

June 10, 1930.

G. S. VERNAM

1,762,252

PRINTING TELEGRAPH EXCHANGE SYSTEM

Filed Nov. 16, 1928

4 Sheets-Sheet 1

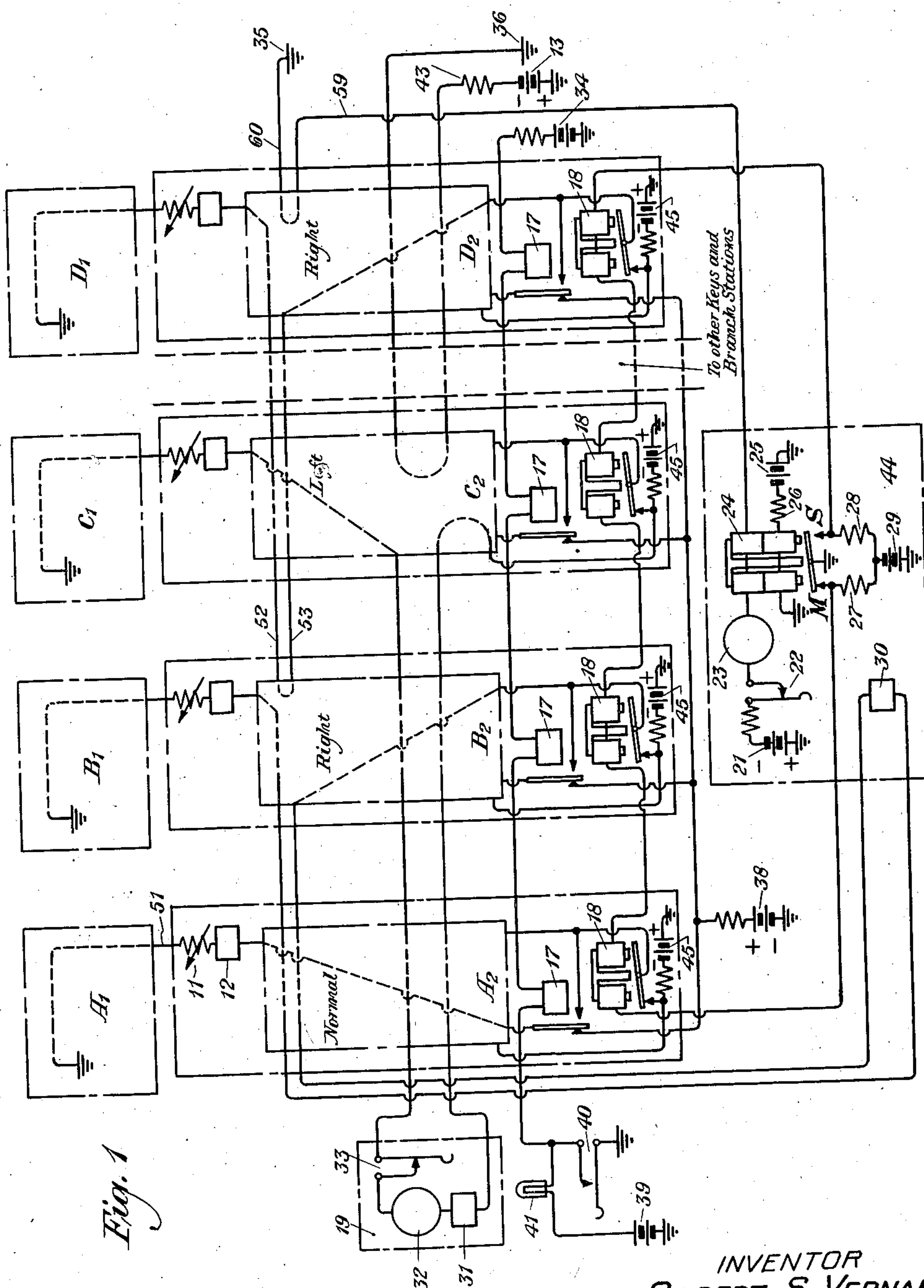


Fig. 1

INVENTOR
GILBERT S. VERNAM
BY *geth*
ATTORNEY

June 10, 1930.

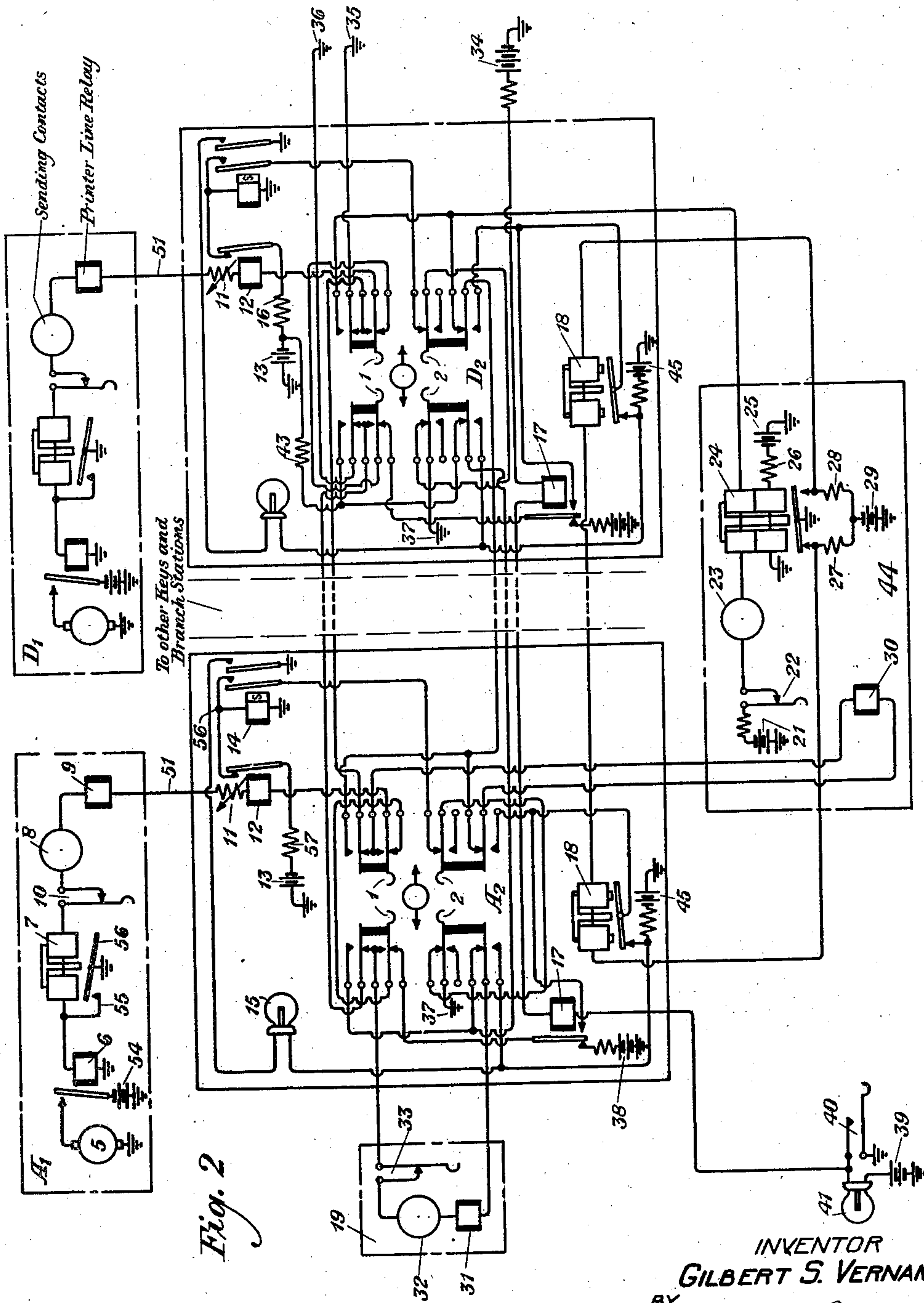
G. S. VERNAM

1,762,252

PRINTING TELEGRAPH EXCHANGE SYSTEM

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4 Sheets-Sheet 2



INVENTOR
GILBERT S. VERNAM
BY *g. s. vernam*
ATTORNEY

June 10, 1930.

