

B. GHERARDI.
 SIGNALING SYSTEM FOR MULTIPLEX TELEPHONE CIRCUITS.
 APPLICATION FILED NOV. 24, 1916.

1,251,364.

Patented Dec. 25, 1917.

3 SHEETS—SHEET 1.

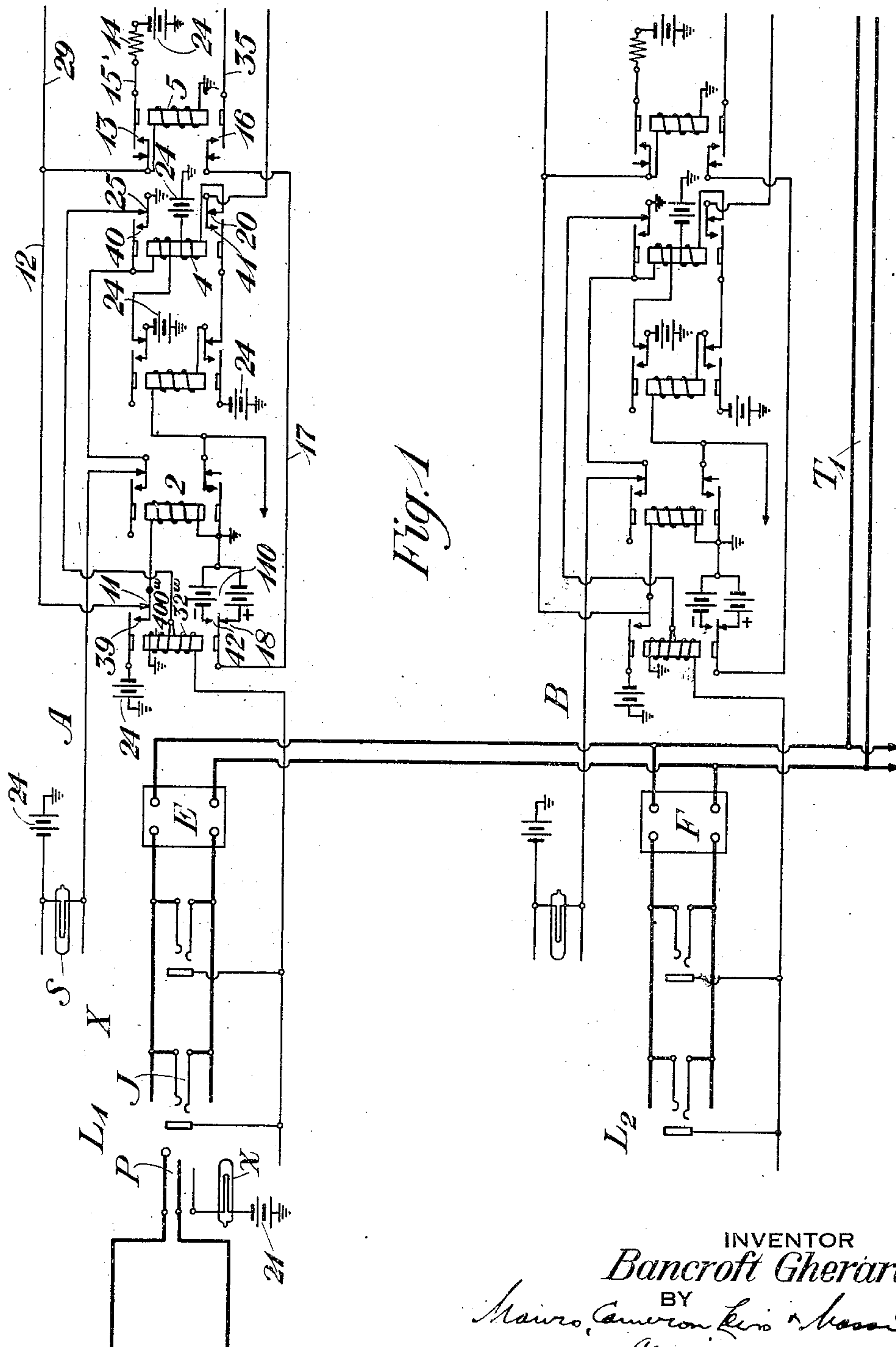


Fig. 1

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