

Jan. 24, 1933.

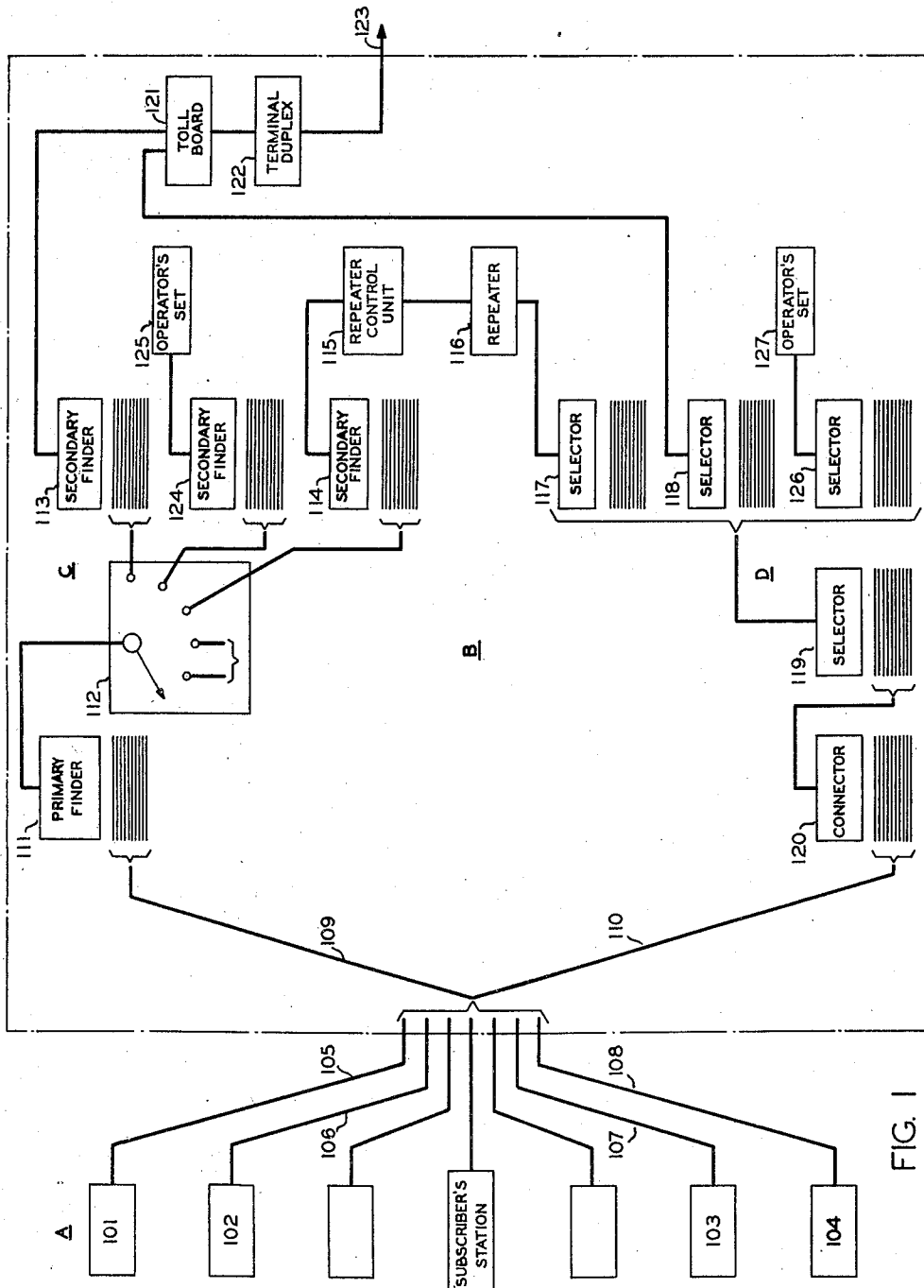
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1,895,097

PRINTING TELEGRAPH EXCHANGE SWITCHING SYSTEM

Filed Sept. 5, 1931

5 Sheets-Sheet 1



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PRINTING TELEGRAPH EXCHANGE SWITCHING SYSTEM

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5 Sheets-Sheet 2

FIG. 2A

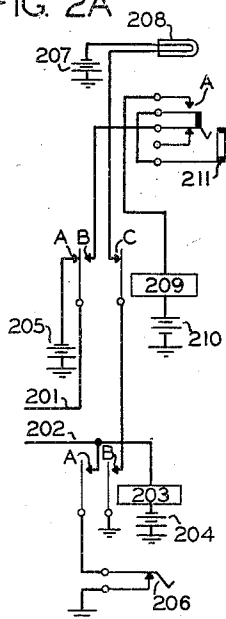


FIG. 2B

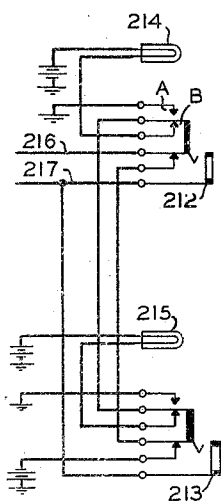
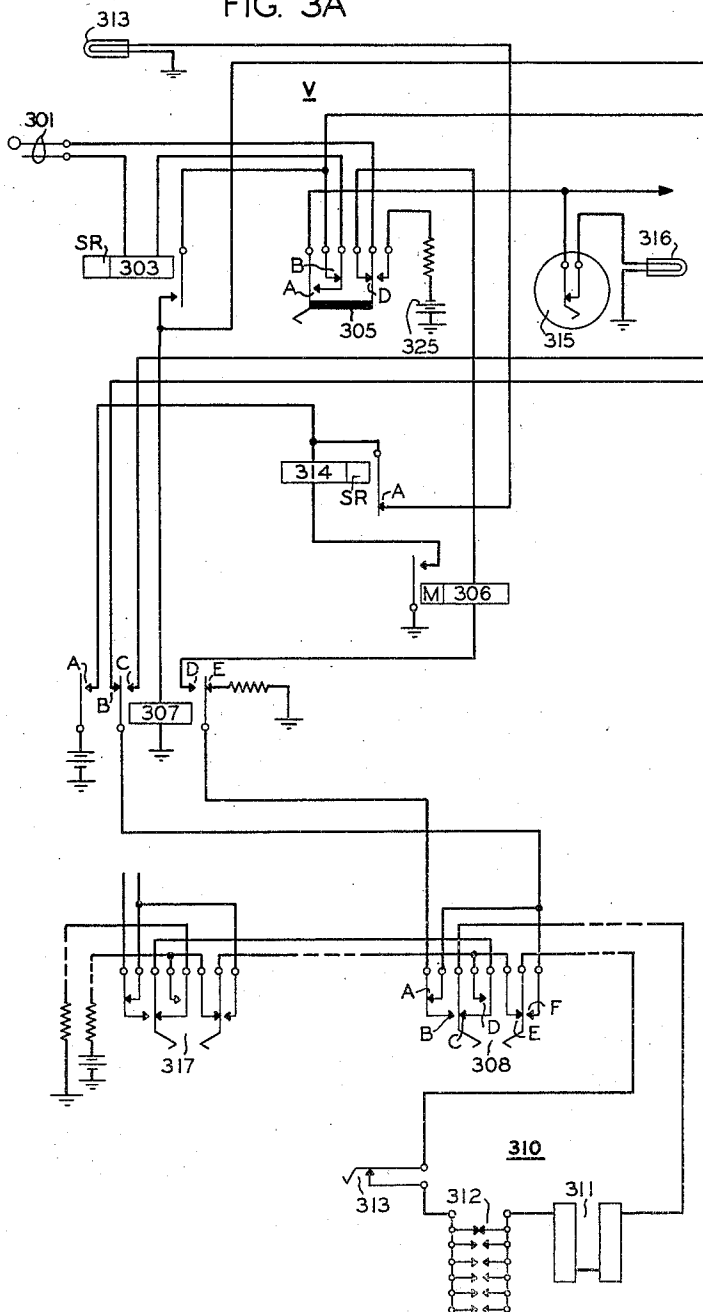


