B. GHERARDI.

SIGNALING SYSTEM.

APPLICATION FILED AUG. 31, 1915.

1,251,363.

Patented Dec. 25, 1917.

3 SHEETS—SHEET 1.

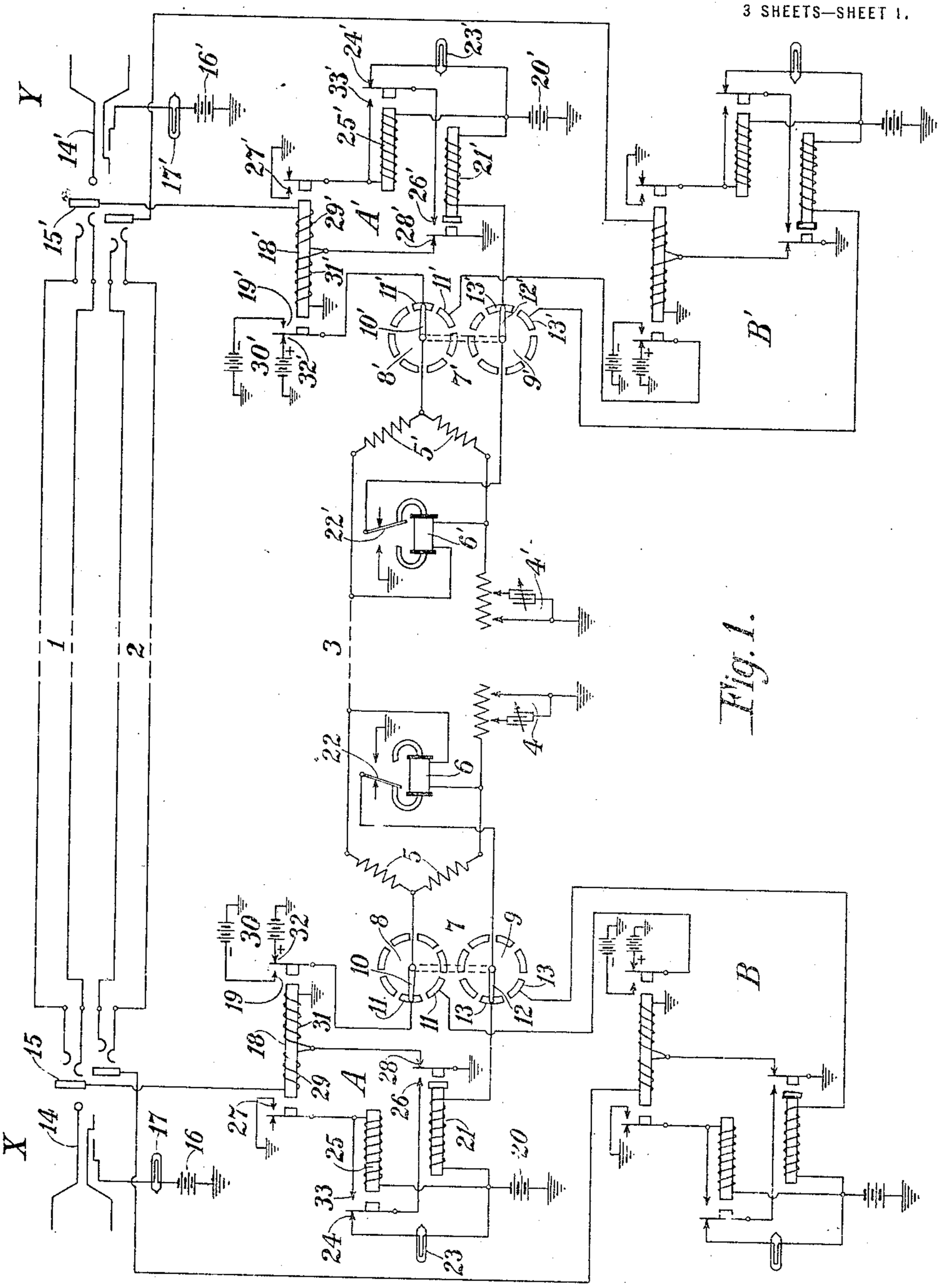

Fig. 1.

Inventor:
Bancroft Gherardi

per Munn, Cameron, Lewis & Massie
Attorneys.

