No. 810,345. PATENTED JAN. 16, 1906.

A. F. POOLE & F. B. HALL.

TELEPHONE PARTY LINE SYSTEM.

APPLICATION FILED OCT. 13, 1902.

4 SHEETS—SHEET 1.

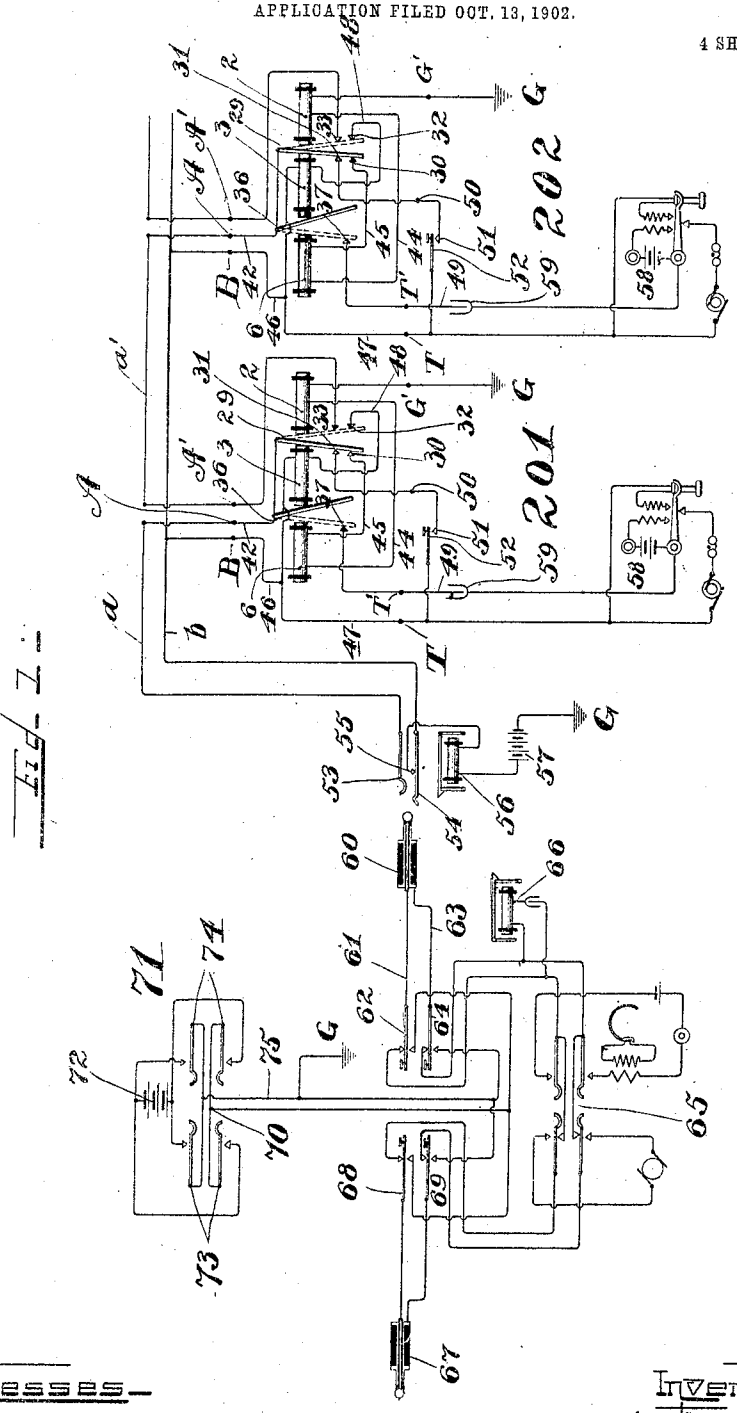

Fig. 1.

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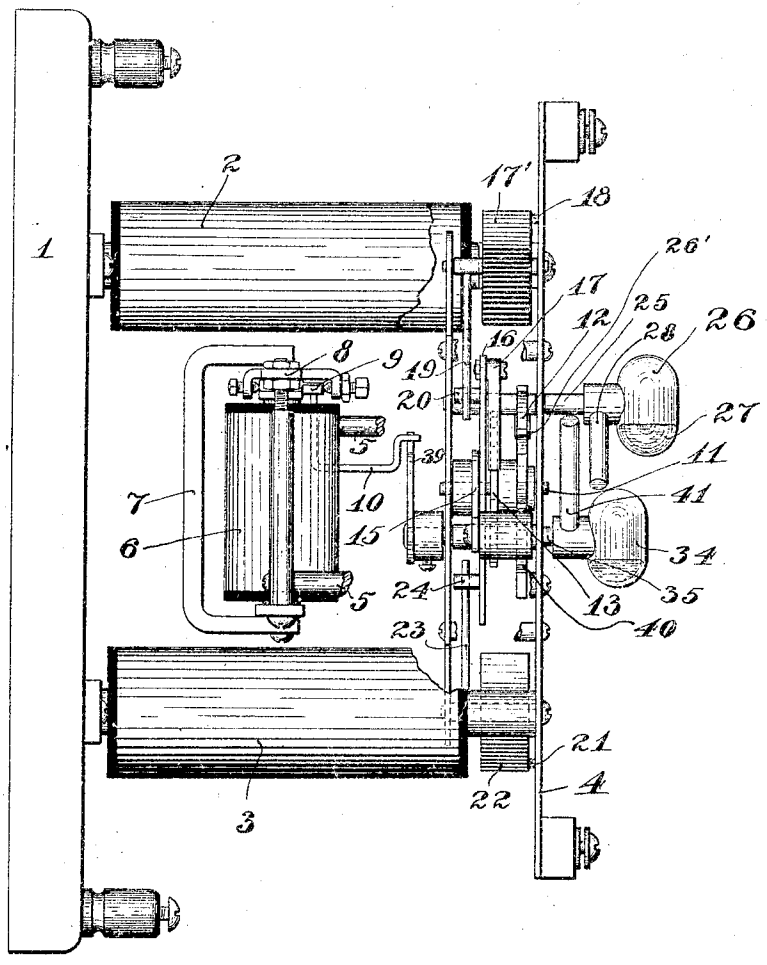
4 SHEETS—SHEET 2.

Fig. 2.



