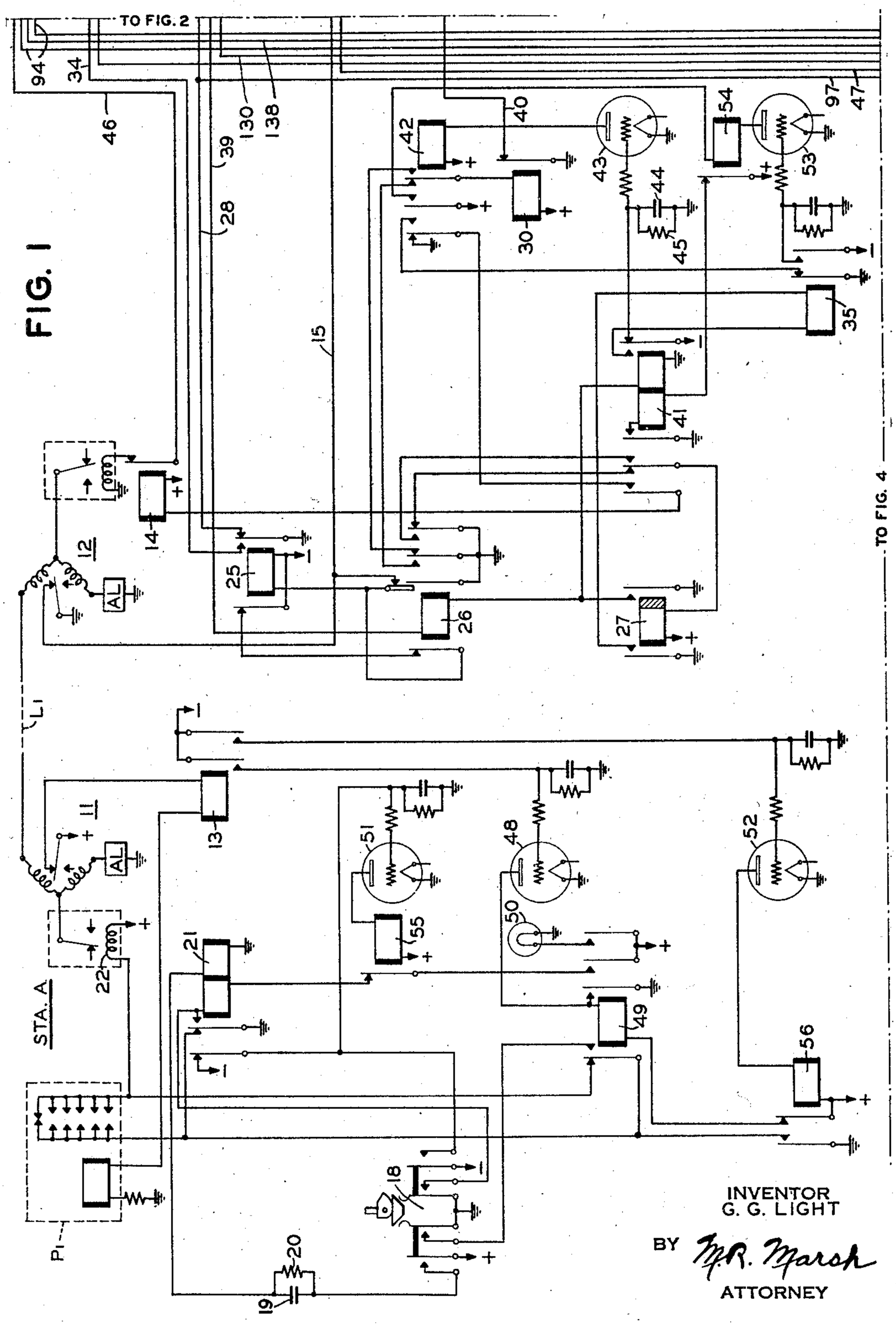
May 14, 1946. G. G. LIGHT 2,400,124

TELEGRAPH EXCHANGE SYSTEM

Original Filed July 31, 1941 5 Sheets-Sheet 1

FIG. 1



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TELEGRAPH EXCHANGE SYSTEM

Original Filed July 31, 1941 5 Sheets-Sheet 2

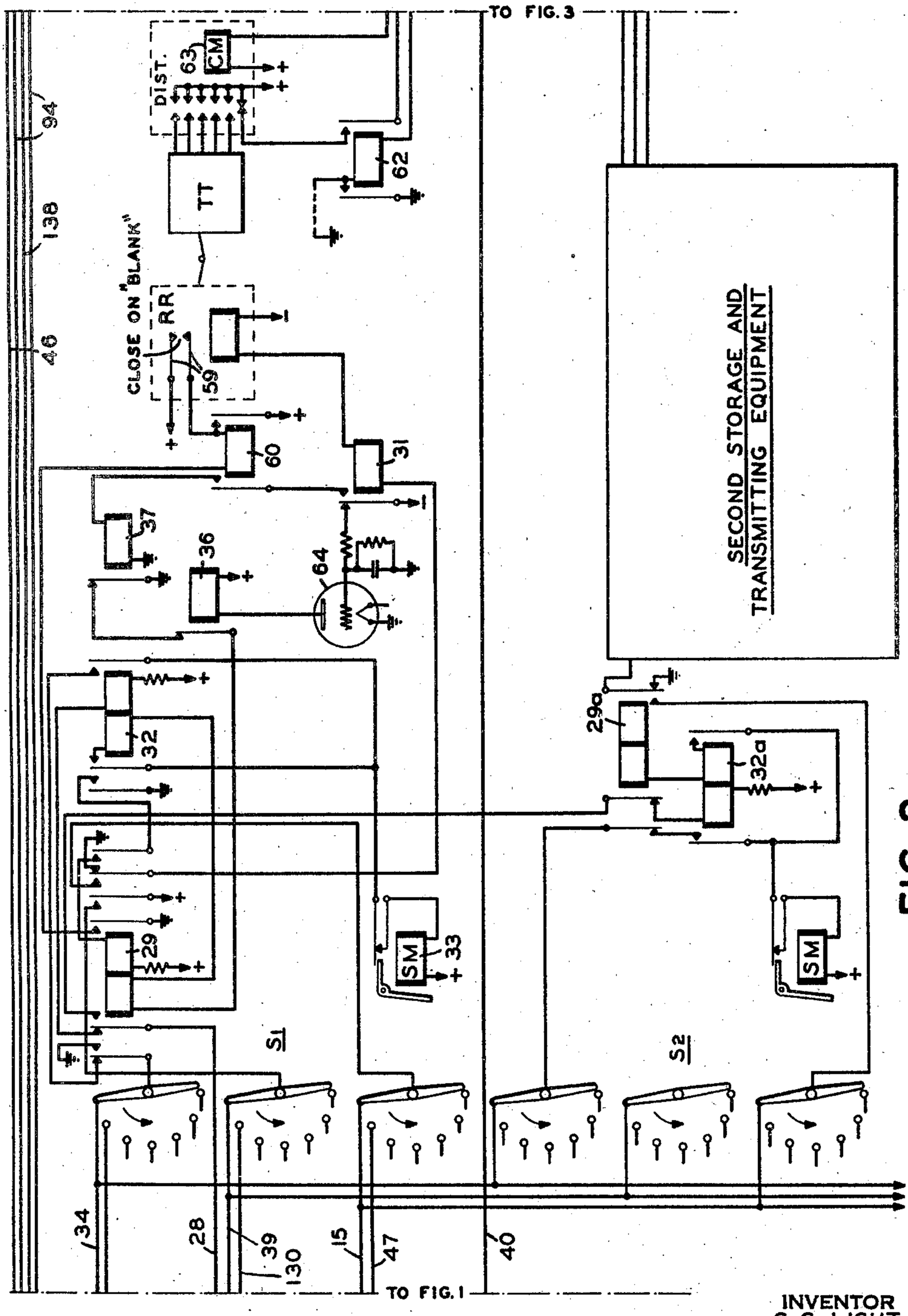

FIG. 2

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TELEGRAPH EXCHANGE SYSTEM

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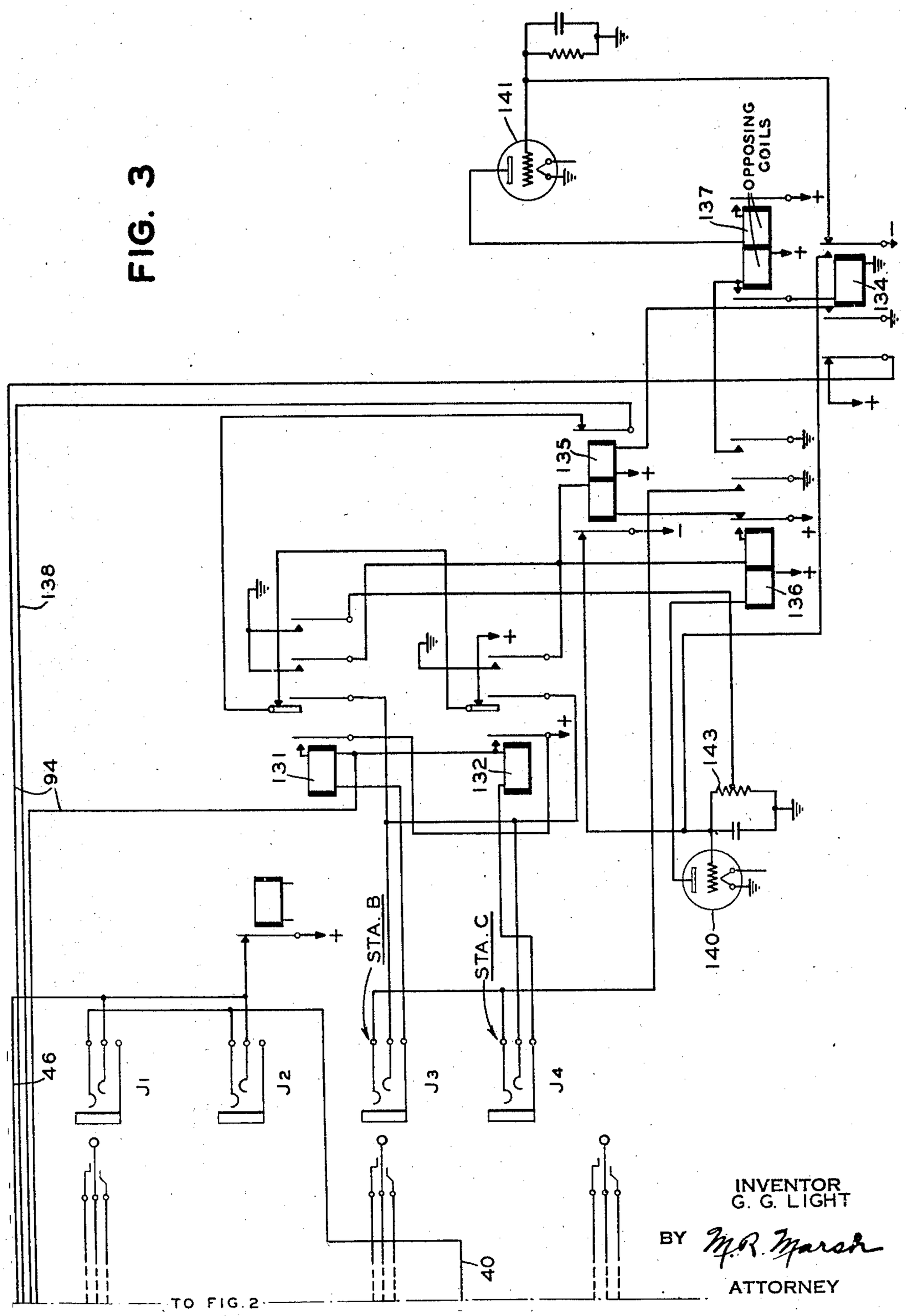
FIG. 3