FIG. 3A



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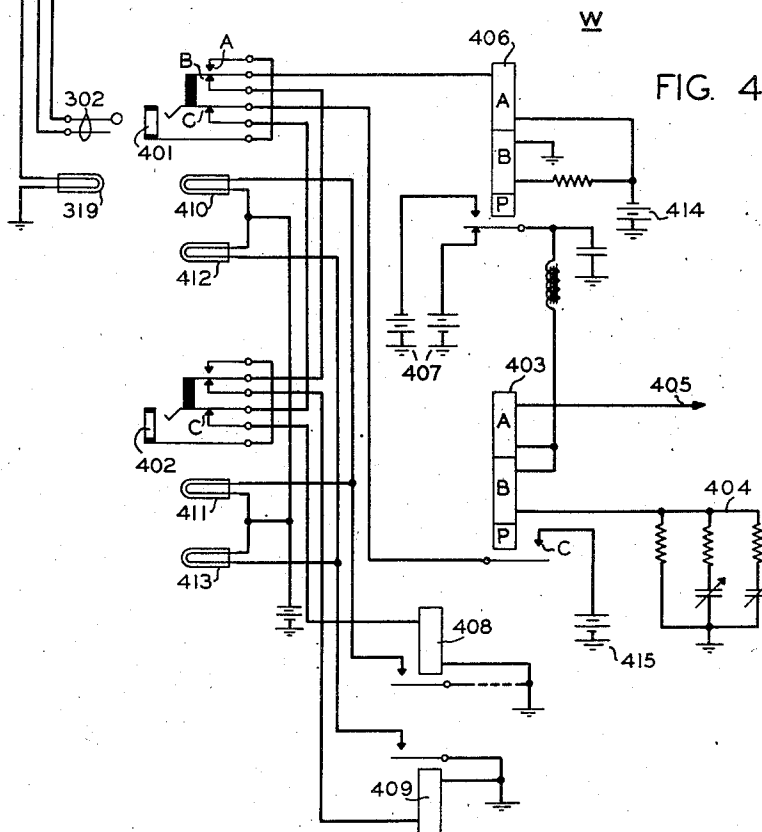
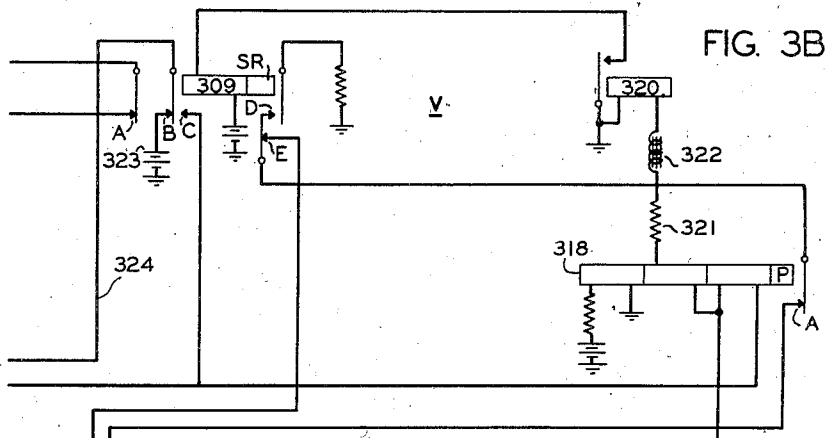
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5 Sheets-Sheet 3



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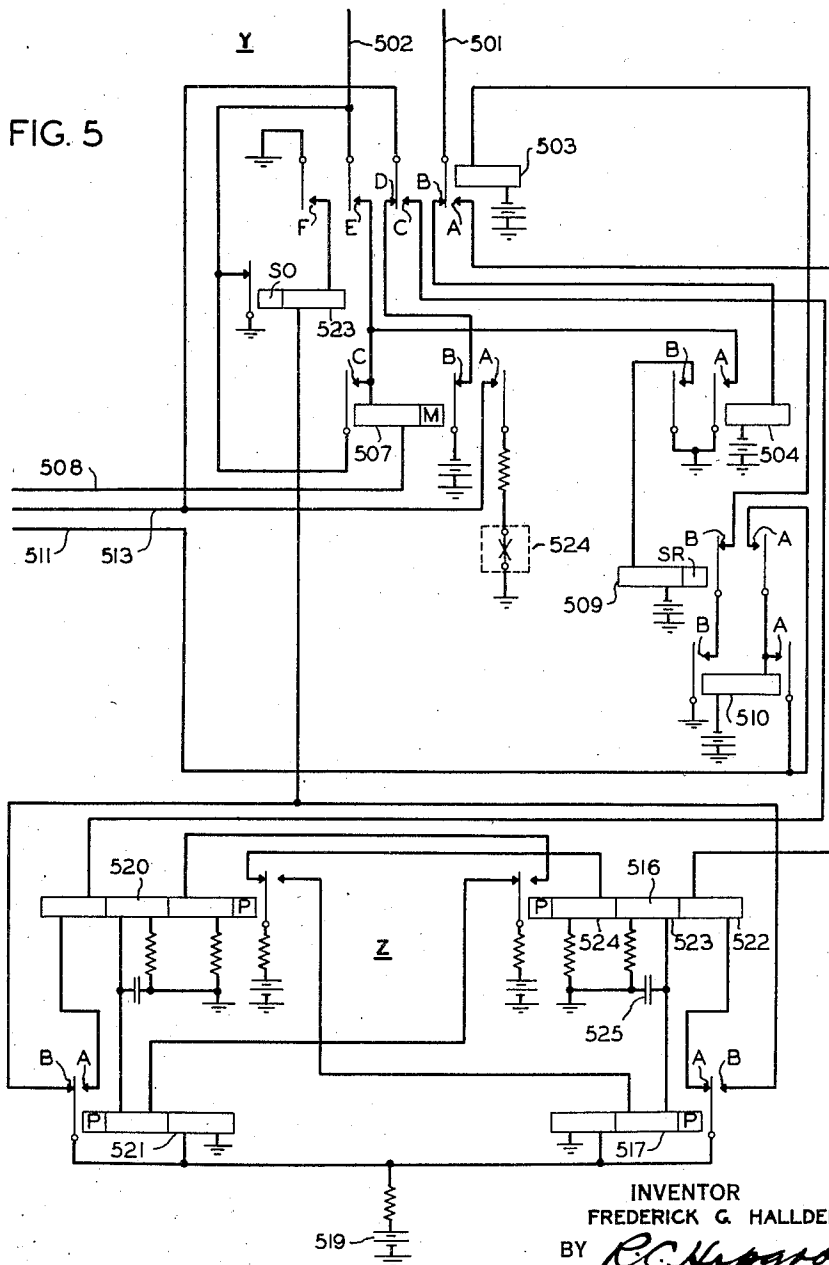
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PRINTING TELEGRAPH EXCHANGE SWITCHING SYSTEM

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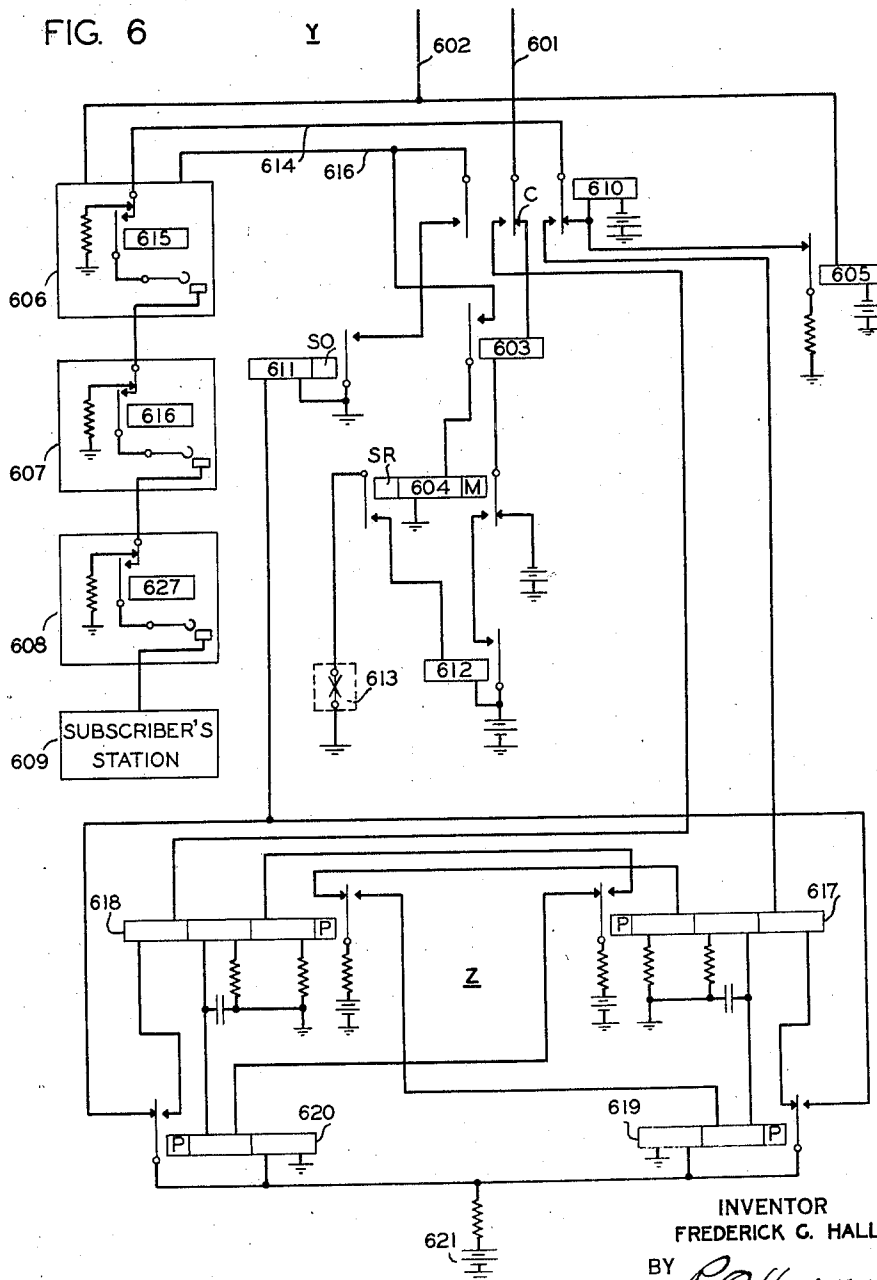
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PRINTING TELEGRAPH EXCHANGE SWITCHING SYSTEM

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PRINTING TELEGRAPH EXCHANGE SWITCHING SYSTEM

Application filed September 5, 1931. Serial No. 561,323.