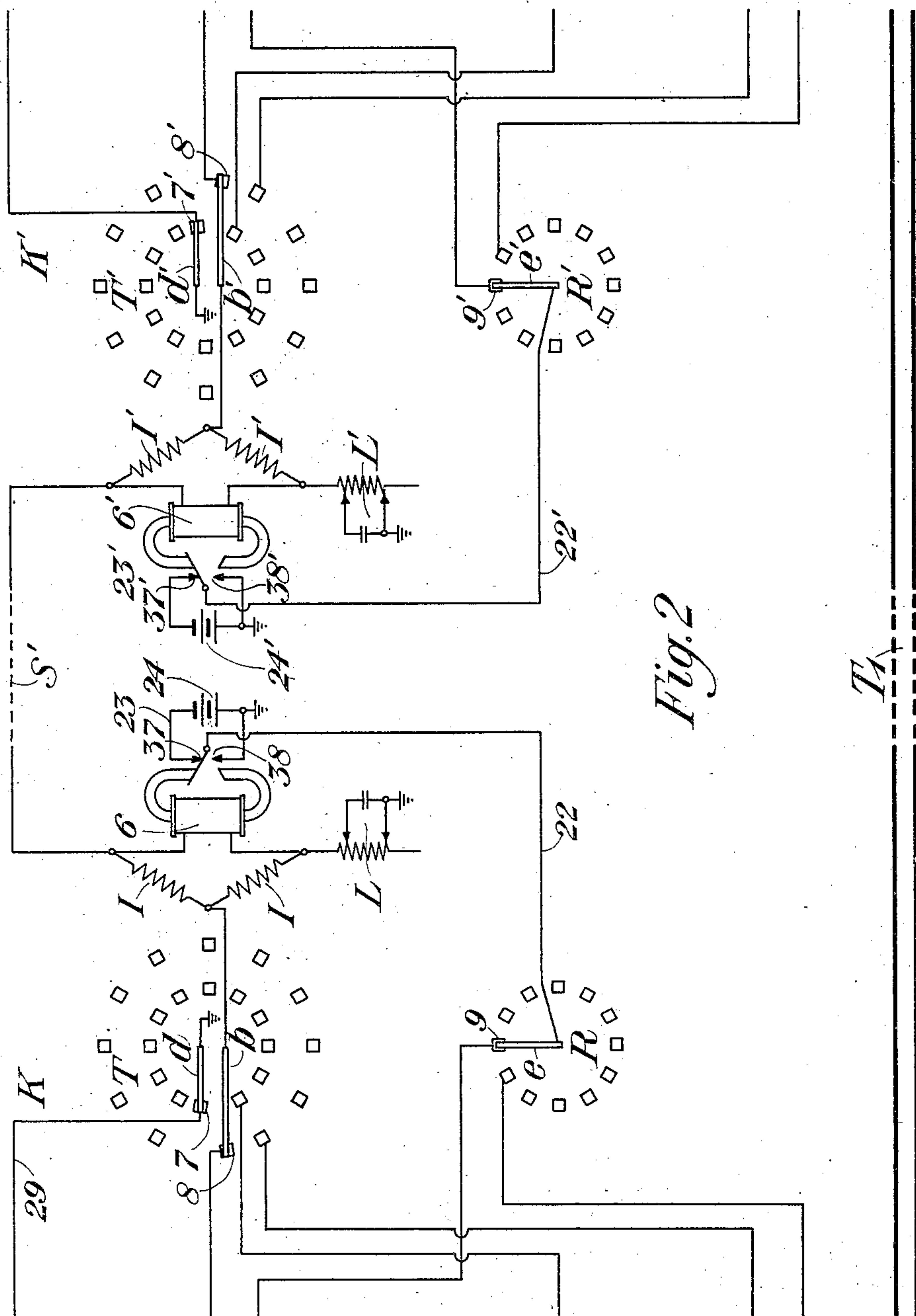
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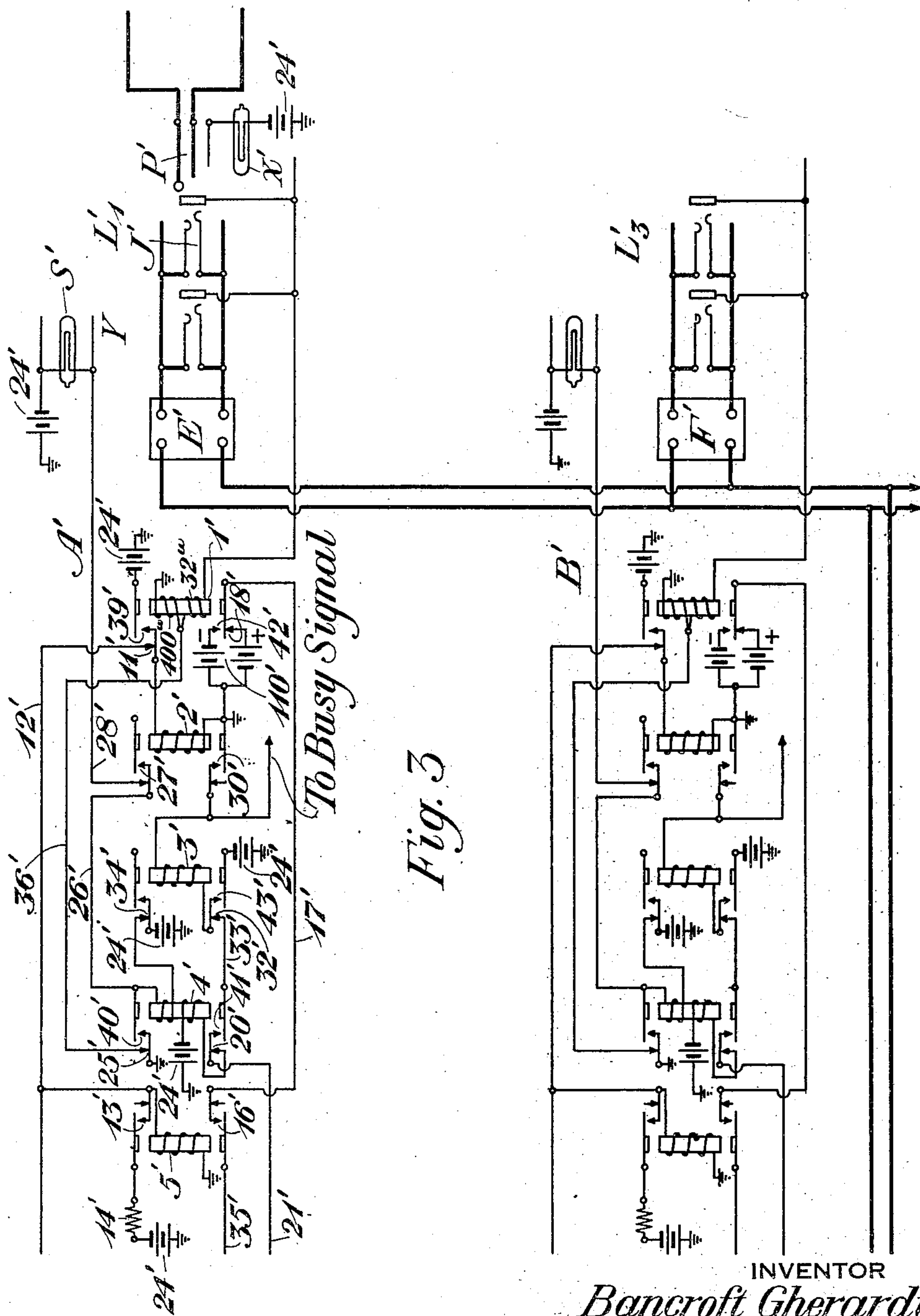


