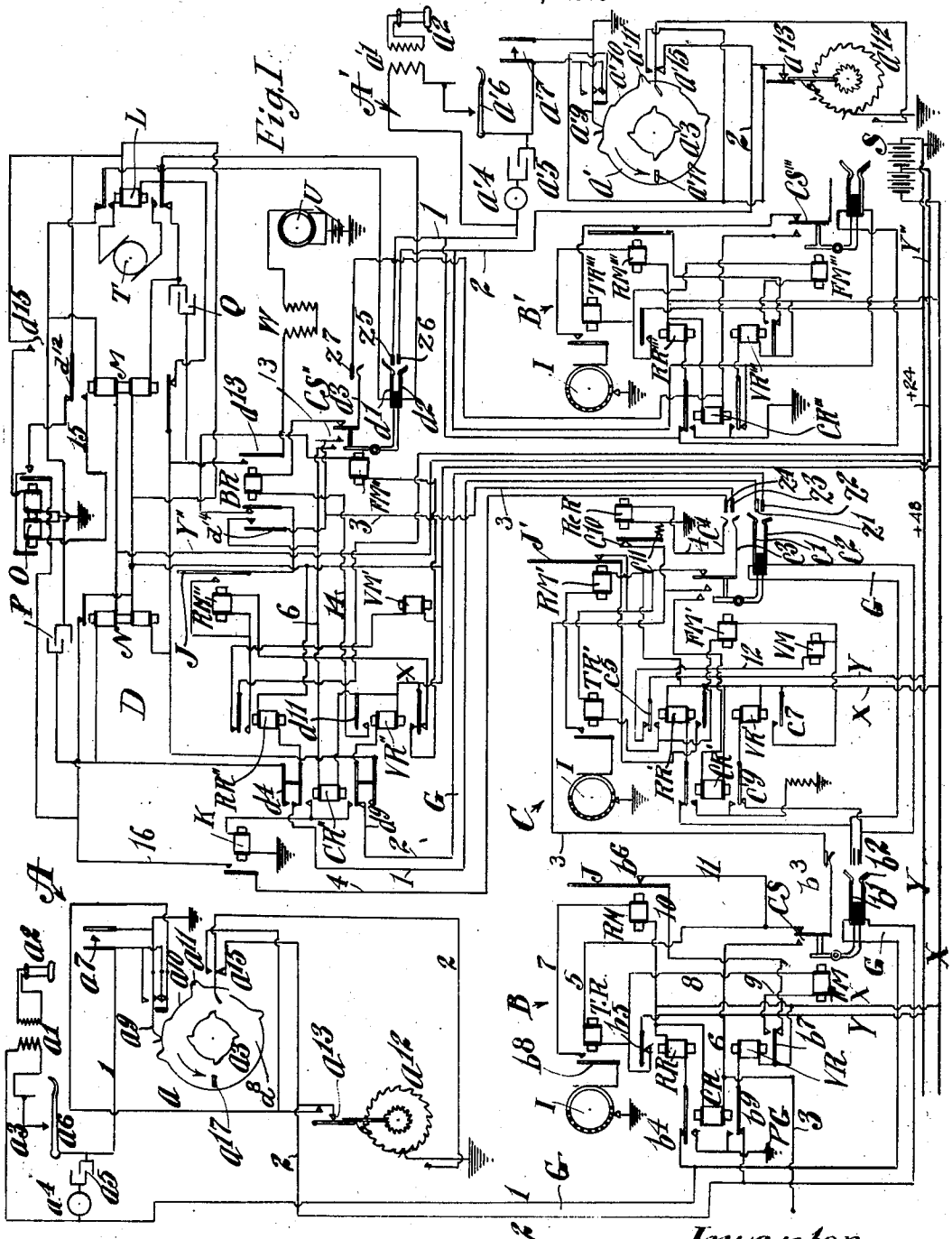
July 27, 1926. 1,593,933

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COMMON BATTERY AUTOMATIC TELEPHONE SYSTEM AND APPARATUS

Filed Dec. 22, 1905 4 Sheets-Sheet 1

Fig. 1



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COMMON BATTERY AUTOMATIC TELEPHONE SYSTEM AND APPARATUS

Filed Dec. 22, 1905 4 Sheets-Sheet 2

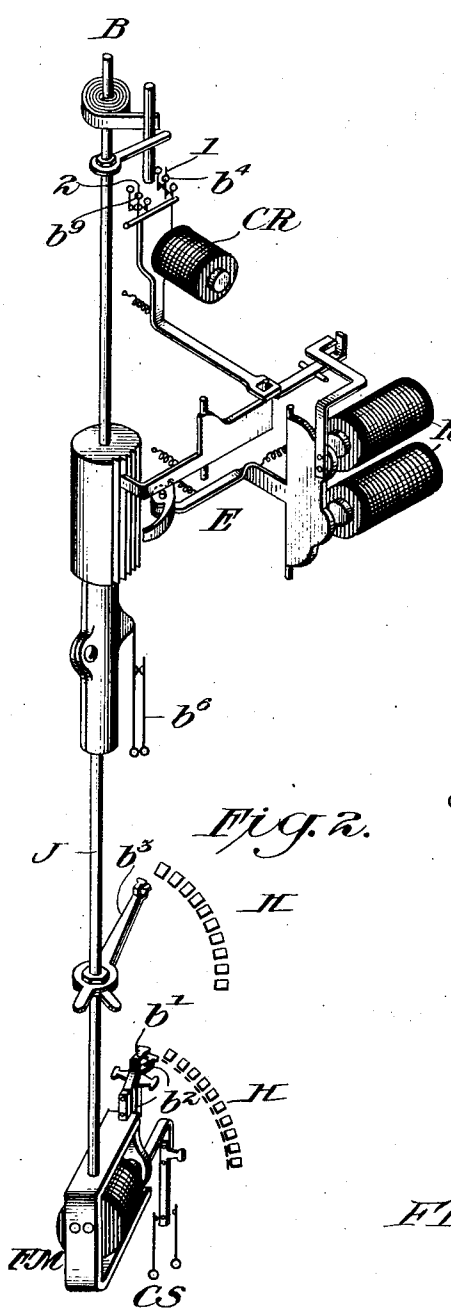


Fig. 2.

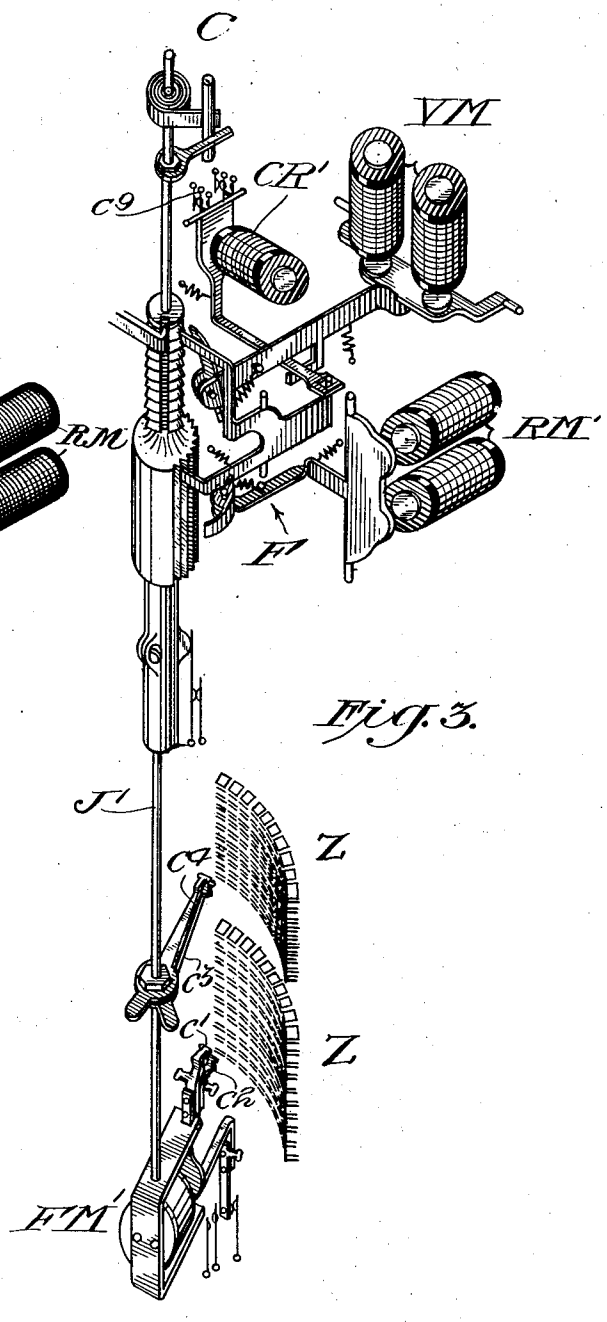


Fig. 3.