This invention relates in general to printing telegraph exchange systems and more particularly to printing telegraph exchange systems for interconnecting not only subscribers' stations associated with the same central office, but also subscribers' stations associated with different central offices.

One of the objects of this invention is to provide a printing telegraph exchange system wherein automatic means are employed for interconnecting subscribers' stations associated with the same central office, or for interconnecting in either direction any one of the subscribers' stations and the associated central office, and wherein semi-automatic means are employed for interconnecting subscribers' stations associated with different central offices.

A further object is to provide a printing telegraph exchange system that affords great flexibility in the types of calls which can be made from any subscriber's station.

In the printing telegraph exchange systems of the prior art, there are systems that permit automatic interconnection between subscribers' stations associated with the same central office, and other systems that permit interconnection between subscribers' stations associated with different central offices; but, so far as applicant is aware, there are no systems that permit both types of interconnection. If the communication requirements of large cities are to be met, and maximum flexibility in the type of calls available to subscribers secured, printing telegraph exchange systems co-ordinating both types of interconnection are necessary.

Accordingly, one of the main features of the present invention is the means by which a subscriber can select either a connection with an idle printer at the associated central office, a connection to a repeater control unit through which he can automatically establish a connection with any called subscriber's station associated with the same central office, or a connection with a toll board through which he can obtain connection with a second central office and then with any called subscriber's station associated therewith.

Another feature is the semi-automatic

means for establishing connection between subscribers' stations associated with different central offices.

A further feature is the repeater control unit interposed between the group of switches extending from a calling subscriber's station and the group of switches extending to a called subscriber's station. This unit has a number of functions, among which may be enumerated the control of the second-mentioned group of switches, the control of a single line repeater, the control of the printer motors at both stations, and the control of an interrupter for indicating when the called subscriber's station is busy.

Other features will become apparent from the following description and from the accompanying drawings, as well as from the appended claims.

The preferred embodiment of the invention is illustrated in the accompanying drawings, of which:

Fig. 1 illustrates diagrammatically the general arrangement of the system;

Figs. 2—A and 2—B illustrate, respectively, the incoming and outgoing local trunk jack circuits at the toll board;

Figs. 3A and 3B illustrate the cord circuit for connecting incoming or outgoing local trunk jacks with the toll board line jack;

Fig. 4 illustrates the toll line jacks on the toll board, together with the associated duplex set;

Fig. 5 illustrates the repeater control unit and its associated single line repeater; and

Fig. 6 illustrates an alternative arrangement of the repeater control unit and single line repeater.

Referring now to Fig. 1, a plurality of subscribers' stations A are shown connected by lines 105-108 to a central office B. At this central office these lines are multiplied by conductors, as 109 and 110, to the branches C and D of automatic switches. The branch C, which may be termed a concentration circuit, includes groups of primary finders 111, selecting circuits 112, and groups of secondary finders 113, 114 and 124. The branch D, which may be termed a switching circuit, includes groups of connectors 120, groups of

second selectors 119, and groups of first selectors 117, 118 and 126. The concentration circuit C is associated through groups of secondary finders 113 with a toll board 121, through groups of secondary finders 114 with repeater control units 115, and through groups of secondary finders 124 with central station receiving operator's sets 125. The repeater control units 115 are associated with repeaters 116 which are, in turn, associated with groups of first selectors 117 and, thus, with the switching circuit D. The toll board 121 is, in turn, associated through a terminal duplex set 122 and toll line 123 with another central office (not shown) identical with B. This second central office has associated with it a plurality of subscribers' stations similar to A, which are likewise multiplied to a concentration circuit and a switching circuit which, respectively, include the switches and circuits previously described. The toll board 121 is also associated with groups of first selectors 118 and, hence, with the switching circuit D.

To contribute to a clearer understanding of the detailed description to follow, a general description will now be given of the operations occurring when the following connections are established: (1) a connection in either direction between a subscriber's station and an idle printer at the associated central office; (2) a connection between two subscribers' stations associated with the same central office; (3) a connection between two subscribers' stations associated with different central offices.

The sequence of operations that occurs when a connection is extended between a subscriber's station and an idle printer at the associated central office, that is, between subscriber's station 101 and a printer in group 125, will first be described. The subscriber 101 initiates a call which causes an idle primary finder in the group 111 at the central office B to operate and extend the line 105 to an idle selecting circuit 112. The subscriber 101 is automatically notified when this operation is completed, and he then dials the number that is assigned to the groups of secondary finders 124 with which are associated the receiving operator's sets 125. The impulses cause an idle secondary finder in that group to extend the line 105 to an idle printer in group 125, and the establishment of this connection automatically reverses the line current, thereby starting the calling subscriber's printer motor and, thus, giving him a signal that he can begin sending. It is to be noted that the central office printer is constantly running while the tending operator is on duty. When communication is ended, the circuit between the stations is released by the central station operator, and the release of the circuit causes a reversal of the line cur-

rent which stops the subscriber's printer motor.

When a connection is extended from a central office printer in group 127 to a subscriber's station, as 104, the following operations take place. The central station operator throws a key (not shown) which conditions for operation a first selector of group 126 individual to the operator's printer. The operator then dials the number assigned to subscriber's station 104 and the dialled impulses successively operate the above-mentioned selector in group 126, a selector in group 119, and a connector in group 120, thus establishing connection between the central office printer and the customer's station 104. After connection has been established, the central station operator throws a key, which reverses the current in the subscriber's line and starts his printer motor. As the central station printer motor is running continuously, communication can be carried on. At the end of the communication, the circuit is broken, and the subscriber's printer motor stopped by means under control of the central station operator.

The operations that ensue when a connection is extended between two subscribers' stations associated with the same central office are the same as those occurring in the extension of a connection between a subscriber's station and an idle printer at the associated central office, up to the point prior to the dialling by the subscriber. The subscriber dials the number assigned to group 114 of the secondary finders with which are associated the repeater control units 115. The impulses cause an idle secondary finder in that group to extend a subscriber's line, such as 105, to the repeater control unit, and, at the same time, the subscriber is informed that his line has been thus extended. Thereupon, he dials the number of the called subscriber and, as the impulses are repeated by the control unit, a first selector in group 117, a second selector in group 119, and a connector in group 120 are operated to connect with the called subscriber's line 106. Though the subscribers' stations are thus interconnected, the printer motors at these stations are at rest. It is, therefore, necessary that the calling subscriber 101 operate a key which cuts in the repeater 116, reversing the current over lines 105 and 106 and starting both printer motors in a manner that will be described hereafter. Communication can then be carried on between the two stations by printer, and, upon its termination, either subscriber 101 or 102 can break the communication circuit, stop both printer motors, and restore the operated switches to normal. If the called subscriber's line is busy, the act of the calling subscriber 101, in cutting in the repeater, will cause an interrupter, previously connected by the repeater control unit to one loop of the

repeater, to operate a bell on the calling subscriber's printer to indicate the busy condition of the called subscriber's line. The calling subscriber can then restore the circuits to normal, as mentioned above.

The semi-automatic extension of a connection between two subscribers' lines associated with different central offices is effected in the following manner. Subscriber 103 initiates a call and this causes an idle primary finder in group 111 to extend the subscriber's line 107 to an idle selecting circuit in 112. When apprised that his circuit has been so extended, the subscriber dials the digit assigned to the toll board 121, thus operating the selecting circuit to connect with an idle secondary finder in group 113, which automatically connects his line 107 to the toll board 121 and lights a calling lamp on the board. In response to this signal, the toll board operator plugs the answering cord of a cord circuit into the proper jack and, after ascertaining the number of the called subscriber's station, establishes a connection through terminal duplex set 122 and over line 123 to the central office with which that station is associated. The operator at this second central station establishes a connection with the called subscriber, in a manner to be described in detail hereafter, by operating the switches in a switching circuit, as D, by means of a dial in a cord circuit, and, the communication circuit being thus established, communication can be carried on between the subscribers' stations. The printer motors at these stations are started by the operator at the associated central station after connection to the central station has been established. Either subscriber can terminate the call by opening the line which causes a lamp to light at both toll boards, and, after being satisfied that the communication has ended, the toll board operators pull down their cord circuits and operate a manual key which releases the operated switches, stops both printer motors, and restores all circuits to normal. For a detailed description of the apparatus employed and the operations occurring in the extension of a connection, in either direction, between a subscriber's station and an idle printer at the associated central office, reference is made to the first-mentioned Vernam application.