G. S. VERNAM

1,762,252

PRINTING TELEGRAPH EXCHANGE SYSTEM

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4 Sheets-Sheet 3

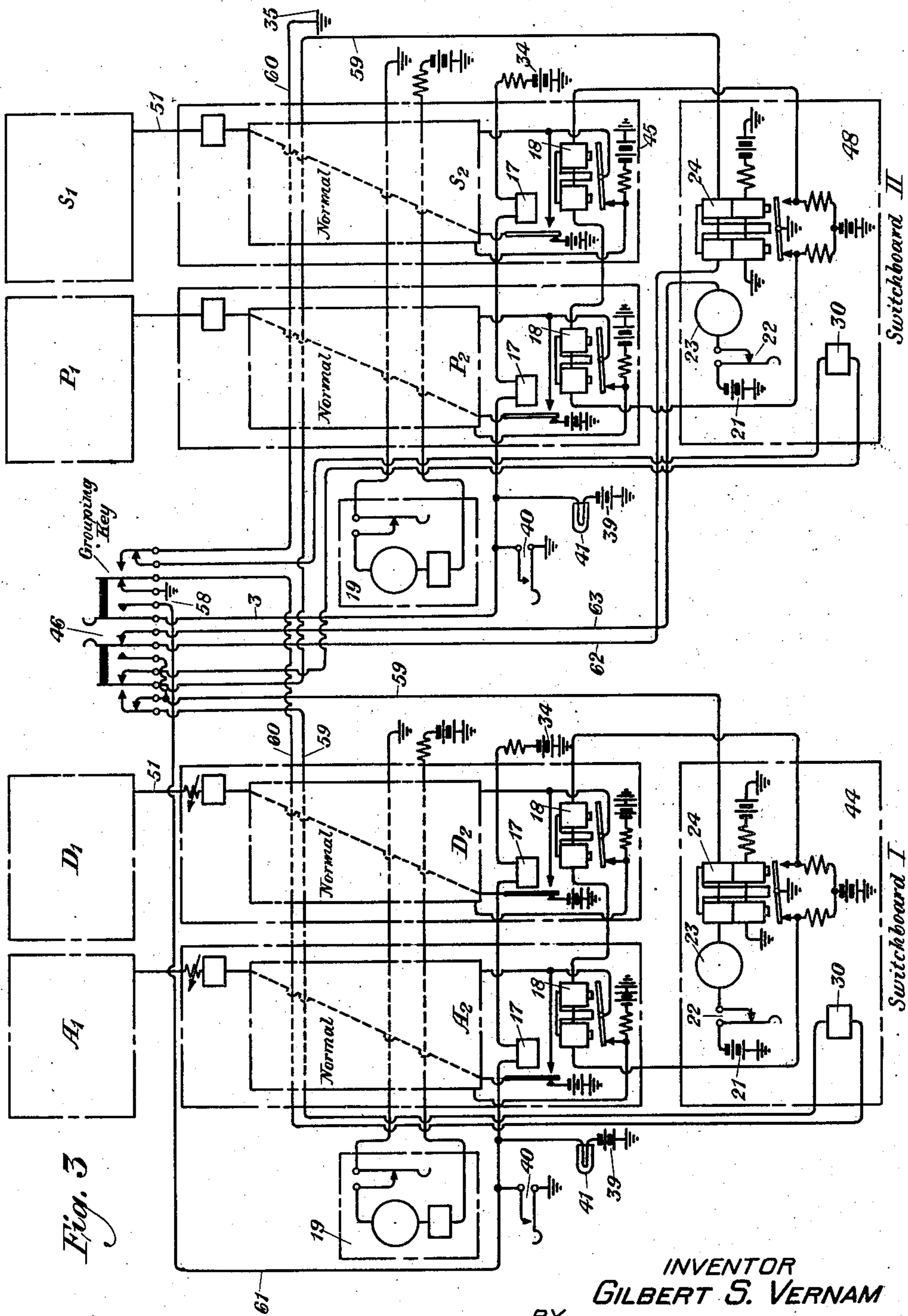


Fig. 3

INVENTOR
GILBERT S. VERNAM
BY
J. V. 402
ATTORNEY

June 10, 1930.

