Jan. 8, 1924. 1,480,403

J. W. LATTIG ET AL

TELEPHONE EXCHANGE SYSTEM

Filed March 16, 1922 11 Sheets-Sheet 1

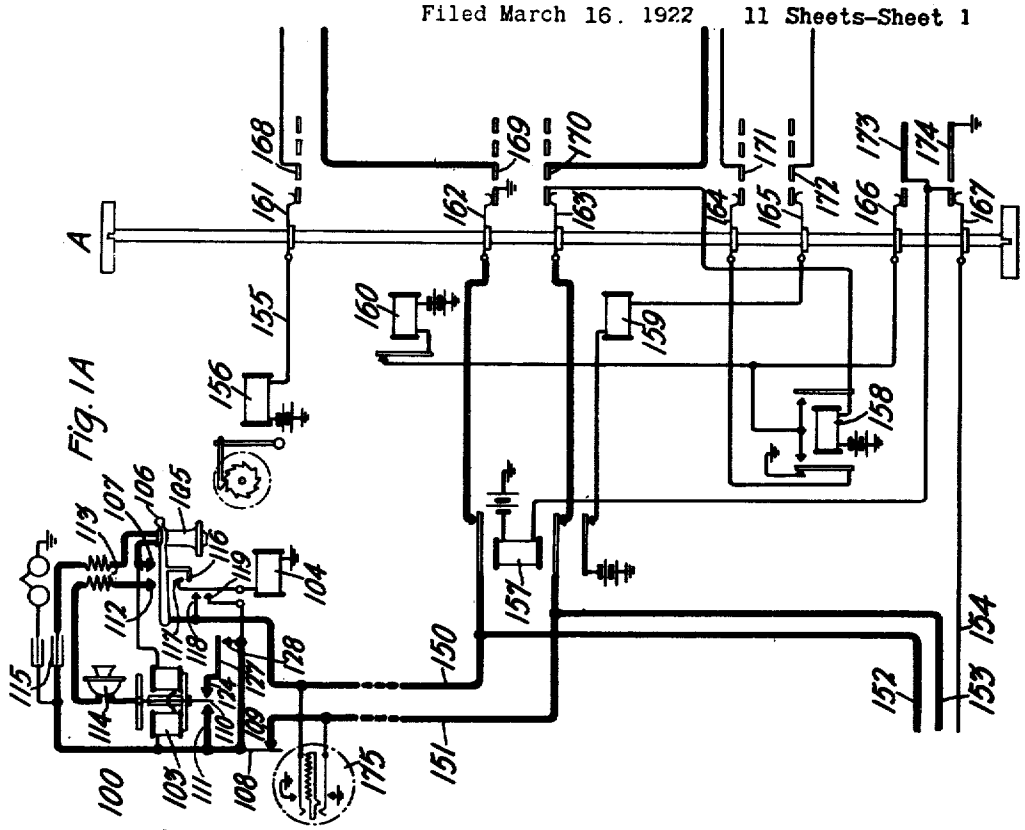


Fig. 1A

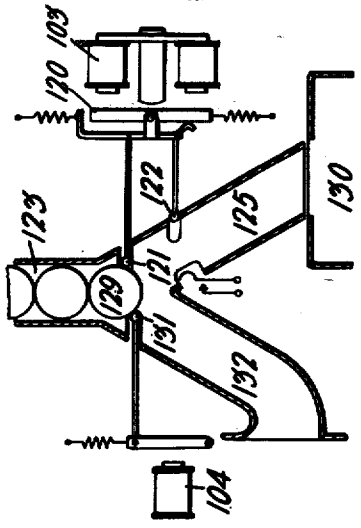


Fig. 7.

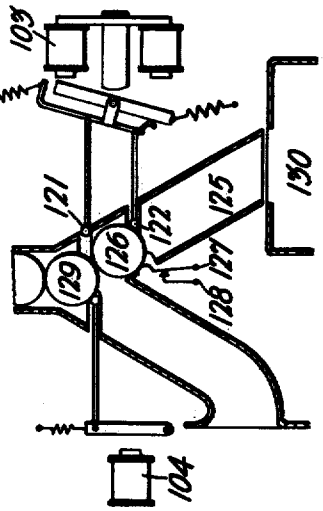


Fig. 8.

Inventors:
Jacob W. Lattig.
Charles L. Goodrum.
by W. E. Beatty. Att'y

Jan. 8, 1924. 1,480,403

J. W. LATTIG ET AL

TELEPHONE EXCHANGE SYSTEM

Filed March 16, 1922 11 Sheets-Sheet 2

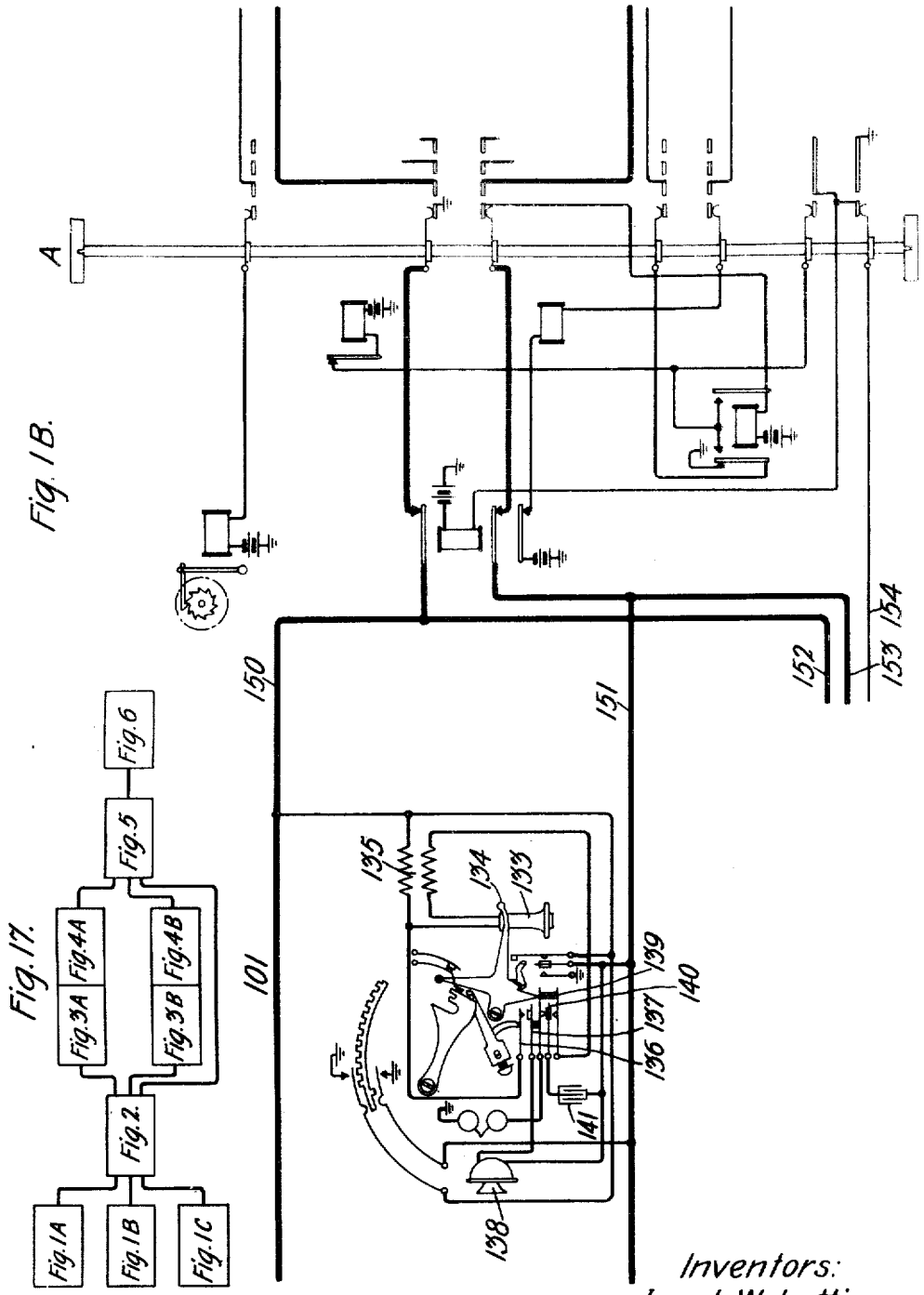


Fig. 1B.

Fig. 1.

Inventors:
Jacob W. Lattig.
Charles L. Goodrum.
by W. E. Beatty Att'y.

Jan. 8, 1924. 1,480,403

J. W. LATTIG ET AL

TELEPHONE EXCHANGE SYSTEM

Filed March 16, 1922 11 Sheets-Sheet 3

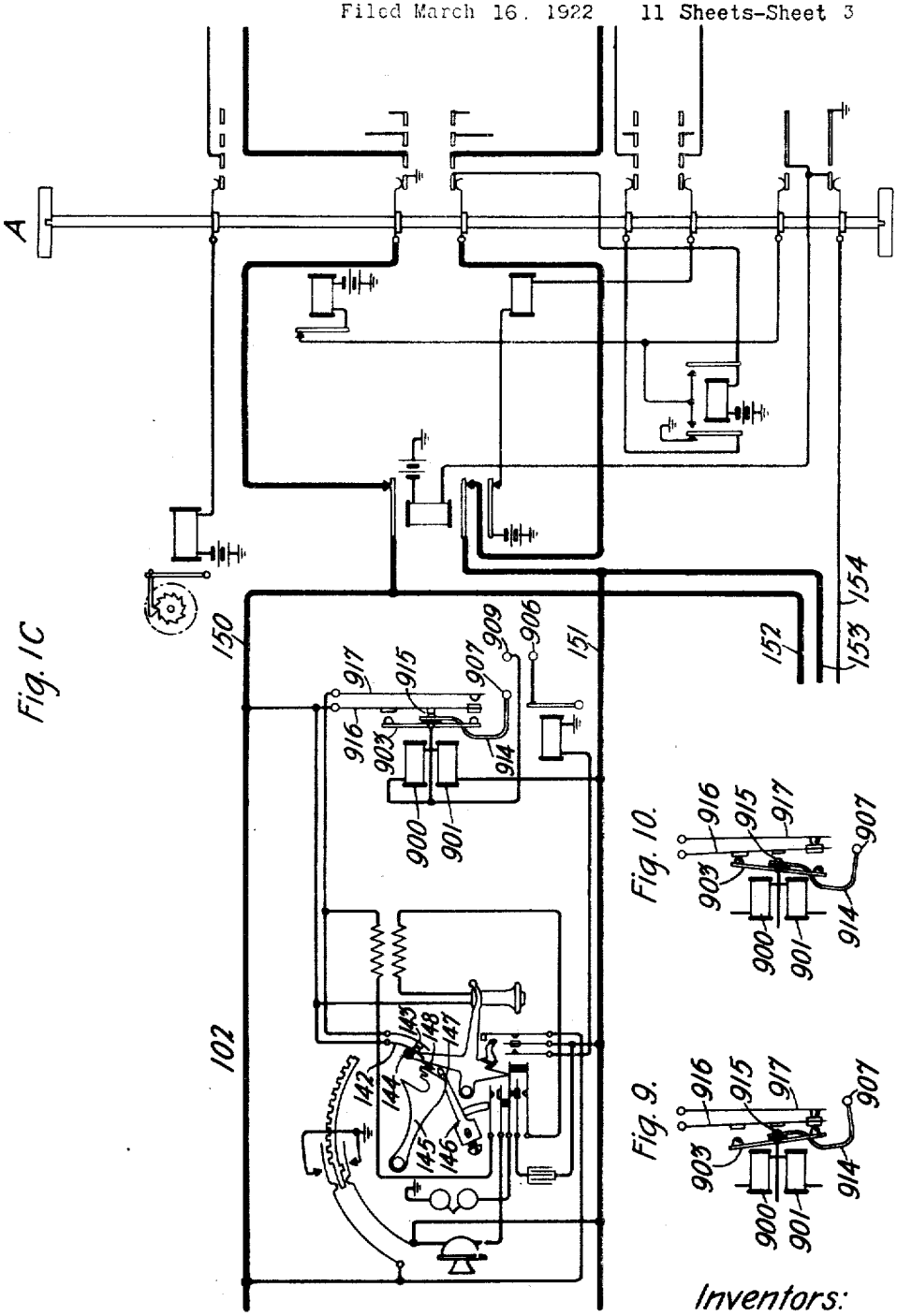


Fig. 1C

Fig. 10.

Fig. 9.

Inventors:
Jacob W. Lattig.
Charles L. Goodrum.

by W. A. Beatty. Att'y.

Jan. 8, 1924. 1,480,403

J. W. LATTIG ET AL

TELEPHONE EXCHANGE SYSTEM

Filed March 16, 1922 11 Sheets-Sheet 4

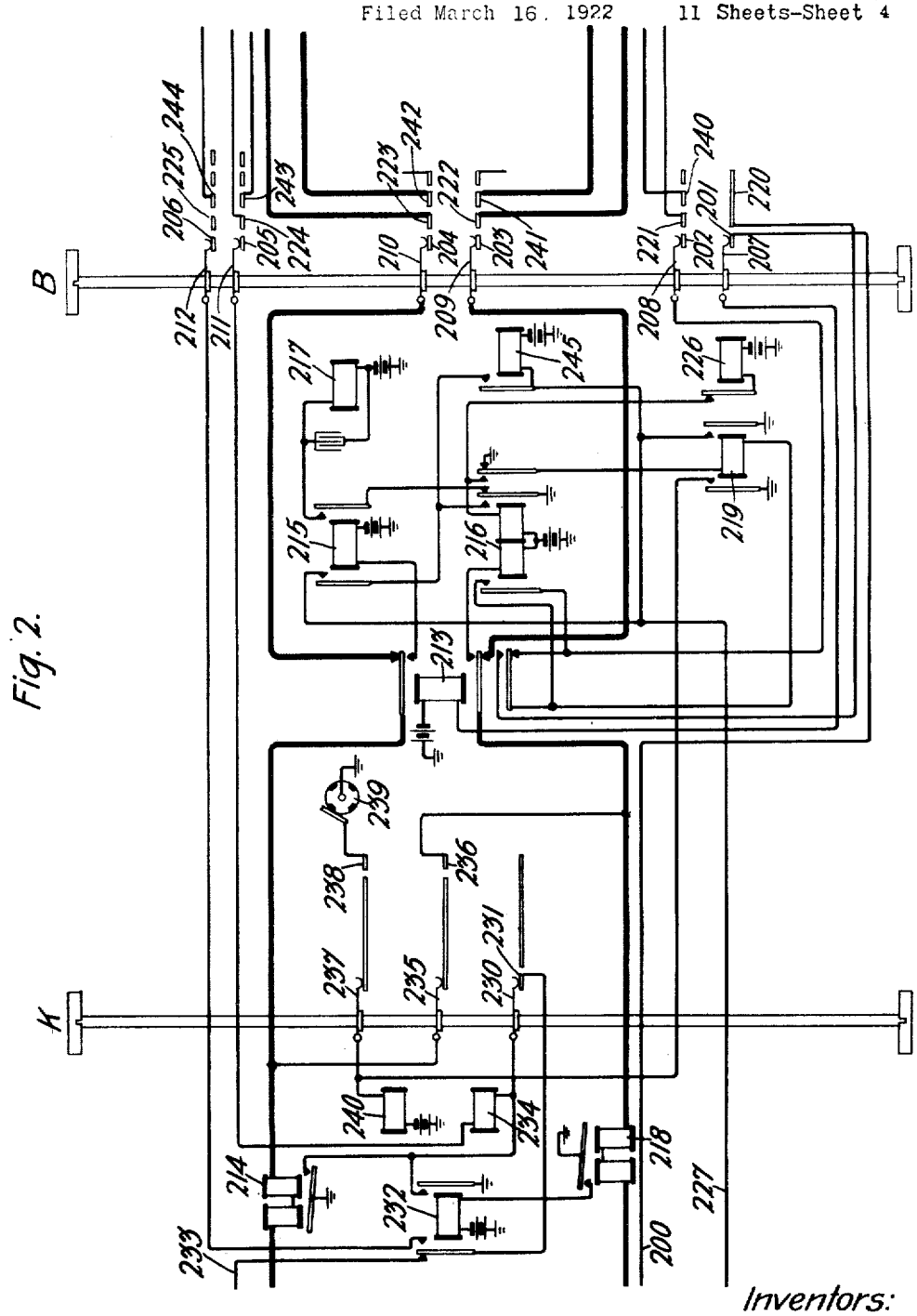


Fig. 2.

