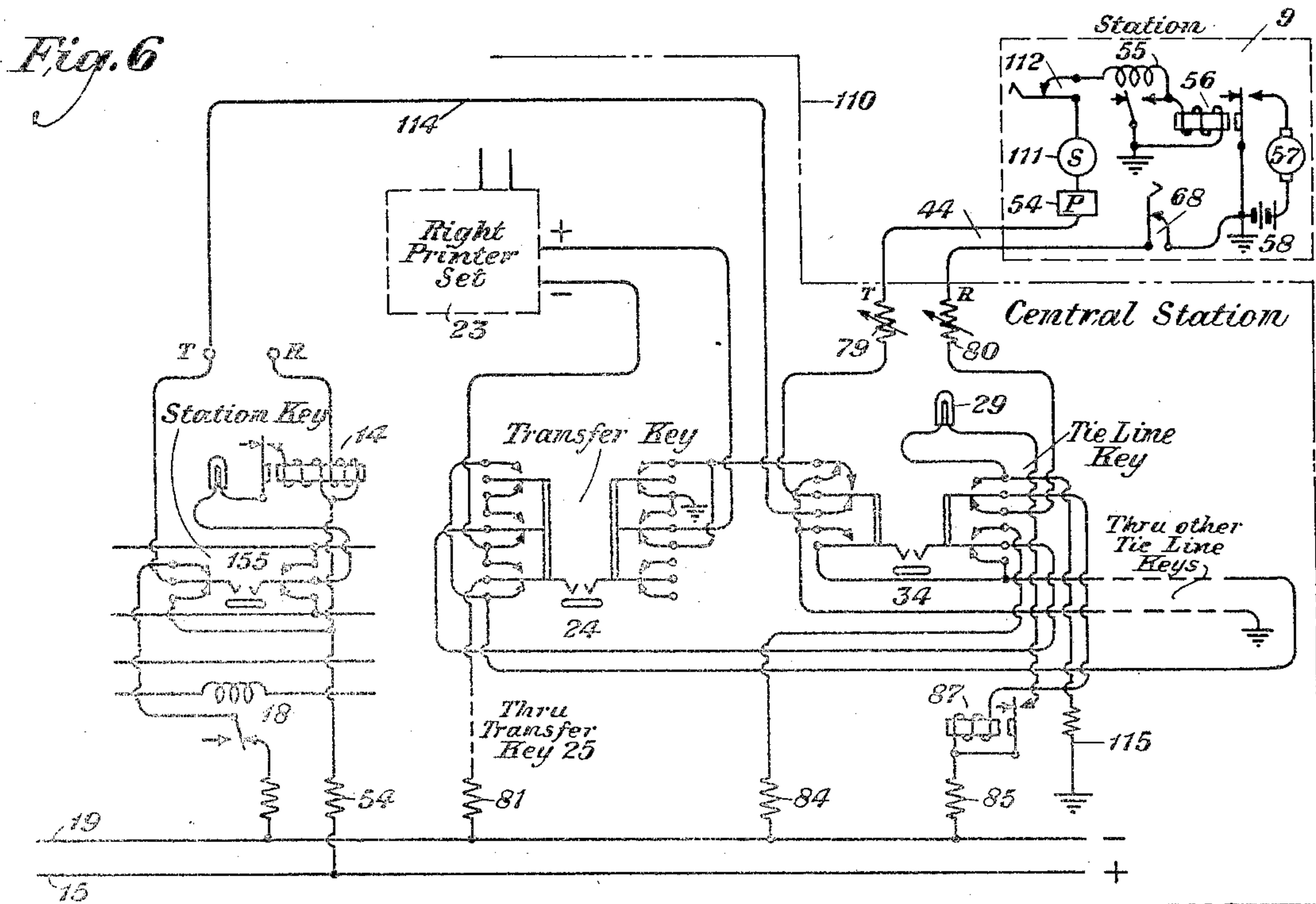
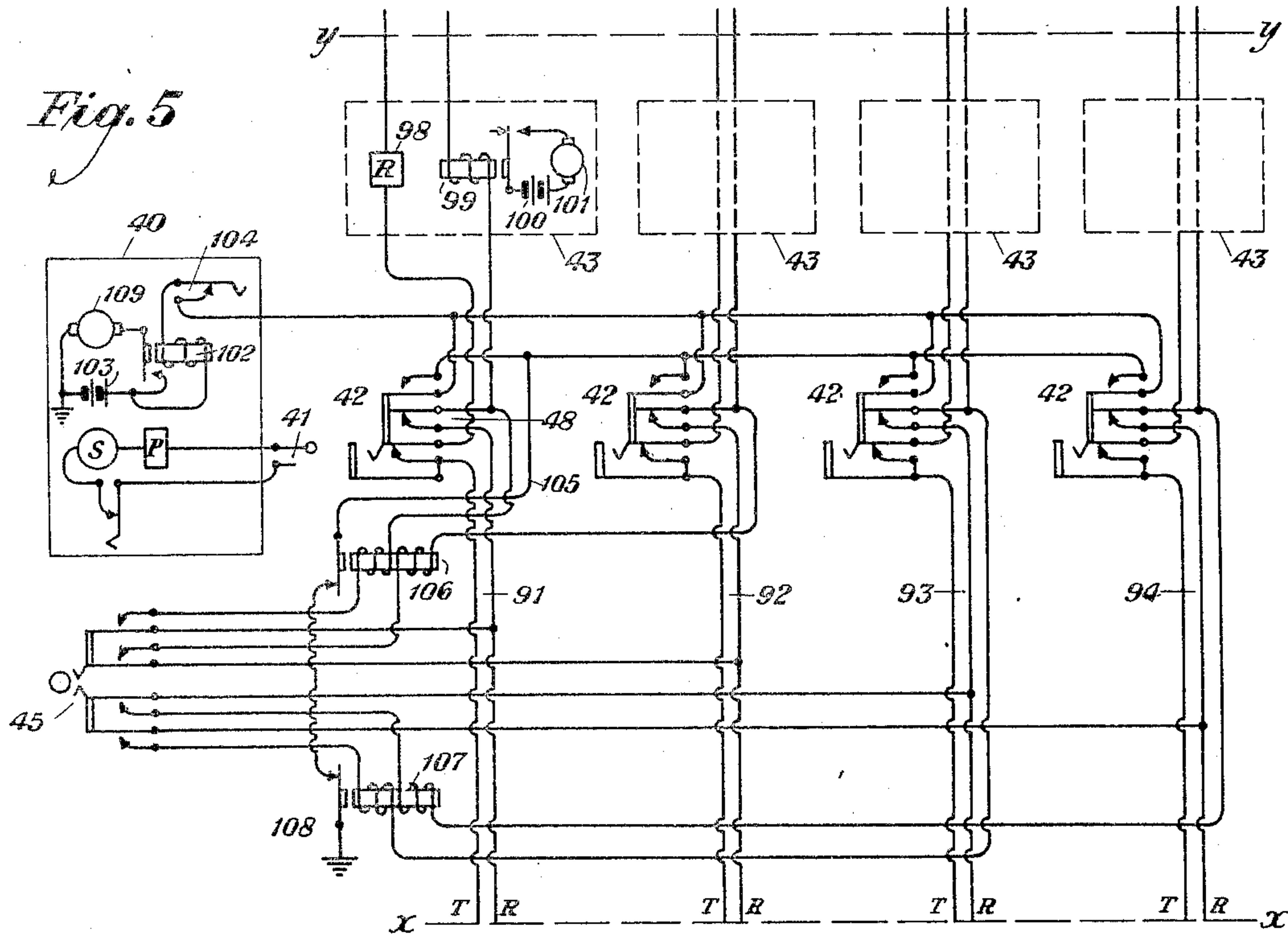
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PRINTING TELEGRAPH SWITCHING SYSTEM

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5 Sheets-Sheet 4



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PRINTING TELEGRAPH SWITCHING SYSTEM

Filed March 16, 1929

5 Sheets-Sheet 5

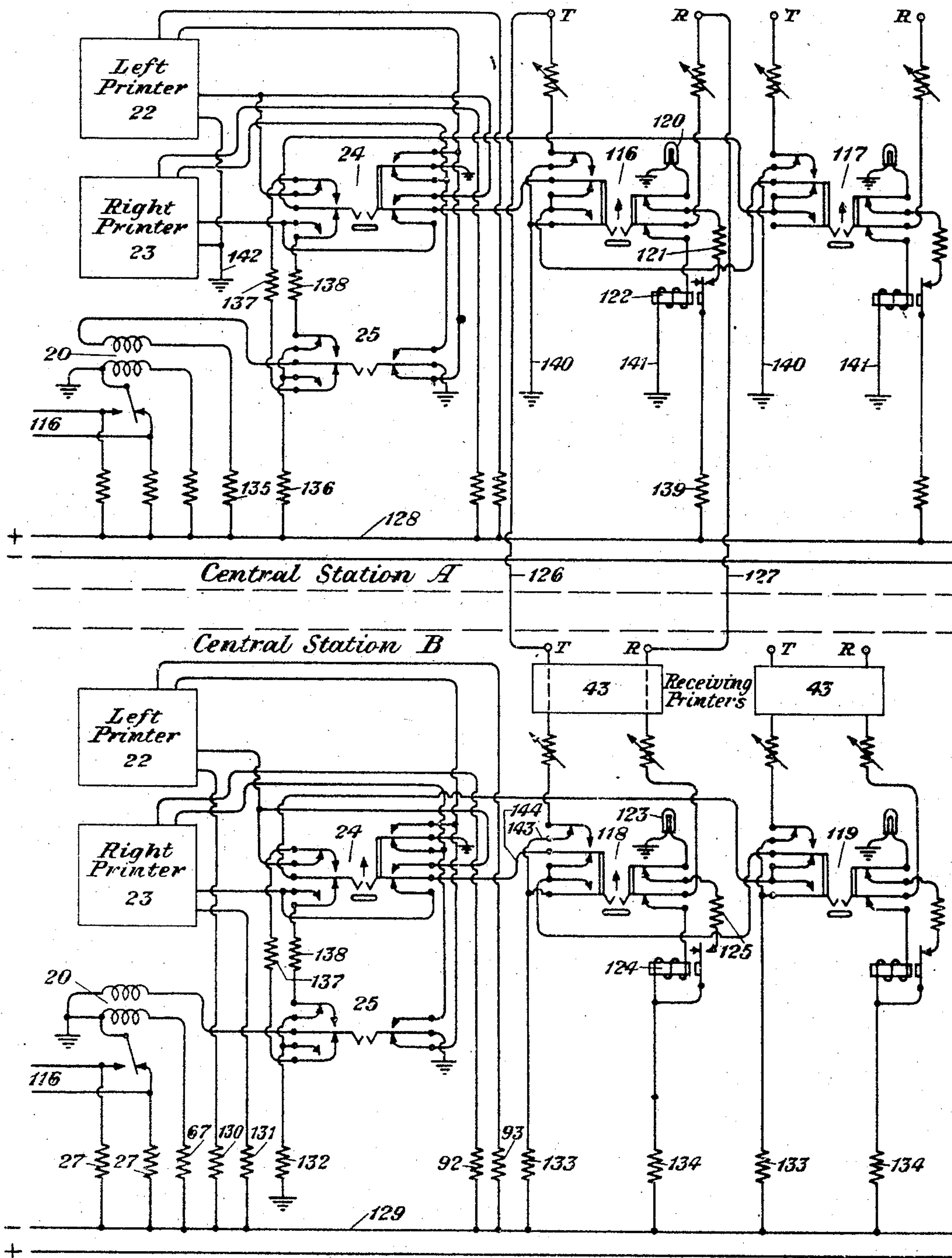


Fig. 7

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PRINTING-TELEGRAPH SWITCHING SYSTEM

Application filed March 16, 1929. Serial No. 347,538.