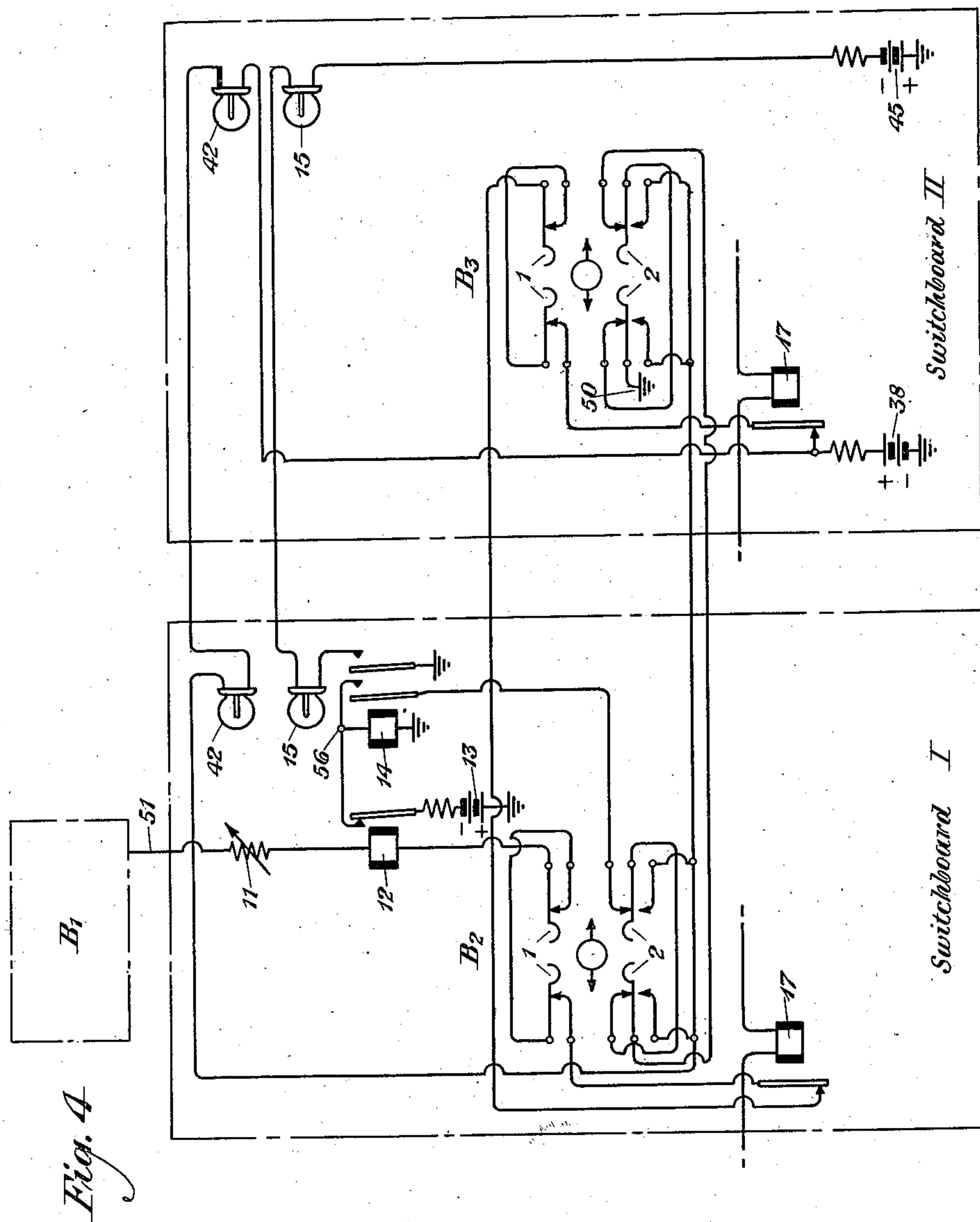
G. S. VERNAM

1,762,252

PRINTING TELEGRAPH EXCHANGE SYSTEM

Filed Nov. 16, 1928

4 Sheets-Sheet 4



INVENTOR
GILBERT S. VERNAM
BY *John*
ATTORNEY

UNITED STATES PATENT OFFICE

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

PRINTING-TELEGRAPH EXCHANGE SYSTEM

Application filed November 16, 1928. Serial No. 319,864.

This invention relates to the art of telegraph communication and describes a telegraph exchange system adapted principally to the use of printing telegraph equipment, whereby two-way service may be carried on between a main or a control station and any one of a plurality of branch stations. A feature of the system consists in the provision of means for simultaneously transmitting or "broadcasting" messages from a telegraph unit at the control station to any or all branch stations.

The system consists of one or more switchboards at the main or control station with lines radiating to printing telegraph sets at branch or outlying stations. Each switchboard has associated therewith one or two printing telegraph sets, depending upon the amount of traffic to be handled. The switching arrangements are such that any branch station can signal the control station and either of the printing telegraph sets associated with a switchboard thereat can be connected to the branch station line for two-way communication. One of the control station printing telegraph sets associated with each switchboard is arranged to accomplish the broadcasting feature pointed out above, that is, it can be used to send simultaneously or "broadcast" to a group or to all branch stations or, on occasion, it can be used to carry on an individual two-way communication with a single branch station. While broadcasting, this set cannot receive from the branch stations, but any branch station during broadcasting thereto, may operate a signal at the control station and be switched to the other control station printer for two-way communication. This action will not affect the receipt of the broadcast message at other branch stations. No means are provided for sending from one branch station to another. The printer units are adapted to employ the neutral telegraph system in which signals are transmitted by the "open and close" method, i. e., by interrupting continuous current of a given polarity.

The exchange system to be described has a maximum capacity of twenty branch lines

per switchboard and will be discussed on this basis. It is to be understood, however, that this limitation as to size, is merely a matter of convenience, and that no inventive skill would be involved in constructing similar switchboards to handle a larger number of branch lines.

Where desirable, a given group of branch lines may be multiplied at two or more switchboards. The switchboards in such case need not be located in the same room or building, although in view of the large number of wires required between switchboards, it will usually be most convenient to locate them near each other. Of course, any desired multiplying arrangement might be used. Thus, all or only a portion of the lines extending to one switchboard might be multiplied at a second.

If more than twenty branch lines are desired, two or more switchboards may be installed to handle the same. This would be equivalent to a plurality of separate switchboard installations of not more than twenty lines each, with the exception that provision is made for broadcasting from a printer associated with one switchboard, to any or all of the branch stations appearing at the plurality of switchboards. This feature is accomplished by the use of so-called "grouping" keys, one grouping key being required to thus associate two switchboards. The wiring is such that with the grouping key non-operated, each switchboard operates as a unit distinct from the other. With a grouping key operated, however, the broadcast printer associated with one switchboard is entirely disconnected while that associated with the other switchboard is made to serve both switchboards in the same manner as though the two switchboards constituted a single switchboard of capacity double that of either alone.

Other operating features of the exchange system are briefly the following: A control station printer associated with a given switchboard may establish two-way communication with a branch station having a line extending thereto, by operation in a proper direction of a three-position "switch-

"ing" key individual to the branch line at the switchboard. If the "switching" key is operated in one direction, the broadcast printer is associated with the branch line, and if operated in the other direction, the individual line control station printer is thus connected.

If it is desired to broadcast to a group of branch stations, the proper switching keys are simultaneously operated to the position required for associating the broadcast printer with such lines. A message transmitted from the broadcast printer will now be printed at the branch stations in question. By operating a single "broadcast" key, the broadcasting printer will be associated with all the branch lines appearing on the switchboard, for broadcasting over all such lines. The broadcasting printer will print a "home copy" of all messages broadcast.

Line signal lamps are provided so that any branch station by operating a "break" key thereat can signal the control station. These lamps are extinguished when the station switching key is operated to answer the call. The signal lamp at the control station associated with a given branch line will light if the "break" key at the corresponding branch station is operated at any time but will remain lighted only while the break key is thus operated if the corresponding switching key of the control station is operated at the time. This feature permits a branch station during broadcasting thereto to signal the control station without interrupting the messages being broadcast to other stations. A branch station thus signaling the control station during broadcasting may be answered by means of the other control station printer without interrupting the messages being broadcast to the other branch stations, by operating the corresponding switching key in the opposite direction.

Where certain branch lines are multipled to two switchboards, busy lamps are provided so that when a control station printer associated with one switchboard is communicating with any such branch line, the busy lamps associated therewith will be lighted at both switchboards.

A control feature is provided whereby the printer set motors at a branch station are running only while a printer unit at the control station is connected to such branch station over the corresponding branch line.

Having discussed above the general terms the principal features of the printing telegraph exchange system disclosed herein, the detailed circuit operation will now be taken up. In the drawings, Figure 1 discloses in schematic form the complete exchange system and is adapted to give a sort of perspective view of the system operation as a whole. Fig. 2 takes up the disclosure of Fig. 1 more in detail and gives a complete circuit

diagram of necessary portions of the exchange system. Fig. 3 discloses the operation of the "grouping" key in connecting the broadcasting printer associated with one switchboard to the branch lines associated with a second switchboard. Fig. 4 discloses the signaling and switching features involved where a branch line is multipled at two switchboards.