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TELEGRAPH EXCHANGE SYSTEM

Original Filed July 31, 1941 5 Sheets-Sheet 4

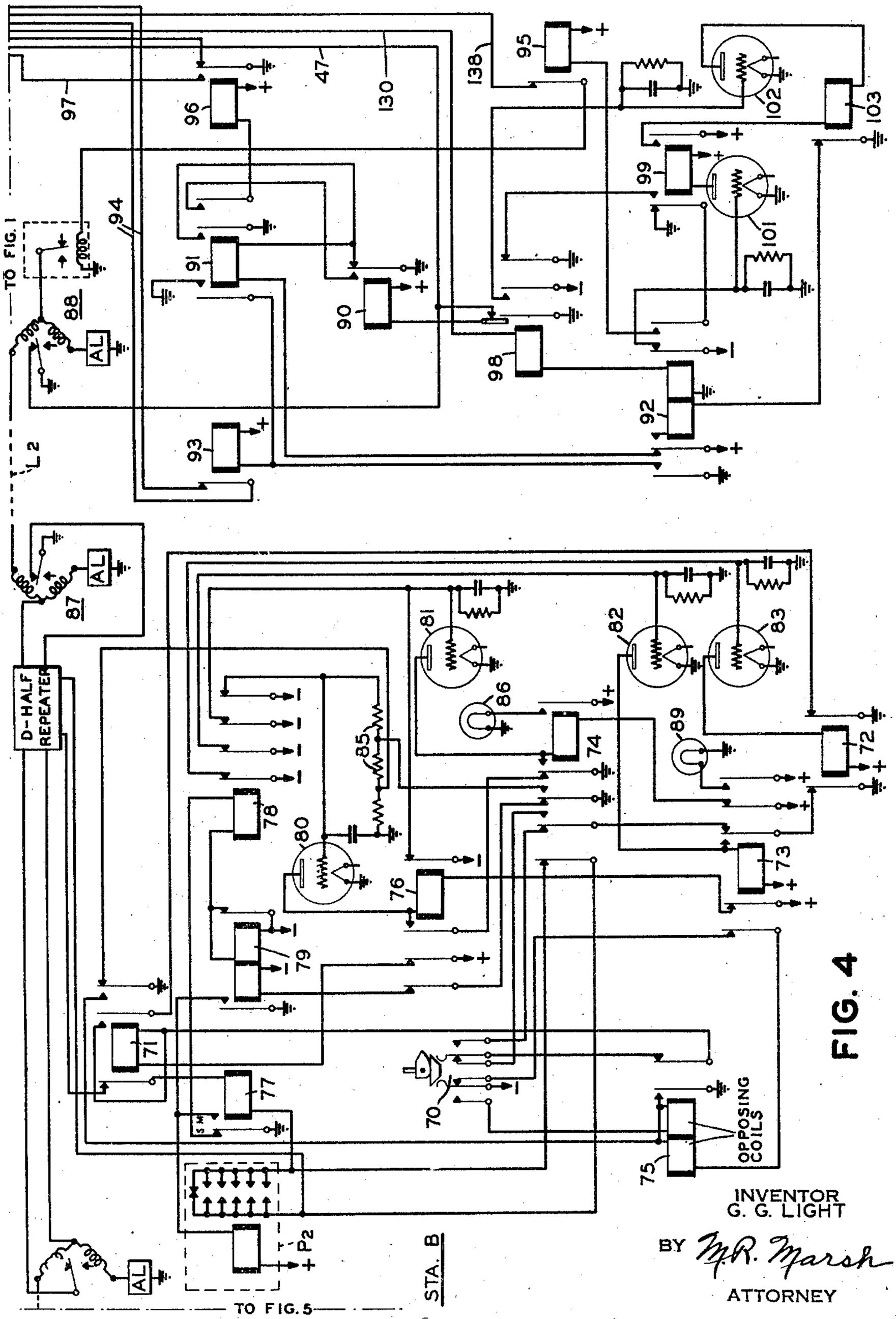

FIG. 4

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TELEGRAPH EXCHANGE SYSTEM

Original Filed July 31, 1941 5 Sheets-Sheet 5

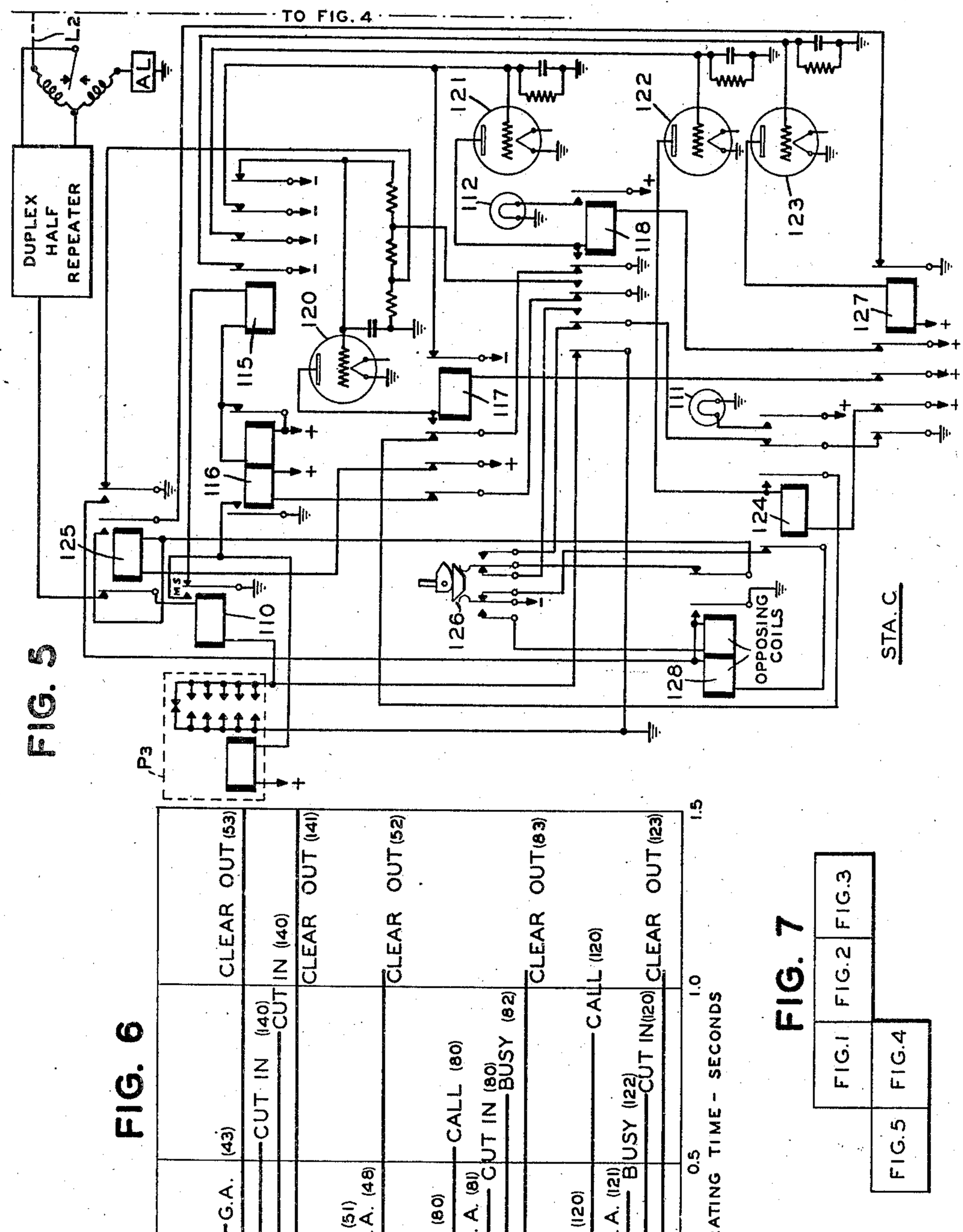

FIG. 5

FIG. 6

FIG. 7

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Patented May 14, 1946

2,400,124

UNITED STATES PATENT OFFICE

2,400,124

TELEGRAPH EXCHANGE SYSTEM

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Original application July 31, 1941, Serial No. 404,765. Divided and this application March 24, 1943, Serial No. 480,264

12 Claims. (Cl. 178—2)

This invention relates to telegraph systems and more particularly to multi-station printing telegraph systems embodying a plurality of stations or offices and arrangements for selectively interconnecting the transmitting and receiving apparatus or printers of the system. The present invention involves an improvement in or modification of the telegraph systems shown in the patent to Wheeler, Hoover and Dirkes, No. 2,193,810, granted March 19, 1940, and in the copending application of G. G. Light and W. B. Blanton, Serial No. 350,402, filed August 3, 1940, and is a division of the application of G. G. Light Serial No. 404,765, filed July 31, 1941, now Patent No. 2,351,621, granted June 20, 1944.

In general terms, the object of this invention is to simplify the selecting and control apparatus in systems of the above-mentioned character, and guard against faulty operation, as for example sending to a station where the receiving apparatus is not conditioned for operation or has been disconnected. Heretofore code transmitters and code-responsive equipment have been commonly employed for selecting stations, operating signals and motor controls, and effecting other functions in a multi-station system. The control equipment in some instances is quite complex, and the system is further complicated as it is necessary to separate the control signals from the printer signals which are ordinarily sent over the same line circuits. In many systems, the character of the telegraph lines limits the character of the controlling code signals that can be used. One feature of the present invention is a novel arrangement for effecting station selection, for seizing and releasing printing or repeating apparatus, and operating supervisory signals or other functions over the line circuit without employing either code transmitters or code-responsive equipment.

Another object of the invention is to interlock the sending and receiving apparatus in a telegraph exchange system, wherein the transmitting apparatus at a main station or switching center may be temporarily connected with an outgoing line, in order that line circuit interruptions may be transmitted for signaling and control purposes from a remote station to the switching center and vice versa, irrespective of connections made to a line at the switchboad in the switching center. With this feature of the invention, it becomes possible to transmit control circuit-interruptions of predetermined length in both directions over the line circuit without the possibility of the duration of the signals being altered or distorted by the transmission of code signals to the line through the switchboard.

Another object of the invention is to provide a system as outlined above which is capable of operating in conjunction with a multistation or way-station circuit in such a manner that the central office may select any one of the stations on the way-station and lock out the unselected stations.