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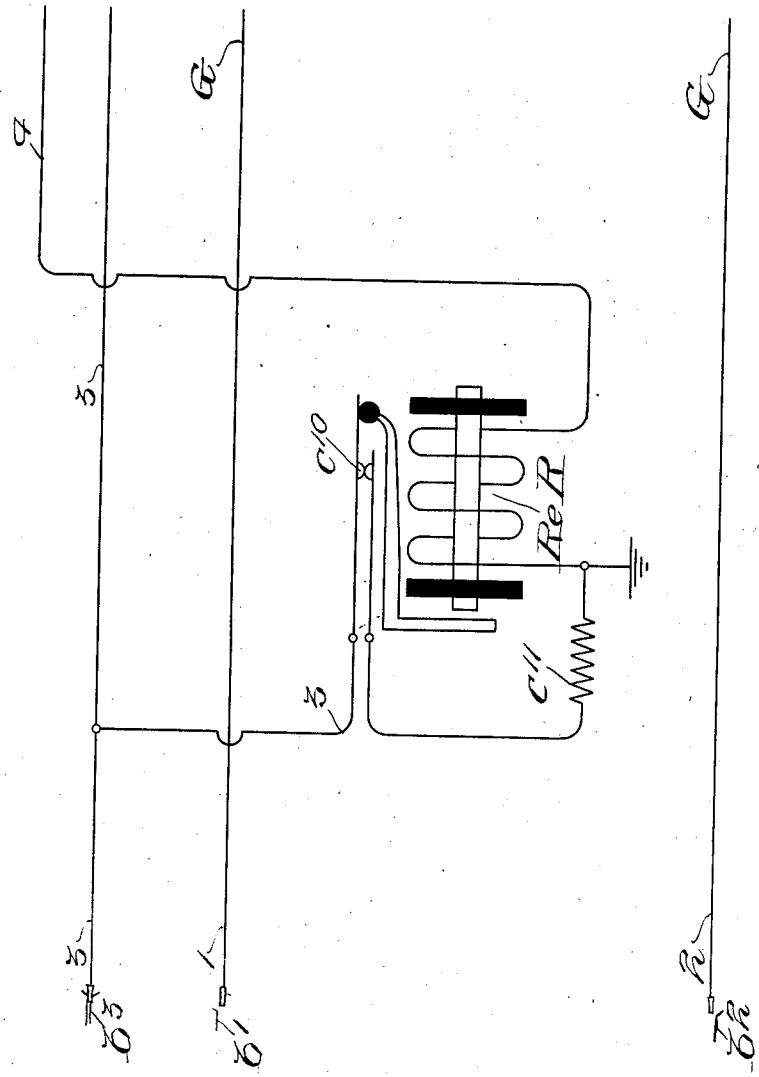
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COMMON BATTERY AUTOMATIC TELEPHONE SYSTEM AND APPARATUS

Filed Dec. 22, 1905 4 Sheets-Sheet 3

Fig. 5.



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COMMON BATTERY AUTOMATIC TELEPHONE SYSTEM AND APPARATUS

Filed Dec. 22, 1905 4 Sheets-Sheet 4

Fig. 6.

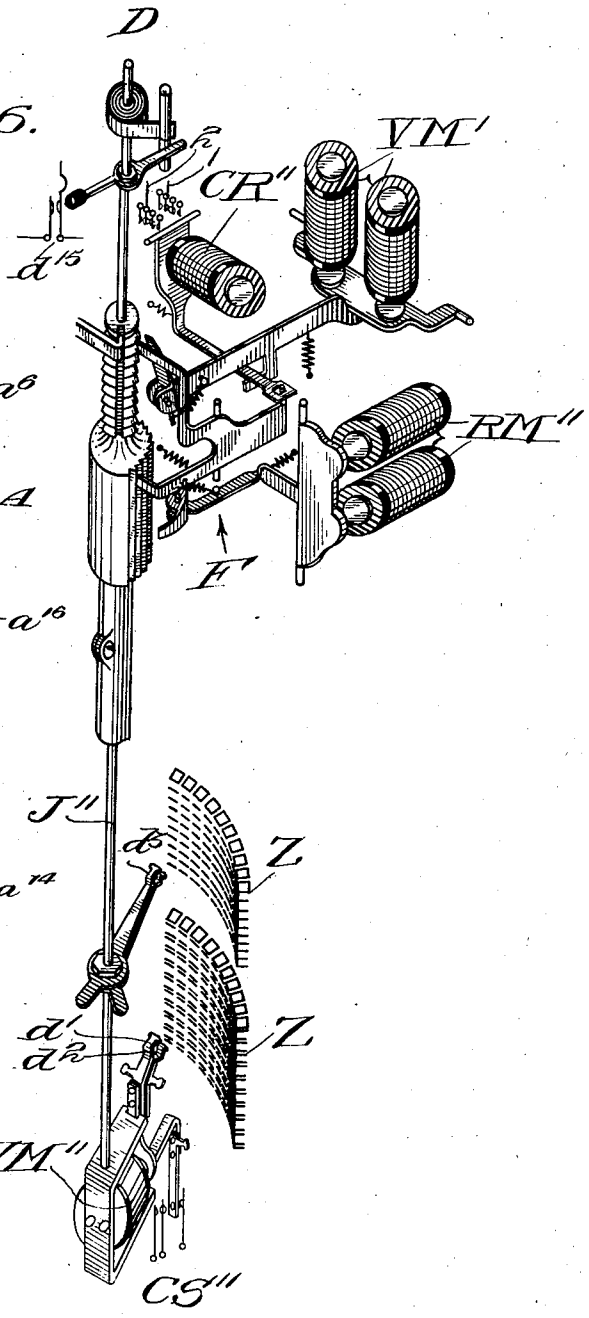
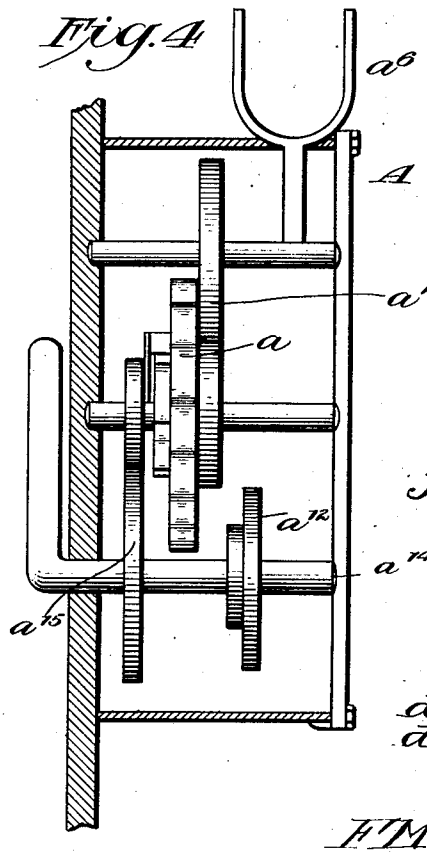


Fig. 4



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Patented July 27, 1926. 1,593,933

UNITED STATES PATENT OFFICE.

HERBERT L. FISH, OF BAKERSFIELD, CALIFORNIA, ASSIGNOR, BY MESNE ASSIGNMENTS, TO AUTOMATIC ELECTRIC INC., OF CHICAGO, ILLINOIS, A CORPORATION OF DELAWARE.

COMMON-BATTERY AUTOMATIC TELEPHONE SYSTEM AND APPARATUS.

Application filed December 22, 1905. Serial No. 292,911.

This invention may be applied to telephone, telegraph, burglar, or fire-alarm systems, but for the sake of brevity, reference will hereinafter be made to telephone systems only.

The objects of this invention are to provide simpler means than heretofore known for allowing one substation to automatically connect with any other substation by placing a specified number of grounds on either one or the other side of the line; to provide simpler means of controlling and operating the switching selectors and connectors; to provide an automatic telephone system with a common battery for conversation and operation; to provide an automatic telephone exchange having a minimum number of contacts for a given number of connections; to provide an automatic telephone exchange applicable for indefinite extension and having a clear talking circuit.

Instead of having, as heretofore, a first selector for every instrument at the exchange, in this system there is a plurality, preferably ten or more, first selectors to every hundred substations, and an instrument to represent each substation at the exchange, which instrument selects one of these first selectors which is not busy. By this means I am enabled to very greatly reduce the number of contacts; as for instance, in a 10,000 system installed in accordance with this invention, 1,400,000 contacts do the work for which 3,600,000 contacts are required in the old system, thus saving in a 10,000 system 2,200,000 contacts, as compared with any former system.

The invention also provides features of novelty which will be hereinafter more fully set forth, among which may be noted:—

Novel means for using a cut off relay in all selectors or connectors which not only cuts off all battery and relays and operating magnets of that instrument from the line, thus causing a clear line, but also causes the locking mechanisms of the instrument to stay locked until at least one of the subscribers hangs up his receiver:—

Novel means for controlling this cut off relay at will from any connected substation; said relay being held closed by a ground on the third or private wire, which ground can be removed by action of either subscriber hanging up; novel means for selecting trunks which are not busy; locking mechanism for holding the line finger of any instrument against the trunk contacts, so long as that certain instrument is in use; automatic means by which, after the selection is made, the subscriber can call the substation wanted by merely placing a ground on the line; automatic means for notifying the calling subscriber when the called line is busy, and for preventing calling subscriber's line coming in contact with the busy line; a divided battery affording a low voltage for talking and a higher voltage for operation,—the higher voltage being grounded and the lower voltage not,—whereby I make it possible to use a ringing relay which is operated from the calling subscriber's instrument for signalling the called subscriber; to provide an automatic selecting instrument having three movements, vertical, rotary, and forward, the first two movements being common to all movable contacts in that instrument, and the latter movement being common only to the talking circuit, known as the rotary and vertical wires.

Other advantages, objects and features of novelty may appear from the subjoined description.

The accompanying drawings illustrate the invention:—

Figure 1 illustrates my invention as applied in a one-thousand system, portions being shown displaced, some in plan and others in elevation for convenience of illustration. The application of the invention to a ten-thousand system or an indefinite extension beyond the ten-thousand system may be accomplished by duplication of certain parts shown in this drawing, as hereinafter more particularly described.

Fig. 2 is a view illustrating the trunk selecting non-numerical subscriber's individual apparatus or line switches B or B′.

Fig. 3 is a view illustrating a numerical trunk selector, such as a first selector.

Fig. 4 is a plan view of the mechanical parts of one form of subscriber's apparatus.

Fig. 5 is a simplified diagrammatic view showing the parts of a first-selector that are

retained on the trunk line when the system is arranged so that the line switch may connect directly with a selector switch.

Fig. 6 is a view illustrating the connector switch D.

In the drawings duplications of certain parts are designated by characters corresponding to those applied to such parts, indices being added to avoid confusion.