Inventors:
Jacob W Lattig.
Charles L. Goodrum.
by W. E. Beatty. Atty.

Jan. 8, 1924. 1,480,403

J. W. LATTIG ET AL

TELEPHONE EXCHANGE SYSTEM

Filed March 16, 1922 11 Sheets-Sheet 5

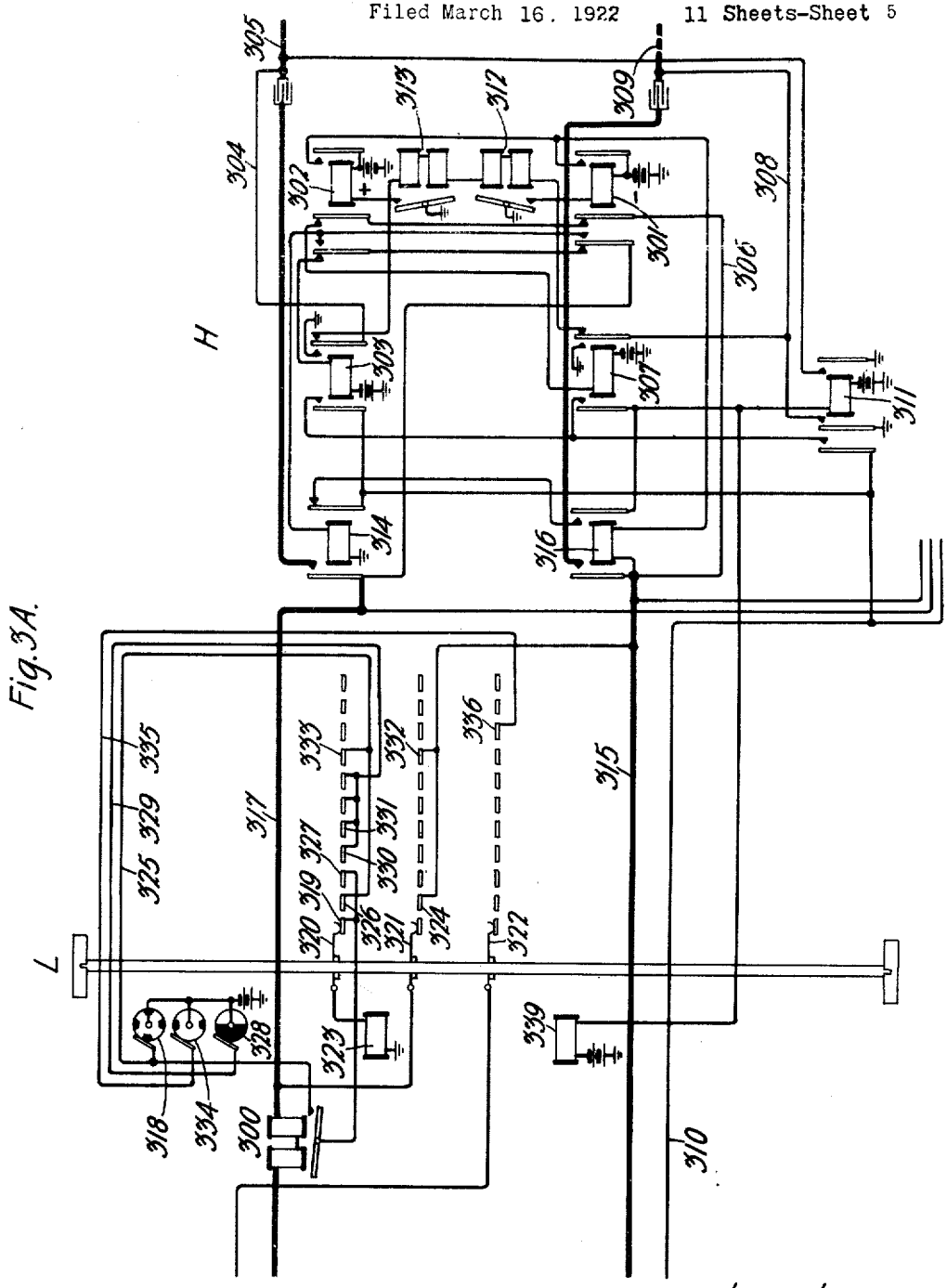


Fig. 3A.

Inventors:
Jacob W. Lattig.
Charles L. Goodrum.
by W. E. Beatty. Att'y.

Jan. 8, 1924. 1,480,403

J. W. LATTIG ET AL

TELEPHONE EXCHANGE SYSTEM

Filed March 16, 1922 11 Sheets-Sheet 6

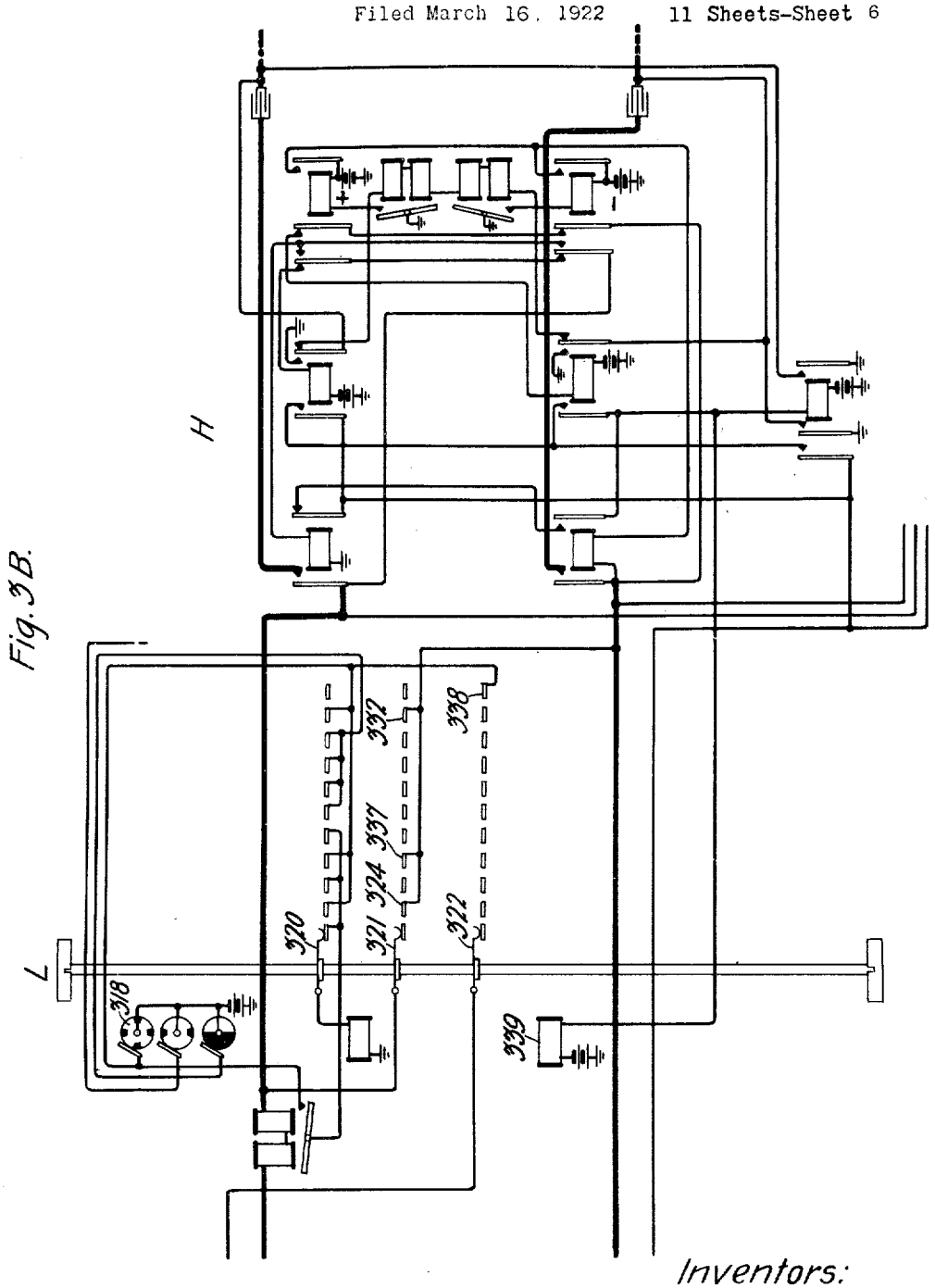


Fig. 3B.

Inventors:
Jacob W. Lattig.
Charles L. Goodrum.
by W. L. Beatty Att'y.

Jan. 8, 1924. 1,480,403

J. W. LATTIG ET AL

TELEPHONE EXCHANGE SYSTEM

Filed March 16, 1922 11 Sheets-Sheet 7

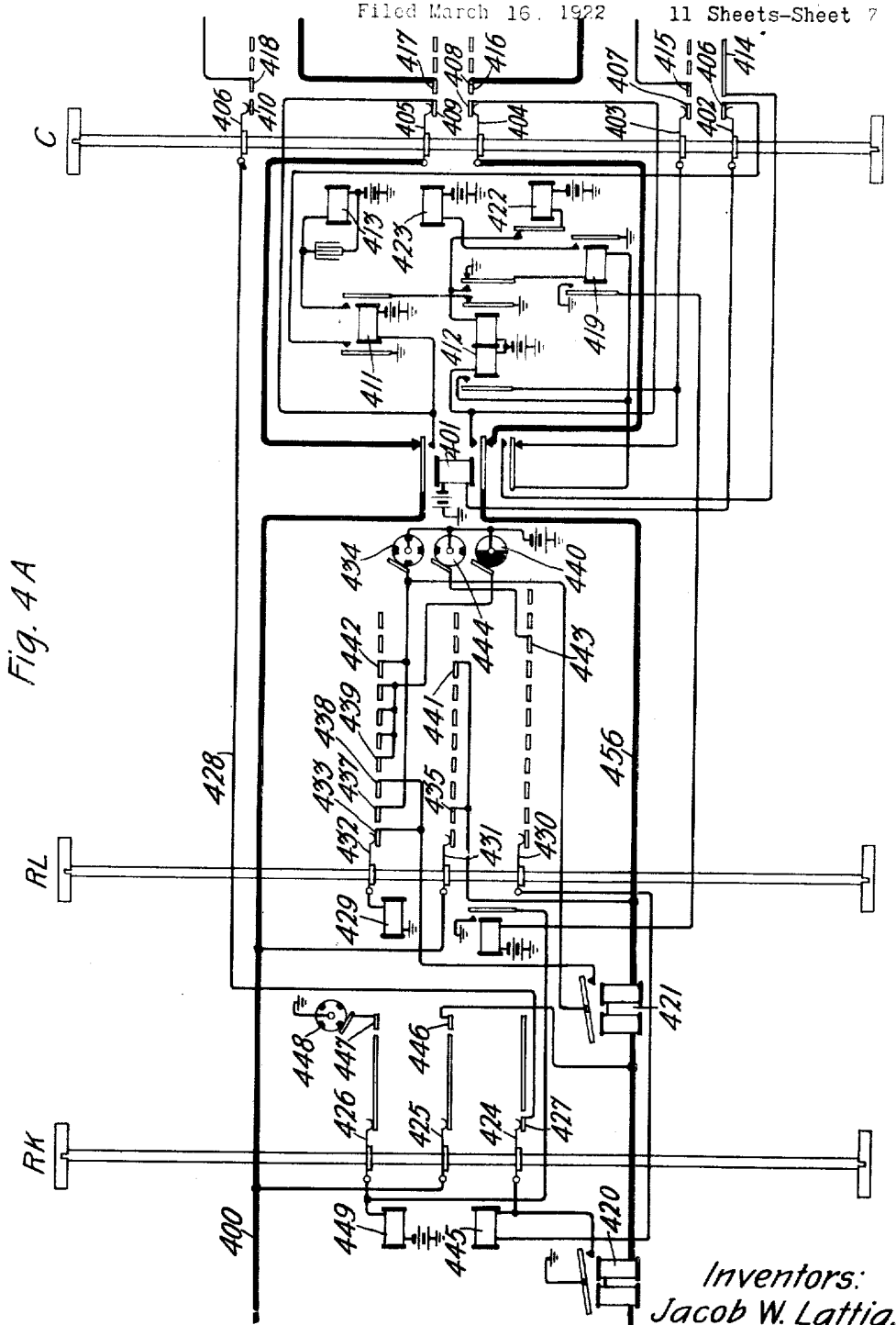


Fig. 4 A

Inventors:
Jacob W. Lattig.
Charles L. Goodrum.
by W. E. Beatty. Atty.

Jan. 8, 1924. 1,480,403

J. W. LATTIG ET AL

TELEPHONE EXCHANGE SYSTEM

Filed March 16, 1922 11 Sheets-Sheet 8

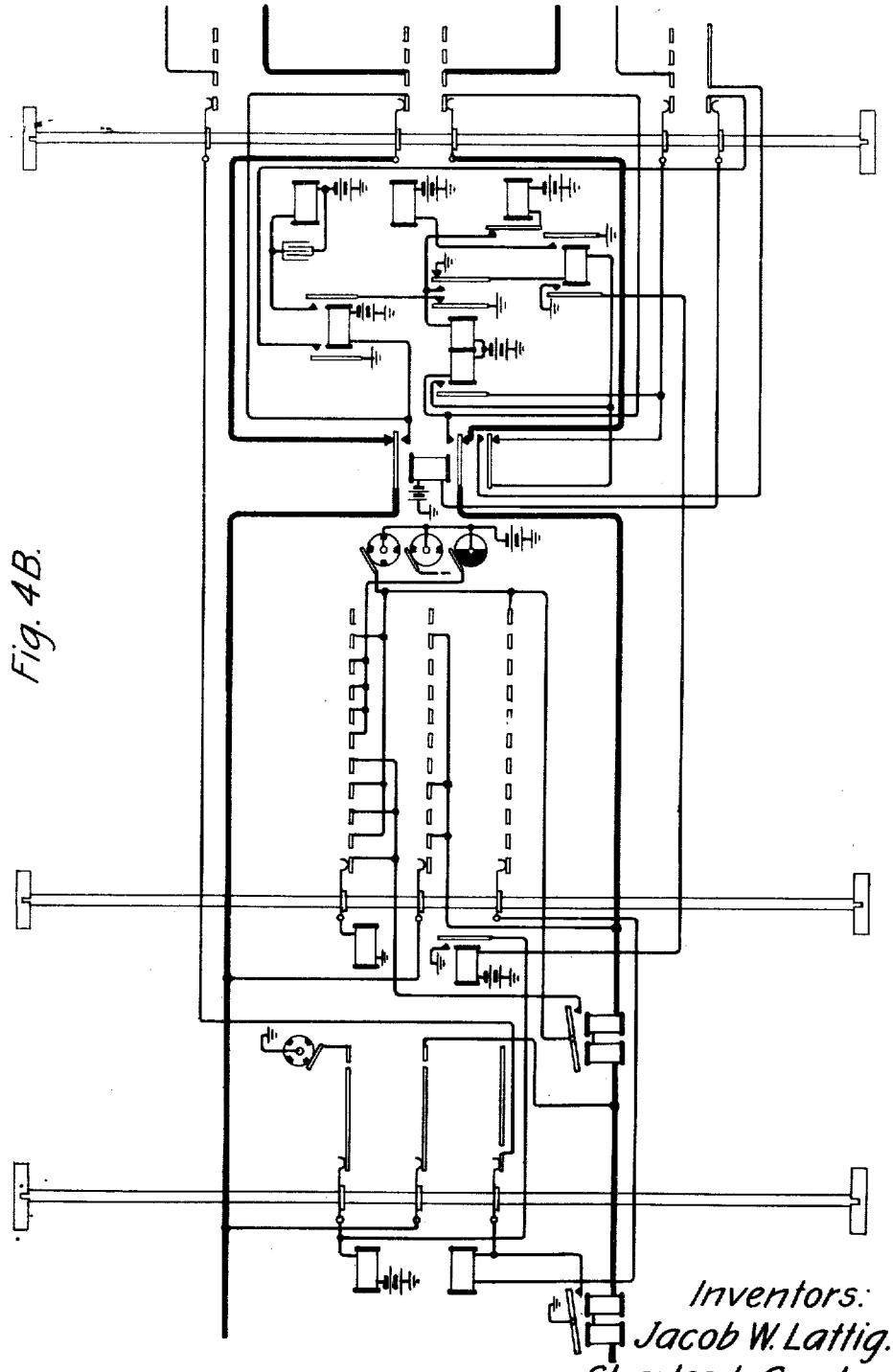


Fig. 4B.