Referring to Fig. 1, a plurality of branch stations designated by the rectangles A_1 to D_1 , inclusive, are connected to switching keys A_2 to D_2 , inclusive, respectively, by means of the branch lines 51. These switching keys are located on the switchboard at the control station. Associated with the switchboard at the control station are the "individual line" printer 19 and the "broadcast" printer 44. The switching keys A_2 to D_2 , inclusive, are three-position keys having a normal, vertical position with operating positions to the right and to the left. With a key in its normal position, as indicated by key A_2 , current from positive battery is supplied from the control station over the branch line 51 to the corresponding branch station. This positive current maintains the printer set motors at the branch station in question non-operative by means of certain remote control equipment, to be described below, associated with the branch station. This positive current is supplied from battery 38 at the control station through the back contact of relay 17, through the switching key in its normal position, through relay 12 and resistance 11, and out over line 51 to the branch station.

If, now, the switching key associated with a given branch line is operated either to the right or to the left, it will reverse the polarity of current supplied to the branch station and will thus start up the printer set motors at such branch station. The operation of such switching key to the right will connect the broadcasting printer 44 to the branch station in question while the operation of the key to the left will connect the individual printer unit 19 to such branch station. For example, in Fig. 1, key C_2 is indicated as operated to the left. For such condition, the positive battery 38 is disconnected at the key contacts from the branch line and in its place is substituted current from negative battery 45, which current flows from the battery 45, through contacts of switching key C_2 , contacts of keys B_2 and A_2 and in series through the line or receiving relay 31, the transmitter 32 and the break key 33 of the control station printer 19, back through the contacts of switching keys A_2 to C_2 , to branch station C_1 over the corresponding branch line 51. The reversal of the polarity of the current to the branch station C_1 starts up the printer set motors at the branch station and thus pre-

5 pares branch station C_1 for two-way communication with the control station printer 19. The operation of the transmitter at either the branch or control station printer will, by interrupting the current supplied from battery 45, cause the message to be typed up on the printer units at both points. The remote control equipment at the branch station is not affected by these current interruptions but maintains the printer set motors running while zero or negative current is supplied to the branch station. It is only when current from positive battery is supplied to the branch station that the printer set motors there are stopped.

10 Key B_2 of Fig. 1 is shown operated to the right connecting the broadcast printer 44 to the branch station B_1 . A circuit is traced from negative battery 45 through contact and armature of polar relay 18 associated with key B_2 , through keys B_2 and A_2 and through the line relay 30 of broadcast printer 44 back through keys A_2 and B_2 to station B_1 over branch line 51. The negative current thus supplied to the branch station B_1 starts up the printer motors there. An additional circuit is traced from negative battery 21 and in series through the break key 22, the transmitter 23 and the line winding of a "master" sending relay 24 associated with broadcasting printer 44 and thence to ground at 35. The master sending relay 24 is a polar relay having at all times current flowing from battery 25 through resistance 26 and through a biasing winding to ground. The current in the biasing winding is about half the magnitude of the current in the line winding, so that normally the current through the line winding maintains the armature operated against the marking contact M against the effect of current in the biasing winding. When, however, the current in the line winding is interrupted, as by operation of the transmitter 23 in series therewith, the current in the biasing winding will operate the armature against the spacing contact S. Thus relay 24 will follow signals in accordance with the operation of transmitter 23.

50 It will be noted, now, that polar relays 18 associated with keys A_2 to D_2 , inclusive, are connected in series between the spacing and marking contacts of the master sending relay 24. Negative battery 29 is connected through resistance 27 to the marking contact of this series circuit and through resistance 28 to the spacing contact, as shown, in the broadcast printer rectangle 44. The armature of master sending relay 24 is grounded. It will now be seen as the master sending relay 24 operates in accordance with the operation of the transmitter 23, it will ground its spacing contact and then its marking contact alternately in succession. When the marking contact is thus grounded,

current will flow from negative battery 29, through resistance 28, through all the polar relays 18 in series, beginning at the right and ending at the left and back to ground through the marking contact of relay 24. On the other hand, when the spacing contact of relay 24 is grounded by suitable operation of the armature thereof, current will flow through negative battery 29, through resistance 27 and through the polar relays 18, in series, in a direction opposite to that first mentioned, beginning this time at the left and ending at the right and back to ground through the spacing contact of relay 24. The polar relays 18 will thus follow the operation of the master sending relay 24 which in turn is controlled by the transmitter 23 of broadcast printer 44.

Referring now to relay 18 associated with key B_2 , it will be seen that the operation of relay 18, as explained, will interrupt the negative current supplied to station B_1 from battery 45 through the contact and armature of relay 18, and in this way the message transmitted from the broadcast printer 44 is caused suitably to operate the line relay at branch station B_1 to type the transmitted message. Since the line relay 30 associated with broadcast printer 44 is in series with branch line 51 extending to branch station B_1 , the message thus transmitted from printer 44 is caused to operate the line relay 30, and in this way, the broadcast printer prints a "home record" of the message transmitted. When the transmitter of the branch station printer B_1 is operative, branch line 51 is interrupted at the branch station, thus interrupting the flow of current through line relay 30 of broadcast printer 44 at the control station. In this way, the message transmitted from the branch station B_1 is caused to be typed up on the broadcast printer at the control station. It will thus be seen that the operation of a single switching key to the right permits two-way communication between the broadcast printer 44 and the branch station in question.

With all the switching keys A_2 to D_2 , inclusive, in their normal position, a circuit is closed from battery 21, in series through the break key 22, transmitter 23 and master sending relay 24 associated with the broadcast printer 44, in series through the contacts of all switching keys beginning with D_2 and ending with A_2 , through the line relay 30 of the broadcast printer, and in series back through the contacts of all the switching keys beginning this time with A_2 and ending with D_2 , to ground at 35. The conductors 52 and 53 indicate the manner in which the circuit traced normally extends through the keys in one direction to line relay 30 and back again. If, now, a plurality of switching keys are operated to the right at the same time, the system is arranged to

broadcast to the branch stations associated with the keys thus operated. For example, in Fig. 1, keys B_2 and D_2 are shown operated to the right, thus arranging the circuit to broadcast to stations B_1 and D_1 .

As shown in Fig. 1, each key has contacts which, with the key operated to the right, short-circuit the leads normally extending from the higher numbered keys through line relay 30 to the broadcast printer and back. The line relay 30 is connected in series with the branch line corresponding to the lowest numbered key, counting from the left on the drawing, which is operated to the right. The highest numbered key which is operated connects the lead from the master sending relay 24 directly to the ground lead 35, while the intermediate keys operated to the right short-circuit the connections normally extending from line relay 30 to the higher numbered keys in order to close through to its corresponding sending relay 18, the branch line of the next higher numbered key thus operated to the right. Thus, in Fig. 1, B_2 is the lowest numbered key which is operated to the right and hence includes the line relay 30, as shown. At the same time the operation of key B_2 to the right short-circuits the leads 52 and 53 normally extending from the line relay 30 to the next higher numbered key which is operated, namely key D_2 , so that branch line 51 associated with station D_1 is connected through to the contacts of relay 18 associated with key D_2 . Key D_2 , being the highest numbered key operated to the right, connects the ground 35 directly to the master sending relay 24, as shown on the drawing.

If, now, a message is transmitted from the broadcast printer 44, the operation of the transmitter 23 will interrupt the circuit containing the master sending relay 24, and the latter will obviously follow the signals. The operation of the master relay 24 in turn will cause a corresponding operation of all the sending relays 18, as explained above. Now, with keys B_2 and D_2 operated to the right, the corresponding branch lines 51 are connected through the armatures and contacts of the corresponding relays 18 to negative battery 45, as shown on the drawing. Hence, the operation of the relays 18 in accordance with the operation of transmitter 23 will interrupt the current supplied to branch stations B_1 and D_1 in accordance with the signals and thus cause the printer units at such branch stations to type up the transmitted message.