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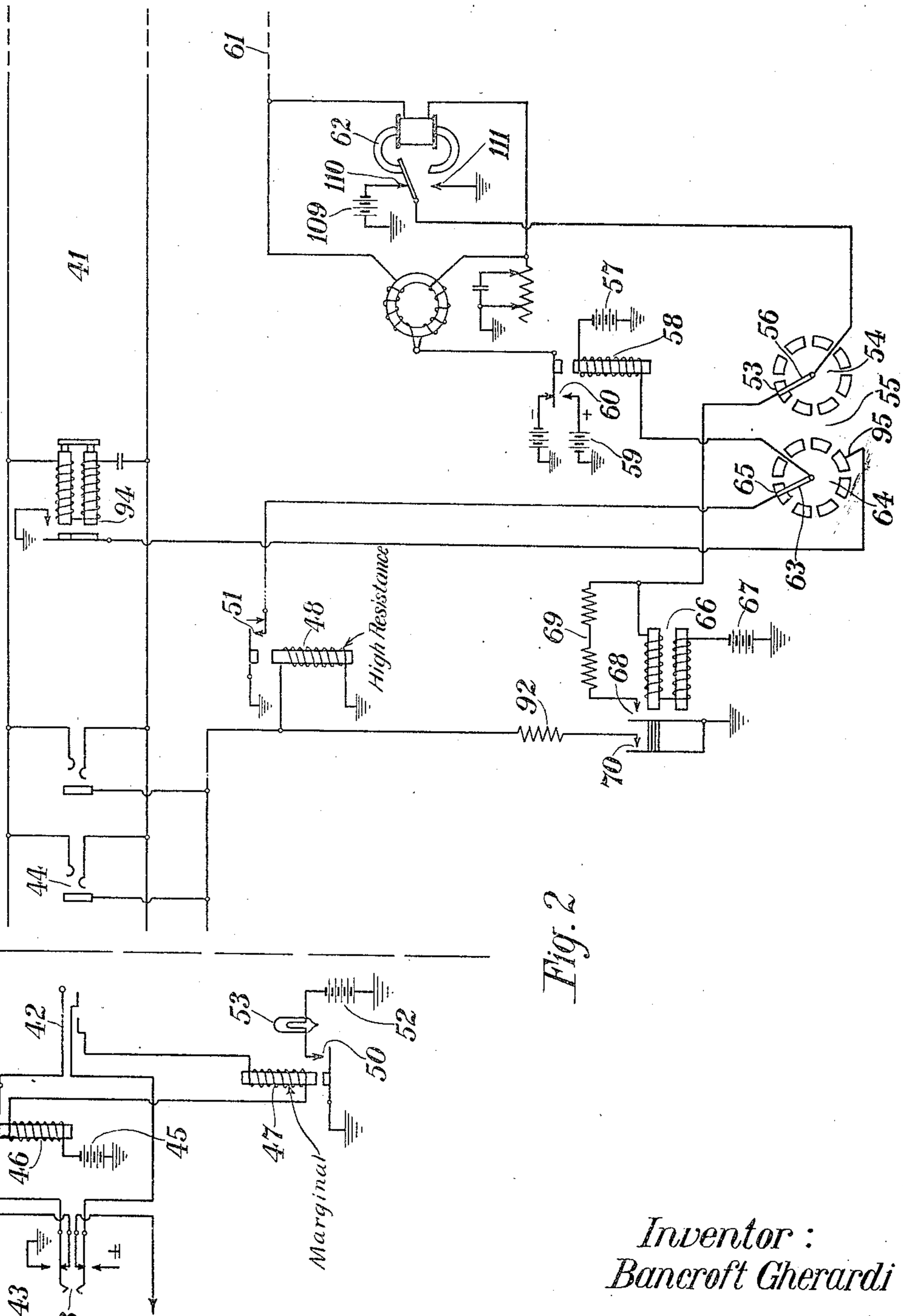

Fig. 2

Inventor:
Bancroft Gherardi

per Mouro, Cameron, Lewis & Chassis
Attorneys.

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3 SHEETS—SHEET 3.