Inventors:
Jacob W. Lattig.
Charles L. Goodrum.
by W. E. Beatty. Att'y.

Jan. 8, 1924. 1,480,403

J. W. LATTIG ET AL

TELEPHONE EXCHANGE SYSTEM

Filed March 16, 1922 11 Sheets-Sheet 9

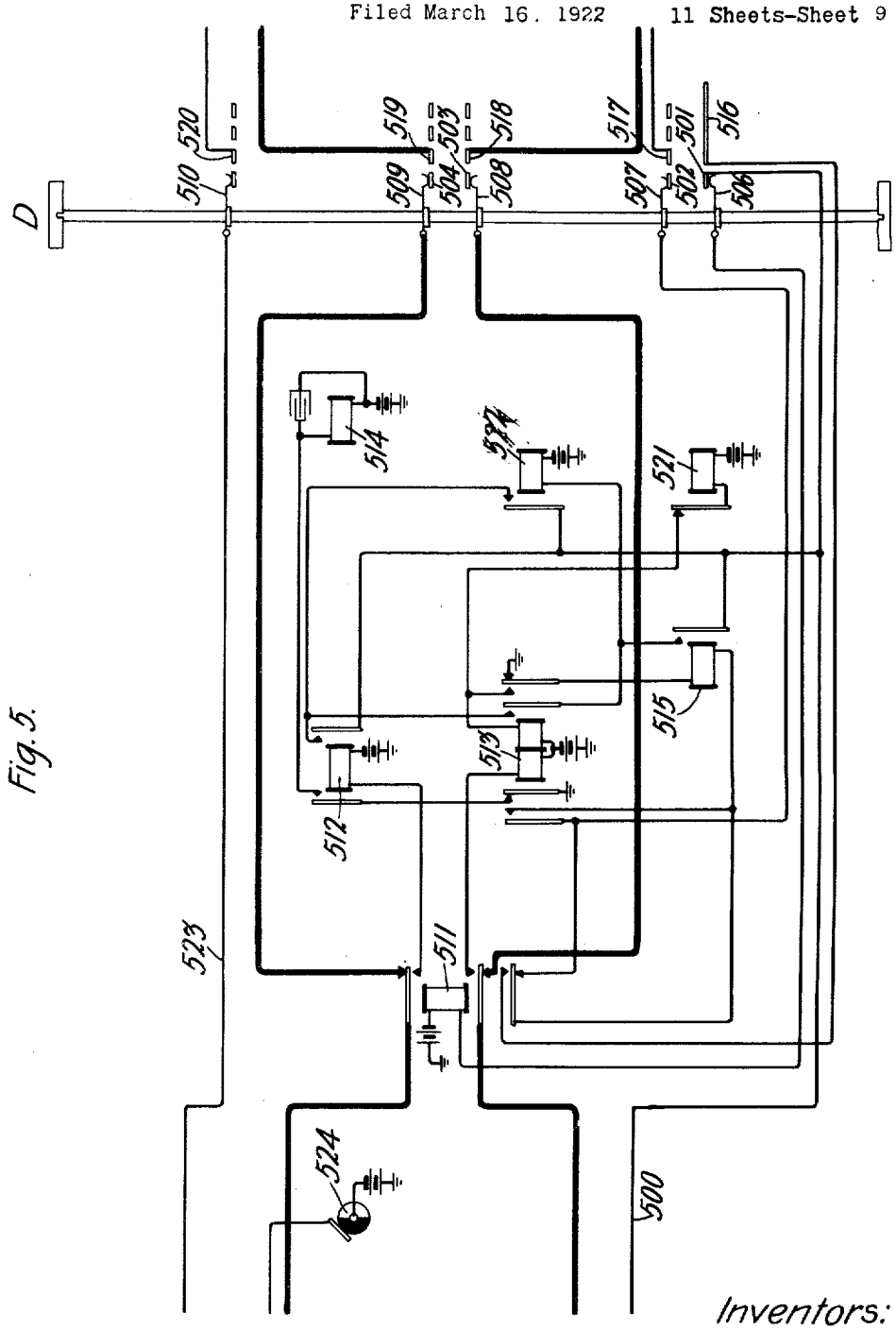


Fig. 5.

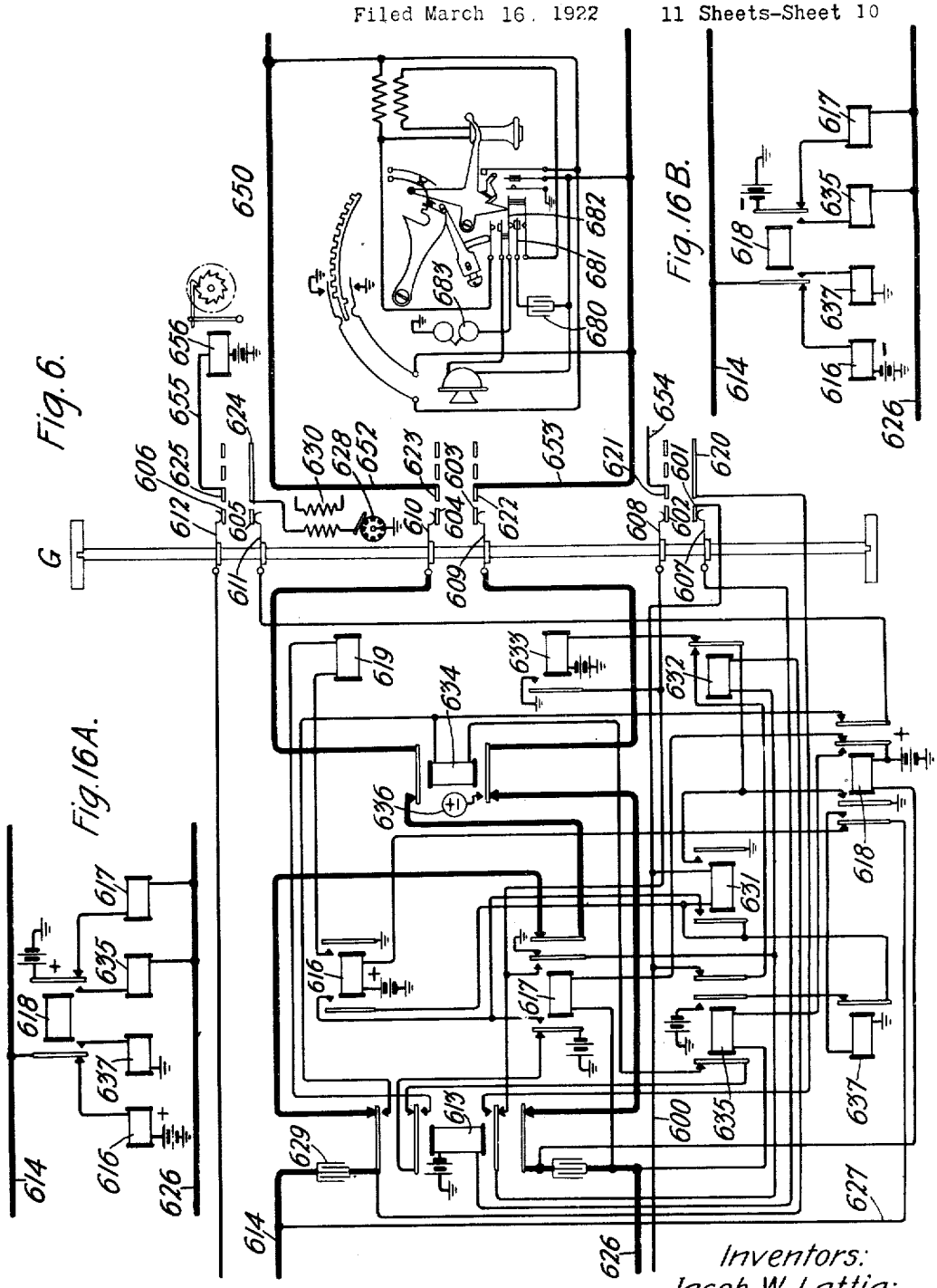
Inventors:
Jacob W. Lattig.
Charles L. Goodrum.
by W. E. Beatty Att'y.

Jan. 8, 1924. 1,480,403

J. W. LATTIG ET AL

TELEPHONE EXCHANGE SYSTEM

Filed March 16, 1922 11 Sheets-Sheet 10



Inventors:
Jacob W. Lattig:
Charles L. Goodrum.
by W. L. Beatty. Att'y

Jan. 8, 1924. 1,480,403

J. W. LATTIG ET AL

TELEPHONE EXCHANGE SYSTEM

Filed March 16, 1922 11 Sheets-Sheet 11

Fig. 11.

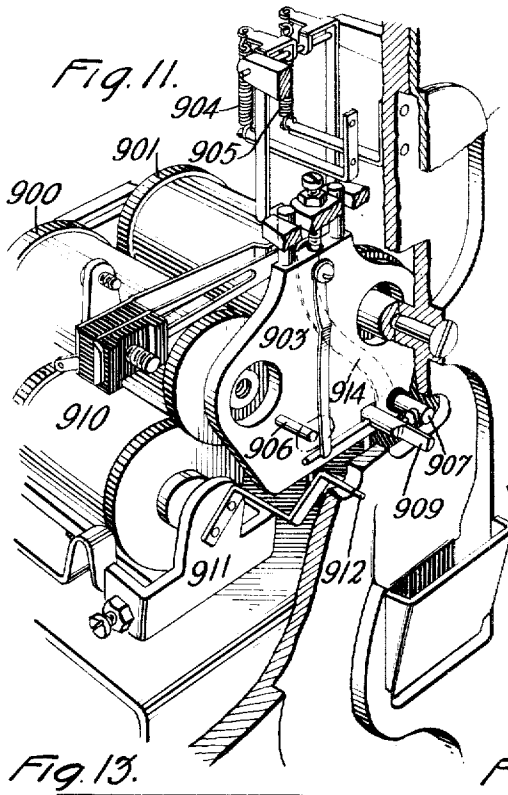


Fig. 12.

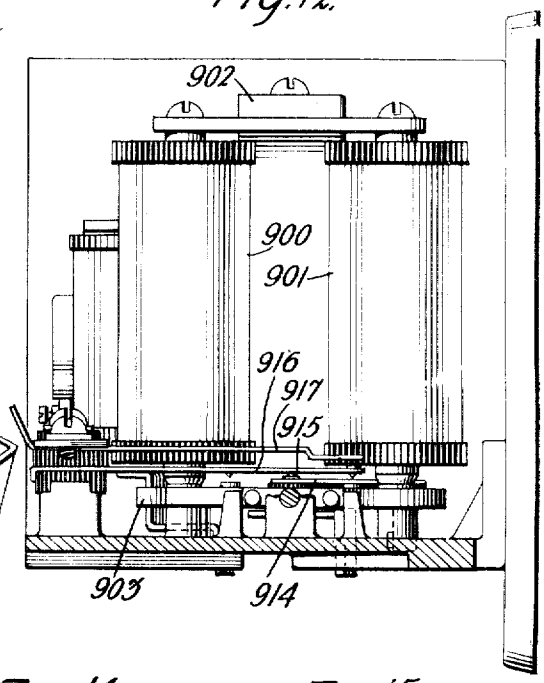


Fig. 13.

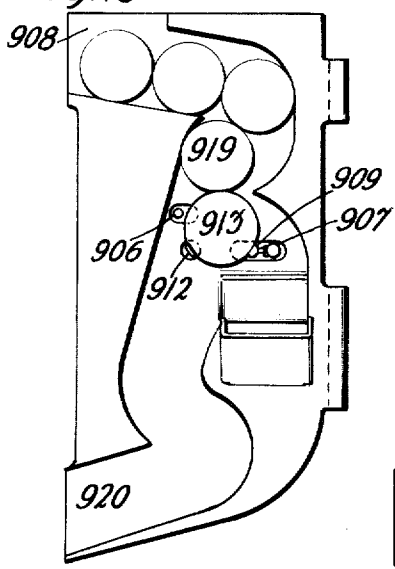


Fig. 14.

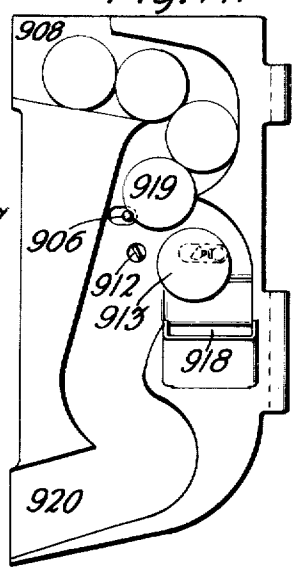
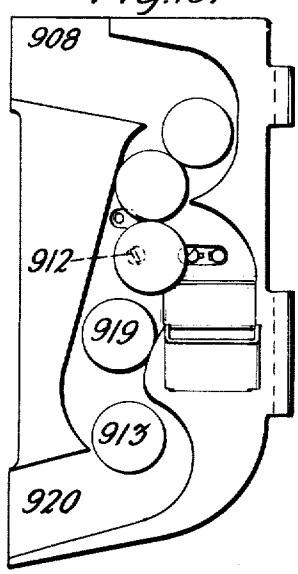


Fig. 15.



Inventors:
Jacob W. Lattig,
Charles L. Goodrum,
by W. E. Beatty. Att'y.

Patented Jan. 8, 1924. 1,480,403

UNITED STATES PATENT OFFICE.

JACOB W. LATTIG, OF BETHLEHEM, PENNSYLVANIA, AND CHARLES L. GOODRUM, OF NEW YORK, N. Y., ASSIGNORS TO WESTERN ELECTRIC COMPANY, INCORPORATED, OF NEW YORK, N. Y., A CORPORATION OF NEW YORK.

TELEPHONE-EXCHANGE SYSTEM.

Application filed March 16, 1922. Serial No. 544,091.

To all whom it may concern:

Be it known that we, JACOB W. LATTIG and CHARLES L. GOODRUM, citizens of the United States, residing at Bethlehem, in the county of Lehigh, State of Pennsylvania, and New York, in the county of New York, State of New York, respectively, have invented certain new and useful Improvements in Telephone-Exchange Systems, of which the following is a full, clear, concise, and exact description.

This invention relates to telephone systems and more particularly to coin collecting and metering systems for automatic telephone exchanges, being a continuation in part of the application of Lattig and Goodrum, Serial No. 52,512, filed September 24, 1915.

The object of this invention is to automatically charge a subscriber for the service which he requires in accordance with the time consumed in conversation and the nature of the connection which has been established therefor.

According to one feature of this invention, upon the successful establishment of a connection the calling subscriber's charging device, which may be a coin collector or a call register or both, is automatically operated for each time unit during which the conversation is kept up.

According to another feature of this invention, if a call is extended to a "reverse-charge" line, instead of the calling subscriber's charging device, the called subscriber's charging device is operated at certain intervals during the conversation. By a "reverse-charge" subscriber, is meant one calls to whom are not charged against the calling but against the called subscriber.

Still another feature of this invention relates to an automatic telephone system in which the rate of the charges made for the time units of the conversation are dependent on the trunk employed for the extension of a call.

Furthermore, this invention contemplates the use of trunk lines of different characteristics, as trunk lines of different length or trunk lines leading to different exchanges.