Referring now to Figs. 1 and 5, a detailed description will be given of that part of the system adapted to extend a connection between subscribers' stations associated with the same central office. This part of the system, as previously mentioned, includes a group of subscribers' stations A (see Fig. 1) and a central office B. At B are located a concentration circuit C, a plurality of repeater control units and repeaters, 115 and 116 respectively, and a switching circuit D. As the subscribers' stations A, the concentration circuit C, and the switching circuit D at

the central office are disclosed in a pending application, Serial No. 470,007, filed July 23, 1930 in the name of G. S. Vernam (henceforth to be termed the first-mentioned Vernam application), they are not described in detail here. The repeaters denoted generally by 116 in Fig. 1 are of the type disclosed in detail by Z in Fig. 5. As this repeater is described in detail in a pending application, Serial No. 462,793, filed June 21, 1930 in the name of F. G. Hallden, only that description which is necessary to explain the co-operation of the repeater Z with the repeater control unit X will be given here. It is, therefore, necessary to describe in detail only the repeater control unit (see Fig. 1—115) and (Fig. 5—Y), to describe enough of the single line repeater (see Fig. 1—116 and Fig. 5—Z) to explain the co-operation between the repeater and the repeater control unit, and to indicate the manner in which the repeater control unit and the repeater co-operate with the concentration circuit (see Fig. 1—C) and the switching circuit (see Fig. 1—D). It may be observed here that the particular arrangement of switches in the concentration and switching circuits as disclosed in the first-mentioned Vernam application is not essential to the present invention, but any arrangement of switches that will perform the function of connecting a calling subscriber's station with a repeater control circuit and then connecting the repeater control unit with a called subscriber's station can be employed. Also, it is to be understood that, in place of the single line repeater disclosed in the above-mentioned Hallden application, any type of single line repeater suitable for the purpose may be substituted.

Referring to Fig. 5, the details of the repeater control unit, denoted generally by 115, Fig. 1, and Y, Fig. 5, will first be described. This repeater control unit Y comprises a marginal relay 504 whose functions are to repeat selecting impulses into the switches of the switching circuit D (see Fig. 1) and to cause the repeater Z to be connected to the calling and called subscribers' stations, a relay 503 for actually connecting in the repeater, a marginal relay 507 for preparing the interrupter 524 for connection with the repeater Z when the called subscriber's line is busy, and the relays 509 and 510 which co-operate to control the relay 503. Also included in the repeater control unit Y is a slow-operating relay 523 whose function is to hold the switches operated in both the concentration and switching circuits, to hold the marginal relay 507 locked, and to control the release of the operated switches through which the subscribers' interconnection is established. The repeater control unit is connected to a particular secondary finder of the group 114, Fig. 1, by the line conductor 501 and the release trunk 502. The manner in

which the line conductor and release trunk are connected to the secondary finder can be observed in detail by reference to the first-mentioned Vernam application.

5 At the repeater control unit Y, the line conductor 501 extends through normally closed contact B of relay 503, winding of marginal relay 504 to grounded negative battery, and the release trunk can be traced from the same
10 secondary finder, through a normally closed contact of the slow-operating relay 523 to ground at the repeater control unit.

Associated with the repeater control unit Y is a single line repeater Z. This repeater consists of the polar line relays 516 and 520 and the polar transmitting relays 517 and 521. Each of the line relays has triple windings 522, 523 and 524. One terminal of winding 522 of relay 516 is connected to grounded positive battery 519 through contact A of transmitting relay 517. The other terminal of winding 522 is connected to a normally open contact A of relay 503 in the repeater control unit Y. One terminal of winding 523 on the
20 same relay is connected through a winding of transmitting relay 517 to a normally open contact of line relay 520. The other terminal of this winding is connected through a resistance to ground. A condenser 525 is inserted in shunt to the resistance in series with the winding 523 and to the winding itself. One terminal of winding 524 is connected through a resistance to ground, and the other terminal of the winding is connected through
30 a normally closed contact of line relay 520 and a resistance to grounded battery. The circuits of the windings of line relay 520 are similar to those of line relay 516, while one terminal of the line winding of line relay 520 is connected to a normally open contact C of marginal relay 503. A circuit from battery 519 of the repeater is adapted to be closed by either transmitting relay 517 or 521 through slow-operating relay 523 of the
40 repeater control unit. The biasing winding on each of the transmitting relays is in a closed circuit which includes battery 519.

In establishing a connection between subscribers' stations associated with the same central station by means of the above-described apparatus, the following operations take place. The calling subscriber 101 (see Fig. 1) establishes a connection with a selecting circuit 112, in a manner described in detail in the first-mentioned Vernam application.
55 Then he dials the number assigned to the repeater control unit connection, and the resulting impulses cause an idle secondary finder in group 114 to connect the subscriber's line circuit with line conductor 501, and over a circuit previously traced to battery associated with marginal relay 504. As the resistance of the winding of relay 504 through which the line circuit is now connected is
60 smaller than the resistance through which the

line circuit was extended at the selecting circuit (see the first-mentioned Vernam application), the line lamp in the line circuit at the calling subscriber's station (see Fig. 2 of the first-mentioned Vernam application) is
70 lighted. This informs the calling subscriber that his line circuit has been extended to the repeater control unit and that the circuit is now in readiness for further dialling.

Associated with the repeater control unit is a switching circuit D (see Fig. 1). As previously mentioned, this switching circuit includes a group of first selectors 117, a group of secondary selectors 118, and a group of connectors 120 which have access to the subscribers' stations A. Extending from the repeater control unit Y are line conductor 513, dial lead 508, and release trunk 511, which are connected to the line conductor, dial lead and release trunk, respectively, of a particular first selector in group 117, Fig. 1. The details of this connection may be understood from an examination of Fig. 3 of the first-mentioned Vernam application.
85

To return to the operations which take place at the repeater control unit Y, the marginal relay 504, upon operating, closes its A contact and thus grounds the dial lead 508 through a winding of marginal relay 507. The grounding of the dial lead, as is well known in the art, prepares the first selector of group 117 (Fig. 1) for operation, and relays of the first selector ground the release trunk 511. Although the relay 507 is thus included in a closed circuit, being marginal it is not operated at this time. Relay 504, at its B contact, closes an obvious circuit for operating slow-releasing relay 509. Relay 509 operates, opening at its B contact the circuit of relay 503 and closing at its A contact
90 a circuit for operating relay 510 which extends from battery, winding of relay 510, contact A of relay 509 to ground on the release trunk 511. Relay 510, upon operating, locks up over an obvious circuit. As previously
100 mentioned, a lamp lighted upon the connection of line conductor 501 to marginal relay 504 of the repeater control unit Y informs the calling subscriber that he can now dial the number of the called subscriber's station. When he does so, relay 504 is caused to repeat the impulses into the dial lead 508 associated with the first selector. It is, therefore, obvious that the dialled impulses will operate the automatic switches in the switching circuit D (Fig. 1) to extend the line circuit 513 and release trunk 511 and, thus, establish connection with the called subscriber's station. When connection is established, the calling subscriber's line circuit is connected to the grounded negative battery associated with relay 504, while the called subscriber's line circuit is connected over conductor 513 to the negative battery associated with contact B of relay 507. As will be apparent from an ex-
120
125
130

amination of the first-mentioned Vernam application, the connection of negative potential to the subscribers' lines holds the printer motors at both stations idle. After dialling, the calling subscriber 101 restores his calling key (not shown) to normal, opening contact 56 (Fig. 2 of the first-mentioned Vernam application). This connects a high resistance into the line circuit, thus releasing marginal relay 504. The release of relay 504 opens at its B contact the previously traced circuit for operating relay 509, and the latter releases, closing a circuit for operating relay 503, which may be traced from grounded negative battery, winding of relay 503, contact B of relay 509, contact B of relay 510 to ground. It is to be noted that relay 406 of connector 400 (see Fig. 2 of the first-mentioned Vernam application) releases more slowly than relay 509 of the repeater control unit Y, so that the release trunk 511 is grounded at the connector 400 during the interval that the dial lead 508 is open, namely, the interval after relay 504 releases and before relay 503 operates. In operating, relay 503 closes its A and C contacts, thus extending the line conductor 501, extended to the calling subscriber's station, to grounded positive battery 519 of the single line repeater Z, and the line conductor 513, extended to the called subscriber's station over a previously traced circuit, to open contact A of transmitting relay 521 over a circuit previously traced. The reversal of current over line conductor 501 operates a polar relay at the calling subscriber's station (see Fig. 2 of the first-mentioned Vernam application), starting the printer motor at that station and removing a high resistance from the line circuit. The removal of this resistance from the line circuit causes line relay 516 of the repeater Z to pull up, thus operating transmitting relay 521 over an obvious circuit. Upon the operation of relay 521, a circuit is closed from grounded positive battery 519, contact A of transmitting relay 521, winding of line relay 520, contact C of relay 503, line conductor 513 to the called subscriber's station. This reversal of current over the called subscriber's line circuit causes the printer motor at that station to be started and a high resistance to be removed from the line circuit in the same manner as occurred at the calling subscriber's station. The calling and called subscribers' stations are thus interconnected through the single line repeater Z. Relay 503, at its F contact, closes the circuit of the slow-operating relay 523. Previously, current was momentarily applied to relay 523 when connection was extended to the repeater control unit Y and before the transmitting relay 521 pulled up, but this application of current was insufficient to operate relay 523. As the operating circuit of this relay is open elsewhere at contacts B of the repeater, which are

opened as soon as relay 503 operates, this relay does not operate but maintains ground on the dial trunk 508 over an obvious circuit, and also on the release trunk 502, thus holding the switches operated in both the concentration and switching circuits. As both line conductors 501 and 513 are now connected, respectively, to the sending and receiving loops of the repeater Z and both printer motors are running, communication can be carried on between the connected subscribers' stations.