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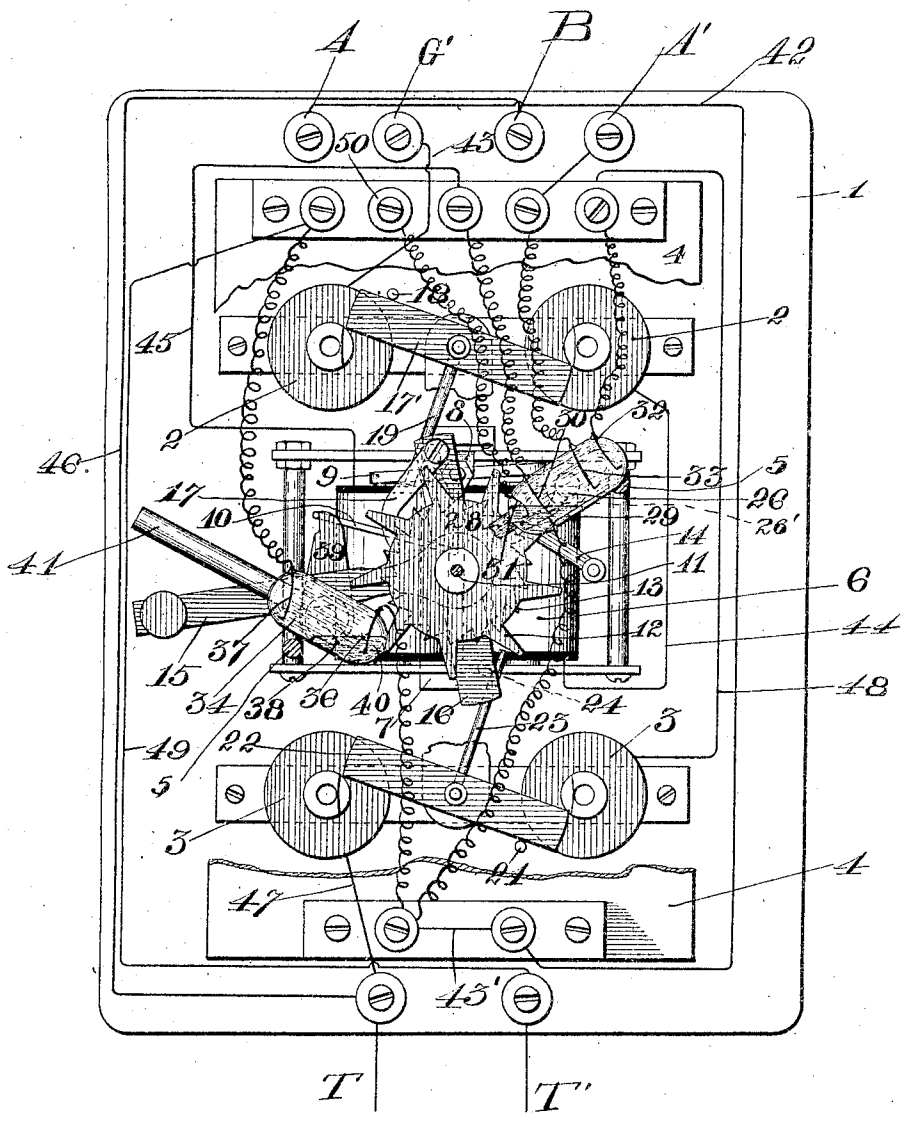
4 SHEETS—SHEET 3.

Fig. 3.



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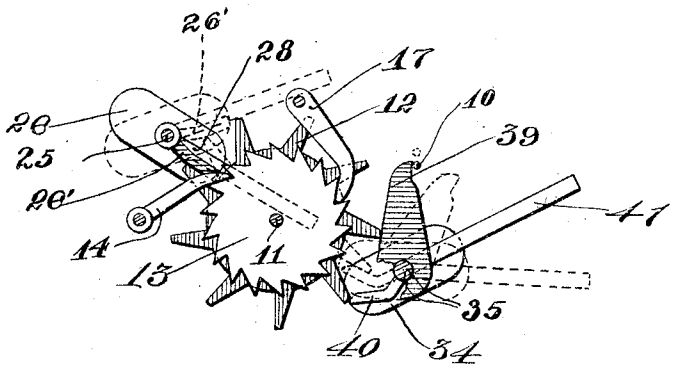
4 SHEETS—SHEET 4.

Fig. 4.



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UNITED STATES PATENT OFFICE.

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TELEPHONE PARTY-LINE SYSTEM.

No. 810,345. Specification of Letters Patent. Patented Jan. 16, 1906.

Application filed October 13, 1902. Serial No. 127,113.

To all whom it may concern:

Be it known that we, ARTHUR F. POOLE and FRANK B. HALL, citizens of the United States, residing at Wheeling, in the county of Ohio and State of West Virginia, have invented a certain new and useful Improvement in Telephone Party-Line Systems, of which the following is a full, clear, concise, and exact description, reference being had to the accompanying drawings, forming a part of this specification.

Our invention relates to telephone party-line systems, and more particularly to what may be termed "party-line selective systems."

The principal objects of our invention are to provide a new and improved party-line system including a new selecting-circuit therefor and improved switching mechanism for use therewith, and thereby to overcome the defects in the construction and operation of party-line systems heretofore employed.

Party-line systems of the prior art may be divided into two classes. In one of these classes the apparatus installed at a subscribers' station on a party-line is intended to respond only to currents of a certain nature with respect to their strength or polarity, or both. Such systems are necessarily delicate in their adjustment, and therefore liable to get out of operative condition. Such systems, furthermore, are necessarily limited to a small number of stations on each line. The other class of party-line systems employ what is generally known as "step-by-step" devices. In this class of systems step-by-step mechanism is installed at each of the substations on a party-line, the said mechanism being operated in synchronism with mechanism at the central station. In such systems the mechanism at all of the substations on any one party-line must be operated at the same time, thereby requiring a very powerful current. A further defect in many of these step-by-step party-line systems has been, that on account of the complication of the mechanism employed, it was very subject to derangement, and a further difficulty arose in that the derangement of the mechanism of any one station was liable to throw out of operative condition the mechanism at all the other stations on the same line, such a general derangement often requiring the personal attention of an expert at each of the stations on a line.