If it is desired to broadcast to all of the branch stations, all the keys A_2 to D_2 , inclusive, should be placed in their normal position. This will arrange all of the circuits as shown for branch station A_1 , causing positive battery 38 to be supplied through the contacts of relays 17 to the branch lines 51.

Under these conditions, if "broadcast" key 40 is operated, it will connect the ground to one end of all of the relays 17 in series, the other end being connected to battery 34. This will cause the simultaneous operation of all the relays 17 and will thus cause each branch line 51 to be disconnected from the positive battery 38, and to be connected through the armature and right contact of relay 17 and through the armature and contact of the sending relay 18 to negative battery 45. The reversal of current in the branch lines will start up the printer set motors at all the branch stations. If, now, a message is transmitted from the broadcast printer 44, the operation of transmitter 23 will cause a corresponding operation of all the relays 18 in accordance with the signals. The operation of each relay 18 by interrupting the current to the corresponding branch station will cause the printer thereat to type up the transmitted message. Lamp 41 supplied from battery 39 remains lighted while key 40 is operated, due to the ground thus obtained. This signal merely serves as a warning to the control station operator that the circuit is arranged for broadcasting to all the branch stations.

An inspection of the circuit tracings for switches B_2 , C_2 and D_2 , operated as shown in Fig. 1, demonstrates the manner in which a communication can be carried on between the individual control station printer 19 and a branch station without having any interfering effect upon messages simultaneously being broadcasted to other branch stations from the broadcast printer 44. Likewise, the fact that keys B_2 to D_2 , inclusive, are operated has no effect on the branch stations for which the keys are in the normal position, as for example, station A_1 .

Referring now to Fig. 2, the remote control, switching and signaling features of the exchange system, will be considered in detail. In Fig. 2, only two branch stations A_1 and D_1 are shown, along with their corresponding switching keys A_2 and D_2 and the apparatus associated therewith. The wiring for the remaining keys and branch stations associated with the switchboard is identical with that shown for stations A_1 and D_1 .

Referring to station A_1 , the printer unit is driven by motor 5, operated from battery 54 applied through the contacts of relay 6. Incidentally, the direct current motor 5 and source of power 54 could be replaced where desirable by an A. C. motor and source of power without affecting the operation of the system. Polar relay 7 is so connected that current supplied from positive battery over lead 51 disconnects the armature 56 from contact 55, as shown. This forces the current flowing through the windings of relay 7 to likewise flow through the winding of relay 6 to ground, causing relay 6 to be oper-

ated and thus disconnect battery 54 from motor 5. On the other hand, current from negative battery supplied over lead 51, in flowing through the winding of polar relay 7, causes the armature 56 to be operated against the contact 55, thus connecting a short circuit to ground across the winding of relay 6 causing its release. The release of relay 6 in turn connects battery 54 to the printer set motor 5 and thus starts the motor running. Polar relay 7 contains a biasing spring which holds the armature 56 against contact 55, while the negative current supplied from the control station is interrupted during the transmission of signals, thus preventing disconnection of motor 5 from the power source during such intervals. The positive current normally supplied over the branch line while the branch station is not in use is of sufficient magnitude to maintain polar relay 7 operated against the biasing effect of the spring.

Having explained the remote control feature, the cycle of operations involved in the establishment and termination of a call between a branch station and the control station will next be considered. Assume for this purpose that switching key A_2 is in its normal or vertical position. Under such condition, positive battery 38 is connected through the contact and armature of relay 17, through an upper left non-operated contact, and thence through an upper right non-operated contact of key A_2 , through the winding of relay 12, resistance 11 and out over branch line 51 to branch station A_1 , and thence in series through the line relay 9, transmitter 8, break key 10, polar relay 7 and relay 6 to ground. This current maintains the printer motor 5 non-operative, as explained, but holds relay 12 at the control station operative to prevent the lighting of line lamp 15 associated with key A_2 thereat, as will be explained below.

Assume now that branch station A_1 desires to initiate a call. Break key 10 thereat is operated to interrupt the flow of current in branch line 51, thus causing the release of relay 12. The release of relay 12 in turn interrupts the flow of current from battery 13, through the armature and contact of relay 12, and through the winding of relay 14 to ground, in turn causing the release of relay 14. The release of relay 14 causes line lamp 15 to light on a circuit from battery 45, through lamp 15 to ground through the right outer back contact of relay 14. Lamp 15, once lighted in this manner, will remain lighted until the call is answered by operation of switching key A_2 at the control station even though break key 10 at the branch station is restored prior to such switching key operation.

To see how this is accomplished, assume that key 10 is restored before key A_2 is

operated. The restoration of key 10 permits again the flow of current through relay 12, causing this relay to re-operate. The re-operation of relay 12, however, does not cause the re-operation of relay 14 to extinguish the lamp 15, due to the fact that relay 14 upon releasing in the manner explained above connects a short circuit to ground across its winding. This short circuit is traced from point 56 through the inner contact and armature of relay 14, through a right non-operated and thence through a left non-operated contact of key A_2 to the ground at 37. Thus, when relay 12 re-operates upon the restoration of key 10, the battery 13 supplied through current limiting resistance 57 flows through the armature and contact of relay 12 and through this shunt circuit to ground, preventing the re-operation of relay 14. When, however, key A_2 is operated either to the right or to the left, this shunt circuit is opened at the key contacts, thus causing the re-operation of relay 14 which removes the ground from lamp 15, extinguishing the same.

If key A_2 is operated to the left, printer 19 will be connected to the branch station A_1 on a circuit from negative battery 45 through the lower left operated contact of key A_2 , in series through the line relay 31, transmitter 32 and break key 33 of printer 19, back through an upper left operated contact of key A_2 and thence through an upper right non-operated contact of key A_2 , through relay 12, resistance 11, and out over lead 51 to the branch station. The current from the negative battery 45 causes the printer set motor 5 at the branch station to start running as explained above. The circuit is now arranged for two-way communication between the control station printer 19 and the branch station printer at A_1 . The positive battery 38 is disconnected at the upper left key contacts from branch line 51 upon operation of key A_2 .

With key A_2 operated to the right instead of to the left the broadcast printer 44 would be substituted for the individual line printer 19. The operation of key A_2 to the right disconnects at an upper right operated contact of the key the source of positive battery 38 from the branch line 51. At the same time a circuit is closed from negative battery 45 through the contact and armature of relay 18, through the lower right operated contact of key A_2 , through line relay 30 of broadcast printer 44, back through an upper right operated contact of key A_2 and out to the branch station over lead 51. The current from negative battery 45 starts up the printer set motors at the branch station, as explained. The sending circuit of the broadcast printer 44 is as follows: from battery 21, through break key 22, transmitter 23 of the broadcast printer

44, the line winding of the master sending relay 24, the lower right non-operated contact of key D_2 and through the corresponding contacts of the intermediate switching keys to key A_2 , through the upper right operated contact of key A_2 and back through the upper right non-operated contact of the intermediate keys to key D_2 , through the upper right non-operated contact of key D_2 to ground at 35. The operation of transmitter 23 will operate all the relays 18, as explained, and by interrupting current from negative battery supplied over lead 51 to the branch station A_1 , will cause the transmitted message to be typed up thereat. On the other hand, the message transmitted from the branch station by interruption of current in the branch line 51 at the transmitter 8 will cause the line relay 30 of the broadcast printer 44 to follow signals and thus type up the message. Incidentally, of course, as was pointed out above, the line relay 30 follows the operation of the transmitter 23 and thus causes the broadcast printer 44 to type up a "home" record of all messages transmitted therefrom.