If the called subscriber's station had been busy, the upper high resistance winding 402 of the relay 401 in the operated connector in group 120 of Fig. 1 is shunted (see Fig. 2, first-mentioned Vernam application) and the current in the dial lead 508 consequently increased. This causes the operation of marginal relay 507 over a circuit which may be traced from battery (not shown) at the connector, through the dial lead of the other switches, dial lead 508, winding of relay 507, contact A of relay 504 to ground. Relay 507, upon operating, locks through its C contact to ground at contact of relay 523, removes negative battery from the line conductor 513, and at its A contact connects the busy interrupter 524 to the armature of relay 503 which rests on its D contact, that relay being now de-energized. The busy interrupter 524 consists of a pair of cam operated contacts which at intervals open the circuit through the interrupter to ground. When the calling subscriber restores the key, as above described, the line circuit 501 and the interrupter 524 are connected by the operation of relay 503 to the loops of the repeater Z. The interrupter then transmits through the repeater Z into the loop to which the calling subscriber is connected, with the result that a bell on the calling subscriber's printer is operated in a manner well known in the art.

Upon observing this indication of a busy called subscriber's line, the calling subscriber momentarily places his key (not shown) in clearout position, causing a high resistance to be placed in the line circuit. The resulting reduction of line current causes relay 516 of the repeater Z to release. This causes relay 521 to release and close its contact B, thereby closing the previously traced circuit of relay 523 which energizes after an interval. Its energization removes ground from release trunk 502 and from dial lead 508, while the removal of ground from the latter causes the removal of ground from release trunk 511. Upon the removal of ground from the release trunks 511 and 502, the switches in the concentration circuit C and the switching circuit D (see Fig. 1) release, and the release of the latter switches applies negative battery to the calling subscriber's line, stopping that subscriber's printer motor in a manner described in the first-mentioned Vernam appli-

cation. The removal of ground from the release trunk 511 also releases relay 510 which, in turn, releases relay 503, thus disconnecting positive battery 519 of the repeater Z from the line conductors 501 and 513. The energization of relay 523 also opens the previously traced locking circuit of relay 507, which releases, disconnecting the interrupter 524 from the repeater Z. All circuits are thus restored to normal.

When a connection has been established between a calling and called subscriber and either subscriber desires to break the connection, the same sequence of operations occurs, as above described, except that the marginal relay 507, not having been operated, is not released, while the release of the switches in the switching circuit D (Fig. 1) stops the printer motor at the called subscriber's station.

In Fig. 6 is shown an alternative arrangement of the repeater control unit Y, the single line repeater Z, and the switching circuit D (Fig. 1). The essential difference between this arrangement and that disclosed in Fig. 5 is that the arrangement of Fig. 6 provides means for starting the printer motors at both the calling and called stations as soon as connection is established between these stations and the repeater control unit, whereas the arrangement of Fig. 5 provides means under control of the calling station for starting the printer motors at both stations after the establishment of connection between these stations and the repeater control unit. As in the arrangement of Fig. 5, the repeater control unit Y is associated with a secondary finder in the concentration circuit C (Fig. 1), a single line repeater Z, and a first selector in the switching circuit D (Fig. 1).

In the present arrangement, however, it is necessary that the line conductor 614, extending from the repeater control unit Y to the first selector 606, be closed, and when this conductor is extended to each successive switch, means must be provided for closing this conductor as soon as it is so extended. This is necessary because the conductor 614, if opened, would release relay 610, connecting in the single line repeater Z before connection has been established with the called station. Accordingly, the line conductor 614 is shown connected to ground through a resistance and contact of relay 615 of the first selector 606. The relay 615 corresponds to the relay 201 of first selector 200 in Fig. 3 of the first-mentioned Vernam application. Likewise, when the line conductor 614 is extended to the second selector 607, it is closed to ground through a resistance and contact of relay 616, and, when extended to the connector 608, is closed to ground through a resistance and a contact of relay 617. Relays 616 and 617 correspond, respectively to relays 301 of selector 300 (Fig. 3) and relay

421 of connector 400 (Fig. 2) of the first-mentioned Vernam application. In other respects, the circuits of switches 606, 607 and 608 are similar to the circuits, respectively, of switches 200 (Fig. 3) 300 (Fig. 3) and 400 (Fig. 2) of the first-mentioned Vernam application.

The connection between the repeater control unit Y and the secondary finder of the concentration circuit C (Fig. 1) is similar to that of the repeater control unit Y of Fig. 5 and the secondary finder. The single line repeater Z of Fig. 6 is connected to the line conductor 601, extending to the calling subscriber's station, and the line conductor 614, leading to the called subscriber's station, as soon as the line conductor is extended to the latter station, for, when this occurs, the line current, as previously mentioned, is decreased and relay 610 is released, connecting the single line repeater Z to these line conductors. It is to be noted that, in the repeater control unit of Fig. 5, the connection of the single line repeater Z to the line conductors 501 and 513 is dependent upon the energization of relay 503, and this relay is not energized until the calling subscriber operates his key to release relay 504. A further difference is that the interrupter 613 is associated directly with the calling subscriber's line when the called subscriber's line is busy, and not indirectly through the single line repeater Z. Also, this interrupter is cut in without any act on the part of the calling subscriber, while in the arrangement of Fig. 5 the calling subscriber must first operate his key before the interrupter is associated with his line.

A detailed description of the arrangement shown in Fig. 6 will now be given. At the repeater control unit Y the line conductor 601 is extended through contact C of relay 610, which is normally energized, winding of relay 603, contact of relay 604 to grounded negative battery. The release trunk 602 is divided into two branches, one extending to grounded negative battery through a winding of relay 605 and the other extending to first selector 606 and to an open contact therein that is connected to ground when the dial lead 616 is closed, as may be seen by reference to the first-mentioned Vernam application. Also included in the repeater control unit Y are a marginal slow-releasing relay 604 for associating the relay 612 with the line conductor 601, an interrupter 613 for alternately energizing and deenergizing relay 612, a relay 610 for cutting the single line repeater Z in and out of circuit with the line conductors 601 and 614, and a slow-operating relay 611 which is de-energized when the single line repeater Z is cut into circuit with the line conductors and grounds the dial lead 616 and, hence, release trunk 602 extending to the switches in both the concentration and

switching circuits, thus holding the switches of these circuits operated.

The operation of the structure described is as follows: when the secondary finder of the concentration circuit C (Fig. 1) establishes a connection with the repeater control unit Y, the release trunk 602 is momentarily grounded at the secondary line finder, operating relay 605, and the line conductor 601 is extended to grounded negative battery through contact of relay 604, maintaining the printer motor at the calling subscriber's station idle. Relay 603 is thereupon energized, grounding the dial lead 616 leading to the first selector switch 606 and connecting marginal relay 604 in series with the dial lead 616. The grounding of the dial lead, as previously explained, results in the grounding of release trunk 602 by relays in the first selector 606, thereby holding up the operated switches in the concentration circuit C (Fig. 1) as well as relay 605. The extension of the line conductor 601 to the repeater control unit decreases the resistance of the line circuit, as the winding of relay 603 is of relatively low resistance, and this lights a lamp at the calling subscriber's station, informing him that the circuit is now in readiness for the dialling of the number assigned to the called station. Accordingly, the calling subscriber dials, operating relay 603, which repeats the impulses into the dial lead 616. The repeated impulses operate the switches 606, 607 and 608 of the switching circuit D (Fig. 1) successively, the line conductor remaining closed as it is extended to each successive switch, and being finally extended to the called subscriber's station 609, while the release trunk and dial lead are extended to the connector 608. When the line conductor 614 has been thus extended, a high resistance at the called station is connected into the line circuit in a manner previously described, and this decreases the current in the line conductor 614, and, since relay 605 is operated, relay 610 is released. Upon its release, relay 610 cuts the single line repeater Z into connection with the line conductor 601 leading to the calling subscriber's station and with the line 614 now connected to the called subscriber's station, applying grounded positive battery 621 to both these lines. The reversal of line current starts the printer motors at both stations in the manner described in detail in the first-mentioned Varnam application. The line relays 617 and 618 of the repeater are held operated over the line circuits just closed, as are also the associated transmitting relays 619 and 620. The energization of these last-mentioned relays opens the circuit of slow-operating relay 611 which thereupon releases, grounding dial lead 616 independently of relay 603, thus holding the operated switches locked up in both the switching and concentration circuits.