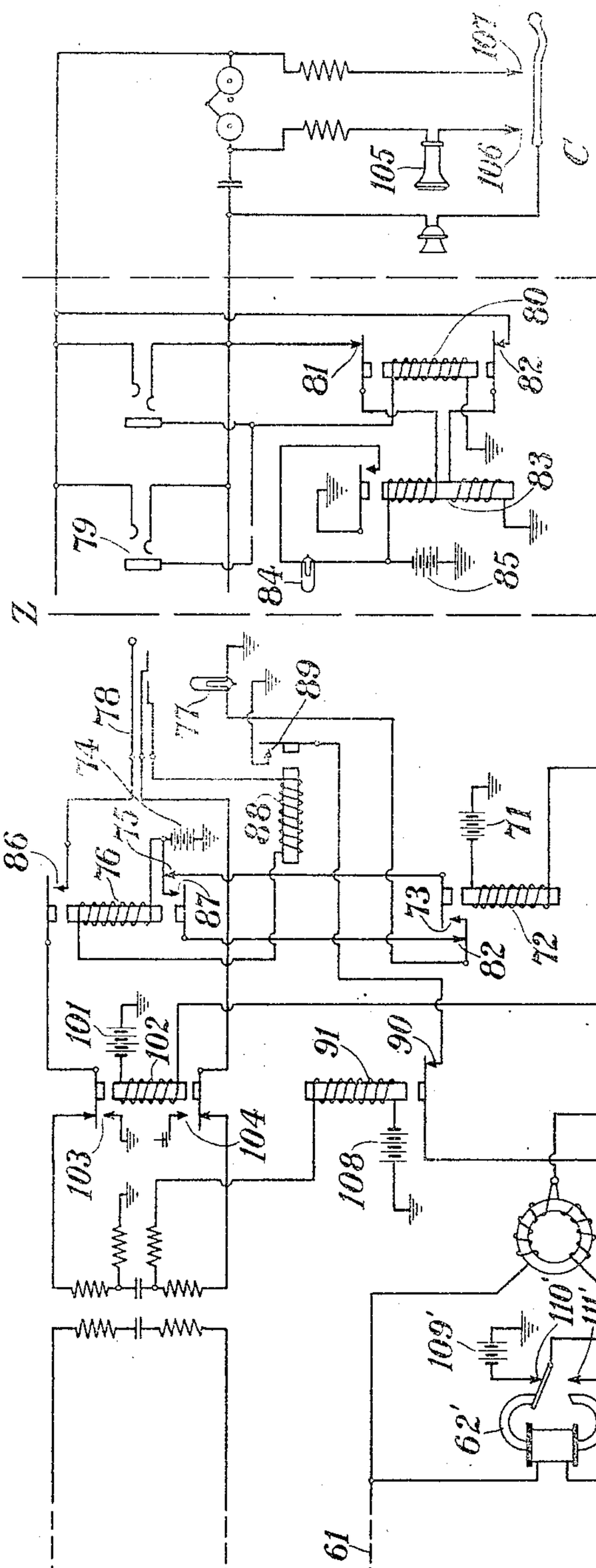

Fig. 3

Inventor:
Bancroft Gherardi

per Mauro, Cameron, Lyric & Massie
Attorneys.

UNITED STATES PATENT OFFICE.

BANCROFT GHERARDI, OF BAYHEAD, NEW JERSEY, ASSIGNOR TO AMERICAN TELEPHONE AND TELEGRAPH COMPANY, A CORPORATION OF NEW YORK.

SIGNALING SYSTEM.

1,251,363. Specification of Letters Patent. Patented Dec. 25, 1917.

Application filed August 31, 1915. Serial No. 48,213.

To all whom it may concern:

Be it known that I, BANCROFT GHERARDI, residing at Bayhead, in the county of Ocean and State of New Jersey, have invented certain Improvements in Signaling Systems, of which the following is a specification.

This invention relates to a signaling system for operating circuits, such, for example, as telephone circuits, and its object is to provide an economical and efficient signaling system.

One important application of the invention is in connection with telephone systems.

It is desirable in present practice, under various conditions, that the two wires forming a metallic telephone circuit be put to several or all of the following uses: (1) as a circuit for telephone conversation; (2) as one side of a phantom telephone circuit; (3) as one or more telegraph circuits; and (4) as a path for operating telephone signals.

It is often very difficult, if not impracticable, to simultaneously employ the two wires of a telephone circuit for all of the above-named purposes or for as many of them as may be desired under the condition existing in a given situation. For example, the usual methods of operating common battery telephone signals interfere with or exclude the use of the wires for telegraphic purposes; and even with magneto signals special signaling means must be employed when the wires are used for telegraph working. This invention provides a system which may be simultaneously and satisfactorily used for all of the above enumerated purposes or for any two or more of said purposes.

In accordance with this invention, one or more operating circuits, with local signaling or translating circuits associated with each end of said operating circuits, are provided with a signaling wire or path having at its two ends switching apparatus preferably operating in synchronism to successively connect the corresponding local signaling or translating circuits to the two ends of the signaling wire. Said signaling wire need not be used exclusively for signaling purposes; for example, in a telephone system it may be composited or otherwise connected on to a telephone circuit. Furthermore the switching apparatus may have any desired number of positions for each operating circuit in order that there may be any desired number of signals or other translating apparatus associated with each of said circuits.