With keys A_2 and D_2 both operated to the right the circuit is arranged so that printer 44 can broadcast to both stations A_1 and D_1 . The circuit for branch line 51 associated with station A_1 remains unchanged and will hence not be retraced. For station D_1 a circuit is traced from negative battery 45, through the contact and armature of relay 18, through the lower right operated contact of key D_2 , through the lower right non-operated contact of the intermediate keys to key A_2 , through the upper right operated contact of key A_2 and back through the upper right non-operated contacts of the intermediate keys to key D_2 , through an upper right operated contact of key D_2 , through relay 12, resistance 11, and out over lead 51 to branch station D_1 . Current from negative battery 45 starts up the printer motors at the branch stations. The sending circuit from broadcast printer 44 is traced from battery 21, through key 22, transmitter 23, line winding of relay 24, through the upper right operated contact of key D_2 to ground at 35. It will thus be seen that the circuits traced in connection with Fig. 2 correspond with the schematic circuit tracing of Fig. 1 where two or more broadcast keys are operated.

Relay 12 is a quick acting type of relay and follows the signaling current interruptions. In order, therefore, to prevent the re-operation of the signaling lamp 15 by the printer current interruptions, relay 14 is made slow acting so that it does not release and close the circuit to operate the lamp.

If it is desired to broadcast to all of the branch stations, the switching keys A_2 and D_2 , etc., are restored to normal and key 40 is operated, connecting ground to operate

all the relays 17 in series from battery 34. The operation of relay 17 disconnects positive battery 38 from the branch line and connects negative battery 45 through the contact and armature of relay 18, through the right front contact of relay 17, through an upper left non-operated contact and an upper right non-operated contact of the switching key, through relay 12 and resistance 11, to the branch station, thus starting the printer set motor thereat. The following sending circuit from broadcast printer 44 is established: from battery 21, through break key 22, transmitter 23, line winding of relay 24, lower right non-operated contact of all the switching keys in succession beginning with D_2 and ending with A_2 , through line relay 30 of the broadcast printer and back through the upper right non-operated contact of all the switching keys in succession beginning with A_2 and ending with D_2 , to ground at 35.

As was mentioned above, any branch station may signal the control station during broadcasting thereto. The operation of the signaling circuit is slightly different depending upon whether the broadcasting is to only a group or to all of the branch stations. During broadcasting to a group of stations it will be remembered that certain of the switching keys are operated to the right. The operation of such a switching key, it will be recalled, opens the circuit shunting the winding of the relay 14 so that relay 14 will be operated or released in accordance with the operation or release of relay 12. Thus, if for this condition, during broadcasting to a branch station, the branch station desires to signal a control station, lamp 15 will be lighted only while break key 10 remains open, releasing relay 12 at the control station. On the other hand, during group broadcasting, it will be recalled, all the switching keys are normal so that the momentary operation of the break key 10 by releasing relay 12 and in turn relay 14 at the control station will complete the shunt circuit across the winding of relay 14, this shunt circuit, of course, being completed to ground through the contacts of the switching key in its normal position. The release of relay 14, of course, lights line lamp 15 permanently in this case, due to the fact that the re-operation of relay 12 upon the restoration of break key 10 does not re-operate relay 14.

The operator at the control station upon noting the lighted lamp 15, may answer the break signal independently of the broadcasting by operation of the proper switching key to the left to associate the individual line printer 19 with the branch line in question. Assuming that station A_1 transmits the break signal during group broadcasting, key A_2 will be operated initially to the right. The operation of this

key to the left will first disconnect the broadcasting circuit from branch line 51 to station A_1 , and will substitute therefor printer 19. When the right contacts of key A_2 are released, the sending relay 18 will be disconnected at the lower right contact of key A_2 . The line relay 30 of broadcast printer 44 will be disconnected at upper and lower right contacts of key A_2 from its series connection in the branch line associated with station A_1 , and will be connected in series with the branch line of the next station to the right having its switching key operated to the right, which in Fig. 2 is station D_1 . This latter circuit is traced from battery 45 and through the contacts of relay 18 at key D_2 , through the lower right operated contact of key D_2 , and in series through the lower right non-operated contacts of the intermediate keys including A_2 , through line relay 30, and back through the upper right non-operated contacts of the switching keys from A_2 to D_2 , through the upper right operated contacts of D_2 to branch station D_1 . The closure of the left contacts of key A_2 will complete a circuit from battery 45 at key A_2 , through the lower left operated contact of key A_2 , through printer 19, through an upper left operated and an upper right non-operated contact of key A_2 , and out to branch station A_1 over line 51.

If the break signal were transmitted by station A_1 during broadcasting to all stations, i. e., with broadcast key 40 operated, key A_2 would be initially in its normal position. Line relay 30 would be in series with relay 24 through the right contacts of all the switching keys, as was explained above. The operation of key A_2 to the left does not affect this series circuit, but does open at an upper left contact of key A_2 the circuit traced from battery 45 at key A_2 , through the contacts of sending relay 18, and broadcast relay 17, in this way disconnecting the broadcast means from station A_1 . The manner in which printer 19 is connected to branch station A_1 by operation of key A_2 to the left, was traced above.

As previously explained, if a break signal is transmitted from a branch station while all the switching keys are normal, the line lamp 15 will be permanently lighted. When the switching key A_2 is operated to the left to answer this signal, it removes the short-circuit from relay 14 by disconnecting the ground 37 at its left inner contact. Relay 14 thereupon operates to extinguish the lamp 15.

It might be mentioned at this point that the variable resistance 11 in series with the branch leads 51 serves the purpose of adjusting the current in the branch line to a proper value for any given resistance of the branch line.

It was pointed out above that it is possible, by means of a grouping key arrangement, to so interconnect two or more switchboards that the broadcasting printer associated with one switchboard could be utilized to broadcast to any of the branch lines associated with the plurality of switchboards. The manner in which this is accomplished is best explained by reference to Fig. 3. In Fig. 3, stations A_1 and D_1 represent a plurality of branch stations connected to switchboard I, while stations P_1 and S_1 constitute a plurality of branch lines associated with switchboard II. The grouping key for interconnecting the broadcasting apparatus of the two switchboards is shown at 46.

A comparison of Figs. 1 and 3 will show the manner in which the grouping key is inserted in the switchboard circuits in order to accomplish the above result. For switchboard I, lead 60 is disconnected from the ground 35 of Fig. 1 and is connected to ground 58 of Fig. 3 through non-operated contacts of key 46. Lead 59 of Fig. 1 is connected in Fig. 3 through the left outer non-operated contacts of key 46 and back to switching key D_2 , as before. Lead 61 of Fig. 3 is connected from broadcast key 40 of switchboard I, as shown, through a right inner operated contact of key 46 to lead 3 connected to relays 17 of switchboard II, as shown. In switchboard II, the circuit is opened between transmitter 23 of the broadcast printer 48 and the master sending relay 24 thereof and extended, by means of leads 62 and 63, through a left inner non-operated contact of key 46. Line relay 30 of broadcast printer 48 is extended through non-operated contacts of key 46 and thence through the switching keys instead of directly through such keys, as is the case in Fig. 1.