In accordance with the above, another object of the invention is to provide means whereby the selection of a station on a way-station circuit is automatically effected from the central station by a plugging operation into one or the other of a plurality of jacks, each individual to one of the stations on the way-station circuit.

A still further object of the invention is to provide a system of the above type embodying the above enumerated features operating in conjunction with a central office wherein the receiving equipment thereat is in a concentrator arrangement.

Other objects and advantages of the invention will appear from the following description of the preferred embodiment thereof shown in the accompanying drawings, wherein:

Figs. 1, 2 and 3 taken together constitute a wiring diagram of a single-station line circuit and the terminal equipment at the main station or switching center;

Figs. 4 and 5 form a wiring diagram of a multistation or way-station circuit, also terminating in the equipment at the main station shown in Figs. 2 and 3;

Fig. 6 is a timing chart illustrating the preferred timing adjustments of the various timing units; and

Fig. 7 illustrates the manner in which Figs. 1 to 5 are arranged to form the complete circuit diagram.

In the drawings, an exchange system is shown in which both single station and way-wire station or multi-station line circuits terminate at a main station or switching center containing a switchboard for interconnecting the line circuits. At the remote stations, a call is initiated by actuating a calling key and terminated by restoring said key. The operation of the calling key causes a predetermined interruption of the line circuit to the main station which is effective to pick up an idle storage and transmitting unit. As soon as an idle unit is seized, a line circuit interruption of a predetermined length is produced at the main station which is effective to operate a "go-ahead" signal

at the remote station. If the line circuit becomes opened or the storage equipment accidentally disconnected, the "go-ahead" signal at the remote station is extinguished or restored to indicate at said station that transmission should be stopped. At the end of the message, the release and restoration of equipment are also accomplished by the transmission of line circuit interruptions of predetermined length, and certain guard features are incorporated, as will be pointed out hereinafter.

In the case of a multi-station or way-station line circuit, the initiation of a call from one of the remote stations to the main station locks out the other station and also initiates a call to the main station in substantially the same manner as in the case of the single station circuit. In making an outgoing connection to the way-station circuit at the switchboard, the desired station is selected by the transmission of a line circuit interruption, of different length for each station on said circuit. The selecting interruption signal is automatically produced upon plugging into one or the other of a plurality of jacks, each individual to one of the stations in the way station circuit. At the end of the call, the circuit is released and the control equipment automatically restored to normal, a "clear-out" circuit interruption signal being transmitted to the remote stations from the main office as in the case of a call to or from a station on the single-station line circuit.