The invention may be more readily understood by reference to the accompanying drawings in which Figure 1 is an arrangement of circuits and apparatus representing one embodiment of the invention, and Figs. 2 and 3 placed end to end with Fig. 2 at the left, represent an embodiment of the invention in connection with a call circuit toll line.

Referring first to Fig. 1, X and Y represent two offices connected by a plurality of telephone circuits 1, 2, there of course being as many of these circuits as traffic conditions may require. Extending between the two offices and common to said plurality of telephone circuits is a signaling path or wire 3, shown in the drawings as having a ground return. Said signaling wire may, if desired, be arranged in a well known manner for duplex operation, for which purpose there may be provided at the ends of the wire artificial balancing lines 4, 4′ and retardation coils 5, 5′. Across the ends of each set of retardation coils are bridged the polarized relays 6, 6′ at offices X and Y, respectively.

The two ends of the signaling wire 3 are connected to commutators 7 and 7′, respectively, the commutator 7 having a transmitting section 8 and a receiving section 9, and the commutator 7′ having, correspondingly, sections 8′ and 9′. The commutators, as conventionally shown in the drawing, are preferably similar to the well-known multiplex distributers that are employed in connection with multiplex printing telegraph systems and are, it will be understood, provided with a synchronizing device (not shown) by means of which synchronism is automatically maintained between the brushes 10, 12 and 10′, 12′, respectively, of said commutators. Said brushes continuously revolve and make contact with the circumferentially arranged segments or terminals of the commutators. The local signaling circuits A and A′ associated with the telephone circuit 1 and individual thereto are represented on corresponding transmitting terminals 11, 11′ and on corresponding receiving terminals 13, 13′ of said commutators. Likewise the local signaling circuits B and B′ individual to the telephone circuit 2 are represented on other

corresponding terminals of said commutators.

In the particular embodiment of the invention shown in Fig. 1, the local signaling apparatus consists of relays and lamps such as are usually employed in common battery signaling systems, and the structure and operation of the circuits and apparatus at office X are identical with the structure and operation of the circuits and apparatus at office Y. Hence, for convenient reference, corresponding parts at the two offices are designated by the same reference numerals, the reference numerals at office X without, and those at office Y with, primes. It will also be seen that the local signaling circuits B, B′ are shown as identical with the local signaling circuits A, A′.

The operation of the system shown in Fig. 1 will now be set forth. Assume that the operator at office X desires to establish connection through office Y over line 1. A plug 14 is inserted in jack 15, thereby connecting battery 16 through supervisory signal lamp 17 and relay 18 to ground. Thereupon said signal lamp is illuminated. Also, the relay 18 is energized and through its contact 19 connects the negative pole of the battery 30 to the contact terminal or segment 11 of the transmitting section 8 of the commutator 7. Commutators 7 and 7′ are in synchronism and therefore while the brushes 10 and 12 of commutator 7 are in contact with terminals 11 and 13, respectively, the brushes 10′ and 12′ of commutator 7′ are in contact with the corresponding terminals 11′ and 13′, respectively, of the commutator 7′. During the time that said contacts obtain, negative current flows from battery 30 through contact 19, segment 11, brush 10 over line 3 and operates the polarized relay 6′ at office Y, thereby closing a circuit for relay 21′ from grounded battery 20′ through segment 13′, brush 12′ and the tongue 22′ of polarized relay 6′ to ground. Relay 21′ is thereby energized and a circuit is closed for the line signal lamp 23′ as follows: from battery 20′, through lamp 23′ contact 24′ of relay 25′, contact 26′, closed by the energization of the relay 21′, to ground. The resultant illumination of the line signal lamp 23′ apprises the operator at office Y of the fact that the operator at office X is calling over line 1. It will be observed that a series of negative current impulses is transmitted over line 3 from battery 30, that is one impulse per revolution of the constantly rotating brush 10. The polarized relay 6′ is thus successively energized and deënergized in rapid succession. As a result thereof, relay 21′ is energized not by a continuous current but by a series of current impulses. In the structure shown in the drawing, it is contemplated that the frequency of said impulses shall be so high and the operation of said relay 21′ shall be so sluggish that said series of impulses will maintain the relay in the same position as would a continuous current.