With the key 46 in its non-operated condition, each switchboard operates independently of the other, and if the wiring of the various circuits is traced, it will be found that each switchboard is connected up in the same manner as shown for Fig. 1 with the exception that certain of the leads are extended through non-operated contacts of key 46. The operation of key 46, however, accomplishes the following changes. The circuit for relays 17 of switchboard I is connected through the operated key contacts via leads 61 and 3, to the circuit for relays 17 of switchboard II, with the result that the operation of broadcast key 40 on switchboard I will furnish a ground to operate all the relays 17 on both switchboards and also to light the lamp 41 on both switchboards. Assuming key 40 on switchboard I to be operated, a circuit is traced from battery 34 on switchboard I through relays 17 of that switchboard to ground at key 40, thus operating the relays. A second circuit is

traced from battery 34 on switchboard II through relays 17 on that switchboard, over lead 3, through the right inner operated contact of key 46, over lead 61 to ground at key, 40, thus operating all the relays 17 on switchboard II. The operation of broadcast key 40 by thus operating the relays 17 on both switchboards has started up the printer set motors at all of the branch stations A_1 to D_1 , and P_1 to S_1 , inclusive. The operation of key 40 at switchboard I furnishes ground to light lamps 41 at both switchboards. For switchboard I the circuit is obvious, while for switchboard II, lamp 41 obtains ground on lead 3 in the manner traced above for the relays 17 at this switchboard. The grouping key operation does not permit broadcasting from printer 48 to branch stations associated with switchboard I.

The transmitting circuit is now traced from battery 21 of switchboard I, through break key 22, sending contacts 23 to sending relay 24 of broadcasting printer 44, through the left inner operated contacts of key 46, over lead 62 through the master sending relay 24 of broadcast printer 48, in series through the switching keys beginning with S_2 and ending with P_2 , through the left operated contacts of switching key 46 in series through the switching keys of switchboard I beginning with D_2 and ending with A_2 , through line relay 30 of printer 44, back through the switching keys A_2 to D_2 , through the right outer operated contacts of key 46, in series through the switching keys of switchboard II, from P_2 to S_2 to ground 35 of switchboard II. The operation of transmitter 23 of printer 44 will thus operate master relays 24 of both printers 44 and 48 in accordance with the signals transmitted. The operation of the master relays 24 will in turn control the operation of all the relays 18 on both switchboards, thus causing the signals transmitted from printer 44 to be broadcast to all of the branch stations associated with both switchboards. In addition, since line relay 30 of printer 44 is in series with the sending circuit, it will print a home record of the messages broadcast.

It will be noted that the operation of key 46 completely disconnects at the key contacts line relay 30 and also transmitter 23 and break key 22 associated with printer 48, these units not being required in the present broadcasting operation. Any branch station, by operating the break key thereat during such broadcasting, may signal the control station in the manner explained above.

In case it is desired to broadcast to a group of branch stations connected indiscriminately to the two switchboards, the operation to the right of the proper switching keys will accomplish this result. This, of course, be-

comes apparent when it is remembered that the operation of grouping key 46 merely extends leads 59 and 60 of switchboard I through the key contacts of switchboard II to master relay 24 of printer 44, and to ground 35, respectively. The net effect therefore, is to associate all the branch lines of both switchboards with printer 44 in the same manner as shown for Fig. 1 for a single switchboard.

As was mentioned above, another feature of the exchange system described herein lies in the fact that branch stations may be multiplied at a plurality of switchboards so that two-way communication may be established between a printer unit at either switchboard and any of the branch stations thus multiplied. In order to accomplish this result, slight circuit modifications are required over those shown in Figs. 1 and 2 where a single switchboard serves a group of branch stations. The required circuit modifications to accomplish this result will now be pointed out in connection with Fig. 4.

Referring to Fig. 4, assume that it is desired to multiple the branch stations B_1 at switching keys B_2 and B_3 on switchboards I and II, respectively. Since these two switchboards may be in different localities, it is necessary to provide busy signals to inform the operators at both switchboards when the line B_1 is in use. In addition, the branch station B_1 must be able to signal the operators at both switchboards. Referring to the drawing, to permit the branch station to signal both switchboards, a lamp circuit is provided which is traced from negative battery 45 of switchboard II through lamp 15 on that switchboard and through lamp 15 of switchboard I, to the back contact of relay 14 on switchboard I. Relays 14 and 12 are connected in the same manner as shown in Fig. 2. A short-circuiting path for relay 14, however, is wired through the contacts of switching keys B_2 and B_3 instead of through the contacts of B_2 only, as was the case in Fig. 2. In Fig. 4, the short-circuiting path of relay 14 is traced from point 56 through the inner back contact and armature of relay 14, through the lower right non-operated contact and the lower left non-operated contact of key B_2 and thence through the lower right and lower left non-operated contacts of key B_3 to ground at 50.

Suppose now that station B_1 of Fig. 4 desires to initiate a call. The break key 10 at such station is operated for a short time, opening the branch line 51 to release relay 12. The release of relay 12 in turn disconnects battery 13 from the winding of relay 14, as explained, and thus connects a ground to lamp 15 of switchboard I through the right outer back contact and armature of relay 14. Lamps 15 on switchboards I and

II thus light over the circuit traced above. The subsequent restoration of break key 10 at station B₁ re-operates relay 12 but relay 14 does not re-operate, due to the short-circuiting path traced from point 56 now connected across its winding. Since this short-circuiting path is traced through the right and left contact of both keys B₂ and B₃, the operation of either key in either direction will open this short-circuiting path, causing the re-operation of relay 14 and thus extinguish the lamps 15 of both switchboards.

As soon as either key B₂ or B₃ is operated, a busy lamp circuit is closed from battery 38 on switchboard II in series through lamps 42 of switchboards II and I, to ground at 50 on switchboard II. If the key circuits are examined, it will be noted that no matter which key is operated in either direction, lamps 42 will in all cases obtain a ground at 50. Lamps 42 are the busy lamps which thus remain lighted during the period that either switching key B₂ or B₃ is operated, and furnish a signal to the operators at both switchboards that the line is busy.

Keys B₂ and B₃ of Fig. 4 are similar to key A₂ or D₂ of Fig. 2. All the key contacts are not shown in Fig. 4, however, since the wiring of the other contacts of these keys is the same as for key A₂ or D₂ of Fig. 2. To tie in the two key circuits, however, it may be pointed out that contact arms 1 and 2 of keys B₂ and B₃ are the same contact arms as shown at 1 and 2 for keys A₂ and D₂, and the sequence of key contacts counting from arms 1 and 2 is the same in both cases. Comparing Figs. 2 and 4, therefore, it will become apparent how the key circuit of Fig. 2 is modified in order to obtain the key circuit arrangement shown in Fig. 4 without otherwise affecting the switchboard operation. Bearing this point in mind, it will become apparent how either the individual line printer 19 or the broadcast printer 44 of switchboards I or II of Fig. 4 could be utilized for individual communication or broadcasting to branch line B₁ of Fig. 4. In connection with Fig. 4, however, it might be pointed out that branch line 51 after passing through the contacts of key B₂, and relay 17 associated therewith in a manner identical with that shown for Fig. 2, is thereafter extended in series in a similar manner through the contacts of key B₃ and relay 17 associated therewith to battery 38. Thus with one key, B₂ or B₃, normal, the other functions just as though the first were not in the circuit.