Our invention contemplates an improved system in which these defects and difficulties are overcome. In accordance with our invention we provide a selective party-line system in which the apparatus installed at each of the substations on a line is operated individually, the apparatus at the substations being operated successively. This operation of but one set of apparatus at a time enables the operation of the system to be accomplished with a relatively small amount of current or strength of current. The system may be employed with any party-line without requiring the installation of new telephone apparatus, the system being well adapted for use with any type of telephone and telephone-circuit.

Another advantage obtained from the use of the system of our invention consists in the fact that the apparatus installed at each of the stations is a duplicate of that installed at all the other stations. Therefore the special adjustment of each subscriber's apparatus is unnecessary and the cost of installation is thereby materially decreased.

Other great advantages obtained by the use of our present system consist in the fact that none of the currents used in the operation of the selective apparatus are broken at the substations, it being a well-known fact among those skilled in the art that the use of make-and-break contacts at party-line substations gives rise to much difficulty on account of the oxidation and deterioration of such contacts due to the sparking caused upon the breaking of the current.

Our improved system presents a further advantage over those heretofore employed in the fact that the strength of the selecting-currents is not material to the proper operation of the substation apparatus.

The objects of our invention are attained through the provision of a double metallic line, one side of which may be continuous throughout the length of the line, each subscriber's apparatus being desirably provided with a bridge connection therewith. The other side of this metallic line may be looped in at each of the substations, one side of each of said loops being connected with a part of the subscriber's selective apparatus. At each of the substations this loop may be provided with a normally open contact. A part of the operation of the system includes the successive closing of these loops, thereby building up this loop-line through the successive substations. The continuity of the loop-line is

thereby attained, there being established by this building-up process two continuous metallic lines extending from the central station associated therewith to the farther end of the party-line. The circuits used in this building-up process may be established, as desired, either through one of the lines in connection with a grounded return or through the two lines themselves.

A further result of the proper operation of the selective apparatus consists in bridging the desired subscriber's telephone across the two metallic limbs of the party-line as previously established. Normally each subscriber's station may be provided with a ground connection, particularly if the grounded return is used in the building-up process previously referred to, a further result of the setting-up operation of the selective apparatus being to break this normally grounded connection.

Our invention further introduces a new and efficient lock-out system, it being impossible when the line is in use by any one party on the line for any other party on the same line to either listen in or signal or in any manner disturb the subscriber who is entitled to the use of the line, and a still more particular advantage of our lock-out system over those heretofore employed resides in the fact that the said lock-out feature is entirely automatic, it being an inherent feature of the party-line system itself, and no special provisions are necessary with our system in order to secure the lock-out feature.

Some of the most desirable objects of our invention are attained by the provision of selective apparatus for the substations, the circuit breaking or changing operations of which are accomplished after a proper flow of current therethrough has ceased—that is to say, a current being sent through the selective apparatus, the circuit changes which are ultimately to be brought about do not occur until the said current has ceased to flow, the selective apparatus being operated upon what might be termed its "reverse" stroke. Many novel features are incorporated in the construction and mode of operation of this improved selective apparatus, which, in addition to the other features of our invention, will be best understood by reference to the accompanying drawings, in which—

Figure 1 is a diagrammatic view showing the circuit connections employed in the operation of our system including a central-station equipment which may desirably be used in connection therewith. Fig. 2 is a side elevation of a set of selective apparatus intended to be installed at a substation, parts being broken away to more clearly reveal the operation thereof. Fig. 3 is a front elevation of the same with other parts similarly broken away. Fig. 4 is a view illustrating details of construction of the said selective apparatus.

In all of said views similar reference characters are applied to like or corresponding parts.

The precise arrangement of the central-station equipment employed is not pertinent to the present invention, it being merely necessary that central-station apparatus be provided whereby currents of desired polarity may be sent over any desired circuits of the party-line. We have, however, shown a manually-operated central-station equipment suitable for use in connection with our party-line system.

Since the circuit arrangements of our system, the sequence of electrical connections made, and other features of the operation thereof will not be readily apparent without an understanding of the mechanical devices employed to carry out our invention, we shall first describe the mechanical construction of the selective apparatus employed and thereafter trace the electrical circuits used in the operation thereof.

The selective apparatus is mounted on a base 1, to which are secured the horseshoe-electromagnets 2 and 3, the front ends of the cores of these electromagnets carrying the sheet-metal frame-piece 4. Carried by the studs 5 5, which extend from the frame-piece 4, is the horseshoe-electromagnet 6, this electromagnet being provided with a permanent polarizing-magnet 7. A frame portion 8 is adapted to pivotally support the armature 9 adjacent to the pole-pieces of the electromagnet 6. This armature is operated only upon a flow of the current through the electromagnet 6 in a certain direction on account of the polarization of said armature caused by the permanent magnet 7. A detent 10 in the shape of a bent wire is secured to the armature 9, the purpose of which detent will be hereinafter more fully set forth. Near the center of the front framework of the device is provided a fixed shaft 11, upon which are rotatably mounted various pieces of mechanism. Thus rotatably mounted upon the said shaft is provided the spur-wheel 12, there being rotatably associated therewith a ratchet-wheel 13. It will be noticed that the ratchet-wheel 13 has twice as many teeth as there are spurs on the spur-wheel 12. A ratchet-pawl 14 prevents the rotation of the ratchet and spur wheels in a clockwise direction. A weighted lever 15 is rotatably mounted upon the shaft 11 just back of the ratchet-wheel 13, this lever having a cross-arm 16 extending in either direction from the shaft 11 perpendicularly to the arm of the lever 15. The upper arm of this cross-bar 16 carries a pivoted ratchet-pawl 17, adapted to engage the teeth of the ratchet-wheel 13. An armature 17′ is pivotally mounted to swing from the normal position (shown in Fig. 3) into alinement with the pole-pieces of the electro-

magnet 2, a stop 18 being provided to determine the swing of the armature. This armature 17′ carries a downwardly-projecting pin 19, so disposed as to engage a pin 20, projecting from the back of the cross-lever 16. Thus upon the energization of the electromagnet 2 its armature is drawn into line with the pole-pieces, thus causing a motion to be communicated through the downwardly-projecting lever-pin 19 and the pin 20 to the cross-arm 16 of the lever 15. The rotary motion of this lever mechanism will be in a clockwise direction, sufficient to draw the pawl 17 back over one tooth of the ratchet-wheel 13. When a current has stopped flowing through the electromagnet 2, the weight of the lever 15 is sufficient to transmit power through the pawl 17 to the ratchet-wheel 13, thereby turning it the space of one ratchet-tooth in a contra-clockwise direction, it being remembered that on account of their rigid association the spur-wheel 12 will rotate in correspondence with the ratchet-wheel 13.