Single-station line circuit

Referring to Figs. 1, 2 and 3 of the drawings, the printer P1 at station A, Fig. 1, is connected through the line L1 to the main office where messages received from station A may be recorded or stored and retransmitted over outgoing lines or channels terminating at said office at the switchboard represented by the jacks J1—J4, Fig. 3. Messages received from station A at the main office and from the other stations over lines terminating at said office are stored in the form of perforated tape in the receiving reperforators such as that shown at RR, Fig. 2, and repeated by the associated tape transmitter TT after the tape transmitter has been plugged into the jack representing the selected outgoing line circuit or channel substantially as described in the above-mentioned copending application of Light and Blanton. The tape transmitter may be similar to that shown in the patent to Angel, No. 2,172,269, dated September 5, 1939. The reperforator may be a printer perforator similar to that shown in the patent to Dirkes and Wentworth, No. 2,143,828, dated January 10, 1939. When one of the remote stations, such as the station A, initiates a call to the main office, a finder switch S1 or S2 is operated to connect an idle receiving reperforator RR to the calling line in a manner to be described below. This general arrangement including a series of finder switches for connecting an idle receiving unit or a reperforator to a calling line is shown in a number of patents in the prior art including the above-mentioned patent to Wheeler et al. The arrangement shown herein is conventional except for certain features to be described, and therefore certain details of construction are omitted for the sake of simplicity.

The line L1 may be any suitable telegraph channel but for purposes of illustration it is shown as terminating at the respective offices or stations in terminal duplex sets 11 and 12 of a conventional character. The keyboard of the printer P1 is connected to the sending leg of the terminal duplex set 11 and the printer magnet is connected to the receiving leg thereof in series with a normally operated relay 13. The sending leg of the terminal duplex set 12 at the main office is connected through the back contacts of relay 14 to the switchboard, while the receiving leg is connected through the conductor 15 and contacts of relay 26 to the winding of relay 25. The energization of relay 26 when the finder switch S1 has connected to the calling line disconnects relay 25 from the receiving leg which is then connected through conductor 15 and the finder switch to the selector magnet of the reperforator RR.

When it is desired to initiate a call from station A to the main office or to one of the lines or channels terminating at the switchboard in the main office, the key 18 is actuated, thus closing a circuit from positive battery through the outer left hand contacts of the key 18, condenser 19 and shunt resistor 20 to the right hand winding of relay 21. The charging current of the condenser 19 causes relay 21 to attract its armatures momentarily, thus opening the line circuit extending from ground through the inner armature and back contact of said relay, the left hand armature and back contact of relay 49 in shunt relation to the keyboard contacts of the printer P1, and the winding of the transmitting relay 22. The operation of the transmitting relay 22 momentarily opens the rest or marking contacts of the differential relay of the terminal duplex set 12 at the main office, thereby opening the circuit of the normally operated relay 25, and said relay becomes deenergized. Upon the deenergization of relay 25, a circuit is closed through the left hand armature and back contact of said relay and the left hand armature and back contact of relay 26 in shunt relation to the winding of relay 25, thereby short-circuiting relay 25 to prevent the attraction of the armatures of said relay when the line circuit is reclosed. The deenergization of relay 25 closes a circuit through its right hand armature and back contact for initiating the operation of the first idle finder switch S1, S2, and so forth, to connect the associated idle reperforator to the line extending to the calling station A. As pointed out above, this general arrangement is well known in the art and various arrangements for distributing successive calls to idle receiving units or reperforators may be employed. As shown, the grounding of the "initiate" conductor 28 by relay 25 closes a circuit through the inner left hand armature and back contact of relay 29 and the right hand winding of relay 32 to battery, assuming that the receiving reperforator RR is idle. If the reperforator RR is in use, relay 29 will be operated to transfer the initiate circuit to the next finder switch S2, as shown.

The energization of relay 32 closes a circuit to the stepping magnet 33 of switch S1, which circuit may be traced through the right hand armature and front contact of relay 32, the left hand outer armature and back contact of relay 29 and the upper wiper of the switch S1 to the grounded bank contacts representing idle lines or lines which are already connected to a receiving reperforator and are thus grounded through the wipers of other finder switches. When the stepping magnet 33 of the switch S1, which is provided with self-interrupting contacts, as shown, has actuated the wipers of the switch into engage-

ment with the bank contacts representing the calling line, in this instance the first bank contacts, the stepping of the switch stops, since the bank contact associated with the upper wiper is no longer grounded through the conductor 34 and the front contact associated with the right hand armature of relay 25 individual to calling station A. Thereupon the short circuit around relays 29 and 32 is opened, and relay 29 becomes energized through a circuit from battery through the stepping magnet 33, the left hand armature and front contact and left hand winding of relay 32, the left hand winding of relay 29, and the armatures and back contacts of relays 36 and 37 to ground. Relay 32 is locked up in series with the left hand winding of relay 29. Since the stepping magnet 33 is of low resistance compared to the windings of relay 29 and 32, the current through the stepping magnet is insufficient to actuate the switch wipers at this time.

The energization of relay 29 as described connects ground potential through the outer left hand armature and front contact thereof to the bank contact associated with the upper switch wiper of the switch S1 to prevent another of the finder switches from connecting to bank contacts multipled to the first contacts of switch S1. The energization of relay 29 transfers the "initiate" circuit through its left hand inner armature and front contact to the control relays associated with the second switch S2 so that the next succeeding call will be picked up by the second storage unit until the first storage unit has been released. The energization of relay 29 also closes a circuit through its second right hand armature and front contact, the middle wiper of the switch S1, conductor 39, the winding of relay 26 and the right hand armature and front contact of normally energized relay 27 for energizing relay 26. The energization of relay 26 closes the circuits of relays 25 and 30 at the right hand inner and middle contacts of said relay, and relays 25 and 30 become energized. The energization of relay 26 also opens at its outer right hand armature and back contact the circuit of slow release relay 27, and after a short interval the latter relay releases its armatures. The energization of relay 30, as described, removes ground potential from the conductor 40 extending to the jacks J1 and J2 of the switchboard individual to the line L1. As indicated, the conductor 40 forms a part of the clutch magnet circuit of any distributor (corresponding to the circuit of the clutch magnet 63 of the distributor shown in Fig. 2) when the associated transmitter is plugged into the jack J1 or J2. Thus, the energization of relay 30, individual to the line L1, stops transmission from the main office over said line to permit control signals or line interruptions to be transmitted to station A. Similar relays are associated with the switchboard circuits of each full duplex line to stop transmission from the main office momentarily while an incoming call is being set up or disconnected over the same line. The slow-release relay 27 is adjusted so that it does not release its armatures until the lapse of sufficient time to insure that the cam shaft of the distributor controlled by relay 30 has come to rest.

In order to indicate to the operator or attendant at station A that a connection to the receiving reperforator has been established and transmission may be commenced, the rest or marking line condition is interrupted for a predetermined period at the main office. This is accomplished as follows: Upon the deenergization of relay 27 as described, the short circuit around the right hand winding of relay 41 is opened, and said relay becomes energized in series with relay 26. Thereupon a circuit is closed from ground through the left hand outer armature and back contact of relay 42, the left hand outer armature and front contact of relay 41 and the winding of relay 14 to positive battery, whereupon relay 14 becomes energized to open the sending leg of the terminal duplex set 12, which operates the receiving differential relay of the terminal duplex set 11 at station A, causing relay 13 to become deenergized. At the same instant the energization of relay 41 opens the connection from negative battery to the grid of a vacuum tube 43 having the plate circuit thereof connected to the winding of relay 42. The vacuum tube 43 constitutes a timing device for operating relay 42 after a predetermined lapse of time, and for this purpose, the grid circuit of the tube 43 is provided with a shunt condenser 44 and grid leak 45 so that the potential of the grid of said tube gradually drifts toward the ground or open-circuit potential whenever the negative cut-off potential has been removed from the grid by the operation of relay 41. Thus, after a predetermined time delay which may be only a fraction of a second, relay 42 becomes energized and opens at its outer armature and back contact the above-described circuit of relay 14. The deenergization of relay 14 recloses the line circuit so that the line interruption is accurately timed by the characteristics of the grid circuit of the vacuum tube 43. The operation of relay 42 also opens the circuit of relay 30, and said relay recloses the clutch magnet circuit 40, thus permitting transmission over the line L1 through the switchboard to be resumed.