Both local and so-called long distance connections may be established and means are provided for charging the calling subscriber, or the called subscriber in case a connection is established to a "reverse-charge" line, accordingly.

Means are provided for charging a subscriber in accordance with any tariff which a telephone company may establish. For instance, the charged subscriber may be charged at one rate for an initial period of conversation, spoken of as the "call", and at a different rate for each additional period of conversation. In the parlance of telephony a "call" consists in the establishment of a connection and the holding of a conversation thereover for a specified length of time and a specific charge which varies with the trunk line used is made. For additional periods of conversation a charge at a different rate is made because no new operation of the apparatus is necessary, it being only required to maintain the originally established connection. Thus in one case a charge of ten cents may be made for a call lasting three minutes and a charge of five cents for each additional period of five minutes. In another case a charge may be made of fifteen cents for a call lasting three minutes and a charge of five cents for each additional period of four minutes. In a third case a charge may be made of five cents for a call lasting three minutes and an additional charge of the same amount for each additional period of the same length. Thus the charges may be varied in any desired manner.

In another aspect of this invention the conversation may be interrupted or may be continuous or uninterrupted. In the case where coin collectors are used the calling subscriber if he is to be the charged subscriber may not insert a coin into the collector until after the connection is established and the called party has answered. He may do this to assure himself that he

has been connected to the right party as when the called subscriber answers, the calling subscriber's transmitter is rendered inoperative, but his receiver is not and he may therefore attempt to recognize the called party's voice before making payment. If he does recognize the called party's voice he may insert a coin in the collector whereupon the conversational circuit will be rendered operative. The calling subscriber may insert only so many coins as are required for the call whereupon if the conversation extends beyond the specified time the conversational circuit will be disabled and he will be required to insert an additional coin to pay for an additional period of time and so on. On the other hand, the calling subscriber after recognizing the voice of the called subscriber may insert a plurality of coins so that they may be collected automatically at the beginning of the call and at the beginning of each additional period of time. Or again, he may insert a plurality of coins before establishing the connection in which case there will be no interruption of the conversational circuit at all and the coins will be collected periodically and automatically.

Where the calling substation is not equipped with a coin collector the charging is done periodically and automatically as in the case where a plurality of coins are inserted before the establishment of the connection, the charging being accomplished by means of the meter individual to the line.

The drawings comprise in all twenty-two figures. Fig. 17 is a key chart showing how certain of the figures may be placed to form diagrammatic illustrations of different kinds of connections which may be established. Figs. 1^A, 1^B and 1^C show diagrammatically three different types of calling substations together with a trunk hunting selector. The trunk hunting selector in each of these three figures is exactly alike but the substation apparatus is somewhat different. In Fig. 1^A the substation apparatus hereinbefore disclosed in the application of Lattig and Goodrum, Serial No. 52,512, filed September 24, 1915, is shown and represents the preferred type of substation and coin collector. Fig. 1^B shows a substation which is not equipped with a coin collector and Fig. 1^C shows a substation equipped with a coin collector of the general type of that disclosed in the patent to Scribner 728,309, granted May 19, 1903. Fig. 2 diagrammatically represents a first selector with a time control switch for controlling the substation meter and coin collector. Figs. 3^A and 3^B diagrammatically represent the apparatus employed in interoffice trunks at the outgoing end thereof together with time control mechanism for controlling the substation meter and coin collector on interoffice calls. Figs. 4^A and 4^B diagrammatically represent the incoming ends of interoffice trunks, each comprising a second selector and a time control mechanism for controlling the called subscriber's meter on a reversed service interoffice connection. Figs. 3^A and 4^A taken together represent one interoffice trunk and Fig. 3^B and Fig. 4^B taken together represent an interoffice trunk of a different character such for instance as would connect to a different distant office or one at a different distance. Fig. 5 diagrammatically represents a third selector and Fig. 6 diagrammatically represents a connector switch. Figs. 7 and 8 are diagrammatic representations of the coin collector employed in Fig. 1^A, Fig. 7 representing the armature of the coin collector in its neutral or normal position and Fig. 8 representing the armature in its position when actuated to collect a coin. Figs. 9 and 10 are schematic representations of the armature and contact arrangements for the magnet of the coin collector used in connection with Fig. 1^C, Fig. 9 representing the armature rotated in one direction and Fig. 10 representing the armature rotated in the opposite direction. Fig. 11 is a perspective view with sections cut away showing the arrangement of the substation magnets and armatures for controlling the disposition of coins in the coin collector used in connection with Fig. 1^C. Fig. 12 is a top view of the same. Figs. 13, 14 and 15 are diagrammatic representations of the coin chute illustrating the operation of the coin collector, and the path taken by the coins as the armature of the coin collector magnet is actuated. Fig. 13 shows the positions which the coins assume when the magnet retains its armature in its neutral position. Fig. 14 shows the disposition of the coins as the armature of the coin collector magnet is moved to the coin collecting position and Fig. 15 shows the operation of the collector as the refund magnet is operated. Fig 16^A and Fig. 16^B are schematic representations of the essential circuit arrangements of the connector switch shown in Fig. 6 when arranged for regular service and for reverse-charge service respectively. Fig. 17 as before stated is a key chart. This figure shows that by using Figs. 1^A, 2, 3^A, 4^A, 5 and 6 (connected as indicated in Fig. 16^A) an interoffice connection over a particular interoffice trunk to a regular called substation may be illustrated. This also shows that by using Figs. 1^A, 2, 3^B, 4^B, 5 and 6 (connected as indicated in Fig. 16^A) a similar connection employing an interoffice trunk line of different characteristics, such a trunk line for instance as would go to a different exchange or an exchange at a different distance may be illustrated. Taking Figs. 1^A, 2, 3^A, 4^A, 5 and 6 connected as indicated in Fig. 16^B, an interoffice reversed service con-

nection is illustrated. With Figs. 1A, 2, 5 and 6 connected as indicated in Fig. 16A, an intraoffice connection to a regular called subscriber is illustrated and with Figs. 1A, 2, 5 and 6 connected as indicated in Fig. 16B, an intraoffice connection to a reversed service called line is illustrated.

The type of switch used in connection with circuits illustrated in Figs. 1 to 6, inclusive, has been shown and described in the patent to Goodrum No. 1,135,011 to which reference may be had for the purpose of amplifying the following description.

Operation of calling substations.

In Fig. 1A, 100 is a diagrammatic representation of one type of substation provided with a coin collector. The substation 100 is connected to the line wires 150, 151. When the receiver 105 is removed from its hook 106 a circuit is established from conductor 150, receiver hook 106, contact 107, winding of polarized relay 103, contact 108, contact 109 to conductor 151. As will hereinafter appear, conductor 150 is connected to ground and conductor 151 is connected to battery. Current flowing through this circuit will energize the polarized relay 103 so as to close contacts 110 and 111. Thereupon a circuit is closed from conductor 150, receiver hook 106, contact 112, primary winding of induction coil 113, transmitter 114, contacts 110, 111, contacts 108 and 109 to conductor 151. Thus, a low resistance bridge including the transmitter is connected across conductors 150 and 151. The receiver circuit is as follows: contact 107, receiver 105, secondary winding of induction coil 113, condenser 115, contacts 111, 110, transmitter 114, primary winding of induction coil 113, contact 112, receiver hook 106 to contact 107.

As the receiver hook is moved upwardly when the receiver is taken therefrom, the member 116 rides under the back of the contact spring 117 and moves it to the right so that it does not make connection with contacts 118 and 119. When the receiver is replaced the member 116 rides down on the outer face of the contact spring 117 and moves it to the left whereby connection is made to contacts 118 and 119 completing a connection from ground through the magnet 104, contact spring 117, contact 118 to conductor 150 and through contact spring 117, contact 119, contacts 108 and 109 to conductor 151. The connection of ground simultaneously to both conductors of the line is for the purpose of releasing the connection as will hereinafter appear.

Figs. 7 and 8 are diagrammatic representations of a coin collector which may be operated by the magnets 103 and 104. The armature 120, shown in Fig. 7, is in its neutral position and controls fingers 121 and 122 which act to collect coins inserted in the chute 123. When magnet 103 (Fig. 7) is energized as described, the armature 120 rotates in a counter-clockwise direction and does not move the fingers 121 and 122 but does close the contacts 110 and 111 (Fig. 1A) as will hereinafter appear. The magnet 103 is under certain conditions energized so that its armature will rotate in the opposite direction thus closing contacts 110 and 124 (Fig. 1A), and moving the fingers 121 and 122 to the position shown in Fig. 8. Upon the energization of magnet 103 in this manner if one or more coins have been inserted in the chute 123, then the first will be deposited in the collection chute 125 in the position of coin 126. In this position contacts 127 and 128 will be closed and the coin 126 will hold the next coin 129 in the position shown in Fig. 8 so that upon the deenergization of magnet 103 the coin 126 will be dropped in the till 130, and the coin 129 will be retained in the position shown in Fig. 7.

Thus if a plurality of coins is inserted in the chute 123, one coin will be collected for each complete operation of magnet 103. If there are coins left in the chute 123 at the conclusion of a conversation or if connection has been made to such a line that magnet 103 will be energized to rotate its armature in a counter-clockwise direction, then the energization of magnet 104 upon the replacing of the receiver on its hook will move the finger 131 and allow the coins still left in the chute 123 to move down into the refund chute 132.

Referring to Fig. 1B, a substation circuit with a calling device of the type disclosed in the patent to Keith, Erickson and Erickson, No. 1,101,853, is shown. When the subscriber at substation 101 removes his receiver 133 from the receiver hook 134, a circuit is closed from conductor 150, the primary winding of induction coil 135, contact 136, contact 137 which is moved upwardly on the removal of the receiver from its hook, transmitter 138 to line conductor 151, thus extending a low resistance bridge from conductor 150 to conductor 151. The receiver circuit is as follows: from receiver 133, secondary winding of induction coil 135, contact 139, contact 140, condenser 141, transmitter 138, contact 137, contact 136, to receiver 133.

Referring to Fig. 1C, there is illustrated a substation circuit the same in many respects as that shown in Fig. 1B. In this case, however, the pair of contacts 142 and 143 are included in the transmitter circuit. When the receiver is removed from its hook a stud 144 bears against the cam 145 in such a manner as to raise it slightly. When the subscriber at this station operates his dial the member 146 rotates and the pin

147 moving along the under edge of cam 145 raises it still further until the insulating stud 148 mounted thereon moves beyond the bent portion of contact spring 142 and allows the connection between contacts 142 and 143 to be opened. When the member 146 returns to its normal position, the cam 145 is retained in its upper position by the insulating stud 148 being hooked over the bent portion of the spring 142, and thus the connection between springs 142 and 143 is maintained open throughout the conversation. When the receiver is replaced on its hook at the conclusion of the conversation stud 144 bears against spring 142 in such a manner as to allow cam 145 to return to its normal position. It will be seen therefore that the connection between springs 142 and 143 is opened when the subscriber at substation 102 has removed his receiver and manipulated his dial. In case substation 102 is called, then, since the receiver is removed from its hook but the dial is not manipulated, the connection between springs 142 and 143 is maintained closed. The function of this will appear in connection with the description of the operation of the substation coin collector.

Referring to Fig. 11 the coin collection and refund magnets of a coin collector, such as is used in Fig. 1c, are illustrated. The coin collection magnet comprises two coils 900 and 901 and a permanent magnet 902. The armature 903 is placed in operative relation to these coils and held in its neutral position by means of springs 904 and 905. The armature 903 is provided with two pins 906 and 907 for controlling the coins. Pin 906 is securely attached to the armature and is of a length insufficient to project into the coin chute 908 so as to interfere with the travel of the coins when the armature is in its neutral position. Pin 907 is attached to the armature 903, but insulated therefrom. This pin cooperates with a pivoted pin 909 which is of sufficient length to project into the coin chute 908 and stop any coins which may be inserted in the said chute. The refund magnet 910 is provided with an armature 911 controlling the pin 912 which also projects under ordinary conditions out into the coin chute and together with the pin 909 holds any deposited coins, such, for instance, as 913 shown in Fig. 13. When a coin thus rests on the two pins 912 and 909, pin 909 is moved toward the right and makes contact with insulated pin 907. Insulated pin 907 is connected through a conducting piece 914 provided with the contact 915 which makes contact with the spring 916 under ordinary conditions. When the armature 903 is moved either in a clockwise or counter-clockwise direction, the connection between spring 916 and contact 915 is broken and the armature 903 is connected to the spring 916 and the spring 916, in turn, is connected to the spring 917, as shown in Fig. 9 and Fig. 10.

If when the armature 903 is in its neutral position a plurality of coins are inserted in the coin chute 908, they will assume the position shown in Fig. 13, the first one 913 resting on the pins 912 and 909, and pin 909 making contact with pin 907. When the magnets 900 and 901 are energized in the direction to cause the armature 903 to rotate in a counter-clockwise direction, the first coin 913 will drop into the collection chute 918. Since the pin 907 is withdrawn from the path of the coins the second coin 919 will lodge against the pin 906 and be held in position of coin 919 of Fig. 14. When the armature 903 again resumes its neutral position, coin 919 of Fig. 14 will take up the position of coin 913 in Fig. 13. Thus, for each operation of the armature 903, one coin will be collected.

If the armature 903 should be rotated in the opposite direction then the coins will remain in the position shown in Fig. 13, being pushed slightly upward, but no coin will be collected or refunded.

When the refund magnet 910 is operated the pin 912 is withdrawn from the path of the coins and the coins will drop into the refund chute 920 in the manner indicated in Fig. 15.

The manner in which this coin collector is operated will be apparent from the circuit shown in Fig. 1c. When the subscriber at station 102 removes his receiver from its hook, the cam 145 will be pushed slightly upward and when he manipulates his dial, the pin 147 riding on the under surface of cam 145 will push it further upward until the insulating stud 148 allows the spring 142 to break contact with spring 143. When the connection has been established, the transmitter circuit of the calling station will be open at the springs 142 and 143 and the calling subscriber will not be able to converse with the called subscriber until a coin is deposited. When a coin is deposited a connection will be made between contacts 907 and 909 and current will flow from conductor 150, through spring 916, contact 915, conductor 914, pin 907, pin 909, coils 900 and 901 to conductor 151, thereupon the coin collector magnet will be energized and will rotate the armature 903 in a counter-clockwise direction, whereupon the coils 900 and 901 will be locked into an energizing circuit independent of a connection between pins 907 and 909. Such a connection will extend from conductor 150, spring 916, armature 903, coils 900 and 901 to conductor 151. Thereupon a connection between springs 916 and 917 will be established which will substitute for the connection between springs 142 and 143, so that

the substation 102 will be put into an operative condition. This condition will last until the end of a predetermined interval of time when the conductors 150 and 151 will be short-circuited and the coils 900 and 901 will be deprived of current so that armature 103 will return to its normal position. Thereupon the substation 102 will be disabled until another coin is deposited.

If a plurality of coins are deposited, the collection of coins will take place automatically and the conversational circuit will not be interrupted.

Operation of "A" switch.

Each calling substation is provided with an individual switch known as an "A" switch whose function it is to connect the calling line to a first selector or "B" switch. The "A" switch is a non-numerical switch having a trunk hunting operation only. The A switches shown in Figs. 1^A, 1^B and 1^C are exactly alike and a description of the switch shown in Fig. 1^A will apply equally well to Figs. 1^B and 1^C. When the subscriber removes his receiver from its hook a circuit is established from ground, the normal contact on which brush 162 rests, the back contact and upper armature of relay 157, conductor 150 through the loop of the substation, conductor 151, inner lower armature and back contact of relay 157, brush 163 and its normal contact, winding of relay 158 to battery and ground. Relay 158 is energized in this circuit and extends the ground on its winding through its right-hand armature and front contact to the back contact and armature and winding of magnet 160 to battery and ground. Magnet 160 is the motor magnet of this switch and upon its energization moves the brushes 161 to 167, inclusive, forward one step. If the first trunk encountered by these brushes is busy, a ground will be found on terminal 171 which will be extended through brush 164, the left-hand armature and front contact of relay 158, the front contact and right-hand armature of relay 158, winding of relay 158 to battery and ground, thus maintaining relay 158 energized. This ground will also be extended to the back contact and armature of motor magnet 160 so as to cause it to continue to step. The ground on the front contacts of relay 158 is also extended through brush 166 to terminal segment 173 and thence to the winding of relay 157 which opens the original circuit for relay 158 and prevents the connection of substation 101 through the brushes 162 and 163 to the terminals of busy trunks.