Referring now to the electromagnet 3, it will be seen that it also is provided with a stop 21, limiting the motion of its swinging armature 22, which in turn carries a lever-pin 23, adapted to engage a pin 24 on the lower projecting arm of the cross-piece 16. Thus an energization of this lower electromagnet 3 will cause the weighted arm of the lever mechanism to rise and upon its release to cause the rotation of the ratchet-wheel through the space of one notch in a manner similar to that produced by the electromagnet 2—that is to say, a temporary current flowing through either the electromagnet 2 or the electromagnet 3 will cause a similar operation of the lever mechanism and the ratchet-wheel and spur-wheel associated therewith.

A rotatable shaft 25 is provided with suitable bearings and carries upon its outer end an exhausted glass bulb 26, containing mercury 27. As best illustrated in Fig. 4, this shaft 25 is further provided with a tail 26′, adapted to be actuated by the spurs of the wheel 12. A weighted lever 28 tends to maintain the mercury-bulb in a tilted or normal position. (Shown in Fig. 3.) It will be seen that upon the rotation of the spur-wheel through the space of one ratchet-wheel tooth the tail 26′ will be engaged by a spur of the spur-wheel 12 to raise the said tail into its alternate position, as shown in dotted lines in Fig. 4, thereby causing the mercury-bulb 26 to be tilted into its alternate position. (Also indicated in dotted lines.) It will be seen, furthermore, that a second rotation of the spur-wheel through the space of one ratchet-tooth will cause the disengagement of the tail 26′ with a spur of the wheel 12, whereupon the weighted lever 28 will cause the bulb to be tilted back into its normal position, as shown in Fig. 3.

It should be noticed here that platinum wires are sealed into the tube 26 in such a way that the bulb and the inclosed mercury form a five-contact switch. The contact 29 is in contact with the mercury in either of its alternate positions, the contacts 30 and 31 being brought into closed connection therewith when the mercury-bulb is in its normal position, the contacts 32 and 33 being brought into contact with the common terminal 29 when the mercury-bulb is in its alternate or abnormal position.

Referring now to the second mercury-bulb 34, which is similarly mounted upon a rotatable shaft 35, it will be seen that this bulb contains the two terminals 36 and 37, which terminals are connected by the inclosed mercury 38 only when the bulb 34 is in its alternate position, (indicated in dotted lines,) there normally being no electric circuit formed between the terminals 36 and 37. The shaft 35 extends through the front framework, where it is provided with a detent-cam 39, which cam of course rotates in accordance with the bulb 34 and the shaft 35. The detent 10, connected with the polarized armature 9, is so disposed as to normally engage and detain the cam 39 in its normal position. (Shown in Fig. 3.) This shaft 35, similarly to the shaft 25, carries a tail 40, adapted to be engaged by the teeth of the spur-wheel 12. The normal disposition of this tail 40 to the spur of the spur-wheel adjacent thereto is such that the release of the detent-cam 39 by the detent-wire 10 will allow the weighted lever 41 to cause the tilting of the bulb 34 into its alternate or abnormal position, thus causing an electrical connection between the terminals 37 and 36. A rotation of the spur-wheel, however, causes the engagement of a spur thereof with the tail 40, so as to depress the said tail, thereby rotating the bulb 34 and its associated detent-cam 39 back into their normal position, where the detent-wire 10 slips over the cam-surface and thereupon catches the detent edge of the cam 39. Thus the bulb 34 is retained in its normal position, (shown in Fig. 3,) except upon the actuation of the polarized armature 9, whereupon the detent-wire releases the cam 39, thus permitting the tilting of the bulb.

The circuit connections of the selective apparatus are diagrammatically illustrated on Fig. 3, where it will be seen that a connection is made between the binding-post A, through the wire 42, to the fuse 43′, connections being made from this point to the terminal 29 in the bulb 26 and to the terminal 36 in the bulb 34. An electrical connection is made between the binding-post G′, through the wire 43, to the electromagnet 2, the said electromagnet being connected in series, through the wire 44, with the electromagnet 6, from which the remaining connection is made, through the wire 45, with the terminal 30 in the bulb 26. Connection is made from the binding-post B,

through the wire 46, to the binding-post T, from which a wire 47 leads to the electromagnet 3, the remaining terminal thereof being connected by the wire 48 with the terminal 32 in the bulb 26. Connection is made, as shown, between the binding-post A′ and the contact 33. A wire 49 connects the binding-post T′ with the terminal 37 in the bulb 34. The contact 31 in the bulb 26 is connected with the binding-screw 50, from which a connection is made with the contact 51 of a key 52. (Shown only in the diagrammatic view, Fig. 1.)

Having thus described the selecting mechanism which may desirably be employed in our improved system, we shall now proceed to describe the circuits employed in the operation thereof.

In Fig. 1 we have illustrated the circuit connections for a party-line, which may be connected with any desired number of substations. In the diagrammatic figure, however, we have shown but two such substations 201 and 202 connected with the line, it being understood that the remaining substations are connected therewith in an exactly similar manner. On account of the impossibility of satisfactorily illustrating in diagrammatic drawing all the mechanism necessary to carry out the operations in our system we have merely attempted to illustrate in the selective apparatus the electromagnets and the electrical contacts controlled thereby. Referring more particularly to Fig. 1, we have shown a metallic telephone-line consisting of the line *b*, which runs straight through from the exchange to all of the substations without a break, and the line *a*, which is desirably looped into each of the substations. The line-wire *a* may be connected with a tip-spring 53 and the line-wire *b* with the sleeve-spring 54 of a spring-jack at the central station. A contact 55 normally makes connection with a long jack-spring and is connected through a line-drop 56 and the battery 57 with the ground G. In the further description of Fig. 1 it should be borne in mind that merely the circuit connections are indicated and that the electromagnets shown correspond with an electromagnet having similar reference characters in the other figures. It should furthermore be borne in mind that the circuit changes caused by the electromagnets 2 and 3 are not brought about except upon the reverse stroke of the mechanism operated thereby.