At station A, the deenergization of relay 13 as described removes negative cut-off potential from the grid of the slow-to-operate or timing vacuum tube 48 and, after a predetermined period of time slightly less than the length of the line interruption caused by the timing tube 43, current flows through the vacuum tube 48 to energize the associated relay 49 and light the supervisory lamp 50 to indicate to the attendant at station A that the connection to the idle reperforator has been completed and transmission may be commenced. The vacuum tubes 48, 51 and 52 at station A and tube 53 at the main office are all arranged like the tube 43 to impart a delayed-operating characteristic to the relay in the plate circuit thereof by control of the grid potential as described above, but the timing of the vacuum tubes is fixed at different periods for the purposes to be pointed out below. By way of example, suitable timing adjustments for the respective timing control units are shown in Fig. 6.

Upon the energization of relay 49 as described, a locking circuit for said relay is closed through its right hand inner armature and front contact and the inner armature and back contact of relay 56. A circuit is also closed through the right hand middle armature and front contact of relay 49, the armature and back contact of relay 55, the left hand winding of relay 21 and the right hand inner contacts of the key 18 whereupon relay 21 becomes energized and removes ground potential at the inner armature and back contact thereof from the keyboard of the printer P1. The energization of relay 49 also opens at its left hand armature and back contact a short circuit around the contacts of the keyboard of the printer P1 so that the printer is

placed in operating condition, the line circuit through the keyboard contacts being connected through the left hand armature and front contact of relay 49 to ground at the left hand inner contacts of the key 18. The operation of the keyboard of the printer P1 transmits alternate rest or marking and spacing permutation code signals over the line L1, the signals being transmitted through the conductor 15 and the contacts of the receiving relay of the terminal duplex set 12 at the main office and the contacts of the lower wiper of the switch S1 to the magnet of the receiving reperforator RR which records the received message in the form of perforated tape adapted to operate an associated tape transmitter TT to repeat the signals through the selected outgoing line circuit of channel.

After transmission has been completed the operator or attendant at station A releases the connected storage and transmitting equipment by restoring the key 18. If the operator fails to restore the key 18 at the end of the message or if, for any reason, no message signals are transmitted for, say thirty seconds, the timing vacuum tube 64 becomes conducting at the end of the selected period and relay 36 in the plate circuit of said tube is energized. The energization of relay 36 releases relays 29 and 32 to release the switch S1 and transmit a disconnect signal to station A in a manner described below in connection with the normal disconnect operation. This feature of the invention prevents the operator at a calling station from tying up a reperforator indefinitely, but it will be noted that release of the switch in this manner will not be effected if the line circuit goes open, as in that case the series line relay 31 remains deenergized and maintains a negative cut-off potential on the grid of vacuum tube 64. Upon the restoration of the key 18 at the end of a message, the line circuit including the winding of the transmitting relay 22 and the left hand inner contacts of the key 18 is opened and at the same moment, the negative cut-off bias potential is removed from the grid of the vacuum tube 51. After a predetermined time interval, current flows through vacuum tube 51 and the relay 55 in the plate circuit thereof becomes energized. The energization of relay 55 opens the circuit of the left hand locking winding of relay 21 and said relay becomes deenergized, thereby reclosing the line circuit including relay 22.

The timing of the line interruption as described is adjusted by employing suitable characteristics for the condenser and leak in the grid circuit of the vacuum tube 51 so that its duration is equal in length to transmission of one character from the keyboard of the printer P1. Therefore, the receiving reperforator RR at the main office responds as though a "blank" or all-spacing code combination had been transmitted, and the blank-reading contacts 59 on the reperforator will momentarily close. The construction of a reperforator having contacts closed upon the reception of a particular code combination, for example, a "blank," is disclosed in the above-mentioned Dirkes and Wentworth patent. The contacts could be applied to the stop member for the blank selection if the sixth pulse cutout was omitted. The closure of contacts 59 effects release of the finder switch S1 in a manner to be described. Upon the operation of relay 55 as described above, the circuit of the left hand or locking winding of relay 21 is opened and the latter relay becomes deenergized. Negative cut-off potential is connected through the outer armature and back contact of relay 21 to the bridge circuit of the vacuum tube 51 whereupon relay 55 becomes deenergized. All relays except relay 49 at station A are now restored to normal but the supervisory lamp 50 remains lighted through a contact of relay 49 until finder switch S1 at the main office has been restored to normal. The purpose of this arrangement will be described hereinafter.

The closure of the blank-reading contacts 59 of the reperforator at the main office closes the circuit of relay 60 and at the end of the blank the line relay 31 which responds to line signals is reenergized to close a circuit through its armature and front contact and the left hand armature and front contact of relay 60 for operating disconnect relay 37. The energization of relay 37 interrupts the circuit through the left hand windings of relays 29 and 32 and said relays become deenergized, thus restoring the selector switch S1 to normal in readiness for the next call. Upon the deenergization of relay 29, the circuit of relay 26 is opened at the second right hand armature and front contact of relay 29. The deenergization of relay 26 operates relay 30 to stop transmission over the line L1 from the main office while transmitting the break signal of such duration as to extinguish the supervisory lamp 50 at the remote station A. The circuit of relay 30 may be traced through the middle right hand armature and back contact of relay 26 and the inner armature and front contact of relay 42. The energization of relay 30 opens the circuit of the clutch magnet of the transmitting distributor of any transmitter which may be connected through the switchboard to the line L1 as described above. The deenergization of relay 26 further opens at its outer right hand armature and front contact the circuit of slow relay 27 and, after a short interval sufficient to permit the cam shaft of the sending distributor to come to rest, relay 27 releases its armatures. Upon the deenergization of relay 27, the circuit of relay 35 is interrupted at the left hand armature and front contact of the first-mentioned relay, and relay 35 becomes deenergized. Upon the deenergization of relay 35, a circuit is closed through the inner armature and back contact of said relay, the outer armature and front contact of relay 42 and the outer left hand armature and front contact of relay 41 for operating relay 14 to interrupt the line circuit at station A at the same instant that negative cut-off potential is removed from the grid of vacuum tube 53 at the outer armature and front contact of relay 35. After a predetermined time interval fixed by the characteristics of the grid circuit of the vacuum tube 53, current flows through the winding of relay 54 in the plate circuit thereof and said relay becomes energized. Upon the energization of relay 54 the circuit of the left hand locking winding of relay 41 is interrupted, whereupon said relay becomes deenergized and opens the above-described circuit of relay 14. The deenergization of relay 14 recloses the line circuit. Upon the deenergization of relay 41, negative cut-off potential is applied through the right hand armature and back contact of said relay to the grid of the vacuum tube 43 whereupon relay 42 becomes deenergized and opens the circuit of relay 30. Upon the deenergization of relay 30, the sending distributor of the transmitter plugged into the line L1 is again rendered operative for transmission.

At station A, the line relay 13 in the receiving leg of the terminal duplex set 11 becomes deenergized in response to the opening of the line circuit by the operation of relay 14, as described above, thereby removing negative cut-off potential from the grids of vacuum tubes 48 and 52. After a predetermined time interval long enough to permit both tubes 48 and 52 to become conductive but slightly shorter than the timing of vacuum tube 53 at the main office, current flow is established through the tubes 58 and 52, and their associated relays 49 and 56 respectively. Since relay 49 was previously locked up through its inner right hand armature and front contact, it remains energized until relay 56 becomes energized. Upon the energization of relay 56 the circuit of relay 49 is interrupted and said relay becomes deenergized to thereby extinguish the lamp 50. At the end of the line circuit interruption, relay 13 again becomes energized and connects negative cut-off potential through its armatures and front contacts to the grids of tubes 43 and 52, thereby deenergizing relay 56 and maintaining relay 49 deenergized.