The calling and called subscribers can now carry on printing communication. When that communication has ended, either of the subscribers, by throwing a key, can cut a high resistance into the line (as explained in the first-mentioned Varnam application), and this releases that line relay of the repeater which is associated with the releasing subscriber. Thereupon the associated transmitting relay releases, operating slow-operating relay 611 which, after a brief interval, removes ground from the dial lead 616. This releases relays in connector 608 which remove ground from the release trunk 602. This, in turn, releases the switches in both the switching and concentration circuits (C and D, Fig. 1), and the release of the switches causes negative battery to be applied to the line circuits at both subscribers' stations, stopping their printer motors and restoring the station circuits to normal. The removal of ground from the release trunk 602 also releases relay 605 which causes the re-energization of relay 610.

If the called subscriber's line is busy when the connector 608 has been operated, the current in the dial lead 616 is increased (see the first-mentioned Varnam application) and the marginal relay 604 is, accordingly, operated. Relay 604 closes an obvious circuit for causing the interrupter 613 to intermittently operate relay 612, whereupon positive battery associated with relay 612 is connected to line conductor 601, starting the printer motor at the calling subscriber's station, and impulses are transmitted to operate a bell on the subscriber's printer informing him that the called line is busy. As, in this case, relay 617 of connector 608 is not operated, the line conductor 614 remains closed to ground through a resistance, and, therefore, relay 610 is not de-energized and the single line repeater Z remains unconnected to the line conductors 601 and 614. Relay 603 operates in response to the impulses from the contact of relay 612 and repeats these impulses into the dial lead 616. This will have no effect on the selectors and connector switch, however, and, as relay 604 is of the slow-releasing type, it will remain energized. After receiving the bell signal, the calling subscriber disconnects, in a manner previously described, releasing relay 603 and thereby opening the dial lead 616, which releases relay 604. Relays in the connector switch 608 now remove ground from the release trunk 602, restoring the switches in both the switching and concentration circuits to normal and also releasing relay 605. Referring now to Figs. 1, 2A and 2B, 3A and 3B, and 4, a description will be given of the apparatus employed and the operations that occur in extending a communication circuit between subscribers' stations associated with different central offices.

The apparatus thus employed will be described first. It will be recalled that, in the general description given in connection with Fig. 1, the communication circuit now to be described is extended from a subscriber's station, such as 101, over line 105 to the central station B, through the switches and a secondary finder in group 113 of the concentration circuit C, to toll board 121, through terminal duplex set 122, thence over toll line 123 to another central station (not shown, but identical with B) and ultimately to a called subscriber's station associated therewith through a terminal duplex set, such as 122, a toll board, such as 121, and a switching circuit as D. For a part of the apparatus mentioned as contributing to the extension of this circuit, no detailed description will be given here, but reference is made to the first-mentioned Vernam application for a complete disclosure. The apparatus of which no description will be given includes that at the subscribers' stations and the switches and their circuits included in the switching and concentration circuits denoted generally by A, D and C, respectively, in Fig. 1. A description will be given here, however, of the toll board denoted generally by 121 in Fig. 1 and the terminal duplex set denoted generally by 122 in Fig. 1.

The toll board 121 (Fig. 1) has mounted thereon a plurality of trunk jacks 211-213 (Figs. 2A and 2B), a plurality of line jacks 401-402 (Fig. 4) and a cord circuit B (Figs. 3A and 3B) for interconnecting any of the trunk and line jacks. It is to be understood that other trunk jacks, other line jacks and additional cord circuits could be readily mounted on the toll board in order to handle any given amount of traffic between the toll lines and the subscribers' stations.

Referring now to Fig. 2A, jack 211 is an incoming trunk jack associated with a concentration circuit, as C of Fig. 1, which is, in turn, associated with a plurality of subscribers' stations, as A (Fig. 1). Jack 212, (Fig. 2—B) with which jack 213 is multipled, is an outgoing trunk jack associated with a switching circuit, as D (Fig. 1), which is, in turn, associated with a plurality of subscribers' stations, as A (Fig. 1). Individual to the jack 211 is a line conductor 201, one end of which is connected to a secondary finder in group 113 (see Fig. 1) in a manner described in detail in the first-mentioned Vernam application, and the other end of which is connected to grounded negative battery through a normally closed contact A of relay 209. This relay, which is controlled through contact A of the jack 211, when energized, serves to connect the line conductor 201 to the tip of the jack 211 and to open the circuit of the calling lamp 208. Also associated with jack 211 is a release lead 202, one end of which is connected to the same

secondary finder as the line conductor 201, and the other end of which is connected to grounded negative battery through the winding of relay 203. This relay, when operated, connects the release lead 202 to ground through a manual release key 206 and closes the circuit of calling lamp 208. Associated with outgoing trunk jacks 212 and 213 is a line conductor 216, one end of which is connected to a first selector in a group such as 118 (see Fig. 1), and the other end of which is connected to grounded negative battery through contacts C of jack 212 and a similar contact of jack 213. The associated dial lead 217 is connected to the same first selector (the manner of both connections may be understood from a reference to the first-mentioned Vernam application) and also to the sleeves of jacks 212 and 213. Busy lamps 214 and 215 are, respectively, associated with jacks 212 and 213, and each of these lamps is arranged to be lighted when one of the multipled jacks is busy.

It is evident that each of the incoming trunk jacks can be multipled to other operators' positions in a manner similar to that in which the outward trunk jacks have been multipled. This would enable any of a number of operators to handle calls received through a particular secondary line finder.

The cord circuit V for interconnecting the incoming and outgoing trunk jacks and the line jacks of the toll board is disclosed in Figs. 3A and 3B. This cord circuit is similar to the station to toll line cord I, Figs. 3 and 4 of a pending application, Serial No. 451,693, filed on May 12, 1930 in the name of G. S. Vernam (hereinafter referred to as the second-mentioned Vernam application). This cord circuit has a subscriber's cord 301 and a line cord 302, each having a tip and a sleeve circuit. In the sleeve circuit of the incoming subscriber's cord 301 is a slow-releasing relay 303 which locks up, when operated, to maintain an operating circuit for relay 307. It is to be noted that relay 303 has an operating circuit shunted around its own normally open contacts by means of a contact of relay 309. Relay 307, upon its operation, is adapted to extend the tip of the plug 301 through the D contact of printer key 308 to a positive battery associated with relay 309. Relay 306 in the tip circuit, and relay 314 in a circuit controlled jointly by relays 307 and 306, control the circuit for operating a supervisory lamp 313. Relay 309 is adapted, when operated, to connect in series the tip circuits of the plugs 301 and 302, and to condition for operation the single line repeater 318, and, when the line plug 302 is inserted in the trunk jack, to open the operating circuit of the slow-releasing relay 303, thus preventing operation of relay 307 and leaving tip of the cord 302 connected through the contacts B and E of relay 307 to ground. Relay 309 also con-

trols the circuit of the supervisory lamp 319. Associated with single line repeater 318 is a relay 320 which controls a circuit for operating relay 309. The former relay is energized upon the closure of the receiving circuit of the toll board jacks to which the plug 302 is connected. The key 308 serves to connect the printer 310 which includes printer magnets 311, transmitter 312, and break key 313, in series with the tip of the cord circuit. Included in each cord circuit is the key 305 which is adapted to associate dial 315 with the sleeve of the outgoing trunk jack circuit. It is to be noted that dial 315 may be multiplied in a manner well known in the art to key 305 of other cords at the same position on the toll board, so that the operator at that position can employ the single dial in connection with any cord. Associated with the dial is a lamp 316 which is lighted when a called subscriber's station is busy.

Referring to Fig. 4, the line jacks of the toll board are shown at 401 and 402, while, associated with these jacks, is the terminal duplex set W. Mounted on the toll board and in association with the line jacks 401 and 402 is the busy relay 409 which is normally energized, but is released when the line cord 302 is inserted in either pack 401 or 402 to cause the busy lamps 412 and 413 to light; and the calling relay 408 which is controlled by line relay 403 of the terminal duplex set W and, in turn, controls the calling lamps 410 and 411.

The terminal duplex set W is of any well known type, such as that disclosed in the second-mentioned Vernam application. It includes a line relay 403 having differential windings A and B, to which are connected the artificial line 404 and the toll line 405, and a transmitting relay 406 and associated battery 407, to which the common point of the line relay differential windings are connected through an armature of transmitting relay 406. The transmitting relay has a normally energized biasing winding B and an operating winding A, one terminal of which is connected to grounded negative battery and the other terminal of which is connected to a spring contact on the line jack 401.