Tracing the circuit from the tip-spring 53 through the line-wire *a*, we come to the binding-post A, from which it will be remembered a connection was made with the terminal contact 29 in the bulb 26 and with the terminal 36 in the bulb 34. Normally the bulb is in such a position that the terminal 29 is connected, by means of the mercury, with the terminals 30 and 31.

It will be seen that the wire *a′* is connected with the binding-post A′ and leads from the binding-post A′ of substation 201 to the binding-post A of substation 202, the circuit arrangements for each subscriber being an exact duplicate of the circuit arrangement of all the other subscribers on the party-line. It will be seen that the binding-posts B of all the stations are connected directly with the *b* wire.

The operation of our system may perhaps, be best understood by tracing the circuits and their attendant operations under the various conditions of operation to which a party-line system is subjected. First, taking that condition under which a party on a party-line—for instance, at station 202—wishes to call central and remembering that the circuit between contacts 36 and 37 is normally open and that connection is normally made between contact 29 and contacts 30 and 31, the subscriber at station 202 makes connection between the key 52 and the contact 51. He thereby closes the following circuit: from contact 51 to contact 31, to contact 30, to electromagnet 6, through wire 44, to electromagnet 2, to binding-post G′, to ground G, through ground to battery 57, to line-drop 56, to contact 55, to spring 54, to line-wire *b*, to binding-bost B at substation 202, to binding-post T, to key 52. Thus we have traced the circuit which will energize the two electromagnets 2 and 6, it being remembered that the electromagnet 6 is provided with a polarized armature operated only when a current flows in the proper direction through the said electromagnet. The battery 57 has a pole thereof connected with the ground, such that the current flowing through any electromagnet 6 located at any of the substations on the line will flow through the said electromagnet in such a direction as to operate the armature, thereby releasing the trip, which permits a tilting of the bulb 34 to make connection between the contacts 36 and 37. The energization of the electromagnet 2 while this current flows will have caused the operation of the lever mechanism 15 16.

Upon the cessation of the current-flow the ratchet mechanism will be operated by the reverse stroke of the lever mechanism, through which the connection of the terminal 29 from that with the contacts 31 and 30 is changed to a connection with the contacts 32 and 33.

The telephonic apparatus 58, installed at substation 202, will thereby have been connected in bridge across the metallic limbs of the telephone-line, a condenser 59 being connected in the telephone-circuit to prevent a flow of battery-current therethrough. It will be seen, furthermore, that through the depression of this key 52 and the ensuing operation of the mechanism controlled by the electromagnet 2 the loop in the line-wire *a*, con-

nected in at station 202, has been closed, thereby affording a continuous electrical path through the line-wire *a*, so far as the substation 202 is concerned, it being apparent that this normally open loop is electrically closed by the connection of the contact 29 with the contact 33.

It should also be pointed out here that the connection of any subscriber's telephone in bridge of the metallic line is absolutely controlled by the relation of the switch-contacts 36 and 37, which contacts may be brought into electrical connection only by means of a current of proper polarity flowing through the electromagnet 6 at the given substation.

The central operator upon receiving the visual signal from the drop 56 places her answering-plug 60 into the answering-jack. She thereupon breaks the connection existing between the spring 54 and the contact 55, which circuit normally includes the line-drop 56 and the battery 57.

It will be seen that the tip-strand 61 completes its circuit partially through a spring 62, which in its normal position makes contact with the remainder of the tip-strand. The sleeve-strand 63 is likewise connected with a key 64, which normally is connected with the remainder of the operator's usual cord-circuit. The operator's cord-circuit need not be particularly described, in that it is familiar to those skilled in the art. It is provided with the usual ringing and listening key 65 and the associated generator and operator's telephone set. Bridged across the cord-strands is the disconnect signal-relay 66. The calling-plug 67 may desirably have keys 68 and 69 connected in circuit therewith, the operations of these keys being hereinafter more fully set forth.

After plugging into the answering-jack the operator depresses the key 62, thereupon making a connection between the tip of the plug 60 and the conductor 70 of the pole-changing circuit 71. This pole-changing arrangement consists, essentially, of a battery 72, which by proper manipulation of the springs 73 and 74 may have either of its poles, as desired, connected with the conductors 70 or 75. The operator manipulates the pair of springs 73 a number of times, at least as great as the total number of stations connected with the calling party-line. She thereby closes a circuit, which may be traced as follows: from the positive pole of the battery 72, through the upper spring 73, to conductor 75, to ground G, there being no circuit connection between the conductor 75 and the key 64. The circuit may be traced through the ground to the binding-post G′ of the substation 201, thence through the corresponding electromagnet 2 and the electromagnet 6, to contact 30, to contact 29, to binding-post A, to line-wire *a*, to tip-spring 53, to tip-strand 61, to spring 62, to conductor 70, to the lower spring 73, to the negative pole of the battery 72. There will be no such circuit formed from the ground of subscriber 202 to the *a* wire, because this circuit would be necessarily traced through a connection between contacts 29 and 30, and it will be remembered that upon the depression of the key 52 at substation 202 the operation of the electromagnet 2 caused a separation of the said contacts 29 and 30. A similar circuit as that traced for substation 201 could not be traced for the substation 203 and the remaining substations upon the line, for the reason that the circuit through the *a* wire for these more remote stations is not completed through the loop entering the nearer substation 201 until the operation of the mechanism caused by the current-flow through the electromagnet 2 of substation 201, it being remembered that the change of connection of the contact 29 is not brought about until the breaking of this setting-up current at the central station. It should be noticed, furthermore, that in this setting-up operation the key 73 connects the battery 72 with the apparatus in such a direction that the actuation of the armature associated with the electromagnet 6 is not brought about. Therefore upon the operation of the key 73 none of the switches associated with the electromagnet 6 is operated.

The first closure of the springs 73 with their associated contacts and the subsequent release thereof causes the ground connection G to be thrown off from the substation 201, and at the same time the loop through this substation is closed by the connection of contacts 29 and 33.