Upon the operator at office Y responding by inserting plug 14′ in jack 15′, a cycle of operations follows which results in the extinguishment of the supervisory signal lamp 17 at office X, thereby informing the operator at that office that the operator at office Y has responded. This cycle of operations will now be described. The insertion of the plug 14′ in the jack 15′ closes a circuit from battery 16′ through supervisory signal lamp 17′ and windings 29′ and 31′ of relay 18′ to ground. The resultant operation of relay 18′ closes a circuit for relay 25′ from battery 20′ to ground through contact 27′ of relay 18′. The energization of relay 25′ opens, at contact 24′, the circuits of line signal lamp 23′ and extinguishes said signal. The operation of relay 18′ also connects through its contact 19′, the negative pole of battery 30′ to segment 11′ of the transmitting section 8′ of the commutator 7′. At the instant when brush 10′ is in contact with said segment 11′, at which time the brush 12 is in contact with segment 13 of the receiving section 9 of commutator 7, negative current from the battery 30′ flows over line 3 and operates polarized relay 6. A circuit for relay 21 is thereby closed from ground through the tongue 22, brush 12, battery 20 to ground. The resultant operation of relay 21 opens its normally closed contact 28 and thereby removes the ground connection from the junction of the two windings 29, 31 of relay 18, thus increasing the resistance in the circuit of supervisory signal lamp 17, and ground to such an extent that said lamp is dimmed and substantially extinguished. This apprises the calling operator at office X of the fact that the operator at office Y has responded. Incidentally it will be noted that since relay 21′ at Y office has remained in its operated condition, thereby holding open its contact 28′, during this cycle of operations, the supervisory signal lamp 17′ at office Y has not received sufficient current to illuminate it.

The signaling operations when it is desired to disconnect after the completion of a telephone conversation is now to be described. Assume that the operator at office X disconnects by removing the plug 14 from jack 15. This operation releases relay 18 which had been supplied with current from battery 16 through the sleeve of jack 15. Relay 25 will, however, remain operated so long as the relay 21 is energized, a circuit for said relay 25 being closed from battery 20 through relay 25, contacts 33 and 26 to ground. This continued energization of relay 25 prevents the false operation of the line signal lamp 23. The above described release of relay 18 puts positive battery on segment 11 through the contact 32 of said relay, and, when brush 10

during its revolution comes in contact with said segment, polarized relay 6′ at office Y is restored to its original position, thereby deenergizing relay 21′ by removing the ground from said relay. The deënergization of relay 21′ grounds through the contact 28′ of said relay, the junction of the two windings 29′, 31′ of relay 18′ and, thereby so decreases the resistance in the circuit of the supervisory signal lamp 17′ as to cause said lamp to be illuminated. This apprises the operator at office Y that the operator at office X has disconnected. The Y office operator therefore withdraws plug 14′ from jack 15′, thereby restoring positive battery through contact 32′ of relay 18′ to segment 11′ of commutator 7′. This restores polarized relay 6 to its original position, thereby removing ground from relay 21 and causing said relay to become deënergized. This completes the cycle of signaling operations associated with making and disconnecting a circuit over line 1 between offices X and Y.

Referring to Figs. 2 and 3, the invention is shown therein in connection with a call circuit toll line 41. For the sake of simplicity only one of such toll lines, with its associated local signaling circuits, is shown, though it will be understood that there may be any suitable number of such toll lines utilizing the common signaling path. In this particular embodiment of the invention the local signaling circuits which are connected with each other over the common signaling wire are adapted to be extended over the subscribers' lines with which connection may be made. The common signaling circuit and its associated apparatus are substantially the same as that of Fig. 1, and in said Figs. 2 and 3, also, the local signaling apparatus consist of relays and lamps such as are usually employed in common battery signaling systems.

The operation of the system shown in Figs. 2 and 3 is as follows: The operator at office W notifies, over a call wire circuit (not shown), the operator at office Z that a connection is desired to subscriber's station C. The operator at office Z then assigns trunk circuit 41 therefor, whereupon the operator at office W inserts plug 42 of cord 43 into jack 44. Thereupon, the circuit of battery 45 is completed through relay 46, relay 47, sleeve of plug 42, sleeve of jack 44 and relay 48 to ground. Relay 47 is not thereby operated since the resistance of relay 48 is so high that insufficient energizing current flows through relay 47. However, relays 46 and 48 are energized and close their respective contacts 49 and 51.