Fig. 3

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UNITED STATES PATENT OFFICE.

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

SIGNALING SYSTEM FOR MULTIPLEX TELEPHONE-CIRCUITS.

1,251,364.

Specification of Letters Patent.

Patented Dec. 25, 1917.

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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 for Multiplex Telephone-Circuits, of which the following is a specification.

This invention relates primarily to a signaling system for use in connection with multiplex telephone systems, as for example the system in which several telephone conversations may be carried simultaneously over the same wire or pair of wires by means of carrier currents similar to those employed in wireless telephony and wireless telegraphy.

By means of such systems two or more simultaneous telephone conversations may be carried on over a single telephone trunk circuit, but to utilize such a system it is necessary to have means for transmitting between the two terminals of this multiplexed telephone trunk signals individual to each separate telephone channel, so that, for example, when any conversation is completed, that fact may be made known at both ends of the trunk and thus the particular connection can be disconnected from the trunk without interrupting the other conversations in progress at the same time.

Up to the present time, while numerous multiplex telephone systems have been described, no satisfactory method of suitably controlling signals in connection with each conversation channel of multiplex systems has been proposed. It is the purpose of this invention to overcome the above mentioned difficulties by providing for each telephone trunk circuit at each end thereof a number of local signaling circuits equal to the number of conversation channels, these local signaling circuits at each end being controlled and kept in association with each other by a signaling wire or path having at its two ends switching mechanisms operating in synchronism to connect the corresponding local signaling circuits simultaneously with the two ends of the signaling wire. The signaling wire or path referred to above might be a separate wire, or it might be one of the channels passing over the telephone trunk which would be assigned to that purpose and which might otherwise have been used for a telephone conversation; or it might be an

ordinary telegraph circuit simplexed or composed on the telephone trunk or any other means of passing electric currents. For the purposes of the illustration which I give below, I have shown the system operating with a separate signaling wire, this wire being duplexed and being equipped at either end with the synchronous device already referred to.

The construction and operation of the signaling system may be more readily understood by reference to the appended drawings, Figures 1 to 3 inclusive of which, when placed side by side in numerical order, illustrate such portions of the complete circuit arrangement and apparatus as is necessary for a full understanding of the invention. For convenience it has been assumed that each trunk is equipped with translators so that a plurality of conversations can be carried on simultaneously. The drawing shows but one trunk circuit but it is obvious that any number of trunks can be employed with the signaling method outlined. Some of these trunks might be "phantom circuits." In order, however, to make the description of the circuit clearer but one arrangement has been shown. On this drawing X and Y represent two offices connected by a plurality of trunk circuits similar to T-1, each provided with translators E, F, etc., whereby a plurality of simultaneously operating talking connections may be extended over the trunk. Extending between the two offices and common to a plurality of trunk circuits is a signaling path or wire S' shown in the drawing as having a ground return. This signaling wire is arranged for duplex operation for which purpose there is provided at the ends of the wire artificial balancing lines L, L' and retardation coils I and I'. Across the ends of each set of retardation coils are bridged the polarized relays 6 and 6' at offices X and Y respectively.

The two ends of the signaling wire S' are connected to interrupters K and K', interrupter K having a transmitting section T and a receiving section R, interrupter K' having, correspondingly, sections T' and R'. The interrupters as conventionally shown in the drawing, are preferably the well-known multiplex distributors that are employed in connection with multiplex printing telegraph systems and are provided with a syn-

chronizing device (not shown) by means of which synchronism is automatically maintained between the brushes *b*, *d*, *e* and *b'*, *d'*, *e'*. These brushes revolve continuously and make contact with the segments or terminals of the interrupters. The local signaling circuits A, B, etc., and A', B', etc., associated with the various telephone circuits which may be simultaneously extended over trunk T—1 and individual thereto, are represented on corresponding transmitting terminals 8 and 8' and on corresponding receiving terminals 9 and 9'.

In the particular arrangement shown, 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. For convenient reference the corresponding parts at the two offices are designated by the same reference numerals, the numerals at office X without and those at office Y with primes.