The second manipulation of the key 73 would cause a similar change in the circuit connections at substation 202 had not a similar change been already brought about through the agency of the electromagnet 2, due to the manipulation of the key 52, located at substation 202. Therefore the second manipulation of the springs 73 causes an operation of the instrumentalities at the third substation 203, corresponding with the operation at substation 201, brought about by the first manipulation of the springs 73. Similarly, each successive manipulation of the key 73 builds up the line-wire *a* to the next succeeding substation, at the same time throwing off the ground connections for the successive substations. Thus after a number of manipulations of the key 73, corresponding to the number of stations on a party-line, all the grounds have been thrown off and the subscriber 202 is alone bridged across the metallic lines *a* and *b*. The operator thereupon releases the key 62, which has been depressed during these operations, whereupon her cord-circuit is connected with

the metallic line, across which the substation apparatus is bridged in a manner familiar to those skilled in the art.

The subsequent operations of ascertaining the subscriber with whom conversation is desired and the calling of the called subscriber need not be described. It may be well to here point out the fact that after the building up of the line, as above described, all the ground connections have been thrown off, so that no other subscriber on the same line can secure the closure of his circuit between contacts 36 and 37, which, it will be seen, is absolutely necessary in order to connect his telephone instruments with the line. It is thus apparent that the lock-out feature of our invention is entirely automatic, requiring no special operations or devices.

Referring now more particularly to Fig. 4, it will be seen that the selective apparatus at substation 202 will have its bulb 26 in the abnormal position indicated, also that by the operation of the polarized armature 9 and the consequent release of the cam 39 the bulb 34 will have assumed its alternate position, as indicated in the dotted lines. The selective apparatus at the other substations will have been actuated only to change the position of the bulbs 26. Upon the completion of the conversation between substation 202 and the called subscriber the operator will receive a disconnect-signal, due to the current from a ringing-generator. Before removing her plug from the jack it is necessary that she restore all of the subscriber's selective apparatus to its normal position. This she does by sending a battery-current over the two limbs *a* and *b* of the telephone-line. It will be seen that in the alternate or built-up condition of the selective apparatus all of the electromagnets 3 are bridged across the metallic lines, the electromagnet 3 being normally and continuously connected with the *b* wire and in the alternate condition being connected through contacts 32 and 29 with the *a* wire.

Referring more particularly to Figs. 2, 3, and 4, it will be seen that the energization of this electromagnet 3 will cause upon the reverse stroke a one-notch rotation of the spur-wheel 12. The tail 26′ will be in its alternate position, as best shown in dotted lines in Fig. 4. Thus upon the forward impulse of the spur-wheel the spur-tooth will disengage the tail 26′, thereby allowing the bulb to drop back into its normal position. Similarly, the impulse imparted to the spur-wheel after the energization of the electromagnet 3 will cause a spur of the wheel 12 to depress the tail 40, thereupon raising the detent-cam 39 to a point where the detent 10 can retain the bulb in its normal position. The operator sends this restoring-current over the two limbs of the metallic line by depressing both of the keys 62 and 64 and thereupon operating the springs 73. Thus the battery 72 is connected through the cord-strands 61 and 63 with the metallic line-wires. Upon the restoration of the selective apparatus the operator withdraws her plug from the jack.

It will be seen that in that station or in those stations in which the bulb 34 has been tilted from its normal position the restoring-magnet 3 when energized by the restoring-current from the central station will restore the said bulb 34 to its normal position, and in all of the stations the actuation caused by the restoring-magnet will restore the bulbs 26 back to their normal position.

Coming now to the case in which central desires to call a given substation upon a given party-line, the operator first plugs into the jack corresponding to the said party-line. She thereupon depresses the key 62 and manipulates the springs 73 a number of times, one less than the number of the substation to be called upon the party-line. Thus if the operator wishes to call the subscriber whose station is the fifth remote from the central station she will manipulate the key 73 four times. The circuit set up by the manipulation of this key has been previously traced, it being remembered that a single operation of the said springs causes the break in the loop at the first subscriber's station to be closed, also that the same manipulation throws off the ground connection at the first substation. The three succeeding manipulations of this key will then successively produce a similar change in the apparatus at substations two, three, and four upon the line. It will also be remembered that the manipulation of the springs 73 does not permit current to flow through the electromagnet 6 in such a direction as to attract the armatures 9. However, after four manipulations of the springs 73 the fifth manipulation is of the springs 74, whereupon the selecting-current is sent through the fifth subscriber's apparatus in the reverse direction, thereby causing the operation of his polarized armature 9. Thus the fifth subscriber's telephone set is bridged across the line. At the same time or immediately thereafter the break in the line at his substation is built up. After this manipulation of the springs 74 the succeeding current impulses are sent out by manipulations of the springs 73, thus causing the remainder of the substations on the line to have their ground connections thrown off. Substation five is then alone bridged across the line in condition to carry on conversation with a calling subscriber, who, it may be assumed, has previously been connected with the other side of the operator's cord-circuit. Under these circumstances the line is built up in the same way as it was under the condition in which the subscriber on the party-line was calling, with the exception that instead of the actuation of the armature 9 being controlled by the key 52 it is controlled by the central op-

erator by the reversal of the direction of the selecting-current.

Another condition to be considered is that in which one station on a given party-line desires connection with another station on the same line. The calling subscriber calls central in the usual manner and asks for the desired connection. Under normal conditions the central operator does not inquire and, indeed, does not know which particular station is the calling-station on a party-line; but when a calling subscriber asks for a connection with another subscriber on the same party-line it becomes necessary for the operator to know the substation-number of both the calling and the called subscribers who are located on the same line. Thus in building up a broken line she is enabled to know which of the building-up impulses are to be reversed in direction, so as to connect the two desired substations with the line-wire *b*.

It will not be necessary for a proper understanding of the operations to trace the circuits employed, it being apparent that the operator upon receiving a line-signal will build up the broken line, as usual, and then inquire for the connection desired by the calling subscriber. Upon learning that the called subscriber's station is located on the same party-line as that of the calling subscriber, the operator will first restore the party-line to its normal condition, as has been previously explained, and will thereafter send out the setting-up impulses, as hereinbefore explained. In building up the line, however, impulses in reverse direction will be employed corresponding in number with the two substations to be connected for conversation. Thus upon building up the line the two required substations will have their telephone instruments connected by the corresponding reverse impulses with the line-wire *b*. The restoration of the mechanism connected with the party-line upon the completion of the conversation is accomplished as heretofore explained for the other conditions of operation.