The closing of contact 51 connects ground to segment 65 of transmitting section 64 of commutator 55. When brush 63 comes in contact with segment 65, the circuit of battery 57 is closed, thereby operating the pole changing relay 58 and momentarily impressing positive battery 59 through contact 60 on signaling line 61. A positive battery current impulse flows over signaling line 61 and operates polarized relay 62′ at office Z, thereby grounding through contact 111′ brush 63′ of the receiving section 64′ of commutator 55′. When brush 63′ makes contact with segment 65′, which it does synchronously with the operation of relay 62′ by positive current impulse from office W over line 61, relay 66′ is operated by current flowing from battery 67′ through segment 65′ brush 63′ and contact 111′ to ground. The consequent closing of contacts 68′ locks relay 66′ by providing a circuit for battery 67′ through resistance 69′ to ground. The closing of contact 70′ of relay 66′ provides a circuit for battery 71 through relay 72 to ground thereby operating said relay. The resultant closing of contact 73 of relay 72 completes a circuit from battery 74 through contact 75 of relay 76 and signal lamp 77 to ground, thereby illuminating said lamp. This cycle of operations, initiated by the insertion of plug 42 into jack 44 and ending in the illumination of lamp 77 apprises the operator at office Z that the calling operator at office W has plugged into the assigned trunk 41.

The second cycle of operations is initiated by the insertion of plug 78 into jack 79, said jack being the switchboard terminal of subscriber's station C. When the sleeve of plug 78 makes contact with the sleeve of jack 79 a circuit is completed from battery 74 through relays 76, 88 and cut-off relay 80 to ground, thereby operating said relays. The operation of cut-off relay 80, opening its contacts 81 and 82, removes line relay 83, subscriber's lamp 84 and battery 85 from operative connection with the subscriber's line, said relay and lamp not being functionally involved in the present operations and functioning only when the subscriber at station C desires to secure telephonic connection through office Z. The operation of relay 76 closes contacts 86 and 87 and opens contact 75, thereby extinguishing lamp 77. The operation of relay 88 grounds segment 53′ of commutator 54′ through contact 89 of relay 88 and contact 90 of relay 91. When brush 56′ makes contact with segment 53′, pole changing relay 58′ is operated momentarily, and sends out a positive current impulse from battery 59′ through contact 60′ over line 61, and operates polarized relay 62, thus grounding brush 56 of commutator 54 which brush is at that time in contact with segment 53. A circuit is thereby established from battery 67 to ground through relay 66, and said relay is thereby operated. The closing of contact 70 shunts relay 48 with resistance 92, thereby increasing the current through relay 47 and operating it. The op-

eration of relay 47 closes a circuit through contact 50 and lamp 53 for battery 52 and said lamp is illuminated. This cycle of operations, ending in the illumination of lamp 53, apprises the operator at office W that trunk 41 has been connected to the subscriber's line terminating in the desired station C.

The third cycle of operations is concerned with the ringing of the signal bell at subscriber's station C. The operator at office W manually operates ringing key 93, thereby impressing an alternating ringing voltage on line 41 and operating relay 94. The operation of relay 94 grounds segment 95 of commutator 64. When brush 63 makes contact with segment 95, pole changing relay 58 is momentarily operated by current from battery 57 through brush 63 segment 95 and the contact of relay 94. This momentary operation of pole changing relay 58 impresses battery 59 through contact 60 on line 61 and a positive current impulse is sent out over said line. This current impulse momentarily operates polarized relay 62′ and grounds through contact 111′ brush 63′ of commutator 64′ which is at that time in contact with segment 95′. A circuit is thereby established from battery 96 through relay 97 segment 95′, brush 63′ to ground, and said relay 97 is operated. The operation of relay 97 closes contacts 98 and 99. The closing of contact 98 locks said relay in its operated position through resistance 100. The above-mentioned closing of contact 99 grounds battery 101 through relay 102, thereby operating relay 102. The operation of said relay impresses ringing current through contacts 103 and 104 on subscriber's line and rings the bell at subscriber's station C. This ringing persists as long as relay 94, at office W, is operated. The subscriber at station C responds by removing the receiver 105 from the hook, thereby closing contacts 106 and 107 in the usual manner. The closing of contacts 106 and 107 establishes a direct current path for battery 108 which operates relay 91 opening contact 90. With contact 90 open pole changing relay 58′ remains unoperated when brush 56′ makes contact with segment 53′, and, therefore, polarized relay 62 is left in its normal position when brush 56 is in contact with segment 53. Relay 66 is therefore deënergized when brush 56 comes in contact with segment 53, and contacts 68 and 70 are thereby opened. The opening of contact 70 removes the shunt around relay 48 and in consequence contact 50 of relay 47 is opened and lamp 53 is extinguished. This apprises the operator at office W of the fact that the subscriber at station C has responded.