With this general description in mind the invention can now be fully understood from the operation thereof, which is as follows:

Assuming that the operator at office X desires to establish a connection to office Y, using the conversation channel terminating at *L*₁, the plug P is inserted in jack J thereby connecting battery 24 through the supervisory lamp signal *x* and the 32-ohm winding of relay 1 to ground, causing the lamp to be illuminated; also relay 1 is energized and through its contact 39 connects battery to the winding of relay 2 causing it to operate. It should be noted that contacts 11—39 of relay 1 are of the make-break type so that when the springs are operated one of the contacts is made before the other is broken. Therefore, at the moment when contact 39 is made a momentary circuit is established from battery 24 through contacts 39 and 11 over conductor 12 to the winding of relay 5 to ground. This momentary impulse causes relay 5 to operate and close contact 13 which closes a circuit from battery 24, through resistance 14, over conductor 15, through contact 13, through the winding of relay 5 to ground, this latter circuit causing the relay to remain energized after it has been operated by the momentary impulse caused by the operation of relay 1. The operation of relay 5 also causes contact 16 to close, which connects segment 8 of interrupter K over conductors 35 and 17, through contact 42 of relay 1, now energized, to the negative pole of battery 110.

Interrupters K and K' are operating in synchronism and therefore while the brushes *b* and *d* of interrupter K are in contact with terminals 7 and 8, the brushes *b'* and *d'* of interrupter K' are in contact with the cor-

responding terminals 7' and 8' respectively. During the time these contacts are closed, negative current flows from battery 110, through contact 18 of relay 1, over conductor 17, through contact 16 of relay 5, and conductor 35, to segment 8, brush *b*, over line S' through winding of relay 6' and artificial line L' to ground, operating the polarized relay 6' at office Y, thereby closing the circuit of relay 4' from battery 24', through winding and contact 20' of relay 4' over conductor 21' to segment 9' of interrupter K', to brush *e'*, over conductor 22', through contact 38' of polar relay 6' to the ground side of battery 24'; said circuit causing relay 4' to be energized. The operation of relay 4' closes contact 40' thereby completing a locking circuit for relay 4' from ground contact 40', winding of 4', upper normal contact of relay 3', to battery 24'. Contact 40' also connects ground over conductor 26' to contact 27' of relay 2', over conductor 28' to the line lamp S' of the conversation channel terminating at *L*₁', to battery 24'; said circuit causing the lamp to light and thereby notify the operator at office Y that she is wanted on that particular circuit.

At the instant when brush *b* of interrupter K is in contact with segment 8, brush *d* of the same interrupter is in contact with segment 7. At the instant this latter circuit is closed, ground is connected from brush *d* to segment 7 over conductor 29 to the winding of relay 5 which is thereby short-circuited and caused to release and open its contacts 13 and 16. The object in opening contacts 13 and 16 is for the purpose of preventing further operation of the circuits closed by these contacts and also to prevent an unnecessary waste of current.

The operator at office Y inserts plug P' in jack J' of the circuit terminating at *L*₁' in answer to the signal received, when battery 24' is connected through the supervisory signal lamp *x'*, through the windings of relay 1' to ground, causing relay 1' to operate. The lamp *x'* is not lighted at this time because contact 25' of relay 4' has disconnected the ground that has been connected to the 32-ohm winding of relay 1' over conductor 36', and the circuit of lamp *x'* passes through the 400-ohm winding of relay 1'. The operation of relay 1' closes contacts 39' and 18' and establishes the following circuits: from battery 24' through contact 39', to the winding of relay 2' and to ground, causing this relay to operate. When relay 2' operates, its contact 27' opens the circuit of the line signal S' causing it to be extinguished. The other set of contacts 30' of relay 2' closes two circuits one of which operates the busy signals associated with the switchboard jacks and the second path prepares the circuit of relay

3' as follows: Ground is connected through contact 30' of relay 2' through the winding of relay 3', through contact 32' of relay 3', over conductor 33', through contact 41' of relay 4' which is now energized; over conductor 21', through segment 9' of interrupter K', over conductor 22' and alternate contact 38' of polar relay 6' to ground. Relay 3', however, is not operated because its circuit at this time is grounded at both ends.