Thus it will be seen that our invention provides a party-line telephone system which overcomes the defects in existing systems and at the same time introduces material advances over the systems of the prior art.

Since the selective apparatus employed in our system is not dependent upon the strength or polarity of the currents employed nor upon what may be termed "marginal currents," the instruments are not delicate in their adjustment, and therefore subject to false operation. The instruments, furthermore, do not depend upon synchronous operation, and therefore cannot introduce difficulties by getting out of step one with another. The selective apparatus is not normally bridged across the selecting-circuit, as in many party-line systems, which thereby introduce difficulties on account of the different resistances encountered by currents flowing from the central station to various substations. In this connection it will be seen that since only one of the selecting electromagnets is operated at a time only a small amount of operating-current is necessary.

In regard to the bridging of the restoring-electromagnets across the line, which are then operated in parallel, it may be pointed out that if for any reason the current strength is not sufficient to operate the mechanism at all of the stations only those restoring-magnets which are not properly operated remain in the circuit. Therefore a second restoring impulse, on account of the largely-decreased number of paths, is sure to operate any of the magnets which fail of operation on the first impulse.

The mercury-tube switches which are preferably employed are of decided advantage over switches heretofore employed on account of the fact that the contacts are not subject to deterioration on account of their exposure to atmospheric conditions, and our present system provides a further great advantage, which, indeed, would be present whether or not the mercury-switches were employed in that the selecting-currents are never broken by the switches at the substations. While the circuit connections are, indeed, changed at the substations, these circuit changes are always made upon the reverse stroke of the operating mechanism when no current is actually flowing therethrough. Thus all the undesirable results caused by a frequently-recurring electric spark between switch-contacts are done away with.

It will be seen that our system provides what may be termed a "double lock-out" feature in that upon receiving a signal at the central station the operator plugs into the line-jack, whereupon the ground connection through the line-drop is broken. This of course at once prevents all the subscribers, except the one who has previously depressed his key 52, from getting the ground connection through the battery 57, which is necessary in order to operate their switches connecting in their telephone apparatus. After the broken line has been set up by the central operator the connections between contacts 30 and 29 are broken at all of the substations. This of course introduces a second break in the circuit necessary for a subscriber to get his telephone apparatus connected with the line. Thus by this double break in the circuit we introduce what may be termed a "double lock-out" feature.

In connection with the lock-out feature our system provides a distinct advantage in that the line and all the apparatus connected therewith are directly under the control of the central operator alone—that is to say, the operator has it within her power to give

connection only to those subscribers whom she desires to connect, and she is enabled at any time to cut off any subscriber who is monopolizing the line. This is also a desirable feature when a party-line is also used for toll-line purposes, it being customary to allow the toll-line business to supercede that of the local substations.

The apparatus used in the operation of our improved system is an exact duplicate at all of the substations, the substation selecting apparatus not being set or adjusted in any way peculiar to its position or number on the party-line, and, indeed, the substations are not individually adjusted even to the extent of a resistance-coil. In so far as the installation of our system is affected by present existing apparatus it is a worthy feature in economical installation that any form of telephonic or signaling apparatus whatsoever may be associated with our selective devices.

As will be apparent from the foregoing description of one embodiment of our invention, it will be seen that the subscriber's telephone apparatus is normally disconnected from the telephone-line, it being then only necessary to connect with the line of that subscriber's telephone set which is to be employed for conversational purposes. This feature presents a decided advantage over those systems in which all of the telephones are normally connected with the line and all of which must be disconnected therefrom save that telephone which is to be used in conversation. Incidentally it might be pointed out that the condensers 59 are normally disconnected from the line. They are therefore not subject to punctures due to lightning discharges, which is an important factor in the operation of a long party-line.

Our invention may be advantageously employed in connection with a metallic toll-line running through and between a number of central stations, it being now a common practice for an operator—say at a principal office at the end of a toll-line—to have a connection only to the first of a series of central stations connecting therewith. In order to secure connection with a more remote central station, it is necessary for the operator at the principal station to order the operators at the subcentral stations to make the connections intervening between the successions of the otherwise continuous metallic line. Our invention as applied to such toll-lines enables the principal operator to have control over the connecting devices at the subcentral stations, whereby she can secure connection with any desired central station.

While we have shown and particularly described one preferred embodiment of our invention, it will be evident that many changes and modifications therein might profitably be employed without departing from the spirit of our invention. We therefore do not wish to limit ourselves to the precise disclosure herein set forth; but,

Having described our invention, we claim as new and desire to secure by Letters Patent—

1. The combination with a central station, of a line running from said central station broken at a series of substations, electromagnetic mechanism controlled from the central station adapted to build up a non-inductive electrical path through said broken line to any desired substation, electric signaling apparatus at each of said substations, a second line connecting all of said substations with the central station, electromagnetic mechanism at each of said substations controlled from said central station adapted to connect said signaling apparatus in circuit with said lines, and means at each of said substations affording a secondary control over the electromagnetic connecting apparatus at the corresponding substation, substantially as described.

2. The combination with a central station, of a line running from said central station broken at a series of substations, electromagnetic mechanism controlled from the central station adapted to build up a non-inductive circuit through said broken line to any desired substation, a return-circuit from said substations to said central station, electric signaling apparatus at each of said substations, a second line connecting all of said substations with the central station, electromagnetic mechanism at each of said substations controlled from said central station adapted to connect the said second line with the signaling apparatus at any of said substations, and means at each of said substations affording a secondary control over the electromagnetic connecting apparatus at the corresponding station, substantially as described.

3. The combination with a central station, of a line running from said central station broken at a series of substations, a return-circuit from said substations to said central station, electric signaling apparatus at each of said substations, a second line connecting all of said substations with the central station, electromagnetic mechanism at each of said substations controlled from said central station adapted to connect the said second line with the signaling apparatus at any of said substations, and means at each of said substations affording a secondary control over the electromagnetic connecting apparatus at the corresponding station, substantially as described.