When an idle trunk has been encountered and no ground is found on terminal 171, the original energizing circuit of relay 158 having been opened by the advance of brush 163 from its normal terminal, relay 158 will become deenergized and open the circuit of motor magnet 160 and cut-off relay 157 whereupon the brushes 161 to 167, inclusive, will come to rest on terminals 168 to 174, inclusive, of an idle trunk.

Whenever the "A" switch has been moved from its normal position, the brush 167 moves on to terminal segment 174, thereby connecting ground to conductor 154 to mark this line as busy, conductors 152, 153, 154 leading to the called multiple of this line.

When substation 100 is connected through conductors 152 to 154, inclusive, as a called substation then a ground is placed on a conductor 154 in a manner hereinafter to be described, and this ground is extended through brush 167, its normal contact, winding of cut-off relay 157 to battery and ground whereby the connection from conductors 150 and 151 is severed from the brushes 162 and 163.

As will hereinafter appear, magnet 159 is a release magnet and functions to return the "A" switch to normal, this circuit being closed at the conclusion of a conversation through means hereinafter described.

Operation of "B" switch.

The calling subscriber's line now having been extended by the "A" switch to a first selector or "B" switch, the subscriber manipulates his dial to directively set the "B" switch on to the terminals of a desired trunk line. Upon the finding of an idle trunk line to the "B" switch by the "A" switch, relay 158 becomes deenergized and a circuit is established from ground, back contact and left-hand armature of relay 158, brush 164, terminal 171, conductor 200, terminal 201, brush 207, winding of cut-off relay 213 to battery. This relay becomes energized and remains in this condition until the brushes of the "B" switch come to rest on the terminals of the desired trunk line. The subscriber at substation 100, now manipulates his dial 175 to send a series of impulses. As the dial 175 is set, contacts 108 and 109 are opened and remain in this condition until the dial returns to its normal position. During the return movement of dial 175, line 150 is grounded a number of times, and thereafter line 151 is grounded once. The impulses sent over the line 150 are for the purpose of directively setting the switch in relation to the desired group of trunks, and the single impulse following over line 151 is for the purpose of causing the change-over whereupon the "B" switch begins to automatically rotate over the terminals of the desired group of trunks until an idle one is found. Each of the impulses sent over line 150 flows in a circuit from ground, the upper dial spring in dial 175, line 150, upper armature and back contact of relay 157, brush 162, terminal 169, polarized re-

lay 214, upper armature and front contact of relay 213, winding of impulse relay 215 to battery and ground. Relay 215 only responds to each one of these impulses and each time it so responds it establishes a circuit from ground, inner right-hand armature and back contact of relay 216, right-hand armature and front contact of relay 215, winding of motor magnet 217 to battery and ground. Magnet 217 steps brushes 207 to 212, inclusive, over groups of trunks. When these brushes have been set in relation to the proper group of trunks, a single impulse is sent from ground, the lower dial spring of dial 175, conductor 151, inner lower armature and back contact of relay 157, brush 163, contact 170, polarized relay 218, inner lower armature and front contact of relay 213, left-hand winding of relay 216, to battery and ground. After the brush 207 had left its normal contact, on the first step caused by the first energization of magnet 217, a circuit is established for maintaining relay 213 energized as follows: from ground, the back contact and outer right-hand armature of relay 216, winding of release relay 219, lowermost armature and front contact of relay 213, terminal segment 220, brush 207, winding of relay 213, to battery and ground. The current flowing in this circuit is sufficient to maintain relay 213 energized but is not sufficient to energize the release relay 219. When relay 216 is energized in the circuit described, it attracts its armatures and breaks the circuit for the energization of relay 213, but if the first trunk of the selected group is busy, then a ground will be found on a terminal such as 221 which will be extended through brush 208, the left-hand armature and front contact of relay 216, lowermost armature and front contact of relay 213, terminal segment 220, brush 207, winding of relay 213 to battery and ground, for maintaining relay 213 energized during the ensuing trunk hunting operation. A branch of this circuit will extend from the left-hand armature and front contact of relay 216, through the winding of release relay 219, the outer right-hand armature and front contact of relay 216, the right-hand winding of relay 216 to battery and ground to maintain relay 216 energized. This circuit also branches at the outermost right-hand armature and front contact of relay 216 and extends through the back contact, armature and winding of motor magnet 226 to battery and ground. As long as busy trunks are encountered a ground will be extended through brush 208 to maintain relays 213 and 216 energized and to provide an energizing circuit for magnet 226. Magnet 226 in energizing steps the brushes 207 to 212, inclusive, forward and breaks its own circuit whereupon it releases, and becoming energized again steps the brushes forward once more. This will continue until an idle trunk is encountered whereupon no ground being extended to brush 208, relays 213 and 216 become deenergized and magnet 226 ceases to operate. As in the first case, these latter circuits through the release relay 219 are not of such a character as to cause its energization and the manner in which it is energized to release the switch will be described hereinafter. For the purpose of this disclosure it will be assumed that the brushes 207 to 212 have been stepped forward in their primary movement by the motor magnet 217 under the direction of the substation dial 175, and automatically under control of motor magnet 226, until an idle trunk connected to terminals 221 to 225, inclusive, has been encountered. It will be assumed in this case that this trunk is one which may extend through the circuits of Fig. 3^A to a circuit which is known as the "H" switch. This is not in fact a switch but rather a repeating circuit for the trunk which leads to an office at a distance and is provided as it is necessary to control the switch at the distant office over two wires.

The circuit shown in Fig. 3^B is identical with that shown in Fig. 3^A with the exception that the auxiliary "L" switch is connected somewhat differently. These two figures represent trunk lines of different character, that is, trunk lines leading to different offices and therefore of different lengths. In the case of Fig. 3^A, the "L" switch is so organized as to require the payment of two toll charges, and the "L" switch of Fig. 3^B is so organized as to require the payment of three toll charges as will hereinafter be more fully explained.

Operation of "H" and "C" Switches.

The calling subscriber now manipulates his dial 175 in the same manner as heretofore described. The series of impulses is transmitted over the upper talking conductor through polarized relay 300, the outer left-hand armature and back contact of relay 301, outer left-hand armature and back contact of relay 302, winding of relay 303 to battery and ground. The first impulse of the series energizes relay 303 which thereupon extends a circuit from ground, the front contact and right-hand armature of relay 303, conductor 304, conductor 305, conductor 400, upper armature and back contact of relay 401, brush 405, terminal 409, winding of realy 411, to battery and ground. Relay 411 completes a circuit from ground, left-hand armature and front contact of relay 411, terminal 406, brush 402, winding of relay 401 to battery and ground. Relay 401 becomes energized in this circuit and substitutes a direct connection from its

upper armature and front contact to the winding of relay 411 in place of that heretofore described. At the same time relay 411 completes a circuit from ground, the inner right-hand armature and back contact of relay 412, the right-hand armature and front contact of relay 411, winding of motor magnet 413 to battery and ground. Magnet 413 steps the brushes 402 to 406, inclusive, forward whereupon the brush 402 is brought into connection with terminal segment 414, and a circuit is established from ground, back contact and outer right-hand armature of relay 412, winding of release relay 419, outer lower armature and front contact of relay 401, terminal segment 414, brush 402, winding of relay 401 to battery and ground. Thus relay 401 is maintained energized until relay 412 becomes deenergized. Each impulse which energizes relay 303, in turn causes the energization of relay 411 and the energization of motor magnet 413, whereby the brushes 402 to 406, inclusive, are stepped forward into relation with the desired group of trunks.

Just before the substation dial 175 comes to rest, a single impulse is sent over the lower talking conductor 315 to conductor 306, inner left-hand armature and back contact of relay 301, inner left-hand armature and back contact of relay 302, winding of relay 307 to battery and ground. Relay 307 establishes a circuit from ground, front contact and right-hand armature of relay 307, conductor 308, conductor 309, winding of polarized relay 420, winding of polarized relay 421, inner lower armature and front contact of relay 401, left-hand winding of relay 412 to battery and ground. Relay 412 becomes energized in this circuit and opens the circuit for relay 401, but if the brush 403 is resting on the terminal of a busy trunk, then as before, a substitute connection for the energization of relay 401 will be provided. Such a circuit will extend from ground, terminal 415, brush 403, left-hand armature and front contact of relay 412, lowermost armature and front contact of relay 401, terminal segment 414, brush 402, winding of relay 401 to battery and ground. This ground will also be extended from the left-hand armature and front contact of relay 412, through the winding of release relay 419, outer right-hand armature and front contact of relay 412, the right-hand winding of relay 412 to battery and ground to maintain relay 412 energized. This circuit will be further extended from the outer right-hand armature and front contact of relay 412 to the back contact and armature of magnet 422, winding of magnet 422 to battery and ground whereupon magnet 422 will automatically step the brushes 402 to 406, inclusive, forward, until an idle trunk is encountered. Thereupon relays 401 and 412 will become deenergized and magnet 422 will cease to operate. Relay 419 will not become energized in any of the circuits just described.

Operation of "D" Switch.

It will be assumed that the "C" switch has been set so that its brushes 402 to 406, inclusive, have come to rest upon terminals 414 to 418, inclusive, of an idle trunk in the desired group and that the circuit is now extended to the "D" switch of Fig. 5.

Upon the deenergization of relays 412 and 401, a circuit will be established from ground, the back contact and outer right-hand armature of relay 412, the winding of relay 419, the lowermost armature and back contact of relay 401, brush 403, terminal 415, conductor 500, terminal 501, brush 506, winding of relay 511 to battery and ground. Relay 511 becomes energized in this circuit and performs a function similar to relay 401 of the "C" switch, relay 213 of the "B" switch, and relay 157 of the "A" switch in a manner similar to that heretofore described. The calling substation 100 now sends a series of impulses which affect relay 303 which in turn intermittently grounds the upper talking conductor 305 which ground will now be extended over conductor 400, the upper armature and back contact of relay 401, brush 405, terminal 417, upper armature and front contact of relay 511, winding of relay 512 to battery and ground. Relay 512 intermittently establishes a circuit from ground, inner left-hand armature and back contact of relay 513, the left-hand armature and front contact of relay 512, winding of motor magnet 514 to battery and ground. Motor magnet 514 steps the brushes 506 to 510 inclusive, forward into relation with the desired group of trunks. Thereafter a single impulse is sent over the lower talking conductor to energize relay 307 which in turn places a ground for a brief interval on conductor 309 which is thereupon extended through the inner lower armature and back contact of relay 401, brush 404, terminal 416, inner lower armature and front contact of relay 511, left-hand winding of relay 513 to battery and ground. During the stepping of the "D" switch in its primary direction, and after the brush 506 has left its normal terminal 501, a circuit was maintained for the energization of relay 511 from ground, the back contact and outer right-hand armature of relay 513, winding of relay 515, lowermost armature and front contact of relay 511, terminal segment 516, brush 506, winding of relay 511 to battery and ground. Upon the energization of relay 513 this circuit is broken but a substitute circuit is thereupon established from ground on terminals such as 517 over which the brush 507 now passes

in searching for an idle trunk of the selected group: brush 507, outer left-hand armature and front contact of relay 513, lowermost armature and front contact of relay 511, terminal segment 516, brush 506, winding of relay 511 to battery and ground, This circuit is also extended through the winding of relay 515, the outer right-hand armature and front contact of relay 513, right-hand winding of relay 513 to battery and ground to maintain relay 513 energized until an idle trunk is found. This circuit is also further extended from the outer right-hand armature and front contact of relay 513, back contact and armature of motor magnet 521, winding of magnet 521 to battery and ground. This is a self-interrupting magnet and controls the brushes 506 to 510, inclusive, so as to step them forward automatically until an idle trunk is selected. When such an idle trunk has been encountered it will be denoted by the absence of ground on the terminals such as 517 whereupon relays 511 and 513 will become deenergized and magnet 521 will cease to operate. The "D" switch is now set upon the terminals of an idle trunk in the desired group and a "G" switch or final connector has been selected. The complete circuits of this switch are shown in Fig. 6 and diagrammatically in Figs. 16^{A} and 16^{B}, the difference between the two being that one is connected as an ordinary connector switch, and the other is arranged as a connector switch serving the free or reverse service lines. Fig. 16^{A} represents a connector of the first type and Fig. 16^{B} represents a connector of the last type. We will assume at this time that the connection has been established to an ordinary connector switch.

Operation of "G" switch.

A circuit is now established from ground, back contact and outer right-hand armature of relay 513, winding of relay 515, lowermost armature and back contact of relay 511, brush 507, terminal 517, conductor 600, terminal 601, brush 607, winding of relay 613 to battery and ground. Relay 613 becomes energized in this circuit and attracts its armatures in the manner and for the same purpose heretofore described in connection with similar relays in the "A", "B", "C" and "D" switches. The calling subscriber now sends his last series of impulses to set the "G" switch on the terminals of the called line. This series of impulses is relayed by relay 303 so that ground is extended to conductor 614, conductor 627, back contact and outer left-hand armature of relay 618, winding of relay 616, to battery and ground. Relay 616 therefore responds to the impulses now being sent by the calling substation. Upon each attraction of its armatures by relay 616, a circuit is established from ground, right-hand armature and front contact of relay 616, winding of motor magnet 619, front contact and inner upper armature of relay 613, back contact and left-hand armature of relay 617 to battery and ground. Magnet 619 steps the brushes 607 to 612, inclusive, forward on to terminals 620 to 625, inclusive, of the called line. After the brush 607 has left its normal position, a circuit for relay 613 is maintained over a path from ground, back contact and inner right-hand armature of relay 617, inner lower armature and front contact of relay 613, terminal segment 620, brush 607, winding of relay 613, to battery and ground. Following the series of impulses which actuates relay 616, a single impulse is transmitted over the lower talking conductor which is relayed by relay 307 of the "H" switch and thence to conductor 626, winding of relay 617, inner right-hand armature and back contact of relay 618, to battery and ground. Relay 617 responds to this single impulse and opens the circuit for the energization of relay 613, just described.

Called line busy.

If the called line is busy, terminal 621 will be grounded and this ground will be extended over brush 608, front contact and inner right-hand armature of relay 617, inner lower armature and front contact of relay 613, terminal segment 620, brush 607, winding of relay 613 to battery and ground whereby relay 613 is maintained in its energized position. A circuit is now alternately closed and opened from ground through the ringing current interrupter 628, secondary winding of busy tone transformer 630, terminal segment 624, brush 611, outer right-hand armature and back contact of relay 618, front contact and outer upper armature of relay 613, condenser 629, conductor 614, conductor 627, back contact and outer left-hand armature of relay 618, relay 616, to battery and ground. No direct current flows through this circuit on account of the condenser 629 but since the secondary winding of the busy tone transformer 630 is included in the circuit just described, busy tone will be transmitted by induction to the calling subscriber's receiver whereby he will be notified that the called line is busy.

Release of connection.

If the calling subscriber replaces his receiver on its hook he thereby simultaneously grounds both conductors 150 and 151, through the winding of magnet 104. Magnet 104 is energized in this circuit and removes the finger 131 so as to allow any coins inserted in the chute 123 to fall down into the refund chute 132. In series with the magnet 104 and in parallel with each other

in this circuit are relays 303 and 307. These relays will thereupon simultaneously connect ground to conductors 305 and 309, resulting in the simultaneous energization of relays 616 and 617. Thereupon a circuit is established from battery, the left-hand armature and front contact of relay 617, the left-hand armature and front contact of relay 616, winding of release relay 631, conductor 600, terminal 517, brush 507, back contact and outer lower armature of relay 511, winding of relay 515, outer right-hand armature and back contact of relay 513 to ground. Thus, relays 631 and 515 are included serially in a circuit. In such a circuit both of these relays become energized. Relay 631 attracting its armature establishes a circuit from ground, the right-hand armature and front contact of relay 631, armature and back contact of relay 632, winding of release magnet 633 to battery and ground. Relay 633 becomes energized and returns brushes 607 to 612 to their normal position.