This invention relates to the art of telegraph communication and discloses a printing telegraph switching system adapted principally to meet the requirements of the police department of a large city or other territory taking in considerable area. The system disclosed would, of course, be applicable to other types of large organizations spread over a considerable territory but having a centralized control group or headquarters from which general orders or other messages were issued from time to time to the various subordinate groups.

In general, the switching system to be described comprises a number of central stations, each equipped with printing telegraph apparatus together with a switchboard for establishing desired connections. Telegraph lines extend between certain of the switchboards for communication purposes. In addition, lines extend from each switchboard to a plurality of branch stations individual to the switchboard, each branch station being equipped with a printing telegraph receiving unit, together with signaling means for signaling the central station and remote motor control equipment. Means are associated with each switchboard whereby a printer unit associated therewith may simultaneously transmit or broadcast messages from the central station to any or all of the branch stations associated therewith.

The system will be explained with reference to its use by the police department of a large city because such a procedure will best disclose the reasons underlying the various features of the system. In line with this procedure, the general description of the system will be preceded by a short discussion of the requirements to be met in furnishing a satisfactory telegraph switching system for the police department of a large city.

In policing a city the size of New York, it is found expedient to efficient operation to sub-divide the city into boroughs with a police headquarters allocated to each borough to which all the precincts of that borough report, and with a general headquarters located at some central point to which all the borough headquarters report. A general

alarm to apprehend a fugitive from justice or the like is first issued from general headquarters to the various borough headquarters, and thereafter each borough headquarters transmits the alarm to the various precincts within its jurisdiction. It is obvious, of course, that in issuing an alarm of this sort, time is of essence, and consequently, a first requisite of a suitable telegraph switching system for transmitting such an alarm is that the message reach all borough headquarters and thence all precincts without appreciable delay. A requirement of this sort immediately suggests the advisability of associating broadcasting means with the switching system in question whereby a message may be simultaneously transmitted to a number of stations.

A second desirable feature of a telegraph switching system of the type here considered, lies in the provision of means whereby a borough headquarters may transmit orders or other messages to any or all of its precincts independently of the general headquarters, due to the fact that many routine orders are transmitted from a borough headquarters to its precincts in which the general headquarters is not particularly interested. To care for this feature of the switching system, it is, of course, expedient to equip each borough headquarters with a switchboard for establishing connections directly to the precincts within its jurisdiction without passing through the general headquarters.

Since the messages transmitted from the borough headquarters to its precincts are usually in the form of orders requiring no answer beyond the acknowledgment of receipt thereof, it is only necessary that the precincts be equipped with receiving printer units, together with some sort of signaling means whereby a precinct may acknowledge receipt of a message. On the other hand, it is necessary that the central stations, i. e. headquarters, be equipped with printing telegraph transmitting units as well as receiving units, since a considerable amount of information is passed from time to time, back and

forth between a borough headquarters and the general headquarters.

It is the purpose of the present invention to disclose a printing telegraph switching system which meets the requirements outlined above in a satisfactory and efficient manner, and in addition contains other desirable features which will be pointed out fully in the subsequent disclosure. Some of the features of the system may be briefly mentioned at this point as follows: As stated above, one-way communication is provided from the switchboard at each borough headquarters to the receiving-only sets at the precincts and some other points within the borough. Two-way communication is provided between the general headquarters and each of the borough headquarters, and also, where desirable, between certain of the borough headquarters. Two printing telegraph transmitting and receiving sets are normally associated with the switchboard at each central station, one set being normally used for sending on the one-way lines and the other set for sending and receiving on the two-way lines. The functions of these two sets at the central station may be interchanged, i. e. the set normally associated with the one-way lines may be used on the two-way lines and vice versa, or, by the proper operation of suitable keys, one set may be used to serve both the one-way and two-way lines, the other set, meantime, being idle and disconnected. The set used for sending to the one-way lines, may send to any one or to any group of such lines by the operation of suitable station keys associated with the one-way lines at the switchboard. By operation of a single "broadcast" key at the switchboard, a central station printer may send simultaneously to all the receiving-only stations within the borough. The general headquarters has one-way lines extending to each of the borough headquarters in addition to the two-way lines, so that by the operation of suitable station keys, the general headquarters may broadcast to all of the borough headquarters as well as to the various precincts within its jurisdiction. The broadcasting printer at the central station will print a "home record" of all messages broadcast. Line lamps are associated with each of the one-way lines at the central station so that the receiving-only stations may acknowledge receipt of a message. Line lamps are provided on the two-way lines extending between central stations so that the operator at one headquarters may signal the operator at another headquarters. Receiving-only printers are normally provided in the two-way lines at general headquarters so that operators at the various borough headquarters may send in messages to general headquarters without waiting for a signal from the general headquarters before sending on the line. When the operator at general head-

quarters subsequently connects a sending set to that line to answer the message, it will not cause an error in the message being received at the time on the receiving set. A remote control feature is provided whereby the motors of the receiving-only sets, both those connected to the one-way lines as well as those connected in the two-way lines at general headquarters, are running only when a sending printer is switched into the line.

The detailed operation of the printing telegraph switching system will be explained with reference to the drawings of which:

Figure 1 gives the layout of a complete switching system involving the features of the invention. In this figure, the various elements are indicated merely by rectangles properly connected with lines to indicate the inter-relation between the various parts of the system.

Fig. 2 also shows the complete layout of a switching system similar to Fig. 1. In Fig. 2 the layout of the apparatus at a central station is shown in considerable detail.

Figs. 3 and 4 are to be taken together, with Fig. 3 placed to the left of Fig. 4. These drawings disclose the circuit diagram of a switchboard and some of the associated central station equipment together with the wiring arrangement of the one-way lines and branch stations connected thereto.

Fig. 5 shows the wiring diagram of the receiving-only printer units connected in the two-way lines at general headquarters, and the manner in which such printer units are connected in the two-way lines. In addition, this drawing discloses the wiring arrangement of an auxiliary printer set adapted to replace one of the regular central station printers in case of trouble thereto, together with the arrangement of the jacks by means of which the auxiliary printer is connected to a desired two-way line in case of trouble.

Fig. 6 shows the manner in which a branch station equipped with a two-way printer unit may be connected to a switchboard to carry on two-way communication with a central station, as well as to receive messages broadcast over the one-way lines from the central station.

Fig. 7 shows a wiring diagram similar in scope to that of Fig. 4, but disclosing an alternative method of associating the two-way lines with the switchboard.

General layout of system

Referring to Fig. 1, the central stations located at the various police headquarters are indicated by the rectangles I to V, inclusive. Central station I is located at general headquarters with each of the remaining central stations located at a borough headquarters. Each central station is equipped with a switchboard 1, having normally asso-

ciated therewith a pair of printing telegraph transmitting and receiving sets indicated by rectangles 3 and 4, respectively. From each switchboard 1, telegraph lines 5 extend to receiving-only stations 2 located at the various precincts within the borough. Central station I combines a borough headquarters with a general headquarters, and hence lines 5 extend from the switchboard thereat to the branch stations 2 within its jurisdiction.

A two-way tie line 6 extends from the switchboard at central station I, to each of the other central stations. By operating suitable keys at the switchboards, a printer set 3 or 4 may be connected to each end of a given tie line 6 for two-way communication thereover. If desirable, additional tie lines, such as 11, may extend between the various borough headquarters. In general, however, tie lines of the latter type are not required, since it is found most expedient to route communications between borough headquarters via the general headquarters.

At the general headquarters, a receiving-only printer 7 is connected in each tie line 6. Remote control equipment is associated with each printer 7 such that the distant central station, such as II, may start the motor of printer 7 and cause a message to be transmitted thereto without waiting for one of the printers 3 or 4 to be associated with the tie line at central station I. The switchboard at central station I is so arranged, that a printer 3 or 4 thereat, may be subsequently associated with the tie line in question without interference to the message being received on printer 7.

In addition to the tie lines 6 extending from general headquarters to the borough headquarters, a one-way line 51 extends from central station I to a receiving-only printer 70 at each of the other central stations. These lines are used when general headquarters desires to broadcast a message to the borough headquarters.

Broadcasting means are associated with the switchboard at each central station. By means of this broadcasting equipment, a printer 3 or 4 at a central station, may broadcast to any or all of the branch stations 2, connected thereto. At general headquarters, the arrangements are such that a printer 3 or 4 thereat, may broadcast to the one-way stations 70 located at the various borough headquarters, as well as to the branch stations 2 associated with central station I.

A branch station 9, equipped with a printing telegraph transmitter and receiver, may be associated with a switchboard 1 over a circuit 10 in such a manner as to receive messages broadcast from the central station, as well as carry on two-way communication with a printer 3 or 4 connected to line 10 by means of suitable switches at the central station. A switchboard may be provided with

an auxiliary printer, such as 8 at central station I, to replace a regular printer 3, 4 or 7, in case of trouble thereto.

Fig. 2 covers the same ground as Fig. 1, but considerably more in detail. Fig. 2 indicates for the most part schematically, the arrangement and general scheme of connection of the various elements associated with a central station, as well as the manner of associating a plurality of central stations. The principal function of Fig. 2 is to enable the reader to quickly comprehend the manner in which the various circuit diagrams to be explained later, tie in with the system as a whole.

Referring to Fig. 2, the branch stations are again indicated by the rectangles 2. Each branch station is connected to the central station by means of a pair of conductors 12. At the central station, the tip conductor of a pair 12 terminates upon a two-position station key 150 to 155, while the ring conductor extends through the winding of a relay 14 to a positive bus-bar 15. The tip conductor is utilized for printing and motor control, while the ring conductor is used for signaling. Each relay 14 controls the operation of a line lamp 29, thus enabling the branch station to signal the central station. Operation of a station key starts the printer set motors at the corresponding branch station and connects sending means to the tip conductor of pair 12 for transmitting to the branch station.

The sending means for sending or broadcasting to the branch stations 2, comprises the sending relays 18 individual to the branch stations, the master sending relays 20 and 21 and a central station printer 22 or 23. This sending circuit will be explained in detail below, although its operation is fairly apparent from an inspection of Fig. 2. With the circuit arrangement shown on the drawing for central station I, printer 22 is associated with the master sending relays 20 and 21 in such manner that these relays will follow signals transmitted from the sending contacts of the printer. Groups of polar sending relays 18 in series, are associated with the contacts of the master relays 20 and 21 so that all of the relays 18 follow the operation of the master relays. Relays 20 and 21 are biased toward the spacing contacts S by means not shown.