It will be noted that an important feature of the invention is the operation of the supervisory lamp 50 solely under the control of the finder switches at the main office, the lamp being lighted as soon as one of the switches has seized an idle reperforator and being extinguished, not by the disconnect key 18, but when the finder switch has been released. Thus, if a false or accidental blank signal is received at the main office owing to line or apparatus trouble, which would cause the switch to release the connected reperforator, the supervisory lamp 50 will become extinguished to indicate that the receiving unit at the main office has been disconnected. Similarly, if the receiving reperforator is disconnected either by the operation of the relay 36 as described above or in any other manner by an attendant at the main office, for example, the supervisory lamp 50 would serve as a positive indication to the operator or attendant at station A to stop sending until the line has been connected to another receiving unit.

As shown, the printer P1 at station A does not respond to its own keyboard to make a home copy of the messages transmitted from the station but is always in readiness to respond to transmission from the main office. However, on lines which are not arranged for full duplex operation, the printer magnet may be connected in series with the keyboard as usual. Since the keyboard contacts are short-circuited by relay 49 when the receiving reperforator at the main office becomes disconnected, the failure of the printer to function provides an immediate signal to the operator that the circuit is not in readiness for transmission.

Way station circuit

The operation of a way station circuit where a plurality of stations are connected through a single series line circuit to the main station includes additional features not embodied in the single station circuit described above. Stations B and C, Figs. 4 and 5, are shown connected to a line circuit L2, which terminates at the main station in the finder switches S1 and S2, as in the case of the line L1. For the purposes of illustration, the line L2 is arranged for half duplex operation, providing for transmission from either of the stations B and C to the main office or switching center or for transmission from the switching center to either of said stations, but not for transmission in both directions at the same time. This illustrates the flexibility of the control system provided by the invention which will operate over either a half duplex, a full duplex (single-station operation), or any normally closed circuit adapted to transmit telegraph signaling impulses.

The operation of the way station circuit is generally similar to that of the single station circuit described above except that provisions are made for operating a busy signal and locking out one of the remote stations when a call is initiated to the main station from the other remote station, and means is provided at the main office or switching center for selectively calling either of the remote stations and locking out the other station. In the idle line condition, the printers P2 and P3 at stations B and C, respectively, are non-responsive to line signals, since the printer magnet is connected to holding ground. In view of the foregoing detailed description of Figs. 1 to 3, the description of the operation of the way station circuit will be directed to these additional features. Assuming that the line circuit is idle and that the operator or attendant at station B desires to initiate a call to the main office or transmit a message through the main office switchboard to an outgoing line or channel, upon the operation of the calling key 70, relay 71 becomes energized to interrupt the line circuit at the left hand armature and back contact of said relay to initiate the operation of one of the finder switches S1 or S2, as described above in connection with Figs. 1, 2 and 3. In this instance, however, instead of a line interruption of indeterminate length, the duration of the line interruption is timed in order to lock out the printer P3 and operate a busy signal at station C.

The circuit of relay 71 may be traced through the left hand armature and back contact of relay 72, the right hand inner armature and back contact of relay 73, the third left hand armature and back contact of relay 74, the right hand make contacts of the key 70, the outer armature and back contact of relay 75, the winding of relay 71, and the middle left hand armature and back contact of relay 76. Relay 71 locks up through its right hand inner armature and front contacts to ground at the right hand armature and back contact of relay 72. The opening of the line circuit by relay 71 closes the back or spacing contacts of the line relay 77, thus closing a circuit through said contacts, the winding of relay 78 and the right hand winding of the normally operated relay 79 for operating relay 78. The energization of relay 78 removes negative cut-off potential from the grid of the timing tube 80 to cause the operation of the associated relay 76 after a predetermined time interval fixed by the characteristics of the grid circuit of said tube. The timing units or tubes 80, 81, 82, 83, as well as the other vacuum tubes shown at the main office and station C, are similar in arrangement and operation to those described above in connection with Figs. 1 and 2, and the timing characteristics of the tubes are shown in Fig. 6. The grid circuit of the vacuum tube 80, however, further includes a tapped leak resistor 85 which is operative to change the timing of the associated tube depending upon which tap on the resistor is connected to ground, as obviously the less resistance that is connected in shunt to the grid condenser, the more rapidly the charge on the

condenser will be equalized to permit the associated tube to become conducting. During the sending of the calling signal, the taps on the resistor 85 are ungrounded, thus delaying the operation of the tube 80 and relay 76 to the maximum extent. When the tube 80 becomes conducting, relay 76 in the plate circuit thereof becomes energized, locks up, and at its left hand middle armature opens the circuit of relay 71, whereupon the line circuit is reclosed. Relay 76 also opens the circuit of relay 79, thus removing holding ground from printer P2. The reenergization of the line relay 77 causes the deenergization of relay 78 and the tubes 81, 82 and 83 are rendered ineffective.

The line interruption initiated as described above and transmitted through the duplex sets 87 and 88 operates the armature of the differential relay of the duplex set 88 to spacing, thus opening the circuit of the line relay 90, and said relay becomes deenergized. A circuit is closed from ground through the armature and back contact of relay 90, the winding of relay 91, and the inner left hand armature and back contact of relay 92 to battery, whereupon relay 91 becomes energized and locks up through its right hand inner armature and front contact to a circuit that is independent of the contacts of relay 90.

The energization of relay 91 closes a circuit through its left hand armature and front contact for energizing relay 93 to open the "seize" circuit of the switchboard control equipment to prevent a transmitter plugged into the line L2 from seizing the circuit until the call that has been initiated from station B has been completed and the circuit released. At the end of the line interruption resulting from the operation of calling key 70, as described above, the line relay 90 is reoperated and closes a circuit through its armature and front contact and the right hand outer armature and front contact of relay 91 for operating relay 96. The energization of relay 96 applies ground potential to the "initiate" circuit 97 to start one of the finder switches hunting for the calling line in the same manner as described above in connection with Figs. 1 and 2. It will be noted that the "initiate" circuit is not closed until the end of the circuit interruption in order to prevent the receiving reperforator RR being connected to the line while the line is still open.

The transmission of the calling line interruption from station B to the main office also releases the line relay 110 at station C for a predetermined interval to cause the operation of the busy lamp 111 at said station and to lock out the station until the line circuit is released by station B. Upon the release of the line relay 110 at the beginning of the calling line interruption, a circuit is closed through the spacing contacts thereof and the windings of relays 115 and 116 for operating relay 115, relay 116 being normally operated through a circuit including its left hand winding, the left hand outer armature and back contact of relay 117 and the second left hand armature and back contact of relay 118. Upon the energization of relay 115, negative cut-off potential is removed from the grid of vacuum tubes 120, 122 and 123, and after a predetermined time interval, somewhat less than the interval for which the timing unit 80 at station B is adjusted, tube 122 becomes conducting to operate relay 124 in the plate circuit thereof. Relay 124 locks up through its right hand inner armature and front contact and the inner left hand armatures and back contacts of relays 117 and 118 so that, if a longer line interruption is received, the operation of either relay 117 or 118 by the associated tubes 120 and 121 will cause the release of relay 124. In the present instance, however, the reclosure of the line circuit deenergizes the relay 115 and tube 120 is maintained non-conducting, whereas the tube 121 has been held non-conducting by the cut-off potential applied to the grid thereof through the contacts of relay 117. The energization of relay 124 closes a circuit through its outer right hand armature and front contact for lighting the "busy" lamp 111, and opens at its middle right hand armature and back contact the circuit of relay 125 so that said relay cannot be operated to open the line circuit or initiate a call in response to the operation of the calling key 126. Thus, the apparatus at station C is locked out while the line circuit is in use by station B, and the "busy" signal 111 remains lighted to indicate to the attendant or operator at station C the busy condition of the line.

Referring again to Figs. 2, 3 and 4, the connection of an idle reperforator through the instrumentality of one of the finder switches S1 and S2 to the calling line applies battery potential through the second right hand armature and front contact of relay 29, the middle switch wiper of the finder switch and the conductor 130 to the windings of relay 98 and 92 to disconnect the line relay 90 from the line circuit and to initiate the transmission of the go-ahead signal to station B, as described above in connection with the transmission of a signal to station A when an idle reperforator has been connected to the line. The operation of relay 98 also establishes circuits for opening the line and timing the opening through the control of tube 102 in response to the subsequent disconnect signal. The energization of relay 92 closes a circuit through its right hand outer armature and front contact for operating relay 95 to open the sending leg of the terminal duplex set 88 at the same instant that negative cut-off potential is removed from the grid of the vacuum tube 101 employed to time the line interruption for operating the go-ahead signal at station B (or station C, in case of a call initiated from that station). When current is established through the relay 99 by the vacuum tube 101, the circuit of relay 95 is broken at the left hand armature and back contact of relay 99 to reclose the line circuit.