In a similar manner relay 515 becomes energized and establishes a circuit from ground, back contact and outer, right-hand armature of relay 412, winding of relay 419, outer lower armature and back contact of relay 401, brush 403, terminal 415, conductor 500, armature and front contact of relay 515, winding of release magnet 522, to battery and ground. Thus relay 419 and magnet 522 are serially included in the same circuit and in this circuit they both become energized. Magnet 522 causes the brushes 506 to 510, inclusive, to return to their normal positions.

Relay 419 becoming energized establishes a circuit from ground, right-hand armature and front contact of relay 419, winding of release magnet 423 to battery and ground. Magnet 423 causes brushes 402 to 406, inclusive, to be returned to their normal positions.

In the meantime, relays 303 and 307 which were simultaneously energized complete a circuit from ground, back contact and outer right-hand armature of relay 216, winding of relay 219, outer lower armature and back contact of relay 213, brush 208, terminal 221, conductor 310, left-hand armature and front contact of relay 303, front contact and left-hand armature of relay 307, winding of relay 311 to battery and ground. Relays 311 and 219 being included serially in the same circuit, both become energized. Relay 311 places ground on each of the conductors 305 and 309 to insure the release of the "C", "D" and "G" switches.

Relay 219 attracting its armature establishes a circuit from ground, right-hand armature and front contact of relay 219, winding of release magnet 245, to battery and ground. Magnet 245 becomes energized in this circuit and causes the brushes 207 to 212, inclusive, to be returned to their normal positions.

A circuit is also established from ground, right-hand armature and front contact of relay 219, conductor 227, terminal 172, brush 165, winding of release magnet 159, back contact and outer lower armature of relay 157, to battery and ground. Magnet 159 becomes energized in this circuit and causes the brushes 161 and 167, inclusive, to be returned to their normal positions. Thus, the entire connection is restored.

Called line idle.

Assuming on the other hand that no ground is found on terminal 621, thus denoting that the called line is idle, the circuit for relay 613 having been broken at the inner right-hand armature of relay 617 and no substitute circuit provided, relay 613 therefore becomes deenergized. A circuit is now established from ground, current interrupter 628, secondary winding of busy tone transformer 630, terminal segment 624, brush 611, outer right-hand armature and back contact of relay 618, winding of relay 634, back contact and left-hand armature of relay 635, back contact and inner upper armature of relay 613, back contact and left-hand armature of relay 617 to battery and ground. Relay 634 is thereupon intermittently energized according as the circuit is intermittently closed through the interrupter 628. Upon each energization of the relay 634, a circuit is closed from a source of ringing current 636, front contact and lower armature of relay 634, brush 609, terminal 622, condenser 680, contact 681, contact 682, ringer 683 to ground. Thus the ringer of the called subscriber's line is alternately rung and this will continue until the subscriber at station 650 responds by taking his receiver off from its hook. Thereupon a low resistance bridge is thrown across conductors 652 and 653, and when the interrupter 628 has come to an open position and relay 634 is deenergized, a circuit is established from ground, back contact and inner right-hand armature of relay 617, winding of relay 632, outer upper armature and back contact of relay 613, back contact and outer right-hand armature of relay 617, back contact and upper armature of relay 634, brush 610, terminal 623, conductor 652, low resistance bridge of the substation, conductor 653, terminal 622, brush 609, lower armature and back contact of relay 634, back contact and outer lower armature of relay 613, winding of relay 618 to battery and ground. Relays 632 and 618 become energized in this circuit. Relay 632 in attracting its armature opens the circuit for the release magnet 633, so that even should the calling subscriber now hang up his receiver, the "G" switch will not be returned to nor-

mal, but the release circuit closed by the energization of release relay 631 will be extended over the armature and front contact of relay 632 through the outer right-hand armature and back contact of relay 635 to conductor 600, where it would cause the release of the other switches of the connection. However, before this can happen upless by chance relay 632 is energized simultaneously with the sending of the releasing impulses from the calling substation, relay 618 will have changed the condition so that relay 635 will be energized. Up to this point, relay 616 is connected on one side to battery and on the other side to conductor 614, and relay 617 is connected on one side to battery, and on the other side to conductor 626 so that there is battery potential on both conductors 614 and 626. When relay 618 is energized, however, the battery connection for relays 616 and 617 is broken at the back contact and inner right-hand armature of relay 618, and the back contact and outer-left hand armature of relay 618, respectively, and new connections are established as follows: Conductor 614 is now connected through the front contact and outer left-hand armature of relay 618 to the winding of relay 637 and thence to ground and conductor 626 is connected through the winding of relay 635, the inner right-hand armature and front contact of relay 618 and thence to battery and ground. The energization of relay 618 results in a connection as follows: from ground, winding of relay 637, front contact and outer left-hand armature of relay 618, conductor 627, conductor 614, terminal 519, brush 509, back contact and upper armature of relay 511. terminal 417, brush 405, back contact and upper armature of relay 401, conductor 400, conductor 305, right-hand armature and back contact of relay 303, winding of polarized relay 313, winding of polarized relay 312, back contact and right-hand armature of relay 307, conductor 309, winding of polarized relay 420, winding of polarized relay 421, inner lower armature and back contact of relay 401, brush 404, terminal 416, inner lower armature and back contact of relay 511, brush 508, terminal 518, conductor 626, winding of relay 635, front contact and inner right-hand armature of relay 618, to battery and ground.

The relays 635 and 637 in the "G" switch and relay 313 in the "H" switch, respond to current in this circuit. Relay 312 in the "H" switch does not respond since the current is flowing in the wrong direction to energize this relay. Relay 313 establishes a circuit from ground, its armature and front contact, winding of relay 302, to battery and ground. Relay 302 connects ground through the winding of relay 314, front contact and outer left-hand armature of relay 302, back contact and outer left-hand armature of relay 301 to conductor 317 and also connects battery through the winding of relay 316 to conductor 315. Thus the calling substation is supplied with a source of talking current at the "H" switch corresponding in direction to the current supplied from the "G" switch.

At this juncture the difference between the "G" switches as indicated in Figs. 16^A and 16^B should be noticed. Fig. 16^A is a schematic drawing of the essential elements of the "G" switch for a regular called station, and Fig. 16^B is a schematic drawing of the essential elements of the "G" switch for a reverse charge called station.

In the one case the positive battery is connected to the right-hand armature of relay 618 and in the other case negative battery is connected to this point. In the first case then relay 313 will respond to the positive battery current and in the other case relay 312 will respond to the negative battery current. It will now be noted that relay 302 will extend positive battery to conductor 315 and relay 301 will extend negative battery to this same conductor and hence the "H" switch will respond to the condition set up by the "G" switch and relay the same polarity of current on to the calling subscriber.

In the first case assumed a circuit will be established from the positive battery, front contact and right-hand armature of relay 302, winding of relay 316, conductor 315, through contact 222, brush 209, back contact and inner lower armature of relay 213, polarized relay 218, terminal 170, brush 163, back contact and inner lower armature of relay 157, conductor 151, contact 109, contact 108, winding of polarized magnet 103, contact 107, switchhook 106, conductor 150, upper armature and back contact of relay 157, brush 162, terminal 169, polarized relay 214, upper armature and back contact of relay 213, brush 210, terminal 223, polarized relay 300, conductor 317, back contact and outer left-hand armature of relay 301, front contact and outer left-hand armature of relay 302, winding of relay 314, to ground. Relays 314, 316 and polarized magnet 103 respond in this circuit. Polarized relays 218, 214 and 300 respond as follows: If the calling subscriber has not as yet inserted any coins in his chute 123, then the current flow in this circuit will be insufficient to cause the energization of these latter three polarized relays, and the polarized magnet 103 now being energized in the direction opposite to that which it was first energized closes the contact 110 to 124, but leaves the transmitter circuit open at contacts 127 and 128 so that the talking circuit at the calling subscriber's substation is disabled. However, a circuit from conductor 150 through the switchhook 106, contact 107,

receiver 105, secondary winding of induction coil 113, condenser 115, contacts 108 and 109 to conductor 151 enables the calling subscriber to hear the voice of the called subscriber. He may now introduce coins into the chute 123 and they will assume the position shown in Fig. 8. As soon as one coin assumes the position of coin 126, contacts 127 and 128 are closed whereby the transmitter circuit is closed from conductor 151, contacts 109, 108, contacts 128, 127, contacts 124, 110, transmitter 114, primary winding of induction coil 113, contact 112, switchhook 106 to conductor 150. This so reduces the resistance of the circuit that current through the windings of relays 314 and 316 and polarized relays 214 and 300 becomes sufficient to energize the latter two. Polarized relay 218 being arranged to respond to current flowing in the opposite direction does not respond.

Operation of the "K" and "L" switches.

Upon the energization of polarized relay 214, a circuit is established from ground, armature and contact of relay 214, brush 230, terminal 231, left-hand armature and back contact of relay 232, conductor 233, terminal 168, brush 161, conductor 155, winding of meter magnet 156 to battery and ground whereupon meter magnet 156 attracts its armature and registers the deposit of one coin. This signifies that a coin has assumed the position of coin 126 where it is beyond recovery by the calling subscriber. At the same time polarized relay 300 attracts its armature and completes a circuit from battery, fast interrupter 318, contact and armature of relay 300, contact 319, brush 320, motor magnet 323 of the "L" switch. Magnet 323 becomes energized and steps the brushes 320 to 322 forward on to their next series of terminals whereupon the calling end of the line is short-circuited from conductor 317, brush 321, terminal 324 to conductor 315, maintaining relays 314 and 316 energized but depriving polarized relays 300, 214, 218 and polarized magnet 103 of current. All of these relays and this magnet become deenergized. Upon the deenergization of polarized magnet 103 its armature assumes the position shown in Fig. 7. Coin 129 is retained in the position shown and coin 126 is deposited in the till 130. A circuit is now immediately established from battery, interrupter 318, conductor 325, terminal 326, brush 320, motor magnet 323 to ground whereupon the brushes 320 to 323, inclusive, are stepped on to the third set of contacts and the short circuit is removed from the calling end of the connection. In the case where a subscriber has originally deposited only one coin, the polarized magnet 103 would again close the contacts 110 and 124, but leave the transmitter circuit open at contacts 127 and 128 so that polarized relays 300 and 214 would not become energized. It is now necessary for the calling subscriber to insert a second coin in the chute 123, and when he does the contacts 127 and 128 will be closed thus again closing the transmitter circuit and reducing the resistance of the calling subscriber's loop so that polarized relays 300 and 214 again become energized. Polarized relay 214 causes the registration of a second charge and polarized relay 300 again closes a circuit for the energization of the motor magnet 323 from battery, fast interrupter 318, contact and armature of relay 300, terminal 327, brush 320, winding of motor magnet 323 to ground. The brushes 320 and 322 are now stepped to their fourth set of contacts.

A circuit is now closed from battery, slow interrupter 328, conductor 329, terminal 330, brush 320, winding of motor magnet 323 to ground, thus causing the energization of motor magnet 323 and causing it to step the brushes 320 to 322, inclusive, on to their next set of terminals whereupon a similar circuit is established from terminal 331. In this manner the brushes 320 and 322 will be slowly stepped forward until the brush 321 comes in contact with terminal 332. The slow interrupter is so timed and the number of contacts in the series beginning with 330 and 331 is so adjusted that a definite time interval will be measured off between the deposit of the last coin mentioned and the arrival of brush 321 on terminal 332. During this definite time interval the subscriber may converse. At the end of this interval the second coin is collected through the short circuit placed on the line through brush 321 and terminal 332 and at this instant the call is terminated. The short circuiting of the line as before causes the deenergization of relays 300 and 214 and the deenergization of polarized magnet 103. The short circuit is immediately removed, however, through the establishment of a circuit from battery, fast interrupter 318, conductor 325, terminal 333, brush 320, winding of motor magnet 323 to ground causing the energization of this magnet and the consequent stepping of the brushes 320 to 322, inclusive, to their next series of contacts. A circuit is now established from battery, medium interrupter 334, conductor 335, terminal 336, brush 322, terminal 224, brush 211, winding of motor magnet 234 of the "K" switch, and thence to the front contact of relay 214, but this contact being open the circuit is not at this time completed. A circuit, however, is completed through brush 230, terminal 231, left-hand armature and back contact of relay 232, conductor 233, terminal 168, brush 161, conductor 155,

winding of meter magnet 156 to battery and ground, but insufficient current flows in this circuit to cause the energization of the meter magnet or the motor magnet 234 and hence no registration is made except the two which have been described. It will thus be seen that the "L" switch of Fig. 3A is arranged to make a charge of two units for the use of this particular trunk.

Suppose the "B" switch had been set on terminals leading through the "L" switch of Fig. 3B. A trunk of different characteristics, that is of different length or leading to a different exchange, is selected, and the "L" switch in this case is arranged for the collection of three units. It will be noted that the brush 321 causes the short-circuiting of the calling line talking conductors three times as it passes over terminals 324, 337 and 332. In this case two coins are collected before conversation may take place, and as the brushes 320 to 322, inclusive, pass over their sixth to ninth terminals inclusive the time allotted for a call over this trunk is measured off.

Another difference between the "L" switch of Fig. 3B and that of Fig. 3A will be noted in the connection to terminal 338 in case of Fig. 3B, and terminal 336 in the case of Fig. 3A. In the first instance, terminal 338 is connected to the fast interrupter 318, and in the second instance the terminal 336 is connected to the medium interrupter 334. Thus, when the charge for a call over the trunk has been collected and the call has terminated, a different speed interrupter in each case is connected through brush 322 to the winding of motor magnet 234 of the "K" switch. Connection to this last terminal may be varied in any maner to conform with the traffic rates established by the telephone company using this apparatus.

Coming back to the operation of the "K" switch, it will be noted that the call has terminated and the transmitter at the calling station has been disabled. If the parties to the connection desire to converse for an additional period of time, the calling party will now insert another coin into the chute 123, which will thereupon take up the position of coin 126 in Fig. 8, closing contacts 127 and 128. Thereupon polarized relay 214 will respond and again close the circuit for operating meter magnet 156. This also places ground connection on the other side of motor magnet 234 so that under the influence of interrupter 334, connected through terminal 336 and brush 322, the "K" switch brushes will be advanced step by step to mark off the time allotted for an additional period of conversation. At the end of this period, brush 235 will make connection to terminal 236, thereby short-circuiting the calling end of the connection and causing the deenergization of relay 214 and magnet 103. Also brush 237 will come into contact with terminal 238 and a circuit will be closed from ground through interrupter 239, terminal 238, brush 237, winding of release magnet 240 to battery and ground. The energization of release magnet 240 causes brushes 230, 235 and 237 of the "K" switch to be returned to their normal position. Relay 214 is now deenergized and magnet 103 has moved its armature into the position shown in Fig. 8. If another additional period of conversation is desired, the calling subscriber now inserts another coin whereupon the same operation will take place.

The calling subscriber may operate his apparatus in another manner; that is, after hearing the voice of a called subscriber he may insert in the chute 123 a plurality of coins whereupon the actions described will take place automatically and coins will be collected periodically, one coin being taken for each operation of the magnet 103 and the same being registered on the meter magnet 156. In case a plurality of coins is inserted, the conversational circuit is not effectively interrupted, for the collection of a coin takes but a fraction of a second and the interruption of the circuit during this operation will not be noticed.

Again it should be noted that the calling subscriber before taking his receiver off the hook and dialing may insert a plurality of coins sufficient, or more than sufficient, to pay for the conversation which he may hold. In this case when he takes his receiver off the hook and magnet 103 is energized in the direction to close contacts 110 and 111, the fingers 121 and 122 are not moved and the coins in the chute are not disturbed.

In case the calling subscriber's substation is not provided with a coin collecting device, a circuit such as is disclosed in Fig. 1B is employed. In this case there is no polarized magnet to disable the substation and hence a path of low resistance from conductor 150 through the primary winding of induction coil 135, contact 136, contact 137, transmitter 138 and conductor 151 will be maintained throughout the connection. Thus polarized relays 300 and 214 will become operated each time as soon as the short circuit is removed from the talking conductors. Thus, the "L" switch of Figs. 3A and 3B and the "K" switch of Fig. 2 will operate automatically and periodically as described. The meter 156 will respond and record charges for the conversation in the same manner as when a coin collector is provided.