The operations which take place when a connection is extended between subscribers' stations associated with different central offices and through the toll board circuits will now be described. Let us assume that the subscriber 101 (Fig. 1) desires to call a subscriber associated with a distant central office other than B, and that the communication circuit is to be extended through the concentration circuit C, toll board 121, and terminal duplex set 122 at the central office B, then over toll line 123 to the distant central office, at which, for purposes of description, we assume to be located terminal duplex set 112, toll board 121, switching circuit D, and to

be associated therewith subscriber's station 104. The calling subscriber 101 initiates a call which extends the subscriber's line 105, in the manner described generally above and in more detail in the first-mentioned Vernam application, to line conductor 201 (Fig. 2A), contact A of relay 209 to grounded negative battery 205. In this way, negative potential is maintained on the calling subscriber's line, with the result that the printer motor at his station remains idle. At the same time the release trunk 202 is extended from the concentration circuit C (Fig. 1) through relay 203 to grounded negative battery 204. As the ground is still maintained on the armature of relay 512 of the secondary finder in group 113 (see Fig. 1 of accompanying drawings and also Fig. 4 of the first-mentioned Vernam application), relay 203 operates, connecting the release trunk 202 to ground through the A contact of relay 203 and the release key 206. At its B contact, relay 203 closes an obvious circuit which lights calling lamp 208. As there are other lamps associated with the incoming jacks multiplied to jack 211, it is obvious that these lamps would be lighted at the same time. One of the toll board operators, upon perceiving the lighted calling lamp, inserts the subscriber's plug 301 into the jack 211. This energizes relay 209 in series with slow-releasing relay 303 and relay 307 over a circuit which may be traced from grounded positive battery 210, winding of relay 209, contact A of jack 211, sleeve of jack, sleeve of plug 301, winding of relay 303, contact B of dial key 305, contact A of relay 309, winding of relay 307 to ground. At its C contact relay 209 opens the circuit of calling lamp 208 which is extinguished, and, at its B contact, extends the line conductor 201 through the tip of the jack 211, tip of plug 301, contact D of dial key 305, winding of relay 306, contact D of operated relay 307, contact A of printer key 308, contact C of relay 307, contact B of relay 309 to grounded positive battery. The reversal of current in the line circuit starts the motor at the calling subscriber's station 101, in a manner described in detail in the first-mentioned Vernam application. Upon the operation of relay 307, supervisory lamp 313 lights momentarily over a circuit extending from grounded positive battery, contact A of relay 307, contact A of relay 314, through lamp 313 to ground. However, as the previously traced line circuit causes the operation of relay 306, relay 314 is immediately operated over an obvious circuit to open the lamp circuit, extinguishing the lamp. The toll board operator then operates printer key 308, opening the C and E contacts of the key and removing the printer set circuit 310 from the control of other multiplied keys as 317, and closing contacts B and F and opening contact A, thus cutting the printer in series with the calling subscriber's

line circuit. He then operates his printer to request from the calling subscriber the number and location of the called subscriber. Upon receiving this information, he then inserts the line plug 302 into the line jack 401. This connects the grounded negative battery 414 through winding A of relay 406, contact A of jack 401, sleeve of jack, sleeve of cord, contact A of relay 318, contact E of relay 309, lamp 319 to ground, thus lighting lamp 319. The completion of this circuit also operates transmitting relay 406 which attracts its armature and sends a marking signal over line 405. The insertion of the plug also releases busy relay 409 by opening its circuit at contact B of jack 401, and this relay, upon releasing, closes an obvious circuit for lighting busy lamp 412 associated with jack 401 and lamps, such as 413, associated with multiple jacks as 402. The marking signal transmitted over the line as 405 closes the receiving leg of the terminal duplex set connected to that line at the other central station. As the apparatus at that station is not shown, the operations that occur there will be described with reference to the apparatus disclosed in Figs. 2, 3 and 4. The marking signal causes the line relay 403 to attract its armature and close its contact C. This energizes calling relay 408 over the receiving loop circuit which may be traced from grounded positive battery 415, contact C of line relay 403, contact C of jack 401, contact C of jack 402, winding of relay 408 to ground. Relay 408 operates, completing an obvious circuit for lighting the calling lamps 410 and 411. Upon seeing this indication of a call, the toll board operator inserts the line cord 302 into the jack 401, opening the contacts B and C of the line jack, thereby releasing relays 409 and 408, lighting the busy signal lamps and extinguishing the calling lamps. The relay 320 energizes over a circuit extending from battery 415, contact C of relay 403, tip of jack 401, tip of cord, winding of relay 318, resistance 321, inductance 322, winding of relay 320 to ground. The operation of relay 320 closes an obvious circuit for relay 309 which in turn energizes, extending the receiving leg from battery 415, contact C of line relay 403, tip of jack 401, tip of cord, winding of relay 318, contact B of relay 307, contact A of printer key 308, contact E of relay 307, resistance to ground. The operation of relay 309 also opens at its A contact the shunt circuit of slow-releasing relay 303, removes positive battery 323 from the conductor 324, opens at its E contact the circuit of supervisory lamp 319, and at its D contact, grounds the sending leg over an obvious circuit, extending over the sleeve of the cord and through the winding of relay 406 to battery 414. The toll board operator then operates printer key 308, which cuts his printer in series with the sending leg. He then op-

erates his printer to request the number of the called subscriber.

A digression is necessary here to explain the operation at the calling toll board when the distant toll board operator inserts the line plug 302 into the line jack 401 to answer a call. When, at the distant toll board, the sending loop is grounded through contact D of relay 309, the transmitting relay 406 is operated to send a marking impulse over toll line 405. This causes the closure of the receiving leg at the calling toll station by the line relay, and, as a result, relay 320 and relay 309 at that station are operated in a manner previously described. The operation of relay 309 extinguishes the supervisory lamp 319, indicating that the distant toll board operator has answered, and also removes battery 323 from the tip of the subscriber's cord circuit, connects the tip of the subscriber's cord through the toll board printer, contact C of relay 309, line circuit winding of relay 318, tip of line cord 302, tip of jack 401, armature and contact C of line relay 403, to grounded positive battery 415, and connects the sending loop from battery 414, winding of transmitting relay 406, contact A of line jack 401, sleeve of jack, sleeve of cord, contact of relay 318, contact D of relay 309, through a resistance to ground, thus placing the sending loop of the terminal duplex set W under control of the relay 318, which is, in turn, under control of the line circuit extending over the tip of the cord circuit, tip of incoming jack 211 to the calling subscriber's station 101. It may be noted here that the relay 318 will not be operated by the opening of the receiving loop of the terminal duplex set, but will be operated only by the opening of the line circuit extending to the called subscriber's station. For a more detailed description of the operation of relay 318, reference should be made to the second-mentioned Vernam application.

As the printer at the calling central station is in series with the line circuit, the called central station operator's request for the subscriber's number will be recorded on that printer. The calling central station operator transmits the called subscriber's number to the distant central office over line 405, where it is recorded on the printer at that office. Upon receiving this information, the toll board operator at the distant central office inserts the plug 301 into the outgoing trunk jack 212 and operates the dial key 305. The insertion of the plug opens, at contact B of the jack, the circuit of the busy lamp 214, while at contact A it closes the circuit of busy lamps as 215 at multiplied jacks as 213. The operation of the dial key 305 connects ground to the dial lead 217 leading to the first selector in the group 118 (see Fig. 1), and connects negative battery 325 to the tip of the cord and to the tip of the jack 212 which leads to the

same selector. The toll board operator then dials the number assigned to the called subscriber, and the impulses operate the switches in the switching circuit D (Fig. 1) in a manner described in detail in the first-mentioned Vernam application. As negative battery 325 is connected to the line circuit 216, the printer motor at the called subscriber's station is not started when the connector establishes connection with that station. After dialling, if the dial lamp 316 remains extinguished, which is an indication that the called subscriber's station is not busy, the toll board operator restores dial key 305, which operates relay 307 over a circuit extending through the contacts and winding of relay 303 and the sleeve of the cord to the dial lead 217, and substitutes positive battery 415 from the terminal duplex set W for negative battery 325, and then starts the subscriber's printer motor. Then the central station operator, by printer, informs the calling central station operator and calling subscriber that the call is completed. As soon as it is evident that communication has been satisfactorily established, both central station operators remove their printers from the circuit by restoring keys 308 to normal.