Six branch stations and two master relays are indicated for central station I of Fig. 2. This is merely for purposes of illustration, however, as a considerably larger number of branch stations may be associated with the switchboard. A single master relay is adapted to control the operation of about 20 sending relays 18 in series, so that the number of master relays required for a given switchboard, will depend upon the number of branch stations connected thereto. Fig. 2

merely illustrates the manner of connecting a plurality of master relays when required.

In Fig. 2, station key 150 is shown in its normal position, and the dashed lines within the rectangle indicate the manner in which the tip conductor of a pair 12 is normally connected to the positive bus-bar 15. Current from positive battery thus normally supplied to the branch station, maintains the printer set motor thereat inoperative through the action of suitable remote control means. Station key 151, on the other hand, is shown operated, and the dashed line indicates how the tip conductor of a pair 12 is connected through the key contacts and through the contacts of the corresponding sending relay 18, to negative bus-bar 19. The current from negative battery activates the remote control means to start the printer set motors at the branch station, so that the subsequent operation of relay 18, as explained above, by interrupting the current in the tip conductor causes a message transmitted from the central station to be printed at the branch station. It will be obvious, of course, that a message transmitted from printer 22 will be sent to all branch stations having operated station keys, since all the relays 18 follow the signals transmitted from printer 22.

Associated with the station keys are a broadcast key 30 and a clear-out key 31. The broadcast key is operated when it is desired to broadcast to all of the branch stations. Operation of the broadcast key 30 completes a circuit to operate all of the broadcast relays 16. Each relay 16 controls the armatures 32 individual to three branch stations, as indicated, and its operation disconnects positive battery from a tip conductor of a pair 12 and substitutes therefor negative battery supplied through contacts of the sending relay 18. The manner in which this is accomplished is obvious from an inspection of station key 151. Incidentally, the station keys should be left normal for this operation. The reversal of current in the tip conductor of pair 12, starts the printer motors at the branch station and the subsequent operation of sending relay 18, as indicated above, interrupts the negative current now supplied over the tip conductor and thus causes the message to be printed at the corresponding branch station. The relays 16 may be released by restoring the broadcast key which is a locking key or operating and releasing the clear-out key 31, which is non-locking.

Tie lines extending between central stations are indicated at 32 and 33. The tip conductor of a tie line is used for printing and the ring conductor for signaling and also for motor control where a receiving-only printer, as 43, is permanently associated with the tie line. Each tie line extends between two central stations and terminates upon the switchboards thereat in a two-position tie

line key. These keys are indicated by rectangles 34 to 38, inclusive. Thus, tie line 32 terminates at central station I upon key 35 and at station III upon key 38. With its tie line keys normal, both conductors of a given tie line, extend from battery at one office to ground at the other. Key 36 is shown normal. With the keys for a given line operated, the ring conductor is opened at the key contacts, and a printer 22 or 23 is connected in the tip conductor at each central station for two-way communication. Keys 35 and 38 associated with tie line 32, are shown operated.

The auxiliary printer 40 may be associated with a given tie line by inserting plug 41 in the proper jack 42. Associated with the printers 22 and 23 are a pair of transfer keys 24 and 25. As mentioned above, by suitably manipulating these keys, either printer may be associated with the master relays, the tie lines, or both. Branch station 13, connected to central station I, and shown located at central station III, corresponds to a station 70 of Fig. 1.

Station 9 equipped with a printing telegraph transmitter and receiver, is shown connected to central station I in such manner that it can receive messages broadcast therefrom, and in addition, can be connected to a printer thereat for two-way communication. As this circuit will be considered below, it is sufficient to point out that this dual result is accomplished by connecting the station 9 over pair 44 to a spare tie line key 34, and extending a lead 46 from a spare station key 155 to the tie line key. The tie line key requires some special wiring but the station key is left unchanged.

With the above picture of the general system operation in mind, the detailed circuit operation will now be considered.

Sending to branch stations

Figs. 3 and 4, taken together with Fig. 3, placed to the left of Fig. 4, show the wiring diagram of the central station equipment as well as that of the one-way branch lines. In Fig. 3, the equipment below line 150 is located at the central station. In connection with these figures, the circuit operation will first be considered for transmitting a message from a central station printer to one or more of the branch stations. The numbering used for Figs. 3 and 4 has been kept the same as that for Figs. 1 and 2 in so far as this is possible. Only three branch stations and one master relay are shown. Referring to the figures, it will be noted that with station key 150 in its normal position, as shown, a circuit is traced from positive bus-bar 15, through resistance 54, through the left back contact and armature of relay 16, through the left non-operated contacts of key 150, through resistance 26 and over the tip conductor of pair 12 to the branch station 2 and thence

at the branch station through the printing telegraph receiving unit 54 and through the windings of relays 55 and 56 in series to ground. Relay 55 is a polar relay which is so connected in the circuit that the current from positive battery operates the same against its spacing contact S.

If, now, the station key 150 is operated, the opening of the lower left key contacts will disconnect the positive battery from the tip conductor and will substitute therefor negative battery supplied from the bus-bar 19 through resistance 55, the marking contact and armature of relay 18, through the left-operated contacts of key 150 and over the tip conductor of pair 12 to the branch station 2. At the branch station, the current flows to ground, as described above. The reversal of current through the winding of polar relay 55 at the branch station 2, due to the substitution of a negative for a positive battery supply, operates the armature of the relay against its marking contact M, and thus completes a short-circuiting path to ground across the winding of relay 56. Relay 56 thereupon releases and completes a circuit through its armature and back contact to connect the source of power 58 to the printer set driving motor 57, thus starting the printer motor. The branch station is now functioning properly for reception of a message from the central station.

Assuming, now, that the transfer keys 24 and 25 (Fig. 4) at the central station are in their normal positions, as indicated on the drawing, a circuit is traced from negative battery supplied from bus-bar 19 through resistance 64 and the upper winding of master sending relay 20, through a left non-operated contact of transfer key 25, through resistance 65 and through an upper left non-operated contact of key 24, and thence in series through the break key 66, sending contacts 61 and printer unit 62 of printer set 22, and back through an upper right non-operated contact of key 24 to ground at 17. A second circuit is traced from the negative bus-bar 19 through resistance 67, through the lower or auxiliary winding of master sending relay 20 to ground.

Resistances 64 and 67 are so proportioned that the current through the line or upper winding of relay 20 is about twice the magnitude of that through the lower or auxiliary winding. The current through the line winding of the relay, therefore, normally predominates and maintains the armature thereof against the marking contact. When, however, the current in the line winding is interrupted, as by operation of the sending unit 61 of printer 22, the current in the auxiliary winding of relay 20 will operate the armature thereof against the spacing contact. In this manner, the armature of the master sending

relay 20 will follow the signals transmitted from the sending unit 61 of the printer 22.

As was mentioned above, the master relay 20 controls the operation of all the individual sending relays 18. The operating windings of the relays 18 are connected in series in a circuit having one end connected to the spacing contact and the other end connected to the marking contact of the master relay 20, as shown. Similar resistances 52 and 53 connect the marking and spacing contacts, respectively, of relay 20 to the negative bus-bar 19. The armature of relay 20 is grounded.

As the armature of relay 20 operates in accordance with signals transmitted from printer 22, it causes the marking and spacing contacts of relay 20 to be grounded alternately. With the armature thereof on contact M, current flows from bus-bar 19, through resistance 52, through the windings of all the relays 18 in series, and thence to ground through the marking contact and armature of relay 20. All the relays 18 are thus operated against their respective marking contacts M. When the armature of relay 20 moves to its spacing contact, the direction of current flow through the windings of relays, is reversed, flowing now through resistance 53 and through the windings of relays 18 in series to ground through the spacing contact and armature of relay 20. Relays 18 are thus operated against their respective spacing contacts. In this way, all the relays 18 are caused to follow signals transmitted from printer 22.

The operation of the sending relay 18, associated with key 150 (assumed now operated) interrupts the current supplied from negative bus-bar 19 to the branch station over the tip conductor of pair 12. These current interruptions cause the transmitted message to be typed upon receiving unit 54 associated with the tip conductor at the branch station. The polar relay 55 is not affected by these current interruptions due to the fact that it is equipped with a biasing spring, not shown, which maintains the armature thereof against the marking contact while no current, or current from negative battery is flowing through the winding of the relay. It is only when current from positive battery flows through the winding of relay 55 that its armature is operated against the spacing contact and against the biasing effect of the spring.

The circuit operations described above are, of course, the same whether only one or any greater number of branch station keys are operated at the same time. For each branch line, the operation of the station key starts up the printer set motor at the corresponding branch station and the subsequent operation of the sending relays 18 individual to the station keys will cause the transmitted message to be typed upon the printers at all of the

branch stations for which the station keys are operated.

At the end of the message, a branch station 2 may acknowledge receipt thereof by the momentary operation of the non-locking key 68. The closure of the contacts of key 68 completes a circuit from the positive bus-bar 15 through resistance 54, through the right winding of relay 14 and thence through resistance 27 and out over the ring conductor to the branch station, and through the key 68 thereat to ground. Relay 14 operates over this circuit and immediately completes a locking circuit for itself through its left winding, left front contact and armature, through line lamp 29, through the right-operated contacts of the station key 13 and thence to ground through non-operated contacts of the clear-out key 31. The line lamp 29 lights over this circuit and furnishes a signal to the central station operator that the transmitted message has been properly received at the branch station.

The central station operator waits until the acknowledgment signal has been received in this manner from each branch station to which the message was broadcast, whereupon she extinguishes the lamps either by restoring the operated station keys or by operation and release of the non-locking clear-out key 31. If no more messages are to be broadcast at the time, the operated station keys are restored which disconnects the ground supplied through key 31 from the corresponding operated relays 14 and lamps 29. The relays thus release and the lamps are extinguished. If it is desired to immediately broadcast a second message, key 31 is operated to extinguish the lighted lamps 29. The operation of the clear-out key 31 removes the ground from the line lamps 29 traced through the operated contacts of the station keys and thus extinguishes the line lamps. Since the line lamps are in series with the holding windings of the relays 14, these relays are released at the same time. The relays 14 can not reoperate again at this time, since the operating circuit through the right winding is open at the contacts of the station key 68, and the circuit through the left or holding winding of the relay is open at the relay contacts.

When all of the messages have been transmitted, the operator at the central station restores the operated station keys. The restoration of the station key 150 disconnects at its left contacts the current from negative battery and substitutes therefor the current from positive battery over the circuit traced above. The current from positive battery now flowing out over the tip conductor to the branch station 2 and through the winding of relay 55 thereat to ground operates the armature thereof against its spacing contact. This operation removes the short-circuit from across the winding of relay 56, causing the

reoperation of the latter relay, which in turn disconnects the source of power 58 from the printer set motor 57, thus stopping the motor. The branch station and central station equipment is now all restored to its normal condition.