At the end of the conversation the calling subscriber in replacing his receiver on its hook causes a ground to be simultaneously connected to conductors 150 and 151 through the operation of contacts 117, 118 and 119. This causes the continued operation of re-

lay 316 and the short-circuiting of relay 314 whereupon a circuit is established from ground, back contact and outer right-hand armature of relay 216, winding of relay 219, outer lower armature and back contact of relay 213, brush 208, terminal 221; conductor 310, right-hand armature and back contact of relay 314, front contact and right-hand armature of relay 316, winding of relay 311, to battery and ground. Relays 311 and 219 are serially included in this circuit and both become energized. In parallel with the winding of relay 311 is the winding of release magnet 339 which also becomes energized in this circuit. Relay 219 attracting its armatures establishes a circuit for the energization of release magnet 245 causing thereby the return of brushes 207 to 212, inclusive, to normal. Through its left-hand armature relay 219 establishes a circuit from ground, left-hand armature and front contact of relay 219, winding of release magnet 240 to battery and ground, causing the return of the "K" switch to normal. In a manner hereinbefore described the "A" switch is returned to normal. Magnet 339 becoming energized releases the brushes 320 to 322, inclusive, of the "L" switch to normal. Relay 311 becoming energized, through its right-hand armature and its inner left-hand armature places ground on both conductors 305, 309, whereby relay 635 is maintained energized and relay 637 is short-circuited. Relay 637 being short circuited releases its armature whereupon a circuit is established from battery, front contact and inner right-hand armature of relay 635, back contact and right-hand armature of relay 637, winding of relay 631, conductor 600, terminal 517, brush 507, back contact and outer lower armature of relay 511, winding of relay 515, outer right-hand armature and back contact of relay 513 to ground. Relays 631 and 515 are serially included in this circuit and both become energized. Relay 515 causes the energization of release magnet 522 in a manner hereinbefore described which in turn causes the return to normal of the brushes of the "D" switch. At the same time a circuit is established in the manner hereinbefore described for the release of the "C" switch in Fig. 4. Relay 631 becoming energized performs no particular function at this time since relay 632 is still operated.

As soon as the called subscriber replaces his receiver on its hook he will connect ground to both sides of the talking connection, thus maintaining relay 618 energized for a short period of time and short-circuiting relay 632. Thereupon a circuit is established from ground, the inner left-hand armature and front contact of relay 618, armature and back contact of relay 632 to the winding of release magnet 633. This causes the energization of release magnet 633 and the brushes 607 to 612, inclusive, are returned to their normal positions.

If the called subscriber had replaced his receiver on its hook first, he would have released the "G" switch and freed his line, but the "G" switch would still be held in the connection established from the calling subscriber's line. In such a case when relay 311 of the "H" switch becomes energized and ground is placed on conductors 614 and 626, simultaneously, both relays 616 and 617 become energized and a circuit is established from battery, left-hand armature and front contact of relay 617, front contact and left-hand armature of relay 616, winding of relay 631, conductor 600, and thence over the circuit previously traced to cause the energization of relay 515 and thereafter the release of the "C" and "D" switches as hereinbefore described.

Reversed charge interoffice connection.

Let it be assumed that a connection is established through the apparatus shown in Figs. 1^A, 2, 3^A, 4^A, 5 and 6 (arranged as indicated in Fig. 16^B). This represents a reversed service interoffice call. The manner of setting up the switches will be exactly the same as heretofore described, the final result being different in that negative battery is connected through the winding of relay 617 to conductor 626 instead of positive battery as in the former case. In this case therefore, the current flowing through the talking circuit of the interoffice trunk is in the opposite direction and the polarized relay 312 is energized instead of polarized relay 313. The current in the talking circuit from the "H" switch to the calling subscriber's line is therefore also reversed and the polarized magnet 103 at the substation is energized to move its armature in such a direction that no coins will be collected should any be in the chute 123 and the transmitter circuit will not be disabled if there are no coins in the chute. In this case polarized relay 218 becomes energized. A circuit is established from ground, armature and contact of polarized relay 218, winding of transfer relay 232 to battery and ground. This relay establishes another circuit from ground, right-hand armature and front contact of relay 232, brush 230, normal terminal 231, left-hand armature and front contact of relay 232, brush 212, terminal 225, but since this circuit ends with terminal 225 it is ineffective in this connection. The function of such a circuit will be apparent later on when a description is given of an intraoffice connection.

Fig. 4^A shows a "C" switch for extending the line and an "RK" and an "RL" switch. The "RK" switch is known as the reverse

"K" switch, and "RL" is known as the reverse "L" switch having functions similar to "K" and "L" switches hereinbefore described. The "RL" switch of Fig. 4A is arranged exactly as the "L" switch of Fig. 3A, and the "RK" switch is arranged in the same manner as the "K" switch of Fig. 2. In an ordinary connection neither the "RL" or the "RK" switches operate because the polarized relays 420 and 421 are not energized when current is flowing in the direction established under ordinary conditions. Whenever a reverse service called line is encountered and battery is reversed on conductor 626, both polarized relays 420 and 421 become energized. Relay 420 establishes a circuit from ground, armature and front contact of relay 420, brush 424, terminal 427, conductor 428, brush 406, terminal 418, conductor 523, brush 510, terminal 520, brush 612, terminal 625, conductor 655, winding of meter magnet 656 to battery and ground, resulting in the energization of the meter magnet and the charging of one call to the called line.

A circuit is also established from ground, winding of motor magnet 429, brush 432, terminal 433, front contact and armature of relay 421, fast interrupter 434 to battery and ground. Motor magnet 429 steps the brushes 430 to 432, inclusive, forward on to their next series of contacts whereupon a short circuit is placed on the line from conductor 400, brush 431, terminal 435, conductor 456. This short circuit deprives polarized relays 420, 421 and 312 of current and each becomes deenergized immediately. However, the brushes 430 to 432, inclusive, are stepped forward to their third series of contacts through the agency of a circuit established from ground, winding of motor magnet 429, brush 432, terminal 437, fast interrupter 434 to battery and ground. As the brushes 430 to 432 are stepped to their third series of contacts, the polarized relays 420, 421 and 312 again become energized. The energization of polarized relay 420 causes the registration of another charge on the meter at the called substation and the energization of polarized relay 421 again completes a circuit through terminal 438 for the energization of motor magnet 429. The brush 432 then encounters terminal 439 where it is connected to the slow interrupter 440 and under the influence of this slow interrupter the brushes of the "RL" switch are slowly moved over their succeeding sets of contacts to mark off the time allowed for a call over this particular trunk. When this time has expired brush 431 encounters terminal 441 whereupon a short circuit is placed on the calling end of the trunk and polarized relays 420, 421 and 312 are deenergized. A circuit is now established from ground, winding of motor magnet 429, brush 432, terminal 442, fast interrupter 434 to battery and ground, so that the brush 432 is immediately stepped on to its next contact where the winding of motor magnet 429 is opened and cannot be affected thereafter. At this point brush 430 encounters terminal 443, thus connecting the medium interrupter 444 to the winding of motor magnet 445 in the same manner as explained in connection with the "L" and "K" switches. As soon as the brush 431 moves away from terminal 441 and the short circuit is removed from the calling end of the line, relays 420, 421 and 312 again become energized and another charge is made against the called line, this being for an additional period of conversation. As relay 420 becomes energized, the circuit through the winding of relay 445 is completed and the intermittent energization of this motor magnet through the interrupter 444 will cause the brushes 424 to 426 to step forward and mark off the time allotted for an additional period of conversation over this particular trunk. At the end of this period brush 425 encounters terminal 426 whereupon the calling end of the trunk is again short circuited causing the deenergization this time of relays 420 and 312. Also brush 426 encounters terminal 447 and completes a circuit through interrupter 448 and brush 426 for the winding of release magnet 449, thus energizing the release magnet and returning brushes 424 to 426, inclusive, back to normal whereupon the short circuit is removed from the line. Relays 420 and 312 again become energized and this cycle of operation is repeated. When the conversation is completed the parties to the connection in replacing their receivers release the connection as hereinbefore described.

Regular intra-office connection.

When a connection is established to another telephone in the same office, the train of switches will include the "A" switch of Fig. 1, the "B" switch and the "K" switch of Fig. 2, the "D" switch of Fig. 5, and the "G" switch of Fig. 6. When the calling subscriber removes his receiver from its switchhook, the "A" switch will be set in the manner hereinbefore described. Upon sending the first series of impulses the "B" switch will be set in the manner hereinbefore described. However, due to the different number of impulses, the brushes 207 to 212, inclusive, will now be set on a local trunk which is here represented as connected to terminals 240 to 244, inclusive. This trunk leads directly to the apparatus of Fig. 5. Impulses now sent over the line by the calling subscriber directly affect the apparatus of the "D" switch and set it in

the same manner as it was heretofore described as being set through the agency of the "H" switch. Also the "G" switch is set in a similar manner. When the called subscriber answers and ground is connected through the winding of relay 637 to conductor 626 and battery is connected through the winding of relay 635 to conductor 614, current will flow through the loop of the calling substation in a direction to cause the energization of polarized relay 214 and polarized magnet 103 to the coin collecting position. The energization of polarized relay 214 causes the registration of one charge on the meter 156 in the manner hereinbefore described. A connection is also established from ground, armature and contact of relay 214, winding of motor magnet 234, brush 211, terminal 243, interrupter 524 to battery and ground. Under the influence of interrupter 524, the "K" switch steps its brushes forward and marks off the time allotted for a local connection. At the end of this time the line is short-circuited through brush 235 encountering terminal 236 and polarized relay 214 and polarized magnet 103 are momentarily deenergized. Also brush 237 encounters terminal 238 and the "K" switch is returned to normal position whereupon another coin is collected and another charge is registered on the calling party's meter. Upon the conclusion of the conversation the train of switches is returned to normal in the manner hereinbefore described.

Reversed service intra-office connection.

When in a local connection a "G" switch such as shown in Fig. 6 arranged as diagrammatically shown in Fig. 16[B] is encountered, ground is connected through the winding of relay 637 to conductor 614 and battery is connected through the winding of relay 635 to conductor 626 whereupon polarized relay 218 becomes energized and polarized magnet 103 becomes energized in the direction to close contacts 110 and 111. Upon the energization of polarized relay 218, relay 232 is energized as hereinbefore described. Thereupon a circuit is established from ground, right-hand armature and contact of relay 232, brush 230, terminal 231, left-hand armature and front contact of relay 232, brush 212, terminal 244, conductor 523, brush 510, terminal 520, brush 612, terminal 625, conductor 655, winding of meter magnet 656 to battery and ground, causing the registration of one charge against the called subscriber. The motor magnet 234 is energized through the battery connection to interrupter 524, and the connection to ground at the right-hand armature and contact of relay 232, and the "K" switch is stepped forward in the same manner as hereinbefore described to mark off automatically and periodically the time units for the call and for the additional periods of conversation.

Upon the conclusion of the conversation the train of switches is released in the manner hereinbefore described.

What is claimed is:

1. In a telephone system, subscribers' lines, automatic switches for establishing a connecting circuit through which a calling and a called subscriber may converse during predetermined time units, charging means, means associated with said automatic switches for operating the same, and automatic means for operating said charging means at different rates in accordance with the length of the conversational period.

2. In a telephone system, subscribers' lines, automatic switches for establishing a connecting circuit through which a calling and a called subscriber may converse during predetermined time units, charging means individual to the calling subscriber's line, means associated with said automatic switches for operating said charging means during the conversation, and means for changing the rate of operation of said charging means during successive time units of the conversational period.

3. In a telephone system, subscribers' lines, automatic switches for establishing a connecting circuit through which a calling and a called subscriber may converse during predetermined time units, charging means individual to said calling line, means controlled by the called subscriber for operating said charging means, means at the central office for short-circuiting the talking conductors of the calling line after a time unit has elapsed, and means controlled by the calling subscriber for rendering conversation again possible.

4. In a telephone system, subscribers' lines, means for establishing a connecting circuit through which a calling and a called subscriber may converse during predetermined time units, charging means individual to the calling line, means controlled by the called subscriber for operating said charging means, and means controlled by the calling subscriber for operating said charging means after the lapse of each time unit.

5. In a telephone system, subscribers' lines, means for establishing a connecting circuit through which a calling and a called subscriber may converse during predetermined time units, charging means, means controlled by the called subscriber for starting the operation of the same, means for rendering said connecting circuit ineffective by short-circuiting at the central office the talking conductors of the calling line after the lapse of each time unit, means controlled

by the calling subscriber for operating said charging means, and means operative thereupon for rendering said connecting circuit again effective.

6. In a telephone system, subscribers' lines, automatic switches for establishing a connecting circuit through which a calling and a called subscriber may converse during time units of predetermined lengths, a coin collector associated with the calling subscriber's line, means controlled by the called and calling subscribers for rendering said connecting circuit effective, an automatic time switch actuated thereupon, means controlled by said time switch for rendering said connecting circuit ineffective after the lapse of a time unit, and means for rendering said connecting circuit again effective if the calling subscriber inserts a coin in said coin collector.

7. In a telephone system, subscribers' lines, a plurality of trunks, means for establishing through any one of said trunks a connecting circuit through which a calling and a called subscriber may converse during predetermined time units, a charging means, means for operating said charging means at one rate during one of said time units, and at another rate during another time unit of the same conversational period if the conversation is established through a certain trunk, and means for changing the rate of operation of said charging means with respect to the mentioned rates if the connecting circuit is established through another one of said trunks.

8. In a telephone system, subscribers' lines, reverse-charge lines, means for establishing a connecting circuit through which a calling and a called subscriber may converse during predetermined time units, a call charging means individual to each of said subscribers' lines, means operative upon the response of the called subscriber if his line is a reverse-charge line for preventing the operation of the calling subscriber's charging means and for operating the called subscriber's charging means, and means for operating the called subscriber's charging means at different rates during the different time units.

9. In a telephone system, subscribers' lines, means for establishing a connecting circuit between a calling and called subscriber, a coin collector at the subscriber's substation and a recording device at the central office for each of said lines, and automatic means for operating said recording device each time a coin is inserted in said collector.

10. In a telephone system, a plurality of subscriber's lines, means including automatic selecting and connecting switches for establishing a talking circuit between two of said lines, means for automatically rendering said talking circuit inoperative at predetermined intervals of time, a measured service device, and means controlled thereby for again rendering said talking circuit operative.

11. In a telephone system, a plurality of subscribers' lines, means including automatic selecting and connecting switches for establishing a talking circuit between two of said lines, a time-controlled mechanism, means controlled by the response of the called subscriber for starting said mechanism in operation, means controlled by said mechanism for rendering said talking circuit inoperative at predetermined intervals of time, and a measured service device on the calling line for again rendering said circuit operative.

12. In a telephone system, a calling and a called line, means including an automatic progressively movable switch for connecting said lines, automatic means for requiring the calling subscriber to pay before beginning conversation, and automatic means for requiring further payments at regular intervals thereafter.

13. In a telephone system, a calling and a called line, means including an automatic progressively movable switch for connecting said lines, a coin collecting device for the calling subscriber, means for requiring the calling subscriber to deposit a coin in said device before beginning conversation, and an automatic mechanism for interrupting the conversation after a predetermined time to require the deposit of an additional coin.

14. In a telephone exchange system, substations, charging means at said substations, mean for automatically and repeatedly actuating said charging means, means responsive to the actuation of said charging means for disabling said substations, and means for automatically rendering ineffective said disabling means.

15. In a telephone exchange system, substations, charging means at said substations, mean for automatically and repeatedly actuating said charging means, means responsive to the actuation of said charging means for disabling said substations, means responsive to the payment of a charge for restoring the normal condition of said substations, and means responsive to the prepayment of a charge for rendering ineffective said disabling means.