In a general way, A (Fig. 1) designates a substation or subscriber's instrument; B designates the trunk selector, one being provided for each substation. C designates what is known to the art as the first selector, ten of these being supplied for each one hundred substations. D designates a connector, there being one hundred of these in a one-thousand system, or ten for each one hundred substations. B′ designates a trunk selector of the called substation; A′ designates the called substation. It is to be understood that A and B and A′ and B′ are indefinitely duplicated in this system. E (Fig. 2) represents the apparatus of the trunk selector showing how a rotary and forward movement is accomplished. F (Fig. 3) represents the construction of the instruments other than the trunk selector showing how the rotary, vertical and forward movements are accomplished.

G (Fig. 1) is the metallic talking and controlling circuit comprising two wires, known as rotary and vertical sides 1, 2, respectively, of the line between each substation as A, A′ and the exchange B, C, D and B′. Between each trunk selector B and the first selector C is said metallic circuit G and also a third or private wire 3, indicating any certain busy trunk and on which all locking devices depend. Between this selector C and the connector D or between succeeding selectors of a larger system circuit G comprises said private wire 3 and also a fourth wire 4 which I term a releasing or restoring wire, for governing the action of the unlocking mechanism.

Between the connector D and the trunk selector B′ of the called subscriber are said metallic circuit G and the private wire 3. Between the trunk selector B′ and the substation A′ of the called subscriber is said metallic circuit G comprising said rotary and vertical sides 1 and 2 of the line.

The sub-station or subscriber's instrument A comprises induction coil a^1, receiver a^2, transmitter a^3, bell a^4, condenser a^5, hook switch a^6, ringing switch a^7 for ringing the called subscriber; an instrument a for performing certain switching operations, which switch comprises a cam a^8 which operates a switch a^9 for holding a ground on the rotary side 1 of the line for a determined time, as during the passage of face a^{10}, to allow the central office mechanism, as B, to select a vacant one of the first selector trunks H (Fig. 2), and then through the action of tooth a^{11} causing a ground on both sides of the line which energizes the forward movement magnet FM of switch B to operate and in turn lock the exchange instrument as B, by reason of the consequent energizing of the cut-off relay CR.

a^{12} is a ground-sending instrument of any suitable construction through the action of which the subscriber obtains the desired number by the usual manipulation.

The trunk selector B comprises a rotary relay RR, a vertical relay VR, a cut-off relay CR, a test relay TR, rotary shaft J (see Fig. 2) adapted to be rotated step by step by the rotary magnet RM, and which shaft carries the wiper b^3 of private wire 3, which wiper slides over the private bank contacts as the shaft rotates. The shaft, furthermore, carries the line wipers b^1 and b^2, which are out of engagement with the line bank contacts while the shaft is rotated, but which after having been rotated to any given position may be given a forward movement by the so-called forward movement magnet FM, and then made to engage a given set of bank-contacts. The said forward movement magnet, as shown in the drawings, is also mounted on the shaft.

The first selector C comprises a duplication of relays and magnets of the trunk selector B with the addition of a restoring relay ReR and a vertical magnet VM. The shaft J′ is like the rotary shaft J, with the exception that it is given a step by step vertical movement by the vertical magnet VM.

The connector D comprises a duplication of relays and magnets corresponding to those heretofore described of the first selector C, with the addition of restoring circuit closure relay K and a ringing relay L and two hanging-up relays M and N for the called and for the calling substations, respectively, for enabling either the calling or called subscriber to restore the switches to their normal positions, an answering subscriber's protective relay O, and two condensers P and Q connected on the rotary and vertical sides of the line, respectively, between the two differential hanging-up relays N and M. The busy test relay BR in the connector, although similar to the test relay TR of the first-selector switch, performs a different office, namely that of releasing the connector switch if the called line is busy.

I is a circuit interrupter which is common to all selectors and places interrupted ground upon the circuit.

S is a common battery which is the source of the energy of all operations and conversation, said battery being divided into two components of higher and lower voltage, as for instance forty-eight volts and twenty-four; the higher voltage being for opera-

tion of the instrument and the lower voltage for conversation.

T is a ringing generator which supplies the current for signalling the called subscribers.

U is an interrupted battery which with repeating coil W comprises apparatus for the busy test.

Referring to the substation A, it is to be understood that there is an operative relation between the hook-switch a^6, the cam a, and the ground-sending instrument a^{12}, such that when the receiver a^2 is taken off of the hook a^6 the usual spring (not shown) operates the cam a one step when the hook rises to close the subscribers' line conductors 1 and 2. This action of the cam, however, opens the line at another point and also forces a ground on the rotary side 1 by the switch a^9. This ground on the rotary side 1 passes through the contact b^4 of the cut-off relay CR, and through the rotary relay RR to the negative side of the battery wire X. This energizes the rotary relay RR and completes the circuit comprising ground wire Y, through the armature and contact b^5 of the rotary relay, through the test relay TR on test relay wire 5, through initiative movement wire 11, through the initiative movement switch b^6, and on the battery wire 10, getting its battery through the armature b^7 of the vertical relay VR, which goes to the battery wire X.

This action energizes the test relay TR and places interrupted ground through the armature b^8 of test relay TR on rotary magnet wire 7 through the rotary magnet RM and through the battery wire X. This causes the rotary magnet to close once and give the shaft J one rotary step, which in turn opens the switch b^6. This rotates the wipers b^1, b^2, in front of the first trunk line contacts and the wiper b^3 onto the first private bank contact. If this trunk is busy, the private bank contact is connected to the non-grounded terminal of battery, and thereupon the action will be as follows: viz,— through private wiping finger b^3, cut-off switch CS, on test wire 5, through test relay TR, through contact b^5, and through ground wire Y, thus holding the test-relay closed long enough to allow the interrupter I to send another ground through the rotary magnet as hereinbefore shown, giving another motion to the rotary shaft J in order to bring the private wiper b^3 onto another private contact. This will continue until a vacant trunk is found, at which instant the circuit is broken through the test relay TR.

The movement just described will occur every time the receiver hook a^6 is allowed to rise from its open to its closed position. At the close of any such movement the cam a has passed around and brought the tooth a^{11} into position to again operate switch a^9 to close the metallic circuit G, and thereby place a ground upon both sides of the line.

This action causes a ground to come on the rotary side 1 as heretofore described, and at the same time on the vertical side through contacts b^9, through vertical relay VR to battery through wire X. This energizes both rotary and vertical relays RR and VR, and completes the circuit from battery wire X, through switch b^7, and on forward movement battery wire 9 through the forward magnet FM, and on the forward movement ground wire 8 through the switch b^5 to ground wire Y. This energizes forward magnet FM and forces the rotary and vertical line fingers b^1 and b^2 over the selected vacant trunk, and also operates the cut-off switch CS which operates the cut-off and locking circuit, (it being understood that the ground on the private wire of the selected trunk is furnished by the first selector C, through the contact c^{10} of the restoring relay ReR, and through coil c^{11} to the ground, this coil being of greater resistance than the test relay TR used in each of the trunk selectors) :—said circuit getting its ground from the first selector C and through the switch point c^{10} through the private trunk 3 and private wiper b^3, through the switch CS, the locking wire 6, the cut-off relay CR, and battery wire X.

This energizes the cut-off relay CR and causes a ground PG to be held on both vertical rotary relays of the switch B. This in turn locks the selector until the ground, through the private wire 3, is released by the energizing of the restoring relay ReR.

The entire action just described takes place during the interval occupied in the raising of the receiver hook a^6, in which time the cam a passes from the first normal position, as in Fig. 1, to the second normal position. The trunk selector is now locked in position on a vacant trunk and ready for selection of the required line in the first selector, the operation of which selection will now be described.

The subscriber at A, appropriately manipulating the ground-sending instrument a^{12}, opens the metallic line G at switch a^{13}, and the requisite number of impulses are given corresponding to the first digit of the line that he wishes. These impulses pass through the vertical wire 2, through the wiper b^2 and through the trunk contact, through contacts c^9 of the cut-off relay CR′ and the vertical relay VR′, and through the battery wire X. This energizes the vertical relay VR′, which closes the following circuit, viz,— from battery wire X, through contacts c^7 of the vertical relay VR′ to the vertical magnet VM, through the wire 12, through the contact c^5 of the rotary relay RR′, to ground wire Y. This energizes the vertical magnet VM a number of times corresponding

to the number of impulses given by the substation A. This gives the shaft J′ a vertical movement, raising the wipers c^1, c^2 and c^3 to the required bank level of trunk multiples.

When the ground-sending instrument a^{12} at A is restored to its normal position it gives the cam a another step around in the same manner as described in the action of the trunk selector; which step in turn causes the first selector C to select a vacant one of the trunks in the same manner and by a like action as described in the trunk selector, and at the same time forces the line wipers upon the selected connector contacts, also locking the first selector and opening the line in the same manner as in the operation of the line switch. By referring to Fig. 4 connection whereby such action will take place will be understood. In the form of apparatus shown in Fig. 4, a^{14} is a shaft upon which the ground-sending instrument operates, actuating cam a through gearing a^{15}. a^{16} is the usual gearing between hook switch and the forward movement cam.

It is to be understood that the mechanism just described is actuated by the usual spring movement not shown.