At the instant when relay 1' operates, a momentary circuit is established as follows: from battery 24' through contacts 39' and 11' of relay 1', over conductor 12', and through the winding of relay 5' to ground, causing this relay to operate and close contacts 13' and 16'. Contact 13' closes a circuit from battery 24', through resistance 14', over contact 13' and through the winding of relay 5' to ground, causing this relay to remain operated after it has been energized by the momentary impulse created by the operation of relay 1'. Contact 16' closes the following circuit: from the negative pole of battery 110', through contact 42' of relay 1', (now energized), over conductor 17', through contact 16' of relay 5', over conductor 35' to segment 8' of interrupter K', through brush b', over the signaling wire S', through the winding of polar relay 6, and through the artificial line L to ground, causing polar relay 6 to operate and connect ground through its contact 38, over conductor 22, to brush e of interrupter K, to segment 9, through contact 20 and winding of relay 4, to battery 24, causing relay 4 to operate. The operation of relay 4 closes contacts 40 and 41 and opens contacts 20 and 25 which establish the following circuit change: Contact 25 opens the ground which has been connected to the 32-ohm winding of relay 1, over conductor 36. The removal of this ground increases the resistance in series with the lamp α so that it will not receive enough current to remain illuminated. Lamp α is therefore extinguished, which indicates to the operator at office X that the operator at office Y has answered the call.

At the same instant that brush b' on interrupter K' was in contact with segment 8', brush d' was also in contact with segment 7'. As soon as this latter contact is made, ground is connected to the winding of relay 5' thereby shortcircuiting it and causing it to release and open its contacts 13' and 16' thus preventing the further operation of the circuits controlled by these contacts.

From the foregoing it will be seen that the operator at office Y in answering the signal by inserting plug P' in jack J' causes a cycle of operations which results in the extinguishing of the supervisory signal lamp α at office X, thereby informing the operator at that office that the operator at office Y has responded. Assuming now that the

operator at office X removes the plug P from jack J associated with circuit L, this operation releases relay 1 which, while releasing, momentarily establishes through contacts 39 and 11 the following circuit: from battery 24 through contacts 39 and 11, over conductor 12, through the winding of relay 5 to ground, causing relay 5 to operate and close its contacts 13 and 16. Contact 13 connects battery 24, through resistance 14, and over conductor 15 and contact 13, through the winding of relay 5 to ground, causing it to remain operated. Contact 16 closes the following circuit: from the positive pole of battery 110, through contact 18 of relay 1, over conductor 17, through contact 16 of relay 5, over conductor 35, to segment 8 of interrupter K, through brush b, over the signaling wire S', through the winding of polar relay 6', through the artificial line L' to ground. The operation of relay 6' closes the following circuits through its contact 37'. From grounded battery 24' through contact 37', over conductor 22' to brush e' of interrupter K', to segment 9', over conductor 21', through contact 41' of relay 4', (which is now energized), over conductor 33', through contact 32' of relay 3', through the winding of relay 3', through contact 30' of relay 2' to ground; said circuit causing relay 3' to operate. Contact 34' of this relay opens the locking circuit from battery 24', through the winding of relay 4', over contact 25' to ground, thereby causing relay 4' to release. Contact 43' of relay 3' connects battery 24' to its winding through contact 30 of relay 2' to ground, thereby causing relay 3' to remain operated. When relay 4' is released, ground is connected through its contact 25', over conductor 36', to the 32-ohm winding of relay 1'. The circuit thus established causes sufficient current to flow from battery 24' to lamp α through the 32-ohm winding of relay 1' so that the lamp will be lighted, thereby indicating to the operator at office Y that the operator at office X has removed her plug from the circuit.

The operator at office Y therefore removes plug P' from jack J', which operation releases relay 1'. Relay 1' in releasing establishes the following circuits: battery 24' is momentarily connected through contacts 39' and 11', over conductor 12', through the winding of relay 5' to ground, thereby causing this relay to operate. Contact 13' of relay 5' connects battery 24', through resistance 14', through the winding of relay 5' to ground, causing it to remain operated. Contact 16' of relay 5' closes the following circuit: from the positive pole of battery 110', through contact 18' of relay 1', over conductor 17', through contact 16' of relay 5', over conductor 35', to segment 8' of interrupter K', through brush b', over the signal wire S', through the winding of polar

relay 6, and through the artificial line L to ground. The operation of polar relay 6, however, at this time does not cause any signals to be operated because its contacts connect battery 24 over conductor 22, through brush *e* of interrupter K, to segment 9, and, since relay 4 has been released by the removal of the plug P, over contact 20 and the winding of relay 4 to the same side of the battery, so that no flow of current will result. This completes the cycle of signal operations associated with making and disconnecting a circuit over line L₁ between offices X and Y. The operation for the other circuits shown will be precisely the same.