If the operator at the central station had desired to broadcast to all of the branch stations, she would have operated the locking broadcast key 30. The operation of key 30 completes a circuit from the negative bus-bar 19 through resistance 28, through the winding of the broadcast relay 16, shown on the drawing, and similarly in series through the windings of all of the other similar relays 16 required for serving other branch stations, not shown on the drawing, and thence through the lower left-operated contact of key 30 to ground at key 31. Each relay 16 operates over this circuit, and for each of three branch stations served by a given relay 16 the operation of the relay replaces the current from positive battery supplied over the tip conductor to the branch station with current from negative battery.

It will be recalled that the current from positive battery, normally supplied through resistance 54 to the branch station over the tip conductor, flows through a back contact and armature of relay 16, so that when this relay operates, the current from positive battery is disconnected from the tip conductor of pair 12 extending to the branch station. At the same time, a circuit is closed from the negative bus-bar 19 through resistance 55, the marking contact and armature of sending relay 18, a front contact and armature of relay 16, through the left non-operated contacts of the corresponding station key as 150 and out to the branch station over the tip conductor. The reversal of current in this manner starts up the printer set motor at each branch station, thus preparing all stations for the reception of the broadcast message which is transmitted in the manner described above.

At the end of the message, each branch station acknowledges receipt of the message by momentarily operating key 68 thereat, which completes the circuit described above for operating the corresponding relay 14 at the central station. In this case, however, a locking circuit for each relay 14 is completed through the left winding and front contact and armature thereof, through the line lamp 29, through the right non-operated contacts of the station key, and thence through an operated contact of key 30 and a non-operated contact of key 31 to ground. The line lamps 29 are lighted over the circuit traced. When the operator has received all of the acknowledgment signals, she extinguishes the line lamps by restoring the broadcast key, or by momentarily operating the non-locking clear-out key 31. Either opera-

tion disconnects the ground at key 31 from the circuit containing the line lamps 29 and the holding windings of the relays 14. The line lamps 29 are thus extinguished and the relays 14 released in the manner explained above.

Whether the operator restores key 30 or operates key 31, depends upon whether or not she desires to immediately broadcast another message. If she does so desire, she merely operates and releases the clear-out key 31 which extinguishes the acknowledgment signals, as explained, but leaves the broadcast relays 16 operated, since these relays obtain ground directly from the contacts of broadcast key 30 without passing through the contacts of key 31. As soon as the acknowledgment signals are extinguished in this manner, the central station operator may proceed to broadcast a second message in the same manner as explained for the first message, at the end of which she will receive the usual acknowledgment signals for the second message, and so on. When the broadcasting is complete, the operator restores the broadcast key 30. This operation disconnects the ground from the series circuit containing the broadcast relays 16, causing the release of these relays. The release of the broadcast relays 16 in turn replaces the negative battery connected to the tip conductor of branch line 12 by the positive battery and stops the branch station motors as explained.

It will be noted that both the broadcast key 30 and the clear-out key 31 have a plurality of contacts, with each set of contacts extending to a different group of branch station keys, as indicated by leads 44, 45, 46 and 70. Leads 44, 45 and 46, respectively, are connected to groups of branch station keys in the same manner as is shown for leads 70. The purpose of this arrangement is merely to limit the magnitude of current flow through a given set of key contacts and thus minimize arcing and burning at the key contacts. Since the line lamps 29 are connected in multiple to the contacts of keys 30 and 31, the total current flow through the key contacts becomes relatively large when many or all of the lamps are lighted. Consequently if all the lamps were associated with a single pair of key contacts in each case, the contacts would soon become badly burned and pitted.

It is, of course, not necessary that the broadcast relays 16 be associated with all of the branch lines. It may well be that there are certain branch lines which it is desirable to include only occasionally in a general broadcast. For example, referring to Fig. 1, when general headquarters at central station I sends out a general broadcast to the one-way stations 2, it is not always desirable that the one-way stations 70 at the various borough headquarters be included. Consequently,

branch lines 51 are not wired through contacts of broadcast relays 16.

Communication over tie lines

The manner in which a central station printer may transmit or broadcast messages over the one-way lines associated with the switchboard has been considered above. The detailed circuit operation involved in communication over the two-way tie lines extending between the various central stations will now be taken up. It will probably be well to refer at this point again to Fig. 2 to note the general layout of a tie line. Referring to Fig. 2, it will be recalled that a tie line, such as 32, extends between two central stations, such as I and III, and terminates at each such station upon the contacts of a tie line key 35 or 38. Referring, now, to Fig. 4, the tie line keys for a given central office are indicated by keys 71 to 74, inclusive. The tie lines extending to the various central stations are connected to the pairs 75 to 78, respectively, associated with keys 71 to 74, inclusive. The variable resistances 79 in the tip conductors of the tie lines serve to adjust the line current to a suitable value for operation of the printer units, the resistance for a particular tie line, of course, being adjusted in accordance with the total resistance of the tie line conductor. In a similar manner, the variable resistances 80 inserted in the ring conductors of the tie lines serve to adjust the total resistance of such conductor to a proper value for suitably operating the signaling equipment.

Referring, for a moment, to tie line 32 of Fig. 2, it will be noted that the tie line extends from battery at one office to ground at the other office. It is immaterial which office supplies the battery and which office the ground, although in general, it is probable that battery would be supplied at general headquarters for all the tie lines extending therefrom to the various borough headquarters, the circuits being grounded at the borough headquarters. With such an arrangement, however, it would be necessary to supply battery from a borough office for a tie line such as 11, Fig. 1, extending between two borough headquarters. The result would be that for such a central station, some of the tie lines extending thereto would be grounded, while others would be provided with battery.

Referring, now, to Fig. 4, the wiring diagram discloses the manner in which the tie line keys 71 to 74, inclusive, are to be connected where some of the tie lines terminating thereon extend to ground at the central station in question, while others are provided with battery thereat. For example, tie lines connected to pairs 75, 76 and 78 extend through the corresponding tie line keys to ground at the central station, whereas a tie line connected to pair 77 extends through

station key 73 to battery. The wiring of a given tie line key is dependent upon whether or not the tie line extends through the tie line key to battery or ground at the central station in question.

With the transfer keys 24 and 25 in their normal positions, as indicated on Fig. 4, the right printer set 23 is associated with the tie line keys 71 to 74, inclusive. With all of the tie line keys in their normal positions, as shown on the drawing, a circuit is traced from the negative bus-bar lead 19 through resistance 81, through the upper left non-operated contacts of transfer key 25, through resistance 82, through the lower left non-operated contacts of transfer key 24, over lead 160 to key 74, through the upper left non-operated contacts of key 74, through the lower right non-operated contacts of key 73 and thence through the upper left non-operated contacts of keys 72 and 71 in succession over lead 91, through left non-operated contacts of key 24, and in series through the break key 66, sending contacts 61 and printer unit 62 of printer 23, back through right non-operated contacts of key 24, through lower right non-operated contacts of keys 71 and 72 in succession, through the upper left non-operated contacts of key 73 and lower right non-operated contacts of key 74 to ground at 83. It will thus be seen from the circuit traced that a pair of leads from the central station printer extends in series through all of the tie line keys so that any tie line may be connected to the printer through the contacts of its corresponding tie line key.

As was stated above, the tie line extends from battery at one office to ground at the other. This condition is true whether the tie line keys are normal or operated. For example, consider the tie line keys 72 and 73. Assume, for the moment, that the tie line key 73 is located in one central office and key 72 in a distant office and that a tie line connected to leads 77 extends to the distant central office and there terminates upon leads 76 associated with key 72, and let the tie line circuit be traced, on this assumption, from one central station to the other. At central station I, the tip conductor is traced from negative bus-bar 19 through resistance 84, through the upper left non-operated contact at key 73, through resistance 79 and out over the tip conductor of the tie line to the distant central station II and thence at the distant station through resistance 79 associated with leads 76 through the upper left non-operated contacts of key 72 to ground at 86.

Going back, now to central station I, the ring conductor extends from negative bus-bar 19, through resistance 85, through the winding of relay 87 and the upper right non-operated contact of key 73, through resistance 80 and out over the ring conductor of the tie line to the distant central station II

and thence, at that station, through resistance 80, and through the upper right non-operated contacts of key 72 and through the winding of relay 87 to ground. The current flowing in this circuit maintains the relays 87 at both central offices operated.

Suppose, now, that central station I desires to communicate over the tie line with central station II. The operator at the central station I operates tie line key 73. This operation disconnects the battery from the ring conductor of the tie line at the upper right contacts of key 73. This interruption of current over the ring conductor of the tie line releases relay 87 associated with key 72 at the distant central station II. The release of relay 87 thereat completes the circuit to light the line lamp 88 associated with key 72. This circuit is traced from the negative bus-bar 19, through resistance 85, through line lamp 88, and through the back contact and armature of relay 87 to ground. The lighting of the line lamp 88 apprises the operator at the distant central station II that a call is waiting on the tie line connected to key 72. The operator at central station II thereupon operates key 72 to connect a printer set to the tie line.

At this point, it should be pointed out that when the operator at central station I operates key 73 to light lamp 88 associated with key 72 at central station II, the corresponding lamp 88 associated with key 73 of the calling station does not light. This is due to the fact that at the calling station the operation of key 73 completes a circuit to maintain relay 87 thereat operated and thus prevent lighting of lamp 88. This latter circuit is traced from the negative bus-bar 19, through resistance 85 and the winding of relay 87, and through the upper right operated contacts of key 73 to ground through resistance 47.

The operation of key 73, in addition to lighting the line lamp 88 associated with key 72 at the distant office, also connects the right printer set located at the central station I in the tip conductor of the tie line through the contacts of key 73. The circuit is traced from negative bus-bar 19 through resistance 84 associated with key 73 through the lower right operated contact of key 73, through the upper left non-operated contact of key 72 and similarly through the non-operated contacts of key 71, through left non-operated contacts of key 24, into printer unit 23 over the lower lead and out over the upper lead, through right non-operated contacts of key 24 and through the lower right non-operated contacts of keys 71 and 72, and through the upper left operated contacts of key 73 out over the tip side of the tie line to ground at the distant central station II.

When, now, the operator at the distant central station, upon noting the lighted lamp 88

associated with key 72, operates that key, circuits are completed to operate relay 87 to extinguish the lamp and to connect the right printer set at central station II in the tip side of the tie line. Relay 87 operates from battery on bus-bar 19, through resistance 85, right operated contacts of key 72 to ground through the winding of relay 87. The operation of the relay disconnects ground from lamp 88 to extinguish the same. The printer circuit is traced as follows: Coming in over the tip side of the tie line from central station I, the current from battery supplied at central station I flows through resistance 79, through the upper left operated contacts of key 72 at central station II through the upper left non-operated contacts of key 71, through left non-operated contacts of key 24 and into the printer set 23 over the lower lead and out again over the upper lead, through right non-operated contacts of key 24, the lower right non-operated contacts of key 71 and through the lower right operated contacts of key 72 to ground at 86. Thus, a circuit has been traced from battery at central station I through printer unit 23 at central station I, over the tip conductor of the tie line to central station II, and through the printer unit 23 thereat to ground. It will be noted that the current flows in the same direction through the printers 23 at both central stations. The tie line keys and transfer keys are so arranged that this is true in general regardless of the circuit in which a printer 22 or 23 is connected.