It is also to be understood that Fig. 1 only illustrates a one-thousand system, and in case of increase to a ten-thousand or greater system, instead of going from the first selector to the connector, connection would be from the first selector to the second or third, depending upon the magnitude of the system. It will also be apparent that if desired all selectors may be omitted and connection may be established directly between the line switch and the connector switch. In case a second selector is to be added to the system there will be four wires leading from the first selector to the second selector, the fourth or releasing wire extending in that case direct to the wiper c^4 of the second selector, there being no release relay ReR in the second selector, nor any switch point controlled thereby leading to ground as in the first selector. Furthermore, the third or private conductor would terminate in the second selector in a spring similar to the CS spring shown in the first selector. Of course, it is evident and it will be clearly understood that when first selectors are omitted the trunk conductors 1 and 2 (Fig. 1, for example) will lead right through from the line switch bank to the connector without a break; but to each trunk line leading from the line switch to the connector the release relay ReR is still allotted to the trunk line, as well as the ground circuit which it controls. Therefore, there will still lead off from the line switch bank three conductors for each trunk line up to the point where the relay ReR is located, and from then on there will be four conductors, as shown in the drawings, Fig. 5. In other words, it amounts to depriving the first selector of all parts except the release relay ReR and permanently connecting the wipers to the connector trunks, and extending the private or locking wire 3 directly through, as clearly shown in Fig. 5.

Through the operation just described, in a one-thousand system, the calling subscriber has been placed in the hundreds he desires and is ready for connection with the special unit of that hundred. This connection is made by the connector D which I will now describe. The construction of the connector D corresponds with that of the first selector C, with the exception of the devices for giving the common battery for conversation, for releasing the instruments, and for keeping the forward motion from taking place if the line is busy, and giving a busy test to the calling subscriber if that line is busy.

The calling substation having been thus placed in the required hundred, the operator will then appropriately manipulate the ground-sending instrument a^{12} to give the required impulses for such vertical motion of the shaft J″ as will bring the wipers d^1, d^2, d^3, to the bank level containing the second digit of the number that he wishes. Said impulses come through the vertical wire 2 of the line and through the vertical wiper b^2 of the trunk selector, taking that path on account of the cut-off relay CR being locked open as heretofore described; in the same manner passing through the first selector, through the contact and out on the fingers c^2, through the contact z^2, through the contacts d^9 of the cut-off relay CR″, through the vertical relay VR″, to the battery wire X.

This energizes the vertical relay VR″, which in turn energizes the vertical magnet VM′ and gives the shaft J″ a vertical motion, carrying the wipers d^1, d^2 and d^3 to the bank level of the number desired. By this time the lug a^{17} on the cam a at substation A has reached a position so as to operate switch a^{15}, thus causing the grounds which are to be sent by the ground-sending instrument to take the path from the vertical to the rotary side of the line just for the one time. Thus, when the ground-sending instrument a^{12} is again appropriately manipulated for the last digit of the number desired, grounds given by this instrument are sent over the rotary side of the line. This energizes the rotary relay RR″ a number of times corresponding to the number of the last digit that is desired, which in turn energizes the rotary magnet RM″ in the manner heretofore described, and gives the shaft J″ rotary motion, so that the line wipers d^1 and d^2 are placed in front of the line desired, and the private wiper d^3 on the private contact z^7 of the line desired. If this

line is busy, it will have a ground upon it from the selector, through which the connector that has made connection and seized the line has been operated, which ground is controlled by the release relay ReR of the said selector. In such case the following action will take place:—

The ground passes through the private wiping finger d^3, through the contact of cut-off switch CS″, the busy relay wire 13, through the busy test relay BR, through the battery wire 14, to armature d^{11} of the vertical relay VR″. (The double ground heretofore described following from the action of the tooth a^{11} on the cam a causes the energizing of both the vertical relay VR″ and the rotary relay RR″).

The energizing of VR″ completes this test relay circuit just described, thereby feeding battery to the circuit through the armature d^{11} of the vertical relay VR″. This energizes the busy test relay BR and opens the forward magnet circuit which keeps the forward magnet from operating, and in turn keeps the line fingers from going upon that line which the private wiping finger has found busy. It also completes the circuit from the battery wire X through the cut-off relay CR″, through locking wire 6, through the armature d^{14} of the busy test relay BR, and on the private wire 3 which gets a ground from the private wire of the first selector, as hereinbefore described. This action energizes the cut-off relay CR″, locks the instrument, and places the common battery and hang-up relays M and N across the conductors 1 and 2. It also completes the busy tone circuit which starts from the busy tone instrument U, through the repeating induction coil W, through the armature d^{13} of the busy test relay BR, and on the vertical side of the line. Passing through the instrument A, it gives a tone in the receiver that informs the calling subscriber that the line he wishes is busy.

The subscriber receiving this busy tone hangs up his receiver and the instruments will be released, as will presently be described. If, on the other hand, the line which this subscriber wishes is not busy, when the ground on both sides of the line heretofore described takes place, the forward movement magnet FM″ will be energized as heretofore described, and line fingers d^1 and d^2 will be placed in contact with the line desired. This operates the cut-off switch CS″ which opens the busy test circuit heretofore described, and operates the following circuit:—

From the battery wire X, through the cut-off relay CR″, on the locking wire 6, to the private wire 3 which gets a ground from the first selector. This energizes the cut-off relay CR″ and thereby places the hanging-up relays M and N and the common battery for conversation purposes and the ringer relay L on the line G.

This action energizes restoring circuit closer relay K, and closes the circuit of restoring wire 4. The hanging-up relay N of the calling substation is energized in the following manner:—

From the battery wire X, through one of the differential windings of the hanging-up relay N, and upon the vertical wire 2, around through the substation instrument A, back upon the rotary wire 1, and through the other differential winding of said hanging-up relay N and to the +24 battery Y″.

The subscriber at substation A now presses the ringing button a^7 which throws the ground upon the line; this energizes the ringing relay L, opens the line, and places generator upon the side of the called substation. This signals the called substation which, coming upon the line, operates the hanging-up magnet M in the same manner as heretofore described in the action of energizing the hanging-up magnet N, and in turn opens the circuit so that the ringing relay cannot be operated, and completes this circuit, viz,—from the battery wire X, through the armature d^{12} of the hanging-up magnet M, through wire 15, through the back differential winding of the answering subscriber's protective relay O, and through to the ground. This energizes the left-hand coil of the protective relay O, thus releasing the armature of the right-hand coil, allowing said armature to fall back against its back contact, and complete restoring wire circuit to the called substation's magnet M from the restoring circuit wire 4 through the armature and contact of the relay K to the wire 16, thence through the armature and contact of the relay O to the spring of the relay M with which the armature d^{12} normally engages.

Thus, if either the called or the calling subscriber hangs up, his respective magnet M or N is released and battery is placed upon restoring wire. This battery passes through the portion 16 of restoring wire 4, through the contact e^4, through the restoring wiping fingers c^4, and on through the restoring wire 4 in the first selector, through the restoring magnet ReR, and through to ground.

This energizes restoring magnet ReR, pulls up the armature c^{10}, and opens the ground circuit on the private wire which has been holding locked all instruments in the circuit, thus allowing all electrical devices of said instruments to be placed back upon the line. When either of the magnets M or N de-energizes a circuit is closed through the release relay ReR, which latter operates to break the energizing circuit through the cut-off relays CR and CR′. The de-energization of these relays CR and

CR′ releases the double dog on the shaft of their respective switches and allows the switch to return to normal position. When the wiping finger C^3 of the switch C is removed from the contact Z^3 the energizing circuit through the cut-off relay CR″ of the connector D is broken and this switch is in turn released. To come back to the called subscriber on the connector again, we find that his line switch B′ is held locked by the private wire ground given by the wiping finger d^3 of the connector D, and is held locked in the same manner as the selectors heretofore described. The locking is done by energizing the cut-off relay CR‴, the circuit for energizing which may be traced as follows: from ground at the selector switch C through the resistance coil C^{11}, through the contact C^{10} and switch contacts of the forward magnet FM′ to the private wiper c^3, private bank contact z^3, and switch contacts of the forward magnet FM″ to the private wiper d^3, contact point z^7 to the cut-off relay CR‴.

The talking circuit between substations A and A′ is as follows, viz,—through the metallic line G, through contacts b^1 and b^2 of the trunk selector B, through the contacts c^1, c^2, of the first selector C, through the contacts d^4 and d^9 of the cut-off relay CR″, through the condenser P and Q, through the armatures of the ringing relay L, out from the line fingers d^1 and d^2, and to the substation A′.

The protective relay O is restored by switch d^{15} being operated for a short interval during the falling of the shaft in its release motion of the connector.

From the foregoing it will be seen that I provide a common battery system in which the first selectors C are arranged and organized on a percentage basis—that is to say, they are less in number than the subscribers having access thereto. The switches B are in the nature of non-numerical trunking switches, as they do not switch in accordance with any of the digits of the called number, and are merely for selecting idle first selectors. It will also be seen that the battery for talking purposes is normally in bridge of the various possible talking circuits—that is to say, it is normally in bridge of the voice current conductors of the connectors D. More specifically considered, said battery for talking purposes is permanently bridged between the line conductors of the connector D, and is also permanently in bridge of all of the other connectors. In this way the calling subscriber receives talking current before the called line is found. In other words, the battery for talking purposes is in bridge of the calling line before the called line is found. Furthermore, the system is independent of the ground at the substations for releasing purposes. When a subscriber releases, all that is necessary is simply the opening of the talking circuit at the substation, and no grounding at the substation is necessary for this purpose. The opening of the line circuit initiates the release, and the selectors are released over trunk-release circuits. My improved system is, therefore, adapted to operate on the two-wire principle, at least so far as the releasing of calling connections is concerned. As far as certain broader aspects of my invention are concerned, I do not therefore, limit myself to a system in which operating grounds are employed at the substations thereof. A system embodying the principles of my invention is operative for talking and releasing without using grounds at the substations of the subscribers' lines. Again, it will be seen that I provide a common battery automatic telephone exchange system in which no side switches are employed, the bridges being opened up or cut off by bridge-cut-off relays. As a matter of further improvement these bridge-cut-off relays have the additional function of serving as release magnets.