The signaling operations associated with the disconnection of the communicating circuit will now be described. Upon the subscriber at station C hanging up his receiver at the completion of the telephonic conversation, contacts 106 and 107 are opened, and the circuit of battery 108 is thereby opened and relay 91 deënergized. The consequent closing of contact 90 of relay 91 grounds segment 53′ through contact 90 and contact 89. When brush 56′ makes contact with segment 53′, the pole changing relay 58′ is energized from its associated battery 57′ through grounded segment 53′. Positive battery 59′ is thereby impressed on line 61 through contact 60′, sending a positive current impulse over said line and operating the polarized relay 62 at office W. Brush 56 is thereby grounded at the instant it is in contact with segment 53 and relay 66 is thereby energized from battery 67. The closing of contact 68 of relay 66 closes a locking circuit for said relay through the resistance 69. The closing of contact 70 of relay 66 shunts the resistance 92 around relay 48 and operates relay 47, thereby illuminating lamp 53. The operator at office W is apprised by the illumination of said lamp that the subscriber at station C has disconnected and responds by disconnecting plug 42 from jack 44. This, by removing the ground connection from the sleeve of plug 42, deënergizes relays 46 and 47 and extinguishes lamp 53. It further deënergizes relay 48 and thereby, by the opening of contact 51, removes ground from segment 65. As a result, pole changing relay 58 is not operated when brush 63 makes contact with segment 65; and, therefore, at the instant when brush 63′ is in contact with segment 65′ at office Z battery 109′ is impressed through contact 110′ on segment 65′, thereby deënergizing relay 66′. The opening of contact 70′ deënergizes relay 72 opening contact 73 and closing contact 82. The closing of contact 82 establishes a circuit from battery 74 through contacts 87 and 82 and signal lamp 77 to ground, thereby illuminating said lamp and apprising the operator at office Z of the fact that the operator at office W has disconnected. The operator at office Z therefore disconnects plug 78 from jack 79 and thereby restores all relays to normal position. This completes the cycle of signaling operations.

The invention is not limited to the specific arrangements herein set forth, since it is capable of numerous other embodiments which come within the scope of the appended claims.

What is claimed is:

1. The combination of an operating circuit extending between two points, a conductive path distinct from but assigned to said circuit also extending between said points, a plurality of local translating circuits individual to said operating circuit at said points, and switching apparatus at the opposite ends of said conductive path for successively connecting corresponding local trans-

lating circuits to the two ends of said conductive path.

2. The combination of a plurality of operating circuits extending between two points, a conductive path associated with said operating circuits, a plurality of local translating circuits individual to said operating circuits, and switching apparatus operating at the opposite ends of said conductive path for successively connecting corresponding local translating circuits to the two ends of said conductive path.

3. In a telephone system, the combination of a telephone circuit extending between two offices; a plurality of local translating circuits individual to said telephone circuit at each of said offices, said local translating circuits at one office corresponding, respectively, to said local translating circuits at the other office; a conductive path extending between said offices; and switching apparatus at the opposite ends of said conductive path for successively connecting corresponding local translating circuits to the two ends of said conductive path.

4. In a telephone system, the combination of a plurality of telephone circuits extending between two offices; a conductive path associated with said telephone circuits; a plurality of local translating circuits individual to said telephone circuits at each of said offices; and switching apparatus at the opposite ends of said conductive path for successively connecting corresponding local translating circuits to the two ends of said conductive path.

5. In a telephone system, the combination of a plurality of telephone circuits extending between two offices; a common signaling path for said telephone circuits; a local signaling circuit individual to each of said telephone circuits at each of said offices; and switching apparatus at each of said offices for successively connecting said local signaling circuits to said common signaling path.

6. In a telephone system, the combination of a plurality of telephone circuits extending between two offices; a signaling path common to said telephone circuits; local signaling circuits at each of said offices individual to each of said telephone circuits; and automatic means operating to connect corresponding local signaling circuits with each other over said common signaling path.

7. In a telephone system, the combination of a plurality of telephone circuits; a signaling path common to said telephone circuits; switching apparatus at each end of said signaling path, said switching apparatus having switch arms connected to the ends of said signaling path and having contact terminals with which said arms successively connect, and a plurality of local signaling circuits for each end of each of said telephone circuits and individual thereto, the local signaling circuits of each telephone circuit being connected to corresponding contact terminals of said switching apparatus at the two ends of said common signaling path.