The motor 60 of the printer unit 23 at each station may be started by operating the locking key 63 to connect the source of power 59 to the motor 60. The function of relay 89 in controlling the motor circuit of the printer unit may, for the moment, be neglected, as this relay is operated under the conditions assumed. The function of this relay will be explained below. Having started, in the manner explained above, the motor associated with the printer set 23 at each of the central stations I and II, respectively, two-way communication may now be carried on between the printer units in question over the tie line, in the usual manner. When the communication is complete, the operator at each central station restores the proper tie line key which disconnects the printer unit thereat from the tie line, reconnecting the tip and ring conductors to battery or ground, as the case may be, through the circuits traced above. With the tie line keys at each end of the tie line restored, the relays 87 are, of course, operated, maintaining the lamps 88 at each office extinguished.

In Fig. 4, a sufficient number of tie line keys are shown to indicate the manner in which the wiring extends from the transfer keys to the first and last tie line keys, as well as the manner in which the wiring extends

from a grounded tie line key to a second grounded tie line key, or from a grounded tie line key to one equipped with battery, and thence on to a third key equipped with ground connection. It is felt that one skilled in the art, after studying this drawing, could wire up a group of transfer and tie line keys in accordance with any key arrangement as regards the battery or ground connection.

Transfer keys

The circuits traced above showed that with the transfer keys 24 and 25 in their normal positions, as shown in Fig. 4, the right printer set 23 is associated with the tie line keys, while the left printer set 22 operates the master sending relay 20 which controls the messages over the one-way lines, as explained above. Now, the purpose of these transfer keys 24 and 25 is to render the system more flexible by introducing switching means whereby either the right or the left printer set may take over the functions of both printer sets, or whereby the printer sets may be reversed, i. e., the tie lines may be placed under control of the left printer set while the broadcasting circuit is placed under control of the right printer set. The manner in which these operations are accomplished will now be explained.

The operation of the upper transfer key 24 transfers the tie lines 75 to 78, inclusive, from the right printer set 23 to the left printer set 22. If key 24 is operated while key 25 is left in its normal position as shown, the left printer set 22 will be connected to the tie line keys 71 to 74, inclusive, as well as to the master sending relay 20. Under such conditions, the left printer set 22 may then be used to send and receive over any one of the two-way tie lines 75 to 78, inclusive, or, if all of the tie line keys 71 to 74, inclusive, are in the normal position as shown, then the left printer may be used to send over the one-way branch lines through its control of the master sending relay 20. The result is that the entire switchboard may be operated from one printer set during times of light load, or, in case of trouble, to the other printer unit. Under the above assumption, that is, with key 24 operated and key 25 normal, the right printer set is merely connected between battery and ground through the key contacts.

The circuits are traced as follows, assuming key 24 operated and key 25 normal: For the right printer set, the circuit is traced from negative bus-bar 19 through resistance 81, left non-operated contacts of key 25, through resistance 82, lower left operated contacts of key 24, into the printer unit 23 over the lower lead and out again over the upper lead and through right operated contacts of key 24 to ground at 17. It will thus be seen from the circuit traced

that the right printer unit is not associated with either the master sending relay 20 or the tie line keys 71 to 74. For the left printer set, a circuit is traced from negative bus-bar 19, through resistance 64, through the line winding of master sending relay 20, through the lower left non-operated contacts of key 25, through resistance 65, through the upper left operated contacts of key 24 over lead 160, through non-operated contacts of all the tie line keys in succession beginning with 74 and ending with 71 and into the transfer key 24 over lead 91, through left operated contacts of key 24, into printer unit 22 over the lower lead and out over the upper lead, through the upper right operated contacts of key 24 and back through all of the tie line keys in succession, beginning with 71 and ending with 74, to ground at 83.

It will be noted that the circuit as traced extended from battery through the winding of the master sending relay, through the contacts of all the tie line keys and through the left printer set. Thus, under this condition, the entire switchboard is under control of the left printer set. The operation of any tie line key will associate the left printer with the tip conductor of the corresponding tie line in the manner explained above, while at the same time disconnecting the master sending relay 20 from the printer control. On the other hand, with the tie line keys all normal, the master sending relay 20 is under control of the left printer unit and will be operated in accordance with a message transmitted therefrom.

If the lower transfer key 25 is operated while the upper key 24 is left normal, the sending circuit for the one-way lines is transferred to the printer unit 23 at the right of the switchboard, while the tie lines are also connected thereto. As a result, the right printer set may now be used to operate the entire switchboard exactly as described above for the left printer unit. With key 25 operated and key 24 normal, the circuit for the left printer set is traced from negative bus-bar 19 through resistance 81, through the lower left operated contacts of key 25, through resistance 65, through the upper left non-operated contacts of key 24, through printer unit 22 and through the upper right non-operated contacts of key 24 to ground at 17. The left printer unit is thus entirely disassociated from the tie line keys and the master sending relay.

For the right printer unit, the circuit is traced from negative bus-bar 19 through resistance 64, line winding of relay 20, left operated contacts of key 25, through resistance 82, through the lower left non-operated contacts of key 24, over lead 82 to key 74, through the contacts of all the tie line keys in succession, beginning with 74 and ending

with 71, and into key 24, as before, over lead 91, through left non-operated contacts of key 24, into printer 23 over the lower lead and out over the upper lead, through right non-operated contacts of key 24 and back through all the tie line keys in succession, beginning with 71 and ending with 74, to ground at 83.

The entire switchboard is thus under control of the right printer set. With the tie line keys all normal, operation of the right printer unit controls the operation of relay 20. On the other hand, with a tie line key operated, the master sending relay 20 is disconnected at the contacts of the operated tie line key, while the right printer set is associated with the tip conductor of the tie line associated with the operated tie line key.

If both transfer keys are operated at the same time, the right printer set 23 controls the master sending relay 20, while the left printer set 22 is associated with the tie line keys 71 to 74, inclusive. For the right printer set, the circuit is traced from negative battery on lead 19 through resistance 64, line winding of relay 20, left operated contacts of key 25, resistance 82, lower left operated contacts of key 24, through printer 23 and back through right operated contacts of key 24 to ground at 17. The left printer set is connected from battery on lead 19, through resistance 81, left operated contacts of key 25, resistance 65, left operated contacts of key 24, over lead 160 to key 74, and thence through contacts of the tie line keys in succession and transfer key 24 and through the printer unit 22 and back through the tie line keys to ground at 83, in the manner explained above. It will thus be seen that the functions of the printer units 22 and 23 are merely interchanged from that of their functions with their transfer keys normal.

Motor control for central station printers

The function of relays 89 associated with the motor control circuits of printers 22 and 23, respectively, is to stop the motor of the idle printer set when the other printer takes over the functions of both printer units upon operation of only one transfer key in the manner explained above. Under such conditions, of course, one printer is entirely disassociated from the tie lines or master relays, and hence there is no reason why the printer motor should be left running.

With transfer keys 24 and 25 normal, a circuit is traced from negative battery 19, over lead 92, through relay 89 associated with printer 23, and back to ground through the lower non-operated contacts of key 24. A similar circuit for printer 22 is traced from negative bus-bar 19, over lead 93, through relay 89 associated with printer 22, to ground

through the right non-operated contacts of key 25. Thus, with both the transfer keys normal, both the relays 89 are operated to maintain the motor control circuits closed. Similarly, if both the transfer keys are operated, both relays 89 will remain operated, relay 89 of printer 22 obtaining ground through the lower right operated contacts of key 24, while relay 89 of printer 23 obtains ground through the lower right operated contacts of key 25. If, however, key 24 is operated and key 25 normal, ground at the key contacts is entirely disconnected from the relay associated with printer 23, and this relay thus releases, opening the motor control circuit to stop the printer set motor. Similarly, with key 25 operated and key 24 normal, ground is entirely disconnected at the key contacts from the winding of relay 89 of printer 22, thereby releasing the relay and stopping the printer set motor.

Auxiliary printer equipment for tie lines

Referring to Fig. 2, it will be recalled that receiving-only printer units 43 were inserted in the tie lines at the general headquarters, so that a distant central office, such as III, might cause a message to be typed up on the printer unit 43 without waiting for the operator at central station I to operate the tie line key and connect a two-way printer 22 or 23 to the tie line. Also, an auxiliary printer 40 might be provided to replace, on the tie lines, one of the regular printers 22 or 23 in case of trouble thereto, or to replace a receiving printer 43 in case of trouble. The circuit between the lines XX and YY of Fig. 2 indicates schematically the manner in which this equipment is associated with the switchboard. Fig. 5 discloses for four tie lines the wiring diagram of the circuits and apparatus indicated between the lines XX and YY of Fig. 2.

Referring to Fig. 5, the receiving printer units are indicated by the rectangles 43. The auxiliary printer unit is shown at 40. Conductor pairs 91 to 94 inclusive, show sections of four tie lines. The receiving unit of printer 43 associated with tie line 91, is shown at 98 connected in the tip conductor of the circuit, while the motor control relay 99 is connected in the ring conductor. It will be recalled that normally current flows over both the tip and ring conductors of a tie line from battery at one central station to ground at the other. When a tie line key is operated, however, the current in the ring conductor is interrupted at the key contacts. Thus, if the operator at a distant station desires to transmit a message over a tie line to a printer 43, the operation of the proper tie line key at the distant station would interrupt the flow of current in the ring conductor of the tie line, which would in turn release the relay 99 associated with the printer 43. The release of

relay 99 connects the source of power 100 to the driving motor 101 to start the motor running. The printer unit 43 would then be in condition to receive a message transmitted from the distant central station over the tie line. The operator at the distant station, without waiting for a signal from the local operator, thereupon proceeds to transmit a message from printer 22 or 23 at the distant station, and this message will be typed up on the printer 43 at the local central station.

At the same time, the interruption of current flow in the ring conductor, as explained, lights the line lamp 88 associated with the tie line at the local station (see Fig. 4), and thus apprises the local operator that a message is being received on a printer unit 43. The local operator could thereafter come in at any time and communicate with the distant station by means of the regular printer 22 or 23 by merely throwing the proper tie line key.

Assuming the local operator has not answered when the distant operator has finished transmitting a message, the restoration of the tie line key at the distant station will complete the circuit through the key contacts to again cause the flow of current over the ring conductor of the tie line. This current flowing through the motor control relay 99 of printer 43 will reoperate the relay and thus stop the printer set motor. It is, of course, to be understood that the receiving printer units 43 are merely optional and may be included or omitted at any central station, as desired.