It will be seen that my invention relates to that type of system in which the subscribers' lines are divided into groups, and in which the connectors have vertical motion to select groups and then rotary motion to find the called line in any selected group. The trunk lines are also divided into groups, and the selectors have vertical motion to select groups and then rotary motion to automatically select an idle trunk in any selected group. The first selectors may be omitted if the system is organized for a relatively small ultimate capacity. On the other hand, and as is obvious, second and even third selectors may be interposed between the selectors C and the connectors D in the event that it may be desired to organize the system for a larger ultimate capacity. As illustrated, each subscriber's number has only three digits. The switching operation in accordance with the first digit is performed by the selector C, and the switching operation in accordance with the last two digits is performed by the connector D, in the well known manner. For a system of greater ultimate capacity, requiring four digits for each number, second selectors capable of trunking in accordance with the second digit of each number may be employed, in the well known manner. For still larger systems, necessitating subscribers' numbers having five digits, third selectors can be employed. This, however, is all well understood and needs no further description.

What I claim is:—

1. An automatic telephone exchange provided with connectors having vertical and rotary movement, a divided battery of higher and lower voltage, the higher voltage

being connected for operation of said connectors, by vertical and rotary motion of the wipers thereof, and the lower voltage for supplying current through coils of the connectors for conversation, the negative side of the higher voltage being grounded, and no ground existing on the lower voltage.

2. An automatic telephone system including a first selector having vertical and rotary movements and provided between the sub-station and the first selectors with a trunk selector for automatically connecting a sub-station with an idle first selector, and means for operating said first selectors vertically and rotatively in accordance with the first digit of the called number.

3. An automatic telephone system including first selectors and provided between the sub-stations and the first selectors with trunk selectors adapted upon a subscriber's taking down the receiver, to automatically pass by busy trunks and stop on the first idle trunk leading to the first selectors before reaching an idle one of said trunks.

4. An automatic telephone system including first selectors and provided between the sub-stations and the first selectors with trunk selectors adapted upon a subscriber's taking down the receiver, to automatically pass by all busy trunks leading to the first selectors and automatically select a trunk which is idle, and means for operating said first selectors vertically and rotatively in accordance with the first digit of the called number.

5. An automatic telephone exchange including trunks provided with a divided battery of higher and lower voltage, subscribers' sub-stations receiving talking current from the lower voltage, metallic circuits connecting these sub-stations with the exchange, switching apparatus operated by the higher voltage for connecting one sub-station to another, and means whereby upon selecting a desired trunk said apparatus is locked thereon.

6. In an automatic telephone system comprising an exchange provided with a divided battery of higher and lower voltage, sub-stations receiving talking current from the lower voltage, a metallic circuit connecting sub-stations with the exchange, switching apparatus operated by the higher voltage for connecting one sub-station to another, the same comprising a movable shaft containing movable contacts, and having a vertical rotary and forward motion, the vertical and rotary movement being common to all said movable contacts and the forward movement being common only to some of said contacts.

7. An automatic telephone system comprising an exchange provided with first selectors, a divided battery of higher and lower voltage, substations receiving talking current from the lower voltage, metallic circuits connecting the substations with the exchange, said exchange being provided with trunk selectors operated by the higher voltage for extending connection to a first selector, with ground third wires for the first selectors, each trunk selector comprising a test relay having a connection of lower resistance to ground than the resistance of the connection to ground on the third wire of the first selector, a movable shaft, and a movable contact carried by said shaft for controlling the operation of the trunk selector.

8. An automatic telephone system including telephone lines, a connector provided with a busy test relay, movable line wipers adapted to engage a line, and means whereby when a busy line is engaged said relay is initially energized and the line wipers thereby prevented from engaging said busy line.

9. An automatic telephone system comprising an exchange provided with a divided battery of higher and lower voltage, substations and metallic circuits connecting the sub-stations with the exchange, receiving talking current of the lower voltage, switching aparatus operated by the higher voltage for connecting one sub-station to another, comprising selectors and connectors, said connectors being provided with locking mechanism, a cut-off relay and a test relay and connections whereby when ground on both sides of the line is established by the calling sub-station, after the desired line is selected and found busy, the said test relay becomes energized, a circuit opened thereby which keeps the line-wipers from engaging the busy line, and two circuits closed thereby, one to signal the calling sub-station that the called line is busy, and the other to cause the cut-off relay to energize and lock the connector, and for placing common battery upon the line, and means for the apparatus to release upon opening the line at the sub-station.

10. An automatic telephone system comprising an exchange provided with a divided battery of higher and lower voltage, subscribers' sub-stations receiving talking current from the lower voltage, metallic circuits connecting the sub-stations with the exchange, and switching apparatus operated by the higher voltage for connecting one sub-station to another, said switching apparatus comprising selectors having relays and an interconnecting trunk having third conductors, means whereby said apparatus is held locked by a ground through resistance on a third conductor, and a relay in the first selector controlling said ground connection whereby such grounds is held as long as said relay remains in normal position.

11. An automatic telephone system comprising on exchange provided with first se-

lectors, interconnecting trunks having third conductors, a divided battery of higher and lower voltage, substations receiving talking current from the lower voltage, metallic circuits connecting the substations with the exchange, trunk selectors associated with said trunks having relays operated by the higher voltage for extending connection to a first selector over one of said trunks and which in operation are held locked by a ground on a third conductor of said last mentioned trunk, and a relay in said first selector, this ground only being released by energizing said relay.

12. In an automatic telephone exchange system, the combination of trunk lines provided with terminals, a switch provided with a pair of line wipers adapted to travel along said terminals, but out of engagement therewith, to select an idle trunk line, means for then moving said wipers endwise to engage the terminal of the selected trunk line, and means at the other ends of said trunk lines for extending connection therefrom.

13. In an automatic telephone exchange system, the combination of lines provided with terminals arranged in different levels, a switch provided with a pair of line wipers adapted to travel along said terminals, but out of engagement therewith, to select an idle line, means for then moving said wipers endwise to engage the terminal of the selected line, and means for moving the wipers from one level to another.

14. In a telephone exchange system, the combination of subscribers' telephone lines, automatic switches less in number than said telephone lines, automatic means for trunking a calling telephone line into connection with an idle automatic switch, each automatic switch provided with a bank of telephone line terminals, line wipers adapted to travel along said terminals, but out of engagement therewith, to select the line of the called subscriber, and means for then moving said wipers endwise to engage the terminal of the called line.

15. In a telephone exchange system, the combination of subscribers' telephone lines, automatic connector switches less in number than said telephone lines, means for effecting a preliminary trunking, means for then trunking in accordance with all except the last two digits of the called number, to extend the calling line into connection with an idle connector switch, each of said connector switches comprising a bank of telephone line terminals, line wipers adapted to travel along said terminals, but out of engagement therewith, to select the line of the called subscriber, and means for then causing the wipers to engage the terminals of the called line.

16. In a telephone exchange system, the combination of subscribers' telephone lines, automatic means for effecting a preliminary trunking when a subscriber calls, suitable means for then switching and connecting in accordance with all of the digits of the called number, said preliminary trunking means comprising automatic switches individual to the telephone lines, trunk lines having terminals in said automatic switches, each switch provided with swinging wipers adapted to travel along a curved line adjacent said terminals, but out of engagement therewith, to select an idle trunk line, and means for then moving the said wipers into engagement with the terminal of the selected trunk line.

17. In a telephone exchange system, the combination of subscribers' telephone lines, subscribers' individual switches, first and second selectors, trunk lines by which an individual switch connects with an idle first selector, trunk lines by which a selected first selector connects with an idle second selector, connectors for completing connection directly with the subscribers' lines, and trunk lines by which the selected second selector connects with an idle connector, said individual switches and selectors and connectors being each provided with a bank of line contacts, wipers adapted to travel along said contacts, but out of engagement therewith, and means for then causing the wipers to engage the contacts of the selected line.

18. In a telephone exchange system, the combination of subscribers' telephone lines, automatic non-numerical switches individual to said lines, trunks leading from said switches, a high potential battery for operating the individual switches, and a low potential battery for supplying talking current to the substations of connected subscribers.

19. In a telephone exchange system, a subscriber's telephone line, an individual switch for said line, trunk lines leading from said individual switch, said switch comprising line relays, release mechanism, a release magnet, means for keeping said magnet energized during use of the switch for talking purposes, means by which the energizing of said magnet locks the switch on the selected trunk line and keeps the line relays energized, and means for de-energizing said magnet to release the switch when the subscribers are through talking.

20. In a telephone exchange system, the combination of automatic switches and trunk-lines for extending connection from a calling line to a called line, provided with line wipers adapted to rotate along the terminals of the said trunk lines, but out of engagement therewith, means for bringing the wipers into engagement with the selected trunk lines, and connectors to which the trunk-lines lead, together with means by

which the calling subscriber operates the selected connector to complete connection with the called subscriber's line.

21. In a telephone system, first selectors, means for operating a selector vertically in accordance with the first digit of the called number, each selector adapted to rotate to automatically extend connection in the direction of the called subscriber, connectors adapted to be selected by said selectors, means for selecting idle first selectors, and means for supplying talking current through the connectors to calling and called subscribers.

22. A common battery telephone system comprising connectors having one motion to select groups and rotary motion to find the called line in any selected group, each connector having two parallel voice current conductors, a condenser in each conductor, and a battery normally in bridge of said conductors at the calling side of said condensers.

23. A common battery telephone system comprising connectors having one motion to select groups and rotary motion to find the called line in any selected group, each connector having two parallel voice current conductors, a condenser in each conductor, and a battery permanently in bridge of said conductors at the calling side of said condensers.

24. A common battery telephone system provided with automatic switches each having first one motion to select groups and then rotary motion to find a line in any selected group, conductors in said switches, and condensers in said conductors, whereby a talking circuit is established between calling and called subscribers, and a battery permanently in bridge of said conductors on opposite sides of the condensers in said conductors.