16. In a telephone exchange system, substations, charging means at said substations, means for automatically and repeatedly actuating said charging means, means responsive to the actuation of said charging means for disabling said substations, means responsive to the payment of a charge for restoring the normal condition of said substations, mean responsive to the prepayment of a plurality

of charges for rendering ineffective said disabling means, and means for refunding excess prepaid charges.

17. In a telephone system, substations, charging means at said substations, means for automatically and repeatedly actuating said charging means, means responsive to the actuation of said charging means for disabling said substations, means for restoring the substation to normal condition, and means for rendering said disabling means ineffective.

18. In a telephone meter service system, a measured service device for assessing toll, said device comprising a meter, electromagnetic means for controlling said meter, and a time mechanism controlled by said means.

19. In a telephone meter service system, a measured service device for assessing toll, said device comprising a meter, electromagnetic means for operating said meter, means for initially operating said first means, and a time mechanism controlled by said last means for operating said first means periodically thereafter.

20. In a telephone meter service system, a call registering device comprising a meter, means for actuating said meter to register a call, and a time mechanism set in motion upon the operation of said meter and adapted to produce an additional actuation of said meter after a predetermined time.

21. In a telephone meter service system, a call registering device comprising a meter, means for actuating said meter to register a call, a time mechanism set in motion upon the operation of said meter, and means controlled by said time mechanism for registering another call on said meter after a predetermined time.

22. In a telephone meter service system, a call registering device comprising a meter, means for actuating said meter to register a call, a time mechanism set in motion upon the operation of said meter, and means controlled by said time mechanism for operating said meter periodically.

23. In a telephone system, a calling and a called line, means for completing a talking connection between said lines, and a call registering device for the calling line, said device comprising a meter, means for operating said meter upon the completion of said connection, a time mechanism set in motion when the meter is actuated, and means controlled by said mechanism for producing an additional actuation of said meter after a predetermined time.

24. In a telephone system, a calling and a called line, means including a plurality of auto switches for completing a talking connection between said lines, and a call registering device for the calling line, said device comprising a meter, means for actuating said meter upon the completion of said connections, a time mechanism set in motion when the meter is actuated, and means controlled by said mechanism for producing an additional actuation of said meter after a predetermined time.

25. In a telephone system, a calling and a called line, means for completing a talking connection between said lines, and a call registering device for the calling line, said device comprising a meter, means for operating said meter upon the completion of said connection, a time mechanism set in motion when the meter is actuated, and means controlled by said mechanism for actuating said meter periodically until said connection is released.

26. In a telephone system, a calling and a called line, means including a plurality of auto switches for completing a talking connection between said lines, and a call registering device for the calling line, said device comprising a meter, means for actuating said meter upon the completion of said connection, a time mechanism set in motion when the meter is actuated, and means controlled by said mechanism for actuating said meter periodically until said connection is released.

27. In a telephone system, a calling and a called subscriber's station, a talking circuit between said stations, a transmitter and a relay at the calling subscriber's station, an energizing circuit for said relay independent of said transmitter, a coin collector, and means by which the called subscriber controls said energizing circuit and operates said collector, said relay closing and maintaining closed during talking the talking circuit.

28. In a telephone system, a calling and a called subscriber's station, a talking circuit between said stations, a transmitter and a relay at the calling subscriber's station, an energizing circuit for said relay independent of said transmitter, a coin collector, and means whereby the response of the called subscriber closes said energizing circuit and operates said collector, said relay closing and maintaining closed during talking the talking circuit.

29. In a telephone exchange system, the combination of a coin collecting toll device and a calling subscriber's telephone station, circuits and a relay for operating said device controlled by a called subscriber's telephone station, and a talking circuit closed by said relay when the called subscriber answers, said relay maintaining said talking circuit closed during talking.

30. In a telephone system, a calling and a called subscriber's station, automatic progressively movable switches for establishing a talking connection between said stations, a transmitter and a relay at the calling subscriber's station, an energizing circuit for

said relay independent of said transmitter, a coin collector, and a magnet by which the called subscriber controls said energizing circuit and operates said collector, said relay closing and maintaining closed during talking the talking circuit.

31. In a telephone system, a calling and a called subscriber's station, automatic progressively movable switches for establishing a talking connection between said stations, a transmitter and a relay at the calling subscriber's station, an energizing circuit for said relay independent of said transmitter, a coin collector, and a magnet controlled by the called subscriber to close said energizing circuit and operate said collector, said relay closing and maintaining closed during talking the talking circuit.

32. In a telephone system, a telephone station, measured service means therefor comprising equipment for controlling the operativeness of the telephone, a relay having an armature, another telephone station, means comprising automatic progressively movable switching mechanism for connecting the two stations, means under control of said other station for energizing said relay for operating said measured service means and for maintaining said relay energized, whereby said measured service means is held operated to render the telephone operative for talking between said stations.

33. In a telephone system, a telephone station, measured service means therefor comprising a circuit controlling the operativeness of the telephone, a relay having an armature, another telephone station, means comprising automatic progressively movable switching mechanism for connecting said stations, means under control of the other station for energizing said relay for operating said measured service means and for maintaining said relay energized, whereby said circuit in the measured service means is held closed to render the telephone operative for talking between the said stations.

34. In a telephone exchange system, the combination of a pair of telephone stations, talking transmitters for said stations, an automatic progressively movable switch for establishing a connection between said stations, a calling mechanism for controlling said switch, a central source of current, said switch comprising means for supplying current from said source to said stations over the conductors of said connection for talking purposes, measured service equipment comprising a circuit for controlling the operativeness of the transmitter of one of said telephone stations, a relay for controlling said equipment, said relay connected to said connection and energized by the current supply for talking purposes to close the talking circuit in said measured service equipment to enable subscribers to talk between said stations, the said relay being maintained energized during talking.

35. In a telephone exchange system, a calling and a called subscriber's station, automatic progressively movable switching mechanism for establishing a connection between the said stations, a pay station apparatus for the calling station, a relay for controlling said apparatus, a central source of current for talking purposes, means controlled by the called station for supplying current from said source to energize said relay to close a talking circuit in said connection, the said relay being maintained energized during talking.

36. In a telephone system, a calling and a called subscriber's station, equipment including talking transmitters at said station, automatic progressively movable switching mechanism for establishing a connection between said stations, an open metallic circuit for the transmitter of the calling station after the connection to a called station is established, a pay station apparatus and a relay for the calling station, means under the control of said called station for energizing said relay to close and maintain closed during talking the metallic circuit for said transmitter and for controlling said pay station apparatus.

37. In a telephone system, a calling and a called line, automatic switches at the exchange for uniting said lines in a talking circuit comprising two inductively connected sections, a device at the calling substation for assessing a charge against the calling subscriber at the beginning of conversation, and automatic mechanism included in the calling section of the talking circuit for controlling said device to assess an additional charge at intervals thereafter.

38. In a telephone system, a toll assessing device associated with a line, an operating circuit for said line, means for extending a connection to any one of a plurality of lines, automatically controlled equipment having a progressively movable element associated with said device, and means for starting said equipment after connection is extended to the called line for variably operating said device depending upon the line to which connection is extended, said operating circuit closed through said progressively movable element.

39. In a telephone system, a measured service device associated with a line, an operating circuit for said device, means for extending a connection from said line to any one of a group of lines, automatic circuit controlling equipment having a progressively movable element associated with said group of lines for controlling the operation of said device, said equipment arranged for variably operating said measured service device whereby the device is oper-

ated to assess one toll if the first line is connected to one line of the group, and operated to assess a different toll if the line is connected to another line of the group, said operating circuit closed through said element.

40. In a telephone system, subscribers' lines, trunk lines of different character, means for extending a connection from a calling to a called subscriber's line over said trunk lines, a meter for the calling line, a meter controlling device common to said lines, means associated with each trunk line for operating said device a predetermined number of times for each call to in turn operate said meter a number of times to record charges varying in accordance with the trunk line used.

41. In a telephone system, subscribers' lines, trunk lines of different character, means for extending a connection from a calling to a called subscriber's line over said trunk lines, a meter for the calling line, a meter controlling device common to said lines, means individual to each trunk line for operating said device a predetermined number of times for each call for recording charges on said meter varying in accordance with the trunk line used.

42. In a telephone system, subscribers' lines, trunk lines of different character, means for extending a connection from a calling to a called subscriber's line over said trunk lines, a meter for the calling line, a meter controlling device common to said subscribers' lines, means associated with each trunk line for operating said device a predetermined number of times for each call for recording charges varying in accordance with the trunk line used.

43. In a telephone system, subscribers' lines, trunk lines of different character, means for extending a connection from a calling to a called subscriber's line over said trunk lines, a meter for the calling line, a meter controlling device common to said lines, an impulse sender associated with each trunk line for operating said device a predetermined number of times for each call for recording charges varying in accordance with the trunk line used.

44. In a telephone system, subscribers' lines, trunk lines of different character, means for extending a connection from a calling to a called subscriber's line over said trunk lines, a meter for the calling line, a meter controlling device common to said lines, means associated with each trunk line for operating said device a predetermined number of times for each call for recording charges varying in accordance with the trunk line used upon the response of the called subscriber.

45. In a telephone system, a calling line, a called line, means for connecting said lines including a plurality of trunk lines, a measured service device for the calling line including a meter and a meter controller, means associated with each trunk line for registering a charge upon said controller for the use of such trunk line, said meter in turn controlled by said controller to assess said charge thereon when the called subscriber answers.

46. In a telephone system, a plurality of exchanges, subscribers' lines in each exchange, means for extending a connection from a line in one exchange to a line in any other exchange, a register for the calling line, and means controlled by the called subscriber for operating said register a predetermined number of times for each call, depending upon the distance between said connected exchanges.

47. In a telephone system, calling and called lines, a registering device for each line, means controlled solely by a calling subscriber for extending a connection from a calling to a called line by means of trunk lines of different lengths, and means controlled by the called subscriber for operating said registering device a predetermined number of times for each call depending upon the length of the trunk line used.

48. In a telephone system, calling and called lines, a registering device for each line, means controlled solely by a calling subscriber for extending a connection from a calling to a called line by means of trunk lines of different lengths, and automatic means controlled by the called subscriber for operating said registering device only a predetermined number of times depending upon the length of the trunk line used.

49. In a telephone system, calling and called subscribers' lines, a register for each line, means for extending a connection from a calling to a called subscriber's line by means of trunk lines of different lengths, a register controlling mechanism common to said lines, said mechanism controlled by the called subscriber to operate said register a predetermined number of times for each call, depending upon the length of trunk line used.

50. In a measured service telephone system, a plurality of exchanges, automatic switches controllable by a calling subscriber in one of said exchanges for extending connections to called subscribers in the other exchanges, a meter for registering toll charges against the calling subscriber, and automatic mechanism permanently associated with said automatic switches for actuating said meter initially in accordance with the called subscriber's exchange, and for actuating said meter once at predetermined time intervals thereafter also in accordance with the called subscriber's exchange.

51. In a measured service telephone system, a plurality of exchanges, automatic switches controllable by a calling subscriber in one of said exchanges for extending connections to called subscribers in the other exchanges, a meter for registering toll charges against the calling subscriber, and automatic mechanism for variably actuating said meter initially a plurality of times in accordance with the called subscriber's exchange, and for periodically actuating said meter thereafter also in accordance with the called subscriber's exchange.

52. In a measured service telephone system, separate groups of trunk lines for use in connecting subscribers' lines at different distances, toll assessing switches associated with the trunk lines of each group for operating calling subscribers' meters to assess initial and elapsed time charges in accordance with the trunk lines in use, and circuit connections in said switches which may be altered in the case of any group of switches to change the initial charge, the elapsed time charge or the elapsed time charge time interval.

53. In a telephone system, a calling line, charging means individual thereto, other lines, a trunk line for use of said calling line in common with other calling lines, a timing device in said trunk line arranged to cause the actuation of said charging means, an interoffice trunk line serving said trunk line in common with other trunk lines of a similar nature, a timing device in said interoffice trunk line arranged to cause the actuation of said charging means, means for extending said calling line through said trunk line and said interoffice trunk line to one of said other lines, and means responsive to the answer of the subscriber on said called line for setting said timing devices into operation.

54. In a telephone system, a calling line, charging means individual thereto, other lines, a trunk line for use of said calling line in common with other calling lines, a timing device in said trunk line arranged to cause the actuation of said charging means to mark off predetermined intervals of time during which conversation may be held, an interoffice trunk line serving said trunk line in common with other trunk lines of a similar nature, a timing device in said interoffice trunk line arranged to cause the actuation of said charging means and to mark off a predetermined interval of time during which conversation may be held, means for extending said calling line through said trunk line and said interoffice trunk line to one of said other lines, and means responsive to the answer of the subscriber on said called line for setting said timing devices into operation.

55. In a telephone system, a calling line, charging means individual thereto, other lines, a trunk line for use of said calling line in common with other calling lines, a timing device in said trunk line arranged to cause the actuation of said charging means to mark off predetermined intervals of time during which conversation may be held, an interoffice trunk line serving said trunk line in common with other trunk lines of a similar nature, a timing device in said trunk line arranged to cause the actuation of said charging means and to mark off a predetermined interval of time during which conversation may be held, means for extending said calling line through said trunk line and said interoffice trunk line to one of said other lines, means responsive to the answer of the subscriber on said called line for setting said timing device associated with said interoffice trunk line into operation, and means responsive to the completion of the operation of said timing device to set said timing device associated with said trunk line into operation.

56. In a telephone system, a calling line, charging means individual thereto, other lines, a trunk line for use of said calling line in common with other calling lines, the timing device in said trunk line arranged to periodically cause the actuation of said charging means, an interoffice trunk line serving said trunk line in common with other trunk lines of a similar nature, a timing device in said interoffice trunk line arranged to cause the actuation of said charging means, means for extending said calling line through said trunk line and said interoffice trunk to one of said other lines, and means responsive to the answer of the subscriber on said called line for setting said timing devices into operation.

57. In a telephone system, a calling line, charging means individual thereto, other lines, a trunk line for use of said calling line in common with other calling lines, the timing device in said trunk line arranged to periodically cause the actuation of said charging means, an interoffice trunk line serving said trunk line in common with other trunk lines of a similar nature, a timing device in said interoffice trunk line arranged to cause the actuation of said charging means, means for extending said calling line through said trunk line and said interoffice trunk line to one of said other lines, means responsive to the answer of the subscriber on said called line for setting said timing device associated with said interoffice trunk line into operation, and means responsive to the completion of the operation of said timing device for setting said timing device associated with said trunk line into operation.

58. In a telephone system, a calling line, charging means individual thereto, other lines, a trunk line for use of said calling line in common with other calling lines, a

timing device in said trunk line arranged to cause the actuation of said charging means, an interoffice trunk line serving said trunk line in common with other trunk lines of a similar nature, an intra-office trunk line also serving said trunk line in common with other trunk lines of a similar nature, a timing device in said interoffice trunk line arranged to cause the actuation of said charging means, means for extending said calling line through said trunk line and said interoffice trunk line to one of said other lines, means responsive to the answer of the subscriber on said called line for setting said timing devices into operation, and means for extending said calling line through said trunk line and said intra-office trunk line to another of said other lines, and means responsive to the answer of the subscriber on said other called line for setting said timing device into operation.

59. In a telephone system, a calling line, charging means individual thereto, other lines, a trunk line for use of said calling line in common with other calling lines, a timing device in said trunk line arranged to periodically cause the actuation of said charging means, an interoffice trunk line serving said trunk line in common with other trunk lines of a similar nature, a timing device in said interoffice trunk line arranged to cause the actuation of said charging means, an intra-office trunk line also serving said trunk line in common with other trunk lines of a similar nature, means for extending said calling line through said trunk line and said interoffice trunk line to one of said other lines, and means responsive to the answer of the subscriber on said called line for setting said timing devices into operation, and means for extending said calling line through said trunk line and said intra-office trunk line to another of said other lines, and means responsive to the answer of the called subscriber on said other called line for setting said timing device into operation.

In witness whereof, I hereunto subscribe my name this 9th day of March, A. D., 1922.

JACOB W. LATTIG.

In witness whereof, I hereunto subscribe my name this 15 day of March, A. D., 1922.

CHARLES L. GOODRUM.