If one of the regular printer units 22 or 23 is in trouble, the transfer keys 24 and 25 may be suitably operated, as explained above, so that the good printer unit can control the master sending relays. The auxiliary printer 40 may then take over the functions of the other printer for two-way communication over the tie lines. The auxiliary printer 40 is associated with a given tie line by inserting the plug 41 in the proper jack 42 associated with the tie line. Each jack 42 has contacts to normally close through the tip and ring conductors of the tie line, as shown. With plug 41 inserted in a jack 42, the printer unit of the printer 40 is connected in series in the tip conductor. At the same time, auxiliary contacts associated with the tip of the jack open the ring conductor of the tie line, thus lighting the line lamp 88 (see Fig. 4), at the distant station to apprise the distant operator that a call is waiting. Furthermore, the insertion of the plug 41 closes the topmost contacts associated with jack 42 to start the printer motor of the printer 40. This latter circuit is traced from battery 103 through motor control relay 102, through key 104, through the upper operated contacts of jack 42 and over lead 105, through the back contacts of relays 106 and 107, in succession, to

ground at 108. Relay 102 thereupon operates to connect source of power 103 to printer motor 109, thereby starting the motor. The distant operator, upon noting the lighted line lamp, will operate a tie line key to associate a printer unit thereat with the tie line, and thereafter two-way communication can be carried on between the distant station and the local station, the latter using the auxiliary printer.

When the call is complete, the plug 41 is removed from the jack 42, thereby opening the circuit containing relay 102 to release the same and stop the motor 109 of printer 40.

If one of the receiving sets 43 is in trouble, it may be replaced with the auxiliary printer 40 by inserting plug 41 in the proper jack 42 and operating the auxiliary printer key 45. The insertion of the plug 41 in a jack 42 connects the printer unit of printer 40 in the tip conductor of the tie line as before, and in addition opens the auxiliary contacts 48 associated with the ring conductor of the tie line. The opening of contacts 48, however, does not in this instance, open the ring conductor of the tie line, since contacts 48 are now shunted by a path traced through one winding of relay 106 or 107 and the corresponding pair of contacts on key 45 which is now operated. For tie line 91, this circuit extends through the left winding of relay 106 and the upper operated contacts of key 45.

Assuming plug 41 to be connected in jack 42 of tie line 91, the current normally flowing in the ring conductor operates relay 106 over the circuit traced above. The operation of relay 106 disconnects ground 108 from the motor control relay 102 associated with printer 40 and thus prevents operation of the relay at this time. If, however, the distant station desires to send on tie line 91, the operation of the tie line key thereat by interrupting the current flow in the ring conductor causes the release of relay 106 at the local station. The release of relay 106 connects ground 108 to relay 102 to operate the same and start up the motor associated with printer 40. Printer 40 may now receive messages from the distant station in the same manner as a printer 43. When the message is complete, the flow of current in the ring conductor consequent upon restoration of the tie line keys, will re-operate relay 106 and thus stop the motor of printer 40.

Two-way branch stations

Referring again for a moment to Fig. 2, it was pointed out above that a station such as 9, equipped with a printing telegraph transmitter and receiver, could be associated with a tie line key and a station key at the central station in such manner as to carry on two-way communication with the central station as well as receive messages broadcast therefrom. The detailed wiring diagram, disclosing the

manner in which connections are made at the central office to accomplish this result, is shown by the drawing of Fig. 6. Referring to Fig. 6, the central station equipment is indicated to the left of the dashed line 110. The two-way station is indicated within the rectangle 9. The equipment for station 9 is the same as that of a one-way station 2 of Fig. 3, discussed above, except that for station 9 a printing telegraph sender unit 111, and a break key 112 (Fig. 6) are connected in series with the receiving unit 54.

At the central station, the tip conductor of a spare station key 155 is connected to an upper left non-operated contact of a spare tie line key 34, as indicated on the drawing. Station 9 is connected over the tip and ring leads of pair 44 to tie line key 34 at the central station in the usual manner. The ring terminal R, associated with station key 155 is left open, as the apparatus associated therewith is not utilized for the present type of circuit arrangement. Since the tip conductor of station key 155, which normally has positive battery connected thereto, is now connected by means of lead 114 to the tie line key 34, it is necessary to change the wiring arrangement of the tie line key somewhat from the wiring of such keys as shown at Fig. 4 in order to prevent the negative battery normally associated with the tip conductor of the tie line key from becoming crossed up with the positive battery normally supplied from the station key over lead 114. Incidentally, the tie line key must have battery associated therewith similar to key 73 of Fig. 4, since the tie line key 34 must furnish battery to operate the printer and signaling equipment at station 9. The changes in wiring of the tie line key 34 also necessitate certain changes in the wiring of the transfer key 24 from that shown for such key in Fig. 4. The changes made in the wiring of the keys will become evident from a comparison of Figs. 4 and 6. In Fig. 6, only the contacts of key 24, which are involved in circuit alterations, are shown connected by means of wires extending to other portions of the switchboard. The contacts of key 24 which are shown blank in Fig. 6 should be connected in the same manner as shown for key 24 in Fig. 4. The changes in wiring indicated on Fig. 6 do not affect the above described functioning of transfer keys.

With the circuit arrangement as shown in Fig. 6, battery from positive bus-bar 15 is normally supplied through resistance 54, through the left non-operated contacts of key 155, over lead 114, through left non-operated contacts of key 34 and over the tip conductor of pair 44 to station 9 and thence in series through printer unit 54, sender 111, break key 112, winding of polar relay 55 to ground through the winding of motor control relay 56. This current maintains the polar relay 55 against its spacing contact as

explained above in connection with the one-way lines.

If, now, it is desired to include station 9 in the broadcast circuit associated with the one-way lines at the central station, the station key 155 is operated which connects negative battery supplied through the contacts of the sending relay 18 to the tip conductor extending to the branch station, thus reversing the direction of current flow through polar relay 55 thereat and starting up the printer set motor at station 9, as was explained above for the one-way lines. The operation of the sending relay 18, in the manner explained above, transmits a broadcast message to station 9, causing it to be typed upon printer unit 54 thereat.

When the message is complete, station 9 may acknowledge receipt thereof by operating key 68 which disconnects ground from the ring conductor of pair 44. This opens the circuit containing relay 87 associated with key 34 at the central station, causing the release of the relay. Upon release of relay 87, a circuit is traced from negative bus-bar 19, through resistance 85, the armature and back contact of relay 87 and through lamp 29 to ground at 115. Lamp 29 lights over this circuit and apprises the central station operator that the message has been received. Upon subsequent restoration of key 68 at station 9, relay 87 at the central station reoperates and extinguishes lamp 29. When the station key 155 is restored by the central station operator, positive battery is reconnected to the tip conductor extending to station 9 which reoperates relay 55 thereat against its spacing contact, thereby stopping the printer set motor at the branch station.

If the central station desires to carry on two-way communication with station 9, the tie line key 34 is operated. The operation of key 34 disconnects at the key contacts, the positive battery supplied over lead 114, and substitutes therefor negative battery for starting up the printer set motor at the branch station. At the same time the operation of key 34 includes a central station printer set in series with the tip conductor for communication with station 9. This latter circuit is traced from negative bus-bar 19, through resistance 84, lower right operated contacts of key 34, through left non-operated contacts of key 24, through printer 23 and back through right non-operated contacts of key 24, through the upper left operated contacts of key 34 and out to station 9 over the tip conductor. The circuit is now functioning properly for carrying on two-way communication between the printer at station 9 and printer set 23 at the central station. If the transfer key 24 happens to be operated, of course, the left printer set will be substituted for the right printer set, as was explained above. At the conclusion of the call, the

restoration of key 34 will reconnect, through the key contacts, the positive battery supplied over lead 114 to the tip conductor extending to station 9, thereby stopping the printer set motor thereat.

If station 9 desires to initiate a call, key 68 is operated, which lights lamp 29 at the central station, in the manner explained above, to apprise the operator thereat that a call is waiting on the line. The call is answered by operating key 34 to connect a central station printer to the line.

Alternative switchboard arrangement

Fig. 7 shows a method of wiring the transfer and tie line keys which, in general, accomplishes approximately the same results as is obtained with the wiring arrangement shown in Fig. 4. In Fig. 7, two central stations A and B are shown. The complete equipment at the central station A is obtained by placing Fig. 7 to the right of Fig. 3 so that leads 116 from central station A of Fig. 7 coincide with leads 116 of Fig. 3. In the same manner, the complete central station B is obtained by placing Fig. 7 to the right of Fig. 3 so that leads 116 from central station B extend to leads 116 of Fig. 3. The numbering for the printer sets, transfer keys and master sending relay is the same for central stations A and B of Fig. 7 as for the corresponding elements of Fig. 4.

It will be recalled by reference to Fig. 4 that the arrangement of the transfer and tie line keys was such that the tie lines could extend indiscriminately to battery or ground as desired, at a given central station. With the arrangement shown in Fig. 7, however, the tie lines terminating at a given central station are all connected to battery, or are all connected to ground thereat. Thus it will be seen that for central station B of Fig. 7, the tip conductors of all tie lines normally extend to battery through resistances 133; whereas, at the central station A, the tip conductors of the tie lines normally extend to ground over their respective leads 140. Likewise, the ring conductors of all the tie lines extend from battery through resistances 134 at central station B; while at central station A all the ring conductors extend to ground at 141.

The chief advantages of the wiring arrangement shown in Fig. 7 over the arrangement shown in Fig. 4 consists in the simple wiring of the tie line keys and in the fact that a central station printer 22 or 23 may be associated with a tie line during reception of a message to a receiving-only printer 43 without interrupting a message being received on the receiving-only printer. To explain how this advantage is obtained, the tie lines terminating at central station B have been equipped with receiving-only printers 43 similar to the printers 43 shown in Fig. 5.

Referring for a moment to tie line key 118 at central station B, it will be noted that normally negative battery is supplied through resistance 134, through relay 124, right non-operated contacts of key 118 and over ring conductor 127 to central station A, through right non-operated contacts of key 116 thereat and through relay 122 to ground at 141. This current maintains relays 122 and 124 operated and also operates the motor control relay in receiving printer 43, as was explained above.

If, now, central station A desires to send to the receiving printer 43 of central station B, key 116 is operated. This opens at the lower right contacts of key 116, the circuit just traced from battery to ground over the ring conductor and thus releases relays 122 and 124 as well as the motor control relay in the receiving-only printer 43 at central station B. The release of motor control relay associated with printer 43 starts up the printer set motors and prepares printer 43 for reception of the message. The operation of key 116 connects a printer set at central station A to the tip conductor 126 extending to central station B. The circuit is traced from ground 142 through right printer set 23 at central station A, through right non-operated contacts of key 24 thereat, through left operated contacts of key 116 and out over conductor 126 to central station B, through the receiving-only printer 43, through left non-operated contacts of key 118 to negative battery through resistance 133. Operation of the sending contacts of printer 23 of central station A will now cause the message transmitted to be typed upon printer 43 at central station B.