25. In a telephone system, a connector having first one motion to select groups and then rotary motion to find the called line in any selected group, a pair of voice current conductors for said connector, a condenser in each conductor, a battery normally in bridge of said conductors on the calling side of said condensers, and an impedance coil in said bridge at each side of said battery.

26. In a telephone system, a connector having first one motion to select groups and then rotary motion to find the called line in any selected group, a pair of voice current conductors for said connector, a condenser in each conductor, a battery permanently in bridge of said conductors on the calling side of said condensers, and an impedance coil in said bridge at each side of said battery.

27. In a telephone system, a pair of voice current line conductors, condensers in said line conductors, means including a pair of switch wipers having first vertical motion and then rotary motion to include the said conductors in a talking circuit, an actuating magnet for producing the vertical motion, another actuating magnet for producing the rotary motion, relays for controlling said magnets, and a battery permanently in bridge of said voice current line conductors on the calling side of said condensers.

28. In a telephone system, an automatic connector having vertical motion to select groups and then rotary motion to find the called line in any selector group, a pair of voice current conductors for said connector, condensers in said conductors, a battery normally in bridge of said conductors on the calling side of said condensers, a relay in said bridge, and releasing means controlled by said relay.

29. In a telephone system, a plurality of automatic first selectors, each adapted to perform a trunking operation in accordance with the first digit of the called number, a switch individual to a calling line for automatically finding idle selectors, said selectors less in number than the subscribers having access thereto, suitable means for completing connection from a selector to the line of a called subscriber to establish a talking circuit between the calling and called subscribers, a pair of voice current conductors included in opposite sides of said circuit, a battery normally in bridge of said voice current conductors, whereby talking current is supplied to at least one of the subscribers, means for releasing the selectors, and means for initiating the release by the opening of the talking circuit.

30. In a telephone system, a selector provided with a release magnet, release mechanism operative to release the selector by the deenergizing of said magnet, a pair of line relays bridged across the conductors of the talking circuit at the central station for said selector, means whereby the energizing of said magnet serves to open up or cut off the said bridge and local switch-controlling circuits controlled by said bridging relays.

31. In a telephone system, an automatic switch, a relay bridge therefor bridged across the conductors of the talking circuit at the central station, a bridge-cut-off relay, release mechanism operated by said bridge-cut-off relay, whereby the release of said switch and the restoration of said bridge are simultaneous, and local switch-controlling circuits controlled by said bridging relays.

32. In a telephone system, an automatic switch provided with a relay bridge, a bridge-cut-off relay, a pair of line wipers, a magnet for actuating said wipers endwise, and an energizing circuit for said bridge-cut-off relay controlled by said actuating magnet.

33. In a telephone system including lines divided into groups, a switch having vertical and rotary motion, the vertical motion first and the rotary motion afterwards, whereby a group is selected and a line is then found in that group, a line relay bridge for said switch, controlling the operations thereof, a common battery for supplying talking current, and a bridge-cut-off relay adapted by a single movement of its armature to open said bridge and thereby prevent short-circuiting of the talking current.

34. In a telephone system including lines divided into groups, a first selector adapted to perform a trunking operation in accordance with the first digit of the called number, having first vertical motion to select a group and then rotary motion to automatically select an idle trunk in the selected group, a relay bridge for said selector controlling the operations thereof, a common battery for supplying talking current, and a bridge-cut-off relay for said selector, adapted by a single movement of its armature to open said bridge and thereby prevent short-circuiting of the talking current.

35. In a telephone system, a plurality of trunks divided into groups, a switch operative under substation control for automatically selecting idle trunks having first vertical motion to select the desired group and then rotary motion to find an idle trunk therein, and suitable common battery means between the selector and a called line for supplying the calling subscriber with talking current before the called subscriber answers.

36. In a telephone system, a pair of subscribers' lines connected with each other by trunk lines at a central office through a metallic circuit, automatic selecting devices for said subscribers' lines, and for each of said trunk lines, a pair of controlling magnets bridged across said metallic circuit line at one of said selecting devices, means under control of said magnets for causing all of said selecting devices to return to their normal position and break the connection between said subscribers' lines and said trunk lines, a battery for talking purposes normally in bridge of said metallic circuit, said automatic selecting devices for said subscribers' lines being non-numerical progressively movable switches individual to said lines.

37. In an automatic telephone system, means for establishing a talking connection comprising a pair of voice-current line conductors, condensers in said conductors, a battery for talking purposes normally in bridge of said conductors on the calling side of said condensers, a subscriber's line, a first selector, a progressively movable switch individual to said subscribers' lines for connecting said selector to said line, selecting contacts for said first selector, a trunk line adapted to be connected to said subscriber's line by said first selector, a second selector for said trunk line, controlling magnets at said first and second selectors, means for energizing the magnets of said first selector to move said selecting contacts into engagement with said trunk line, a switch actuated by said magnets during their selecting operation to disconnect said magnets from said line, a release magnet for said first selector, a separate conductor individual to said trunk line, and means controlled by the magnets of said second selector for causing the operation of the release magnet of said first selector over said separate conductor, substantially as described.

38. In a telephone system, a pair of subscribers' lines connected with each other by trunk lines at a central office through a metallic circuit, automatic selecting devices for said subscribers' lines, and for each of said trunk lines the selecting devices for said subscribers' lines being individual thereto, a pair of controlling magnets bridged across said metallic circuit line in a trunk other than that of the selecting device first operated, said magnets energized during talking, means under control of said magnets for causing all of said selecting devices to return to their normal position and break the connection between said subscribers' lines and said trunk lines, and means for initiating a release between calling and called subscribers by simply opening the talking circuit at one end thereof, whereby the system is independent of the ground at the substations for releasing purposes, substantially as described.

39. In an automatic telephone system, a subscriber's line, a non-numerical selecting switch individual to said line at a central office, a trunk line to which said subscriber's line is extended by the movement of the selecting switch of said subscriber's line, a selecting switch for said trunk line, a pair of controlling magnets for each of said selecting switches adapted to control the selecting movements of said switches, the magnets at the selecting switch of said subscriber's line being in an open bridge across said subscriber's line during a connection between said line and said trunk, said magnets in the selecting switch of said trunk being connected in a closed bridge across said trunk during a connection with said line, means associated with the selecting switch of said line and controlled by the bridged magnets of the selecting switch of said trunk to cause the selecting switch of said line to assume its normal position, disconnecting said line from said trunk, and means for initiating a release between calling and called subscribers by simply opening the talking circuit at one end thereof,

whereby the system is independent of the ground at the substations for releasing purposes.

40. In an automatic telephone system, a built-up circuit between two subscribers' lines, selecting switches and trunk lines involved in building up said circuit, one of said selecting switches being non-numerical and individual to a subscriber's line, controlling magnets connected with said circuit at some of said selecting switches, other controlling magnets disconnected from said circuit at other of said selecting switches, means at the switches having connected magnets for causing those switches having disconnected magnets to disconnect said built-up circuit, and means for initiating a release between calling and called subscribers by simply opening the talking circuit at one end thereof, whereby the system is independent of the ground at the substations for releasing purposes.

41. In an automatic telephone system, a subscriber's line, a non-numerical selector individual thereto, selecting contacts for said selector, a trunk line adapted to be connected to said subscriber's line by said selector, a first selector for said trunk line, controlling magnets at said selectors, means for energizing the magnets of said non-numerical selector to move said selecting contacts into engagement with said trunk line, a switch actuated by said magnets during their selecting operation to disconnect said magnets from said line, a release magnet for said non-numerical selector, a separate conductor individual to said trunk line, means controlled by the magnets of said first selector for causing the operation of the release magnet of said non-numerical selector over said separate conductor, and means for initiating a release between calling and called subscribers by simply opening the talking circuit at one end thereof, whereby the system is independent of the ground at the substations for releasing purposes.

42. An automatic telephone system comprising a temporarily established talking circuit, a selector relay bridge individual to a calling line and temporarily disconnected or cut off from the said circuit, a connector relay bridge energized during talking and retained across the said circuit for releasing purposes, selector and connector releasing means controlled by the said connector relay bridge, and means for initiating a release between calling and called subscribers by simply opening the talking circuit at one end thereof, whereby the system is independent of the ground at the substations for releasing purposes.

43. In a telephone exchange system, the combination of a talking circuit, a plurality of bridges on the conductors of said circuit, one of said bridges being individual to a calling subscriber's line, automatic means for reducing the number of bridges before talking, releasing means for disconnecting between subscribers, means for retaining one of said bridges other than the one individual to the line to control the said releasing means, said retained bridge for supplying current to the line during talking and means for initiating a release between calling and called subscribers by simply opening the talking circuit at one end thereof, whereby the system is independent of the ground at the substations for releasing purposes.

44. In a telephone system, a pair of subscribers' lines connected with each other by trunk lines at a central office through a metallic circuit, automatic selecting devices for said subscribers' lines, and for each of said trunk lines, each subscriber's device individual to the subscriber's line and provided with means for automatically selecting idle trunks, a pair of controlling magnets bridged across said metallic circuit line in a trunk other than that of the selecting device first operated, said magnets energized during talking, means under the control of said magnets for causing all of said selecting devices to return to their normal position and break the connection between said subscribers' lines and said trunk lines, a common battery for talking purposes, and means whereby said battery is connected to said bridge of the line before the called line is found. substantially as described.

45. In an automatic telephone system, a subscriber's line, a selecting switch for said line at a central office, a trunk line to which said subscriber's line is extended by the movement of the selecting switch of said subscriber's line, a selecting switch for said trunk line adapted to select idle trunks, a pair of controlling magnets for each of said selecting switches adapted to control the selecting movements of said switches, the magnets at the selecting switch of said subscriber's line being in an open bridge across said subscriber's line during a connection between said line and said trunk, said magnets in the selecting switch of said trunk being connected in a closed bridge across said trunk during a connection with said line, means associated with the selecting switch of said line and controlled by the bridged magnets of the selecting switch of said trunk to cause the selecting switch of said line to assume its normal position, disconnecting said line from said trunk, a common battery for talking purposes, and means whereby said battery is connected through one of said bridges across the calling subscriber's line before the called line is found, substantially as described.