At station B, the deenergization of the line relay 77 operates relay 78, as described above, to remove negative cut-off potential from the grids of the vacuum tubes 80, 81, 82 and 83. Just before the end of the line circuit interruption, the tube 81 becomes conducting and relay 74 in the plate circuit thereof is energized. Relay 74 becomes locked up and opens the locking circuit of relay 76 at its inner left hand armature. The energization of relay 74 lights the "go-ahead" supervisory lamp 86 to indicate that transmission may be commenced, and at its outer left hand armature and back contact removes the short circuit around the keyboard contacts of the printer P2. After transmission has been completed, the circuit is released and the equipment restored to normal by restoring the key 70. At this time a line interruption is again produced under the control of the timing unit 80, but now the upper tap connection on the resistor 85 in the grid circuit of the tube 80 is grounded through the second left hand armature and front contact of relay 74, thus decreasing the time required for the grid of the vacuum tube 80 to return to a

potential which will permit current flow through the tube. The shorter line interruption is indicated by the diagram of Fig. 6. The length of the line interruption corresponds to the transmission of a "blank" and the receiving reperforator closes its blank-reading contacts, as described above, to release the associated finder switch. When the control relays associated with the finder switch are restored to normal, battery potential is removed from the conductor 130 to cause the release of relay 98 and the transmission of a line interruption for the purpose of clearing out the apparatus at the calling station B and extinguishing the busy lamp and restoring the equipment at station C.

In view of the foregoing description, it will be evident that the release of relay 98 operates and then releases relay 96 after a time interval determined by the adjustment of vacuum tube 102 and its associated relay 103. The release of the line relay 77 at station B for this period of time causes the energization of relay 78, as described above, to operate first to remove cut-off potential from the tubes 80, 81, 82 and 83. The tubes 80 and 81 become conducting, but a moment later the tubes 82 and 83 also become conducting and the clear-out relay 72 and relay 73 are operated. As soon as the line circuit is reclosed and relay 78 deenergized, relays 72 and 73 become deenergized and the equipment at station B is restored to normal.

Similarly, at station C, the reception of the long circuit interruption causes the energization of the clear-out timing unit 123 and the associated relay 127 to unlock the relay 124, extinguish the busy lamp 111 and restore the equipment at station C to normal.

In the case of a call initiated from station C by the actuation of the calling key 126, an idle reperforator at the main office is seized and the printer at station B locked out in substantially the same manner as described above in connection with the placing of a call from station B. However, as indicated in the diagram of Fig. 6, the calling signal sent from station C is of longer duration than that sent from station B, and the timing unit 82 of station B which responds to the busy signal (call from station C) is adjusted to require a longer circuit interruption than the timing unit 122 controlling the busy signal at station C. Upon the operation of relay 73 in response to the initiation of a call from station C, the "busy" lamp 89 at station B is lighted and the circuit to relay 71 is opened to prevent its operation if key 70 should be actuated at this time. Station C receives a "go-ahead" signal from the main station, sends a disconnect signal and responds to a clear-out signal from the main station, generally in the same manner as described above in connection with a call from station B.

When a message is received at the main station for one of the stations B or C on the multistation circuit, the operator plugs the call into line L2 at the switchboard and the transmission of the message is preceded by an automatic selection signal which renders the printer of the called station operative and locks out the printer of the other station. Thus, for example, assuming that the reperforator RR, Fig. 2, has recorded a message for the station B on the line L2, the associated tape transmitter TT is plugged into the jack J3 individual to said line. Likewise, calls for station C are plugged into jack J4 individual to the line L2. Assuming that the line circuit is not in use when the plug is inserted in the jack J3, a circuit is closed from ground at the winding of relay 62 in the cord circuit through said winding to the lower contacts of the plug and jack J3, the winding of relay 131, circuit 94 extending through the armature and back contact of relay 93, and the left hand armature and back contact of relay 134 to positive battery whereupon the relay 131 becomes energized. The control relays and circuits associated with the cord circuit and switchboard are not shown in detail, since they are shown in the copending application of Light and Blanton referred to above and are unnecessary for the understanding of the present invention. Since this circuit for seizing the line L2 includes contacts of relay 93, it will be apparent that relay 131 will not be energized until after any call which is in progress from one of the remote stations B and C has been completed.

The energization of relay 131 closes a circuit from ground through the third armature and front contact thereof, the left hand winding of relay 135, and the inner armature and back contact of relay 136 for operating relay 135. At its second armature and make-before-break contacts relay 131 transfers the line circuit through the contacts of relay 135, conductor 138 and the contacts of relay 95 to the sending relay so that the tape transmitter TT will be operative to send over the line circuit L2 when the clutch-magnet circuit is closed at the end of the selection signals. The operation of relay 135 interrupts the sending circuit for a predetermined interval effective to render the printer P2 at station B operative and to operate the busy signal at station C. The operation of relay 135 is timed by the vacuum tube 140, since negative cut-off potential is removed from the grid of said tube at the left hand armature and back contact of relay 135, and the tube 140 after a predetermined interval energizes relay 136 to break the circuit of relay 135 and thereby reclose the line circuit. The grid leak resistor 143 associated with the vacuum tube 140 has a tapped connection to the outer armature and front contact of relay 131 so that the timing of the tube 140 is comparatively short in the case of a transmitter plugged into the jack J3 (see timing chart, Fig. 6). In the case of a transmitter plugged into the jack J4, relays 132 and 135 are operated in a similar manner to that described above, but the tapped connection to the resistor 143 is not grounded so that the timing unit 140 causes a longer line interruption, operative to cut in station C and operate the busy lamp at station B.

In the case of the shorter line interruption, the deenergization of line relay 77 at station B energizes relays 78 and 79, as described above, and after a predetermined time interval the timing unit 80 causes relay 76 to become energized and locked up. The energization of relay 76 interrupts the left hand locking circuit of relay 79, and relay 78 becomes deenergized when the line circuit is reclosed. The deenergization of relay 79 removes ground potential from the printer magnet of the printer P2 and said printer will respond to the printer signals received over the line L2. At station C, however, the same line interruption operates the line relay 110, control relays 115 and 116, the timing unit 122, and the associated busy relay 124, thereby lighting the "busy" lamp 111. Relay 116 remains locked up to contacts of relays 117 and 118 so that the printer magnet of printer P3, which is grounded at the

contacts of relay 116, does not respond to the line signals. The operation of relay 124 also locks the equipment so that the operation of the calling key 126 will not be effective to render the printer operative or initiate a call.

In the case of the longer circuit interruption to select station C, the timing unit 120 operates after timing unit 122 and causes the energization of relay 117 to render the printer P3 operative, and the busy lamp 111 is extinguished when relay 115 is restored. At station B, however, the longer circuit interruption operates relay 73 through the instrumentality of the timing unit 82 to light the "busy" lamp 89, and the printer magnet of the printer P2 is locked against operation by the energization of the relay 79.

When the connection to the line L2 is electrically broken in response to the end-of-message signal, as described in the above-mentioned copending application of Light and Blanton, relay 131 becomes deenergized and opens at its third armature and front contact the locking circuit of relay 136, whereupon said relay becomes deenergized. The deenergization of relay 136 opens the circuit through the left hand operating winding of relay 137, but said relay is locked up through the left hand armature and front contact of said relay and the winding of relay 134 to ground, whereby relay 137 remains energized and relay 134 becomes energized as soon as relay 136 becomes deenergized. The energization of relay 134 removes negative cut-off potential at its right hand armature and back contact from the grid of timing unit 141 at the same instant that the line circuit is opened by the energization of relay 135 through a circuit including the left hand armature and front contact of relay 134. After a predetermined time interval fixed by the grid circuit of the tube 141, the flow of current through said tube and the right hand winding of relay 137 in opposition to the left hand winding of said relay causes said relay to become deenergized. Thus, the timing unit 141 times the circuit interruption employed to clear out the called station and restore the busy lamp at the other station in the same manner as described above. The deenergization of relay 137 opens the circuit of relay 134, which in turn opens the circuit of relay 135. The deenergization of relay 135 recloses the line circuit in readiness for the next call either from or to one of the remote stations B and C. It will be noted that the seize circuit 94 is held open at the left hand back contact of relay 134 until the end of the clear-out signal to prevent another transmitter which might be plugged into the line from obtaining a connection until the equipment is restored to normal. In the case of a call through the jack J4, the same clear-out signal is transmitted under the control of timing unit 141 upon the deenergization of relay 132 when the cord circuit is disconnected.