While for purposes of illustration I have shown and described my invention as embodied in a specific form, it will be understood that the invention is not limited to the specific arrangements herein set forth, since it is capable of numerous other embodiments falling within the scope of the appended claims and may be applied to electrical systems, other than telephone systems when a similar system of signals or control is desirable.

What is claimed is:

1. The combination of a plurality of operating circuits, a common trunk over which said circuits may be simultaneously extended between two points, a conductive path distinct from but common to said circuits also extending between said points, a plurality of local translating circuits individual to said operating circuits at said points, 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.

2. In a telephone system, the combination of a plurality of telephone circuits, a common telephone trunk over which said circuits may be simultaneously extended between two offices, a plurality of local translating circuits individual to said telephone circuits 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 signaling path.

3. In a telephone system, the combination of a plurality of trunks extending between two offices, a plurality of talking circuits simultaneously extending over each trunk, a plurality of local signaling circuits individual to said talking circuits at each of said offices, a signaling path extending between said offices, and switching apparatus at the opposite ends of said signaling path for

successively connecting the corresponding local signaling circuits to the two ends of said signaling path.

4. In a telephone system, the combination of a plurality of trunks extending between two offices, a plurality of talking circuits simultaneously extending over each trunk, a plurality of local signaling circuits, one for each of said talking circuits and individual thereto at each of said offices, a signaling path common to the plurality of said trunks extending between said offices, and switching apparatus at the opposite ends of said signaling path for successively connecting the local signaling circuits associated with a plurality of trunks to the signaling path.

5. The combination of a plurality of operating circuits, a common trunk over which said circuits may be simultaneously extended between two points, a common signaling path for said operating circuits, a plurality of local signaling circuits each individual to one of said operating circuits, and switching apparatus operated at the opposite ends of said signaling path for successively connecting corresponding local signaling circuits to the two ends of said signaling path.

6. In a telephone system, a plurality of telephone circuits, a common trunk over which said circuits may be simultaneously extended between two points, 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 automatic means operating to successively connect corresponding local signaling circuits with each other over said common signaling path.

7. In a signaling system, the combination of a plurality of operating circuits, a common trunk over which said circuits may be simultaneously extended between two points, a signaling path common to said operating circuits, local signaling circuits at each of said points associated with said operating 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 points associated with said operating circuits, and means under the control of said switching mechanism for signaling over said common signaling path and said local signaling circuits.

8. In a signaling system, the combination of a plurality of operating circuits, a common trunk over which said circuits may be simultaneously extended between two offices, a signaling path common to said operating circuits, local signaling circuits at each of said offices associated with said operating 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, and
5 electromagnetic switching mechanism associated with said operating circuits and with said local signaling circuits for signaling over said common signaling path and said local signaling circuits.

10 9. The combination of a plurality of operating circuits, a common trunk over which said circuits may be extended between two points, a signaling path between said points, a signaling circuit individual to each of said
15 operating circuits at each of said points, relays associated with the ends of said path, and switching apparatus at the opposite ends of said signaling path for successively connecting corresponding local signaling
20 circuits to said relays.

10. In a signaling system, the combina-

tion of a plurality of trunks extending between two points, a plurality of simultaneously operating communication circuits extending over each trunk and common there- 25
to, a signaling circuit at each point individual to each communication circuit, a signaling path common to a plurality of trunks extending between said points, and means to successively connect the local signaling cir- 30
cuits corresponding to the communication circuits of a plurality of trunks to the ends of said signaling path.

In testimony whereof, I have signed my name to this specification in the presence 35
of two subscribing witnesses, this twenty-first day of November, 1916.

BANCROFT GHERARDI.

Witnesses:

SAMUEL RASMISAN,
R. S. SUTLIFFE.