It was mentioned above that the operation of key 116 releases relay 124 at central station B. The release of relay 124 completes a circuit from negative battery on bus-bar 129, through resistance 134, armature and back contacts of relay 124, resistance 125 and right non-operated contacts of key 118 to ground through lamp 123, thus lighting the lamp. The lighting of lamp 123 apprises the operator of central station B that a message is being received on printer 43. The operator of central station B may connect a two-way printer with conductor 126 at any time thereafter to answer the call by operating the tie line key 118. The operation of key 118 will not interrupt in any way a message being received at that time upon printer 43, due to the fact that battery supplied through resistance 133 to conductor 126 is not disconnected until other battery supplied through the printer at central station B is connected to conductor 126. This result is brought about by the fact, referring to key 118, that as the key is operated, the conductor 144 is connected to conductor 126 before conductor 143 is disconnected there-

from, owing to the make-before-break arrangement of the contacts on key 118. As soon as conductor 144 is connected to lead 126, a circuit is completed from negative bus-bar 129, through resistance 131, through printer set 23, right non-operated contacts of key 24, over lead 144, through left operated contacts of key 118 and out over lead 126 to ground through printer set 23 of central station A, as described above. The battery now supplied through resistance 131 at central station B takes the place of that supplied through resistance 133 so that the latter battery may be now disconnected at the contacts of key 118 by the complete operation thereof without interrupting the message being received on printer 43.

In addition to the above, the operation of key 118 opens at the upper right contacts of key 118 the circuit containing lamp 123, thus extinguishing the lamp. Printer set 23 at central station B may now carry on two-way communication with the corresponding printer at central station A, due to their interconnection over lead 126. The transfer keys 24 and 25 of Fig. 7 accomplish the same functions as the corresponding keys of Fig. 4.

Referring back for a moment to Fig. 4, if the circuit for associating a printer set 22 or 23 with a tie line be examined again, as traced above, it will be noted that there is a possibility of a slight interruption in battery supplied over the tip conductor during operation of the tie line key. This interruption occurs if the upper left contacts of a tie line key are opened before the lower right contacts are closed and might possibly cause an error in a message being received on a receiving-only printer 43 associated with the tie line in question. It is possible by proper adjustment of the key contacts to overcome this condition in the circuit arrangement of Fig. 4.

What is claimed is:

1. A telegraph switching system comprising, in combination, a plurality of central stations with tie lines extending from each central station to any of the remaining stations, a group comprising a plurality of branch stations individual to one of said central stations, other groups of branch stations individual to any or all of the remaining central stations, lines connecting each branch station with its corresponding central station, telegraph means at each central station and at each branch station, means whereby said telegraphic means at one central station may communicate over a tie line with corresponding telegraph means at any other central station connected thereto, and means whereby said telegraphic means at a central station may communicate with the corresponding means at any said branch station connected thereto.

2. In a telegraph switching system as set

forth in claim 1, means associated with said telegraphic means at a central station whereby said telegraphic means thereat may simultaneously transmit or broadcast messages to any or all of said branch stations connected to said central station.

3. A telegraph switching system comprising in combination, a plurality of central stations each equipped with printing telegraph means, tie lines extending from each central station to certain of the other central stations, means whereby said printing telegraph means at one central station may be associated with a tie line for two-way communication thereover to the corresponding printing means similarly associated with said tie line at the distant central station, a group comprising a plurality of branch stations associated with one said central station, printing telegraph means at each said branch station, lines extending from each branch station to said central station, other groups of branch stations individual to one or more of the remaining central stations and similarly connected thereto, means whereby said printing telegraph means at a central station may send individually to any branch station connected thereto, and means whereby said printing telegraph means at the central station may simultaneously transmit or broadcast to any or all of said branch stations connected thereto.

4. In a telegraph switching system as set forth in claim 3, signaling means associated with said tie lines at each central station, whereby a calling central station may operate a line signal at a called central station, and means whereby said called station may extinguish said signal, signaling means associated with said branch stations, whereby any said branch station may operate a line signal at the central station to acknowledge receipt of a message transmitted thereto, and means whereby said central station may extinguish said signal.

5. A telegraph switching system comprising a plurality of telegraph stations with lines extending from each such station to any of the remaining stations, printing telegraph transmitters and receivers located at each said station, switching means at each station whereby a printer set at any station may be associated with any said line for two-way communication with a printer set similarly connected to said line at the distant station, printing telegraph receiving sets individual to said lines at one or more said stations, remote control means associated with said receiving sets whereby the station connected to the distant end of any said line may start the motor of the corresponding receiving set at the local station and transmit messages thereto without waiting for a printing telegraph transmitter and receiver to be associated with said line at the local station.

6. A telegraph switching system comprising a central station equipped with printing telegraph transmitters and receivers, a plurality of branch stations connected thereto each equipped with printing telegraph receivers, one or more branch stations equipped with printing telegraph transmitters and receivers connected to said central station, tie lines extending from said central station to other similar central stations, means whereby a printer set at said central station may be associated with any said tie line for two-way communication thereover with a printer set similarly connected to said tie line at the distant central station, means whereby a printer set at said central station may be connected to any of said branch stations first mentioned for sending thereto, means whereby a central station printer may be connected to any of said branch stations last mentioned for two-way communication therewith, and means at said central station whereby a central station printer thereat may broadcast to any or all of said branch stations.

7. A telegraph switching system comprising a central station equipped with a printing telegraph transmitter and a plurality of branch stations each equipped with a printing telegraph receiver, branch lines extending from each branch station to the central station, a two-position locking broadcast key associated with said branch lines at the central station, sending means controlled by said broadcast key whereby the central station printer may broadcast to all of said branch stations, remote control means associated with said branch stations whereby the printer set motors thereat are running only while said broadcast key is operated, and signaling means whereby any branch station may acknowledge receipt of a message from the central station.

8. A telegraph switching system comprising a central station equipped with a printing telegraph transmitter and a plurality of branch stations each equipped with a printing telegraph receiver, branch lines extending from each branch station to the central station, a plurality of two-position station keys individual to said branch lines at the central station, a two-position locking broadcast key associated with said station keys, means including said station keys whereby the central station printer may send individually to any of said branch stations, means including said station keys whereby said central station printer may broadcast to a group or all branch stations, means including said broadcast key whereby the central station printer may broadcast to all said branch stations, remote control means associated with said branch stations whereby the printer set motors thereat are running only while the corresponding station key or said broadcast key is operated, and means whereby any

branch station may signal the central station to acknowledge receipt of a message.

9. A telegraph switching system comprising a central station equipped with a printing telegraph transmitter, and a plurality of branch stations each equipped with a printing telegraph receiver, branch lines extending from each branch station to the central station, a plurality of two-position station keys individual to said branch lines at the central station, a two-position locking broadcast key and a non-locking clear-out key associated with said station keys, means including said station keys whereby the central station printer may send to any or all of said branch stations, and signaling means whereby any said branch station may acknowledge receipt of a message, said signaling means including a line extending from the branch station to the central station, a signal key associated with said line at the branch station, means at the central station responsive to the operation of said signal key for operating a line signal at the central station, a locking circuit for said line signal completed thereupon through operated contacts of the corresponding station key and non-operated contacts of said clear-out key, means including said broadcast key whereby the central station printer may broadcast to all of said branch station printers, said signaling means associated with any branch station being operable thereafter to acknowledge receipt of said message responsive to said signal key operation, a locking circuit for the line signal completed thereupon through non-operated contacts of the station key, operated contacts of the broadcast key and non-operated contacts of the clear-out key.

10. A telegraph switching system comprising a central station and a plurality of branch stations, lines connecting each branch station with the central station, a plurality of two-position station keys individual to said branch stations at the central station, a two-position broadcast key and a two-position clear-out key associated with said station keys, telegraph means at each branch station and at the central station, means including said station keys whereby the telegraph means at the central station may send individually to the telegraph means at any branch station, means whereby a branch station may acknowledge receipt of such a message, said means comprising a signal circuit extending from each branch station to the central station, a signal key associated therewith at the branch station, a relay at the central station responsive to said signal key operation to operate a line signal, a locking circuit for said line signal completed through operated contacts of said station key and non-operated contacts of said clear-out key, means including said broadcast key whereby said central station telegraph means may broadcast to all

said branch stations, signal means whereby any branch station may acknowledge receipt of such a message, said signal means including the signal means first mentioned, together with a locking circuit for said line signal completed through non-operated contacts of the corresponding station key, operated contacts of the broadcast key and non-operated contacts of the clear-out key.

11. A telegraph switching system comprising a plurality of stations with telegraph means at each station, tie lines extending from each station to any of the other stations, a plurality of two-position tie line keys individual to said tie lines at each central station, said tie line keys being operable singly to associate said telegraph means at a central station with any said tie line connected thereto whereby said telegraph means thereat may communicate with other telegraph means similarly connected to said tie line at the distant station.

12. A telegraph switching system comprising a plurality of stations each equipped with a printing telegraph transmitter and receiver, tie lines extending from each said station to any of the other stations, a plurality of two-position tie line keys individual to said tie lines at each station, signaling means associated with each said tie line key, means responsive to the operation of a tie line key at any said station for associating the printer set thereat with the corresponding tie line and for operating a line signal at the distant station connected to said tie line, means responsive to the operation of the corresponding tie line key at the distant station to extinguish the line signal thereat and to associate the printer set thereat with said tie line for two-way communication with said printer set first connected.

13. A telegraph switching system comprising a plurality of telegraph stations each equipped with a printing telegraph transmitter and receiver, telegraph lines comprising a printer circuit and a signaling circuit extending from each said station to other stations, a plurality of two-position keys individual to said telegraph lines at each office, whereby a printer set thereat may be connected to a desired line for two-way communication with a printer set similarly connected to said line at the distant station, signaling means individual to said signaling circuits at each station, comprising a line signal and a normally operated relay for maintaining said line signal extinguished, means responsive to the operation of any said key at a given station for releasing at the distant station said relay associated with a corresponding signal circuit to operate the line signal thereat, said means at the first station being further adapted to prevent the release of said relay associated with the operated key thereat, whereby the line signal remains extin-

guished at the station first mentioned, and means responsive to the tie line key operation at the distant station for extinguishing said operated signaling means thereat.

5 14. A telegraph switching system comprising a plurality of central stations each equipped with printing telegraph transmitters and receivers, telegraph tie lines connecting each central station with a plurality of
10 the remaining central stations, signaling means individual to said tie lines at each central station whereby a calling station may signal a distant or called station, switching means whereby printer sets may be connected
15 to a given tie line at the calling and called stations for two-way communication thereover, a group of branch stations connected to a given central station, other groups of branch stations similarly connected to one or
20 more of the remaining central stations, two-position station keys individual to each branch station at a given central station, means at said central station including said station keys, whereby a printer set thereat
25 may send individually to any of the branch stations connected thereto, or may broadcast to any or all of said branch stations, signaling means whereby each branch station may signal the central station to acknowledge the
30 receipt of such message, and means whereby one printer set at a given central station may send to the branch stations connected thereto without interference to a second printer set located at said central station communicating over a tie line to a distant central
35 station.