It is contemplated that various types of control and switching equipment may be employed, since the invention is not limited to that shown and described herein but includes modifications falling within the terms of the appended claims.

What is claimed is:

1. In a multi-station telegraph system, a main office or switching center and a plurality of other branch stations, telegraph lines or channels connecting said other stations to said main office, switching means at said main office for interconnecting said lines or channels, printers at said stations for effecting communication over said lines or channels, certain of said lines or channels having more than one branch station serially associated therewith, means at the main office for continuously interrupting the normal condition of such multi-station line or channels for different periods and means responsive thereto and dependent upon the length thereof for selecting one of said branch stations and locking out the other of said stations.

2. In a multi-station telegraph system, a main office or switching center and a plurality of other stations, telegraph lines or channels connecting said other stations to said main office, switching means at said main office for interconnecting said lines or channels, printers at said stations for effecting communication over said lines or channels, one of said lines having more than one branch station serially associated therewith, means at each station on said last-mentioned line to interrupt and close the circuit a single time to thereby initiate and complete a call, and means operative upon the initiation of a call from one of the plurality of stations on a single line by a single line interruption for locking out and maintaining locked out the other of said stations thereon.

3. In a multi-station telegraph system, a main office or switching center and a plurality of other stations, telegraph lines or channels connecting said other stations to said main office, switching means at said main office for interconnecting said lines or channels, means at said stations for effecting communication over said lines or channels, one of said lines or channels having a plurality of stations in series thereon, said last-mentioned line or channel terminating in a plurality of jacks at said main office equal in number to the number of branch stations thereon, means dependent upon the connection to one or the other of said jacks for interrupting the line circuit for respective different lengths of time and means responsive to such interruptions to effect selection of a desired station on said line or channel.

4. In a multi-station telegraph system, a main office or switching center and a plurality of other stations, telegraph lines or channels connecting said other stations to said main office, certain ones of said lines or channels serially connecting more than one of said other stations with said main office, terminals at said main office for each of said multi-station lines or channels equal in number to stations connected thereto, telegraph signal storage repeating means at said main office, means for connecting said storage repeating means to said terminals and means operative on the connection of said repeating means to a terminal of a multi-station line or channel to select the station individual thereto and lock out the other station on said line or channel.

5. In a multi-station telegraph system, a main office or switching center and a plurality of other stations, telegraph lines or channels connecting said other stations to said main office, certain ones of said lines or channels connecting more than one of said other stations with said main office, terminals at said main office for each of said multi-station lines or channels equal in number to stations connected thereto, telegraph signal repeating means at said main office, means for connecting said repeating means to said terminals and means operative on the connection of a repeating means to a terminal of a multi-station line or channel to select the station individual thereto and lock out the other station on said line or channel and to prevent the operative connection of other repeating means at said

main office to other terminals of said line or channel.

6. In a telegraph system, a main station or switching office, a plurality of branch stations, a telegraph line or channel connecting said branch stations in series with said main station, a plurality of jacks one for each of said branch stations at said main station associated with said line or channel, permutation signal transmitting means at said main station, said means terminating in a plug insertable in said jacks to effect transmission of permutation signals over said line or channel, a line interrupting means at said main station, means operative on the insertion of said plug in any one of said jacks to control said line interrupting means to interrupt said line or channel prior to the transmission of permutation signals thereover, and means dependent upon the jack into which said plug is inserted to determine the length of time said line interrupting means interrupts said line or channel.

7. In a telegraph system, a main station or switching office, a plurality of branch stations, a telegraph line or channel connecting said branch stations in series with said main station, a plurality of jacks one for each of said branch stations at said main station associated with said line or channel, permutation signal transmitting means at said main station, said means terminating in a plug insertable in said jacks to effect transmission of permutation signals over said line or channel, a line interrupting means at said main station, means operative on the insertion of said plug in any one of said jacks to control said line interrupting means to interrupt said line or channel prior to the transmission of permutation signals thereover, means dependent upon the jack into which said plug is inserted to determine the length of time said line interrupting means interrupts said line or channel, means responsive to line interruptions at said branch stations and means controlled by said last-mentioned means to select the branch station on said line or channel represented by the jack into which said plug is inserted at said main office.

8. In a telegraph system, a main station or switching office, a plurality of branch stations, a telegraph line or channel connecting said branch stations in series with said main station, a plurality of jacks one for each of said branch stations at said main station associated with said line or channel, message signal transmitting means at said main station, said means terminating in a plug insertable in said jacks to effect transmission of message signals over said line or channel, a line interrupting means at said main station, means operative on the insertion of said plug in any one of said jacks to control said line interrupting means to interrupt said line or channel prior to the transmission of permutation signals thereover, means dependent upon the jack into which said plug is inserted to determine the length of time said line interrupting means interrupts said line or channel, station selecting and locking out means at each of said branch stations and means controlled by the line interruptions transmitted from said main station to select the branch station represented by jack into which said plug is inserted and to lock out the other of said branch stations.

9. In a multi-station telegraph system, a main office or switching center, a plurality of branch stations, telegraph lines or channels each connecting a plurality of said branch stations to said main office, switching means at said main office for interconnecting said lines or channels, message signal transmitting and receiving means at said branch stations for effecting communication over said lines or channels, message signal receiving and storing devices at said main office for receiving and storing message signals from said branch stations, means to automatically and temporarily connect a message signal receiving and storing device to a line or channel in response to a call consisting of a single line interruption from a branch station on said line or channel, and means to lock out the others of said branch stations while said message signal receiving and storing device is connected to said line or channel in response to the call from the calling branch station.

10. In a multi-station telegraph system, a main office or switching center, a plurality of branch stations, telegraph lines or channels each connecting a plurality of said branch stations to said main office, switching means at said main office for interconnecting said lines or channels, permutation signal transmitting and receiving means at said branch stations for effecting communication over said lines or channels, permutation signal receiving and storing devices at said main office for receiving and storing permutation message signals from said branch stations, means to automatically and temporarily connect a permutation signal receiving and storing device to a line or channel in response to a call consisting of a single line interruption from a branch station on said line or channel, and means to indicate at the others of said branch stations on said line or channel when a permutation signal receiving and storing device at said main office is connected to said line or channel in response to a call from the calling branch station.

11. In a multi-station telegraph system, a main office or switching center, a plurality of branch stations, telegraph lines or channels each connecting a plurality of said branch stations to said main office, switching means at said main office for interconnecting said lines or channels, permutation signal transmitting and receiving means at said branch stations for effecting communication over said lines or channels, permutation signal receiving and storing devices at said main office for receiving and storing permutation message signals from said branch stations, means to automatically and temporarily connect a permutation signal receiving and storing device to a line or channel in response to a call consisting of a single line interruption from a branch station on said line or channel, means to lock out the others of said branch stations while said permutation signal receiving and storing device is connected to said line or channel in response to the call from the calling branch station, and means to indicate at the calling station when the connected permutation receiving and storing device has been disconnected from said line or channel.

12. In a multi-station telegraph system, a main office or switching center, a plurality of branch stations, telegraph lines or channels each connecting a plurality of said branch stations to said main office, switching means at said main office for interconnecting said lines or channels, permutation signal transmitting and receiving means at said branch stations for effecting communication over said lines or channels, permutation signal receiving and storing devices at said main office for receiving and storing permutation message signals from said branch stations, means responsive

to a calling branch station for connecting an idle permutation signal receiving and storing device to the associated line or channel and locking out the other of said branch stations on said line or channel, means at the calling branch station to initiate disconnection of the connected permutation signal receiving and storing device from the line or channel, means at said main office to thereupon effect transmission of a clear-out signal to said line or channel, and means at said branch stations on said line or channel and responsive to said clear-out signal to restore said stations to normal condition.

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