Communication can then be carried on between the calling and called subscribers' stations associated with different central offices. When communication is ended, the subscribers ordinarily disconnect at nearly the same time, and the first subscriber to disconnect causes a high resistance to be inserted in the line circuit, thus reducing the line current. For a detailed explanation of the manner in which this is done, reference is made to the first-mentioned Vernam application. This reduction in the line current causes marginal relay 306 (Fig. 3A) to release, and after an interval slow-releasing relay 314 also releases, lighting the supervisory lamp 313 associated with the plug 301 that is connected to the jack associated with the first of the two subscribers to release. The reduction in line current also operates single line repeater 318 by opening its line winding alone, and the sending leg is consequently opened, causing the transmitting relay 406 to send a spacing impulse over the line 405. This spacing impulse opens the receiving leg at the other toll board, as previously described, and relay 320 releases, causing relay 309 to release after an interval, thus closing a circuit for operating supervisory lamp 319. If the supervisory lamp as 313 at this central office has not been lighted by the disconnection of the subscriber associated therewith, that lamp will be lighted as soon as the subscriber does disconnect. It is to be noted that the single line repeater 318 at the central office associated with the subscriber last to disconnect is not released and, consequently, no spacing impulse is transmitted back to the other office, so that the lamp 319

at that office is not lighted. Nevertheless, upon noting the lighted lamp 313, the toll board operator at that office pulls down the cord Y, as does also the toll board operator at the other central office at which the lamps 313 and 319 have both been lighted, thus indicating that both subscribers have disconnected. This extinguishes the lighted lamps and restores the cord circuits to normal. The operator at the calling central station then opens the release key 206, opening the release trunk 202 and causing the release of the operated switches in a manner described in detail in the first-mentioned Vernam application. The removal of the plug 301 from the outgoing trunk jack 212 at the called central station disconnects the ground from the dial lead 217 and causes the release of the switches at that station. All circuits are then restored to normal.

If the called subscriber's station had been busy, the dial lamp 316 at the distant central station would have lighted (in a manner described in the second-mentioned Vernam application) and the distant toll operator would then operate his printer to inform the calling subscriber and the calling toll board operator that the called subscriber's station is busy. Upon noting this, both toll board operators pull down their respective cord circuits and the calling toll board operator momentarily operates release key 206 to remove ground from the release trunks. This releases the operated switches and restores all circuits to normal.

What is claimed is:

1. In a printing telegraph exchange system, a first and a second station, a central office associated therewith, an incoming and an outgoing branch of switches, a single line repeater and a repeater control unit at said central office, means under control of said first station for selectively operating said incoming switches to establish a connection to said repeater control unit, means thereafter under control of said first station for establishing a connection between said unit and said second station, and means responsive to said connection for interconnecting said first and second stations through said repeater.

2. In a printing telegraph exchange system, a first and a second station, a central office associated therewith, an incoming and an outgoing branch of switches, a single line repeater and a repeater control unit at said central office, means under control of said first station for selectively operating said incoming switches to establish a connection to said repeater control unit, means thereafter under control of said first station for establishing a connection between said unit and said second station, and means at said unit thereafter under control of said first station for interconnecting said stations through said repeater.

3. In a printing telegraph exchange system, a first and a second station, an associated central office having a repeater control unit, a repeater, an incoming branch and an outgoing branch of switches controlled from said first station for establishing respectively a connection between said first station and said unit and between said unit and said second station, and means under control of said first station for disconnecting said stations from said unit and interconnecting them through said repeater.

4. In a printing telegraph exchange system, a first and a second station, an associated central office having a repeater, a repeater control unit, an incoming branch and an outgoing branch of switches controlled from said first station for establishing respectively a connection between said first station and said repeater control unit and between said repeater control unit and said second station, and means responsive to the last-named connection for disconnecting said stations from said unit and interconnecting them through said repeater.

5. In a printing telegraph exchange system, a first and a second station, a central office associated therewith, said office having a repeater, a repeater control unit, an interrupter, switches under control of said first station for establishing a connection between said station and said unit, other switches controlled by said first station through said repeater control unit for testing the condition of said second station, means in said repeater control unit operable when said second station is busy for connecting an interrupter to said unit, and means under control of said first station for interconnecting said first station and said interrupter through said repeater.

6. In a printing telegraph exchange system, a first and a second station, a central office provided with a repeater, a repeater control unit, an interrupter and switches controlled from the first station for establishing a connection from said station to said control unit, other switches controlled from said first station through said control unit for testing the condition of said second station, means in said control unit operable when said second station is idle for interconnecting said stations through said repeater, and means likewise in said control unit and operable when said second station is busy for interconnecting said interrupter and said first station without interconnecting them through said repeater.

7. In a printing telegraph exchange system, a first and a second station, a central office, a repeater control unit, a repeater and an interrupter at said office, a plurality of switches responsive to impulses transmitted from said first station for establishing a connection between said first station and said

repeater control unit, a plurality of other switches responsive to selecting impulses transmitted from said first station for testing the condition of said second station, means in said unit operable when said second station is busy for preparing said interrupter for association with said repeater, means thereafter operable from said first station for interconnecting the interrupter and said first station through said repeater, and means under the control of the first station for disestablishing the connection between said first station and said repeater.

8. In a printing telegraph exchange system, a first and a second station, an associated central office having a repeater control unit, a repeater and switches controlled from said first station for establishing a connection between said first and second stations and said repeater control unit, means in said repeater control unit thereafter operable from said first station for connecting said stations through said repeater, and means under control of either station for disestablishing said connection.

9. In a printing telegraph exchange system, a first and a second station, a central office associated therewith having a repeater, a repeater control unit, and switches controlled from said first station for establishing a connection between said first and second stations and said repeater control unit, means in said repeater control unit responsive to the connection of said second station and said unit for interconnecting said stations through said repeater, and means under control of either station for disestablishing said connection.

10. In a printing telegraph exchange system, a central office having automatic switches, a repeater control unit and a repeater, a calling and a called station associated with said office, printing telegraph apparatus and driving means therefor at each of said stations, means under control of said calling station for operating said switches to establish a connection from said calling station to said repeater control unit, means in said repeater control unit for retransmitting impulses from said calling station to operate other switches to establish a connection from said unit to said called station, means in said repeater control unit thereafter operable from said first station for interconnecting said stations through said repeater and means at each station responsive to said interconnection for starting the driving means at each of said stations.

11. In a printing telegraph exchange system, a central office having automatic switches, a repeater control unit and a repeater, a calling and a called station associated with said office, printing telegraph apparatus and driving means therefor at each of said stations, means under control of said

calling station for operating said switches to establish a connection from said calling station to said unit and from said unit to said called station, and means responsive to the establishment of said last-mentioned connection for interconnecting said stations through said repeater and means responsive to said interconnection for starting the driving means at each of said stations.

12. In a printing telegraph exchange system, a first and a second station, each having printing telegraph apparatus and driving means therefor operable in response to a reversal of line current, a central office connected to each of said stations by a telegraph line, automatic switches, a repeater and a repeater control unit at said office, means under control of said first station for operating said switches to establish a connection between said first and second stations and said repeater control unit, means responsive to the establishment of said last-mentioned connection for interconnecting said stations through said repeater and means responsive to said interconnection for reversing the current in each of said telegraph lines to start the driving means at each of said stations.

13. In a printing telegraph exchange system, a first and a second station, each having printing telegraph apparatus and driving means therefor operable in response to a reversal of line current, a central office connected to each of said stations by a telegraph line, automatic switches, a repeater and a repeater control unit at said office, means under control of said first station for operating said switches to establish a connection between said first and second stations and said repeater control unit, means thereafter operable from said first station for interconnecting said stations through said repeater and means responsive to said interconnection for reversing the current in each of said telegraph lines to start the driving means at each of said stations.

14. In a printing telegraph exchange system, a plurality of stations, printing telegraph apparatus and driving means therefor at each of said stations, a central office having a plurality of switches and a toll board, said toll board including trunk line jacks and a link circuit, means in said link circuit effective upon the connection of said link circuit with said trunk jacks for operating said switches to establish a connection between said toll board and any one of said stations, and additional means in said link circuit thereafter effective for causing the actuation of the driving means at the connected station.

15. In a printing telegraph exchange system, a first and a second station each provided with a printer and a normally inert driving means therefor, a central office provided with a repeater and with switching

means under control of one station for establishing a connection through said repeater to the other station, and means at each station responsive to the connection through said repeater for starting the driving means at said stations.

16. In a printing telegraph exchange system, a first and a second station each provided with a printer and normally inert driving means therefor, a central office provided with a repeater and with switching means under control of one station for establishing a connection through said repeater to the other station, said repeater being effective after the establishment of the last mentioned connection to start and to stop the driving means at each of the connected stations.

17. In a printing telegraph exchange system, a subscriber's station provided with a printer and normally inert driving means therefor, a central office provided with a concentration board, switching means for establishing a connection in either direction between said concentration board and said subscriber's station, a toll board and a link circuit for establishing through said concentration board a connection in either direction between said switching circuit and said toll board, and means at said subscriber's station for starting said driving means, said means being responsive to the connection of said link circuit to said concentration board during the extension of an inward circuit to said toll board, and responsive only to the extension of a connection through said switching means to said subscriber's station during the extension of an outward connection from the toll board.

In witness whereof, I hereunto subscribe my name this 4th day of September, 1931.
FREDERICK G. HALLDEN.