46. In an automatic telephone system, a built-up circuit between two subscriber's lines, trunk lines and selecting switches for

selecting idle trunks and a connector switch involved in building up said circuit, controlling magnets connected with said circuit at some of said selecting switches, other controlling magnets disconnected from said circuit at other of said selecting switches, means at the switches having connected magnets for causing those switches having disconnected magnets to disconnect said built-up circuit, a common battery for talking purposes, means in said connector whereby said battery is connected across the calling line before the called line is found, substantially as described.

47. In an automatic telephone system, a subscriber's line, a non-numerical selector individual thereto provided with means for selecting idle trunks, selecting contacts for said selector, a trunk line adapted to be connected to said subscriber's line by said selector, a first selector for said trunk line, controlling magnets at said selectors, means for energizing the magnets of said non-numerical selector to move said selecting contacts into engagement with said trunk line, a switch actuated by said magnets during their selecting operation to disconnect said magnets from said line, a release magnet for said non-numerical selector, a separate conductor individual to said trunk line, means controlled by the magnets of said first selector for causing the operation of the release magnet of said non-numerical selector over said separate conductor, a common battery for talking purposes, and means whereby said battery is connected across the calling line before the called line is found, substantially as described.

48. An automatic telephone system comprising a temporarily established talking circuit, a selector and a connector, a selector relay bridge temporarily disconnected or cut off from the conductors of said circuit, a connector relay bridge retained across the said circuit for releasing purposes, selector and connector releasing means controlled by the said connector relay bridge, a common battery for talking purposes, and means whereby said battery is connected through said connector bridge and across the conductors of the talking circuit before the called line is found.

49. In a telephone system, a pair of subscribers' lines, selector and connector switches for connecting said lines, means for operating said switches, release magnets for each of said switches, multiple circuits for energizing said magnets, said magnets being energized during conversation, and means whereby the subscribers may release said switches by controlling said release magnets.

50. In a telephone system, a pair of subscribers' lines, selector switches and connector switches having two motions in planes at right-angles to each other to connect said lines, means for operating said switches, release magnets for each of said switches, means for energizing said magnets in multiple, said magnets being energized during conversation, and means under the control of the subscribers for deenergizing said magnets and thereby releasing said switches.

51. In a telephone system, a pair of subscribers' lines, a plurality of automatic switches for connecting said lines, means for operating said switches, a release magnet in each of said switches, means for energizing said magnets in multiple, said magnets being energized during conversation, and means under the control of the subscribers to deenergize said magnets and thereby release said switches.

52. In a telephone system, a pair of subscribers' lines, a line switch individual to said lines, selector switches and connector switches having movements in planes at right-angles to each other for connecting said lines, means for operating said switches, a release magnet for each of said switches, a multiple circuit for all of said release magnets, means for energizing said magnets, said magnets remaining energized during conversation, and means under the control of the subscribers for deenergizing said magnets to thereby release said switches.

53. In a telephone system, a pair of subscribers' lines, selector and connector switches having movements in planes at right-angles to each other to connect said lines for conversation, a relay in said connector, release magnets for said switches, multiple circuits having a common ground for energizing said magnets, said magnets being energized during talking, and a relay for controlling said ground connection, said relay being controlled from the substations through said relay in the connector, whereby either subscriber may release said switches.

54. In a telephone system, a pair of subscribers' lines connected by trunk lines at a central office, automatic switching devices for said subscribers' lines having movements in planes at right-angles to each other to select a given line, and means whereby either the calling or called subscriber may release by simply opening the talking circuit, whereby the system is independent of the ground at the substations for releasing purposes.

55. In a telephone system, a subscriber's line, an automatic switch individual to said line, a second subscriber's line, means for establishing connection from said first to said second subscriber's line, or from said second line to said first line, an operating relay for said switch connected to said line, a cut-off relay, and means for energizing said cut-

off relay to disconnect said operating relay from said line when said first line is calling or is being called.

56. In a telephone system, a subscriber's line, a progressively movable non-numerical switch individual to said line, switch arms for said switch normally connected to said line, means for establishing a connection from or to said line, an operating magnet in said switch normally connected to the line, a cut-off relay, and means for energizing said cut-off relay to disconnect said operating magnet from the line when said line is calling or is being called.

57. In a telephone system, a subscriber's line, a progressively movable switch individual to said line, switch arms for said switch normally connected to said line an operating magnet for said switch normally connected to the line, means for establishing a connection from or to said switch normally connected to the line, a cut-off relay, and means for energizing said cut-off relay to disconnect said operating magnet from the line when said line is calling or is being called.

58. In a telephone system, subscribers' lines divided into goups, means including automatic progressively movable switches normally disconnected from the subscribers' lines common to said lines and accessible thereto for establishing a talking circuit between a calling and a called subscriber's line, said talking circuit divided into two inductively connected sections, one section on the side of the calling subscriber and another section on the side of the called subscriber, and a battery normally bridged across the calling end of the talking circuit, at a point between one of said automatic switches and the called line.

59. In a telephone system, subscribers' lines divided into groups, means including automatic progressively movable switches normally disconnected from the subscribers' lines common to said lines and accessible thereto for establishing a talking circuit between a calling and a called subscriber's line, said talking circuit divided into two inductively connected sections, one section on the side of the calling subscriber and another section on the side of the called subscriber, a battery normally bridged across the calling end of the talking circuit at a point between one of said switches and the called line, and a transmitter for the calling subscriber connected to receive current from said battery.

60. In a telephone system, subscribers' lines divided into groups, means including automatic progressively movable switches having movements in different planes and normally disconnected from the subscribers' lines common to said lines for establishing a talking circuit between a calling and a called subscriber's line, said means also for extending the talking circuit from a calling line to one of said automatic switches before the talking circuit is extended to the called line, a battery normally bridged across the calling end of the talking circuit at a point between one of said automatic switches and the called line, means for releasing the switches in said connection operated by current from said battery, and means for initiating the release by opening the talking circuit.

61. In a telephone system, a pair of subscribers' stations, a line connecting each with a central office, an automatic progressively movable switch for connecting the central office ends of said lines, release mechanism for breaking said connection, an electromagnet controlling said mechanism, a circuit for said magnet, said circuit controlled over the line from either station whereby the release mechanism may be operated by opening either line.

62. In a telephone system, a pair of subscribers' stations, a line connecting each with a central office, an automatic progressively movable switch for connecting the central office ends of said lines, release mechanism, an electromagnet controlling said mechanism, a circuit for said magnet, said circuit controlled over the line from either station whereby the release mechanism may be operated by opening either line, a plurality of links at the central office, and means for joining said links for connecting the central office ends of said lines.

63. In a telephone system, a pair of subscribers' stations, a line connecting each with a central office, an automatic progressively movable switch for connecting the central office ends of said lines, release mechanism, an electromagnet controlling said mechanism, a circuit for said magnet, said circuit controlled over the line from either station whereby the release mechanism may be operated by opening either line, a plurality of links at the central office, and means for joining said links for connecting the central office ends of said lines, said means including a progressively movable switch.

64. The combination with a line having a pair of line conductors, a plurality of other similar lines, a switch individual to said first line for connecting the conductors thereof with any one of said other pairs, a magnet for releasing said switch, a plurality of release circuits for said magnet one for each one of said other lines, said switch having means for including said magnet in any one of said circuits, a relay, a circuit for said relay including said conductors in series for energizing said relay, said relay controlling the circuit in which said release magnet is included to open the same when the said series circuit is opened.

65. The combination with a line having a pair of line conductors, a plurality of other similar lines, a progressively movable switch individual to said first line for connecting the conductors thereof with any one of said other pairs, a magnet for releasing said switch, a plurality of release circuits for said magnet one for each of said other lines, said switch having means for including said magnet in any one of said circuits, a relay, a circuit for said relay including said conductors in series for energizing said relay, said relay controlling the circuit in which said release magnet is included to open the same when the said series circuit is opened and a test circuit associated with each one of said other circuits for controlling the operating of said switch to determine in which release circuit the release magnet shall be included.

66. In a telephone exchange system, the combination of a calling subscriber's line, a called subscriber's line, automatic switch mechanism for connecting the two lines together, release mechanism, a release circuit, a trunk conductor in said release circuit, a centralized source of talking current, means consisting of a single pair of relay coils for feeding talking current to the calling subscriber's line, means consisting of a single pair of relay coils for feeding talking current to the called subscriber's line, and means for closing the release circuit by the opening of the calling subscriber's line.

67. In an automatic telephone system, the combination with a pair of telephone lines connected for conversation, of a pair of relays having coils through which the transmitter current is furnished to each of said lines, said relays being actuated during conversation by current flowing over the telephone line and through the transmitters, an automatic switch through which said conversational circuit is established, a release magnet for said switch, and means whereby the interruption of the current through either of said relays will complete the circuit through said release magnet to thereby effect the release of said automatic switch, substantially as described.

68. In an automatic telephone system, the combination with a called telephone line, of a relay and a source of current bridged between the limbs of the line at the central office during conversation, said relay being actuated over the telephone line, automatic apparatus at the central office for establishing the conversational connection with said line, a release magnet for said apparatus, the release of said relay being adapted to establish a circuit through said release magnet whereby the automatic apparatus is released, substantially as described.