8. In a telephone system, the combination of a plurality of telephone circuits, a signaling path common to said telephone circuits, local signaling circuits for each end of each of said telephone circuits and individual thereto, switching apparatus at each end of said signaling path for successively connecting corresponding local signaling circuits to the ends of said common signaling path, subscribers' lines adapted to be connected to said telephone circuits, and means by which the connected signaling circuits may be extended over said subscribers' lines.

9. In a telephone system, the combination of a plurality of telephone circuits extending between two offices; a signaling path, likewise extending between said offices, common to said telephone circuits; local signaling circuits, individual to said telephone circuits, at each of said offices; switching apparatus at each of said offices operating when any one of said telephone circuits is taken for use to connect its local signaling circuits with each other over said signaling path; subscribers' lines adapted to be connected to said telephone circuits; and means by which the local signaling circuits of a telephone circuit are extended over a subscribers' line when the latter is connected to the telephone circuit.

10. In a telephone system, the combination of a telephone circuit extending between two offices; a signaling path likewise extending between said offices; local signaling circuits for each end of said telephone circuit and individual thereto; switching apparatus at each end of said signaling path for connecting said local signaling circuits to the ends of said signaling path; subscribers' lines adapted to be connected to said telephone circuit; and means by which one of said local signaling circuits may be extended over a subscriber's line when the latter is connected to said telephone circuit.

11. In a telephone system, the combination of a plurality of telephone circuits extending between two offices, a signaling path common to said telephone circuits, local signaling circuits at each of said offices associated with said telephone circuits, switching apparatus at each end of said signaling path for successively connecting corresponding local signaling circuits to the ends of said common signaling path, switching mechanism at said offices associated with said telephone circuits, and means under the control of said switching mechanisms for signaling over said common signaling path and said local signaling circuits.

12. In a telephone system, the combination

of a plurality of telephone circuits extending between two offices, a signaling path common to said telephone circuits, local signaling circuits at each of said offices associated with said telephone circuits, switching apparatus at each end of said signaling path for successively connecting corresponding local signaling circuits to the ends of said common signaling path, and electromagnetic switching mechanisms associated with said telephone circuits and with said local signaling circuits for signaling over said common path and said local signaling circuits.

13. In a telephone system, the combination of a plurality of trunk telephone circuits extending between two offices, local telephone circuits connecting subscribers' stations with said trunk telephone circuits, a signaling path common to said local telephone circuits, local signaling circuits at each of said offices associated with said trunk telephone circuits, switching apparatus operating at each end of said signaling path for successively connecting corresponding local signaling circuits to the ends of said common signaling path, and means associated with said trunk telephone circuits and said local signaling circuits for changing the condition existing on local telephone circuits which may be connected with said trunk telephone circuits.

14. In a telephone system, the combination of a plurality of trunk telephone circuits extending between two offices, local telephone circuits connecting subscribers' stations with the said trunk telephone circuits, a signaling path common to said trunk telephone circuits, local signaling circuits at each of said offices associated with said trunk telephone circuits, switching apparatus operating at each end of said signaling path for successively connecting corresponding local signaling circuits to the ends of said common signaling path, and means associated with said trunk telephone circuits and said local signaling circuits for controlling the indication of the condition existing on the local telephone circuits which may be connected with the said trunk telephone circuits.

15. In a telephone system, a telephone circuit extending between two offices, a signaling path distinct from, but assigned to said telephone circuit, local signaling circuits individual to said telephone circuit at each office, switching apparatus, operating to connect the local signaling circuits with said path, subscribers' stations, means to connect said telephone circuit with said subscribers' stations, and means operative over said signaling path, to apply signaling current over the subscriber's line when connected to said telephone circuit.

16. The combination of an operating circuit extending between two points, a signaling path between said points, a plurality of local signaling circuits individual to said operating circuit at said points, relays associated with the ends of said signaling path, and switching apparatus at the opposite ends of said signaling path for successively connecting corresponding local signaling circuits to said relays.

17. In a telephone system, the combination of a trunk circuit extending between two offices; a signaling path likewise extending between said offices; local signaling circuits for each end of said trunk circuit and individual thereto; switching apparatus at each end of said signaling path for connecting said local signaling circuits to the ends of said signaling path; extensions adapted to be connected to said trunk; and means by which one of said local signaling circuits may be extended over an extension when the latter is connected to said trunk.

In testimony whereof, I have signed my name to this specification in the presence of two subscribing witnesses, this 27th day of August 1915.

BANCROFT GHERARDI.

Witnesses:
G. E. FOLK,
K. W. WATERSON.