15. A telegraph switching system comprising a central station having connected thereto a plurality of printing telegraph branch
40 stations, a plurality of tie lines extending from said central station to other similar central stations, a pair of two-position transfer keys having associated therewith a first and a second printer set at said central station,
45 said transfer keys normally associating said first printer set with the branch stations and said second printer set with the tie lines for communication purposes, said transfer keys being operable simultaneously to reverse the
50 functions of said printer sets, whereby the first printer set becomes associated with the tie lines, and the second printer set with the branch stations, said transfer keys being operable singly, respectively, to disconnect said
55 first and second printer sets, respectively, and to associate said second and first printer sets, respectively, with said branch stations as well as said tie lines, whereby the printer thus associated may communicate with said
60 branch stations and also over said tie lines.

16. A telegraph switching system comprising a central station having connected thereto a plurality of printing telegraph branch
stations, a plurality of tie lines extending
45 from said central station to a plurality of

other similar central stations, a pair of two-position transfer keys at the first central station having associated therewith a first and a second printer set, said transfer keys normally associating said first printer set with
70 the branch stations for sending thereto, and normally associating the second printer with the tie lines for communication thereover, one said transfer key being operable singly to disconnect the first printer and to associate
75 the second printer with the branch stations as well as the tie lines, whereby said second printer may send to the branch stations and also communicate over the tie lines, the other transfer key being operable singly to disconnect the second printer and to associate
80 the first printer with the tie lines as well as the branch stations, both said transfer keys being operable simultaneously to reverse the functions of said first and second printer sets
85 whereby the second printer becomes associated with the branch stations and the first printer with the tie lines.

17. A telegraph switching system comprising a central station having connected thereto a plurality of printing telegraph branch
90 stations, a plurality of tie lines extending from said central station to a plurality of other similar central stations, switching means at the first central station having associated therewith a first and a second printing telegraph set, said switching means normally associating said first printer set with
95 the branch stations for sending thereto, and associating said second printer with the tie lines for communication thereover, said switching means being operable in one sense to disconnect said first printer and to associate said second printer with the branch stations and also with the tie lines for sending
100 to any branch stations and also for communicating over any tie line, said switching means being operable in a second sense to disconnect said second printer and to associate said first printer with the branch stations and also
105 with the tie lines, and said switching means being operable in a third sense to reverse the normal functions of said first and second printers, whereby the second printer becomes associated with the branch stations only and
110 the first printer with the tie lines only.

18. A telegraph switching system comprising a plurality of central stations each equipped with printing telegraph transmitters and receivers, tie lines extending from
120 each central station to a plurality of the remaining central stations, a plurality of two-position tie line keys individual to said tie lines at each of the central stations, any said tie line key being operable to associate a central station printer thereat with the corresponding tie line and to operate signaling means at the distant central station connected thereto, the tie line key associated with said
125 tie line at the distant station being then oper-

able to extinguish said signaling means and to associate a printer set thereat with the tie line for two-way communication with the first printer, a plurality of branch stations each equipped with printing telegraph receivers, branch lines extending from each branch station to one said central station, a plurality of two-position station keys at said central station individual to said branch lines, means at the central station including said station keys, whereby a central station printer may send individually to any of the branch stations, or may broadcast to any or all said stations, and signaling means whereby any branch stations may acknowledge to the central station receipt of a message therefrom.

19. In a telegraph switching system as set forth in claim 18, a branch station equipped with a printing telegraph transmitter and receiver, connected to the central station, means at the central station including a tie line key and a station key whereby said branch station printer may be connected with a central station printer for two-way communication, and, in addition, may be connected to said broadcast means for reception of messages broadcast from said central station.

20. In a telegraph switching system as set forth in claim 18, a station equipped with a printing telegraph transmitter and receiver, lines extending from said station to a spare tie line key at the central station, whereby said station may be connected to a central station printer for two-way communication, a circuit at the central station associating said tie line key with a spare station key whereby said station may receive messages broadcast from the central station to the aforementioned branch stations, means whereby said station may signal the central station to initiate a call, or acknowledge receipt of a message therefrom, and remote motor control means whereby the printer set motor at said station is running only while said tie line key or said station key is operated.

21. A telegraph switching system comprising a plurality of telegraph stations with lines extending from each such station to certain of the remaining stations, printing telegraph transmitting and receiving sets located at each said station, switching means at each station whereby a printer set thereat may be associated with any said line for two-way communication with a printer set similarly connected to said line at the distant station, printing telegraph receiving sets individual to said lines at one or more said stations, remote control means associated with said receiving sets whereby the station connected to the distant end of any said line may start the motor of the corresponding receiving set at the local station and transmit messages thereto without waiting for a printing tele-

graph transmitting and receiving set to be associated with said line at the local station, said switching means being adapted to associate a printing telegraph transmitting and receiving set with said line at the local station without interruption to a message being received on said receiving set.

22. A telegraph switching system comprising a plurality of telegraph stations each equipped with printing telegraph sets, a plurality of lines extending between any of said stations, switching means individual to said lines at each station whereby a printer set thereat may be associated with any said line for two-way communication with a printer set similarly connected to said line at the distant station, an auxiliary printer at one or more said stations, means whereby said auxiliary printer at a given station may be connected to any said line for two-way communication thereover, means whereby the motors of the auxiliary printer are running only while thus connected to a line.

23. A telegraph switching system comprising a plurality of stations each equipped with printing telegraph sets, a plurality of lines extending from each station to other stations, switching means at each station individual to said lines for connecting a printer set thereat with any said line, receiving-only printer sets individual to said lines at one or more stations, remote motor control means associated with said receiving printers whereby the distant station associated with a given line may start the motors of the corresponding receiving set at the local station and send thereto, an auxiliary printer set at said local station for replacing any said receiving printer, switching means for connecting said auxiliary printer to a given line, and remote control means associated with the auxiliary printer whereby the distant station associated with said given line may start the motors of said auxiliary printers.

24. A telegraph switching system comprising a plurality of stations each equipped with printing telegraph transmitting and receiving sets, a plurality of lines connecting each station with a plurality of the other stations, switching means individual to said lines at each station for connecting a printer set to any said line thereat, receiving-only printer sets individual to said lines at one or more stations, remote control means individual to said receiving sets whereby distant stations may start and stop the motors thereof, auxiliary printer sets individual to one or more said stations, means whereby an auxiliary printer may be connected to any line for two-way communication with a distant station and means whereby the motors of said auxiliary printer are running only while thus connected, means whereby an auxiliary printer at a given station may replace a receiving printer thereat, said means including

said means for connecting the auxiliary printer to the proper line, relay means for controlling the operation of the auxiliary printer motors, and a key switch operable to place said relay means under control of the distant station connected to said line.

25. A telegraph switching system in combination comprising a plurality of stations each equipped with a printing telegraph set, lines comprising a printer circuit and a signaling circuit extending from a first station to each of the other stations, switching means at each station for connecting the printer set thereat with a line for two-way communication with the distant station, an auxiliary printer at the first station, jacks individual to the lines thereat and a plug associated with the auxiliary printer for connecting the same to any said line, auxiliary contacts on each jack for completing a circuit to start the motors of said auxiliary printer upon insertion of the plug therein, additional contacts on each jack normally closing through the corresponding signaling circuit but operable upon insertion of the plug therein to connect in series in said signaling circuit relay means and normally open contacts of a key switch, said key switch being operable thereafter to close said contacts and thus place said relay means under control of the distant station, and said relay means controlling the motor circuit of said auxiliary printer whereby said distant station may start and stop the motors thereof.

26. A telegraph switching system comprising in combination a headquarters central station, a plurality of branch central stations, lines extending from said headquarters central station to each of said branch central stations, a group of branch stations individual to said headquarters central station, a group of branch stations individual to each of said branch central stations, lines extending to each of said branch stations from its corresponding central station, printing telegraph apparatus at each of said stations, switching means at said headquarters central station for associating printing telegraph apparatus thereat with printing telegraph apparatus at any of said branch central stations for two-way communication, switching means at said headquarters central station for associating printing telegraph apparatus thereat with printing telegraph apparatus at any of the branch stations individual to said headquarters central station for communication therewith, and switching means at the branch central stations for associating printing telegraph apparatus thereat with printing telegraph apparatus at any of the branch stations individual to the respective branch central stations for communication therewith.

27. A telegraph switching system comprising in combination a headquarters central

station, a plurality of branch central stations, lines extending from said headquarters central station to each of said branch central stations, a group of branch stations individual to said headquarters central station, a group of branch stations individual to each of said branch central stations, lines extending to each of said branch stations from its corresponding central station, receiving-only printing telegraph apparatus at each of said branch stations, sending-and-receiving and receiving-only printing telegraph apparatus at each of said central stations, switching means at said headquarters central station for associating sending and receiving printing telegraph apparatus thereat with the lines extending to any of said branch central stations for two-way communication with sending-and-receiving printing telegraph apparatus adapted to be similarly associated with said lines at said branch central stations, switching means at said headquarters central station for associating printing telegraph apparatus thereat with receiving-only printing telegraph apparatus at any of the branch stations individual to said headquarters central station for one-way communication thereto, switching means at each branch central station for associating sending-and-receiving printing telegraph apparatus thereat with receiving-only printing telegraph apparatus at any of the branch stations individual to the respective branch central stations for one-way communication thereto, switching means at said headquarters central station for associating sending-and-receiving printing telegraph apparatus thereat with receiving-only printing telegraph apparatus at any of said branch central stations for one-way communication thereto, and switching means at each of said branch central stations for associating sending-and-receiving printing telegraph apparatus thereat with receiving-only printing telegraph apparatus at said headquarters central station for one-way communication without waiting for the association of sending-and-receiving printing telegraph apparatus at said headquarters central station.

28. A telegraph switching system comprising in combination a headquarters central station, a plurality of branch central stations, lines extending from said headquarters central station to each of said branch central stations, a group of branch stations individual to each of said branch central stations, lines extending to each of said branch stations from its corresponding branch central station, a printing telegraph transmitter at said headquarters central station, a printing telegraph receiver and a printing telegraph transmitter at each of said branch central stations, a printing telegraph receiver at each of said branch stations, means at said headquarters central station for broadcasting

from the printing telegraph transmitter thereat to the printing telegraph receivers at any or all of said branch central stations, and means at each of said branch central stations
5 for broadcasting from the printing telegraph transmitter thereat to the printing telegraph receivers at any or all of the branch stations individual thereto.

29. A telegraph switching system comprising in combination a headquarters central station, a plurality of branch central stations,
10 lines extending from said headquarters central station to each of said branch central stations, a group of branch stations individual to said headquarters central station, a group
15 of branch stations individual to each of said branch central stations, lines extending to each of said branch stations from its corresponding central station, a printing telegraph transmitter at said headquarters central station,
20 a printing telegraph receiver and a printing telegraph transmitter at each of said branch central stations, a printing telegraph receiver at each of said branch stations, means
25 at said headquarters central station for broadcasting from the printing telegraph transmitter thereat to the printing telegraph receivers at any or all of the branch central stations and at any or all of the branch stations individual to said headquarters central station,
30 and means at each of said branch central stations for broadcasting from the printing telegraph transmitter thereat to the printing telegraph receivers at any or all of the branch
35 stations individual thereto.

In testimony whereof, I have signed my name to this specification this 15th day of March, 1929.

GILBERT S. VETNAM.

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