4. The combination with a central station, of a line running from said central station broken at a series of substations, electromagnetic mechanism controlled from the central station adapted to build up a non-inductive

circuit through said broken line to any desired substation, other electromagnetic mechanism controlled from said central station adapted to break said electric circuit at said substations, a return-circuit from said substations to said central station, electric signaling apparatus at each of said substations, a second line connecting all of said substations with the central station, electromagnetic mechanism at each of said substations controlled from said central station adapted to connect the said second line with the signaling apparatus at any of said substations, and means at each of said substations affording a secondary control over the electromagnetic connecting apparatus at the corresponding station, substantially as described.

5. In a selective party-line system, the combination with switching mechanism comprising a mass of mercury for making or breaking electric circuits, of electromagnetic means for actuating said mechanism, and means for causing current to flow through said electromagnetic means, the operation of said switching mechanism being accomplished wholly upon the cessation of said current-flow, substantially as described.

6. The combination with a central station, of a line running from the said central station broken at a series of substations, electromagnetic mechanism adapted to be actuated by suitable electrical impulses to build up a non-inductive circuit through said broken line to any desired station, other electromagnetic mechanism adapted to be actuated by a suitable electric impulse to break said electric circuit at said substation, a return-circuit from said substations to said central station, electric signaling apparatus at each of said substations, a second line connecting all of said substations with the central station, electromagnetic mechanism at each of said substations adapted to be actuated by an electric impulse of suitable polarity to connect the said second line with the signaling apparatus at any of the substations, means at each of the substations affording a secondary control of the electromagnetic connecting apparatus at the corresponding station, and means provided at the central station whereby the operator may control said electromagnetic mechanism by causing suitable electric impulses to flow therethrough, substantially as described.

7. The combination with a central station, of a line running from said central station broken at a series of substations, neutral electromagnetic mechanism controlled from the central station adapted to build up a non-inductive electrical path through said broken line to any desired substation, electric signaling apparatus at each of said substations, a second line connecting all of said substations with the central station, electromagnetic mechanism at each of said substations controlled from said central station adapted to connect said signaling apparatus in circuit with two of said lines, and means at each of said substations affording a secondary control over the electromagnetic connecting apparatus at the corresponding substation, substantially as described.

8. The combination with a central station, of a line running from said central station broken at a series of substations, electromagnetic mechanism controlled from the central station adapted to build up a non-inductive electrical path through said broken line to any desired substation, a return-circuit from said substations to said central station, electric signaling apparatus at each of said substations, a second line connecting all of said substations with the central station, electromagnetic mechanism at each of said substations controlled from said central station adapted to connect one of said lines with the signaling apparatus at any of said substations, and means at each of said substations affording a secondary control over the electromagnetic connecting apparatus at the corresponding station, substantially as described.

9. The combination with a central station, of a line running from said central station broken at a series of substations, electromagnetic mechanism controlled from the central station adapted to build up a non-inductive electrical path through said broken line to any desired substation, other electromagnetic mechanism controlled from said central station adapted to break said electrical path at said substations, a return-circuit from said substations to said central station, electric signaling apparatus at each of said substations, a second line connecting all of said substations with the central station, electromagnetic mechanism at each of said substatons controlled from said central station adapted to connect one of said lines with the signaling apparatus at any of said substations, and means at each of said substations affording a secondary control over the electromagnetic connecting apparatus at the corresponding station, substantially as described.

10. The combination with a central station, of a line running from said central station broken at a series of substations, electromagnetic mechanism controlled from the central station adapted to build up a non-inductive circuit through said broken line to any desired substation, a return-circuit from said substations to said central station, electric signaling apparatus at each of said substations, a second line connecting all of said substations with the central station, electromagnetic mechanism at each of said substations controlled from said central station adapted to connect said signaling apparatus in circuit with two of said lines, and means at each of said substations

affording a secondary control over the electromagnetic connecting apparatus at the corresponding station, substantially as described.

11. The combination with a central station, of a line running from said central station, broken at a series of substations, a return-circuit from said substations to said central station, electric signaling apparatus at each of said substations, a second line connecting all of said substations with the central station, electromagnetic mechanism at each of said substations controlled from said central station adapted to connect said signaling apparatus in circuit with two of said lines, and means at each of said substations affording a secondary control over the electromagnetic connecting apparatus at the corresponding station, substantially as described.

12. In a selective party-line telephone system, the combination with a central station, of a line running therefrom to a series of substations normally broken at each of said substations, signaling apparatus at each of said substations normally disconnected from said broken line, and means whereby the central operator may connect the signaling apparatus at two of said substations in circuit simultaneously with said broken line, substantially as described.

13. In a selective party-line telephone system, the combination with a central station, of a line running therefrom to a series of substations normally broken at each of said substations, signaling apparatus at each of said substations normally disconnected from said broken line, and means whereby the central operator may connect the signaling apparatus at a plurality of said substations in circuit simultaneously with said broken line, substantially as described.

14. In a selective party-line telephone system, the combination with a central station, of lines running from the central station to a series of substations, one of said lines being normally broken at each substation, signaling apparatus at each substation normally disconnected from said broken line, and means controlled from each substation and from the central station, whereby the corresponding signaling apparatus may be connected with the broken line, substantially as described.

15. In a selective party-line system, the combination with a central station, of lines running from the central station to a series of substations, one of said lines being normally broken at each substation, signaling apparatus at each substation normally disconnected from said broken line, and means primarily controlled from the central station whereby any substation signaling apparatus may be connected with the broken line and secondarily controlled from each substation, whereby the corresponding signaling apparatus may be connected with the broken line, substantially as described.

16. In a selective party-line system, the combination with a central station, of lines running from the central station to a series of substations, one of said lines being normally broken at each substation, signaling apparatus at each substation normally disconnected from said broken line, and means controlled from each substation, and from the central station, whereby the corresponding signaling apparatus may be connected with the broken line, substantially as described.

17. In a selective party-line system, the combination with a central station, of lines running from the central station to a series of substations, one of said lines being normally broken at each substation, means for building up said broken line through any number of said substations, signaling appa ratus at each substation normally discon nected from said broken line, and means controlled from each substation, and from the central station, whereby the corresponding signaling apparatus may be connected with said broken line, substantially as described.

In witness whereof we hereunto subscribe our names this 6th day of October, A. D. 1902.

ARTHUR F. POOLE.
FRANK B. HALL.

Witnesses:
MINNIE K. COCHRAN,
LANDY SISSON.