In practice it is planned to so construct the switchboards that the insertion of a grouping key to associate the broadcasting equipment of two switchboards, or the wiring modifications necessary for multiplying

branch lines at a plurality of switchboards may be quickly and easily accomplished. These practical features, however, are not indicated on the drawings, as they would cause confusion.

What is claimed is:

1. In a telegraph exchange system, in combination, a plurality of branch stations and a central station each equipped with a printing telegraph transmitter and receiver, a single line connecting each branch station to the central station, means at the central station to simultaneously transmit or broadcast from a central station printer to any or all branch station printers, means whereby any branch station may signal the central station during broadcasting thereto, and means whereby the central station may communicate individually with such branch station over a second central station printer during such broadcasting to the other branch stations and without interfering therewith.

2. In a telegraph exchange system, in combination, a plurality of branch stations each equipped with a printing telegraph transmitter and receiver, a central station equipped with a first and a second printing telegraph transmitter and receiver, a line connecting each branch station with the central station, switching keys at the central station, one for each branch line, broadcast means interposed between said second central station printer and said switching keys, said switching keys being operable singly to a first position to associate said first printer or operable singly to a second position to associate said second printer with the corresponding branch line for two-way communication with the branch station, and any or all of said keys being operable simultaneously to said second position to connect said broadcast means to the corresponding branch lines for broadcasting thereover, said key contacts being so arranged that the operation of any key singly to the first position while other keys are operated to the second position, permits the simultaneous operation of both control station printers without interference.

3. In a telegraph exchange system as set forth in claim 2, additional means controlled by a single broadcast key, said key being operable to simultaneously connect said broadcast means with all said branch lines for broadcasting thereover, and means whereby the broadcast printer prints a copy of messages broadcast.

4. In a telegraph exchange system, a plurality of branch stations equipped with a printing telegraph transmitter and receiver, a central station, a single communication circuit from each branch station to the central station, a first printing telegraph trans-

mitting and receiving set at the central station, a single manually operated switching means thereat for simultaneously connecting said first central station printer to all of
 5 said branch stations for broadcasting there-
 to, a second printing telegraph transmitter and receiver at the central station, and key switches individual to the branch lines
 10 thereat for connecting any branch line to the second printer for two-way communication therewith without disturbing the communication between the first central station printer and the remaining branch stations.

5. In a telegraph exchange system, a plurality of branch stations and a central station each comprising printing telegraph transmitter and receiving equipment, a line
 15 connecting each branch station with the central station, a switching key, a normally operated line relay, a slow-release relay and a line lamp associated therewith individual to each branch line at the central station,
 20 said line relay releasing in response to a break signal transmitted from the branch station to permanently release said slow-release relay to light said line lamp, said switching key being operable to extinguish
 25 said line lamp and restore control of said slow-release relay to said line relay whereby said slow-release relay releases thereafter in
 30 response to a break signal from the branch station but only for the duration thereof while said switching key remains thus operated.

6. In a telegraph exchange system, a plurality of branch stations and a central station each equipped with a printing telegraph transmitter and receiver, a single circuit
 35 connecting each branch station with the central station, means at the central station to operate a line signal thereat in response to a break signal transmitted from a branch station over the corresponding
 40 branch line, means at the branch station for starting and stopping the printer set motors thereat in accordance with the control current transmitted over the corresponding
 45 connecting circuit from the central station, and means at the central station for connecting a central station printer with any
 50 said connecting circuit or circuits for communication thereover to the corresponding branch stations.

7. In a telegraph exchange system, a plurality of central stations, a plurality of branch stations each connected to one of said
 55 central stations, a printing telegraph transmitter and receiver at each branch and central station, and means to simultaneously
 60 transmit from the printer set associated with one central station through all the central stations to any or all of the branch station printing telegraph sets.

8. In a printing telegraph exchange system, a plurality of substations each equipped

with a printing telegraph transmitter and receiver, a plurality of central stations each equipped with printing telegraph transmitters and receivers, a line connecting each
 70 branch station and a central station, switching keys at the central station, one for each substation connected thereto, a master transmitting device at each central station for transmitting simultaneously to any or all
 75 the branch stations connected thereto under control of one of the printing telegraph transmitters at that station, and grouping keys for placing all said master transmitting devices at the several central stations under
 80 the control of the printing telegraph transmitter at one only of the central stations.

9. In a printing telegraph exchange system as described in claim 8, means comprising said switching and grouping keys in
 85 their normal positions for closing a series circuit through all the switching keys at each central station, the transmitter associated with said master sending device at that station and one of the receivers at that
 90 station, and means comprising said grouping keys in their operated position for closing a series circuit through all of the switching keys of all of the central stations and a transmitter and receiver at one only of said
 95 central stations.

10. In a printing telegraph exchange system, a plurality of branch stations and a plurality of central stations each equipped with a printing telegraph transmitter and receiver, a line connecting each branch station
 100 with a central station, a master transmitting device at each central station, means associated with each master transmitting device whereby the central station printer thereat may broadcast to any or all branch
 105 stations connected to said central station, a grouping key associated with each central station but one, each said grouping key being operable individually to place the master transmitting device at such station under control of the printing telegraph transmitter at the preceding station whereby said
 110 printer may broadcast to any branch stations connected to the two central stations thus connected, a plurality of said grouping keys in sequence being operable to place the master transmitting device at each such station under control of the printer transmitter at the central station preceding said sequence whereby said printer may broadcast
 115 to any of the branch stations connected to any of the central stations thus connected.

11. In a telegraph exchange system, a plurality of branch stations each equipped with a printing telegraph transmitter and receiver, a plurality of central stations each equipped with printing telegraph transmitters and receivers, a line connecting each
 125 branch station to the plurality of central

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stations, means whereby a printer set at any central station may establish two-way communication with any branch station, means whereby a printer set at any central station may broadcast to any or all of said branch stations, means whereby the printer set motors at a branch station are running only while a central station printer is connected thereto, means whereby a branch station may signal all central stations, and means whereby busy signals are operated at all the central stations while a branch station is connected to a central station printer.

12. In a telegraph exchange system, a branch station and a plurality of central stations each equipped with a printing telegraph transmitter and receiver, a line connecting the branch station with the plurality of central stations, a switching key at each central station individual to said branch station, a normally operated line relay in said branch line, a slow-acting relay controlled thereby and a line lamp for each central station, said line relay releasing in response to a break signal transmitted from the branch station to permanently release said slow-acting relay whereby said line lamps are lighted, said switching key at any central station being operable to restore control of said slow-acting relay to said line relay whereby said line lamps are extinguished and are operable thereafter only during transmission of a break signal, any said switching key while thus operable from its normal position being adapted to connect the corresponding central station printer to the branch station for two-way communication and to complete a busy circuit to operate busy signals individual to said branch line at each central station while said switching key remains operated.

In testimony whereof, I have signed my name to this specification this 14th day of November, 1928.

GILBERT S. VERNAM.