69. In an automatic telephone system, the combination with a pair of telephone lines connected for conversation, of a pair of condensers, one interposed in each voice current conductor connecting said telephone lines, a pair of relays and a source of current bridged between said voice current conductors, one on each side of said condensers for furnishing transmitter current to the telephone line, automatic apparatus for said connection, a release magnet for said apparatus, the release of either of said relays being adapted to actuate said release magnet to effect the release of the automatic apparatus at the central office, substantially as described.

70. In a telephone system the combination with a substation telephone line, of trunk lines, an automatic spring restored line switch for said line operated upon initiation of a call from said line, to select an idle one of said trunks, a cut-off relay for said line energized after connection with said trunk and means associated with a selected trunk and controlled at said substation for deenergizing said relay, whereby said switch is released.

71. In a telephone system the combination with a substation telephone line, of an automatic spring restored line switch therefor, a line relay for controlling the selecting operation of the switch, a cut-off relay for said switch for disconnecting the line relay from said line, and mechanism controlled by said cut-off relay for restoring said switch when said switch is operated.

72. A telephone system comprising a substation telephone line, trunk lines, an automatic spring restored line switch for said line operated responsive to initiation of a call over said line to select an idle one of said trunks, a cut-off relay for said line, means associated with said trunk for energizing said cut-off relay responsive to said selection, said means being controlled from the calling substation to deenergize said relay, and release means for said switch thereby rendered effective.

73. A telephone system comprising a substation telephone line, trunk lines, a line relay for said line, an automatic line switch for said line operated responsive to said line relay to select an idle one of said trunks, a cut-off relay for said line, means associated with said trunk for energizing said cut-off relay responsive to such selection, said means being controlled from the calling substation to deenergize said cut-off relay, and mechanically operated release means for said switch thereby rendered effective.

74. In a telephone system, the combination with a substation telephone line, of an automatic switch therefor, spring restoring means for the switch, a plurality of trunk lines, a line relay for controlling the selection of an idle one of said trunk lines by said switch, a cut-off relay for said switch for

disconnecting the line relay from the line after a trunk is selected, and mechanism controlled by said cut-off relay for operating said first means to restore said switch to normal when disconnection is desired.

75. A telephone system comprising a substation telephone line, trunk lines, a control relay for said line, a non-numerical spring restored switch for said line operated responsive to said control relay to select an idle one of said trunks, a cut-off relay for said line, a circuit including a conductor of said trunks for energizing said cut-off relay, and means controlled from the calling substation to deenergize said cut-off relay to release said switch.

76. A line switch for telephone systems comprising contacts and cooperating wipers, restoring means for said wipers, trunk lines, a motor magnet for operating said wipers to select an idle one of said trunk lines, a cut-off relay energized over a conductor of said selected trunk, and means mechanically associated with said cut-off relay for controlling the restoration of the wipers when said relay deenergizes.

77. In a telephone system the combination with a substation telephone line, of trunk lines, an automatic line switch for said line operated upon initiation of a call from said line to select an idle one of said trunks, holding means for maintaining said switch in its advanced position, a cut-off relay for said line energized over a conductor of said trunk after connection with said trunk, and means controlled at said substation for deenergizing said relay whereby said holding means is operated to permit the said switch to restore.

78. In a telephone system the combination with a substation telephone line, an automatic spring restored switch individual thereto, a control relay for said line energized upon initiation of a call at said substation, said switch being responsive to the energization of the said control relay to extend the circuit of said line to an idle trunk line, a cut-off relay for said line energized over a conductor of said trunk upon the extension of said line, and means controlled from said substation for deenergizing said cut-off relay whereby the switch is released.

79. A telephone system comprising a subscriber's line provided with a non-numerical trunking switch, a group of trunk lines accessible to said switch, means controlled over said line for operating said switch to automatically select an idle one of said trunk lines, a cut-off relay for said switch energized upon the connection of said switch to an idle one of said trunk lines over a conductor of said trunk independent of the talking conductors, means controlled over the said line for deenergizing said cut-off relay, and mechanical means controlled by the deenergization of said cut-off relay to restore said switch.

80. In an automatic telephone exchange system, a calling and a called line extending from their respective stations to the exchange, a plurality of selective switches, operated responsive to successive sets of current impulses controlled at the calling station, connecting said lines, switching mechanisms at the stations adapted to be operated to open the metallic circuits of their lines, release magnets at the exchange, one for each of said switches, and apparatus adapted to be actuated responsive to the opening of either line circuit to operate each magnet to restore its respective switch to normal.

81. In an automatic telephone exchange system, a calling line and a called line extending from their respective stations to the exchange, a plurality of selective switches, operated responsive to successive sets of current impulses controlled at the calling station, connecting said lines, a central source of current supplying current for conversational purposes to the transmitters of the stations of said lines, apparatus at the stations for interrupting the flow of said currents, and apparatus at the exchange operative responsive to the interruption of said flow of current to restore all of said switches to normal.

82. A telephone system including metallic circuit telephone lines divided into groups, a link circuit, a directively controlled step-by-step switch at one end of said link circuit, automatic means for connecting a calling one of said lines to said link circuit, directive current impulses for causing a step-by-step operation of said switch, first to a group of lines and then to a line in a group to complete a connection with a called one of said lines, and electromagnetic release means for said switch capable of being operated solely by the opening of the metallic circuit of one of said connected lines.

83. A telephone system including telephone lines, a directly controlled step-by-step selective switch at a central exchange provided with wipers, means for stopping the wipers of said switch, first to a group of lines then to a line in a group to connect one of said lines with another for conversation, a release relay for said selective switch held energized during conversation, electromagnetic release means, substation controlled means for opening the metallic circuit of a connected one of said telephone lines to de-energize said relay, and circuits controlled by such operation of said relay to actuate said electromagnetic means to restore said switch to normal.

84. An automatic telephone system in-

cluding a pair of telephone lines, a plurality of selective switches linking said lines together, a release circuit extending to a plurality of switches linking said lines, electromagnetic release mechanism for each of said plurality of switches, contacts of said switches included in said circuit serving to protect the talking circuit against intrusion, and means for closing said circuit long prior to the time of release and thereafter maintaining it continually closed and for opening said circuit when release is desired to deenergize said mechanisms to cause restoration of their respective switches.

85. An automatic telephone system including a pair of telephone lines, a plurality of selective switches linking said lines together, a release circuit extending to a plurality of switches linking said lines, electromagnetic release mechanism for each of said plurality of switches, contacts of said switches included in said circuit serving to protect the talking circuit against intrusion, relay mechanism controllable from the substation of one of said lines, means for altering the operative condition of said mechanism when disconnection is desired, and switching mechanism responsive to said altered condition to open said release circuit to deenergize said electromagnetic release mechanism whereby the respective switches are released.

86. An automatic telephone system including a pair of telephone lines, a plurality of selective switches linking said lines together, a release circuit extending to a plurality of switches linking said lines, electromagnetic release mechanism for each of said plurality of switches, relay mechanism controllable from the substation of one of said lines, means for altering the operative condition of said mechanism when disconnection is desired, and switching mechanism responsive to said altered condition to open said release circuit to deenergize said electromagnetic release mechanisms whereby the respective switches are released.

87. An automatic telephone system including a pair of telephone lines, a plurality of link-circuits having selective switches interconnecting said lines, a talking circuit extending through said switches, a release circuit extending therethrough and separate from the talking circuit, electromagnets for the respective switches for use in releasing the same, said electromagnets being connected with said release circuit and held energized while connection continues, and means for altering the connections of said release circuit when disconnection is desired to de-energize said electromagnets to release the switches.

88. A telephone system including a pair of telephone lines, selective switches connecting said lines, a release electromagnet for each of said switches, connected in parallel to a trunk release conductor, means for energizing said electromagnets and maintaining them continually energized during the progress of connection and while connection exists, and switching means responsive to the opening of the metallic circuit of one of said lines for deenergizing said electromagnets to effect restoration of said switches.

89. A telephone system comprising a pair of telephone lines, two-dimension selector and connector switches with means for operating them to connect a calling one of said lines with a called one of said lines, a release electromagnet for each of said switches, means for effecting and maintaining a continuous energization thereof during the progress of connection, and switching means controlled over the connected telephone lines for causing deenergization of the said electromagnets whereby any deenergization thereof will restore the switches.

90. A telephone exchange system comprising a plurality of subscribers' metallic line telephone circuits, interconnecting link-circuits, means, including an electrically controlled switch, for connecting said link circuits so as to establish conversational connection between calling and called lines, and means whereby one of the connected substations, independently of the other sub-station, may restore said switch to normal by breaking a metallic circuit.

91. A telephone system including metallic circuit telephone lines divided into groups, a link circuit, a directively controlled step-by-step switch at one end of said link circuit, automatic means for connecting a calling one of said lines to said link circuit, directive current impulses for causing a step-by-step operation of said switch, first to a group of lines and then to a line in a group to complete a connection with a called one of said lines, and electromagnetic release means for said switch capable of being operated solely by the opening of the metallic circuit of one of said connected lines.

92. A telephone system including telephone lines, a directively controlled step-by-step selective switch at a central exchange provided with wipers, means for stepping the wipers of said switch, first to a group of lines then to a line in a group to connect one of said lines with another for conversation, a release relay for said selective switch held energized during conversation, electromagnetic release means, substation controlled means for opening the metallic circuit of a connected one of said telephone lines to deenergize said relay, and circuits controlled by such operation of said relay to actuate said electromagnetic means to restore said switch to normal.

93. In an automatic telephone exchange

system, a calling line and a called line extending from their respective stations to the exchange, a plurality of selective switches, operated responsive to successive sets of current impulses controlled at the calling station, connecting said lines, switching mechanisms at the stations adapted to be operated to open the metallic circuits of their lines, and apparatus at the exchange actuated responsive to the opening of a line circuit metallically to restore all of said switches to normal.

94. A telephone exchange system comprising a telephone line, associated automatic switches and link-circuits for extending the circuit of said line, relays bridged across the line and adapted to be energized at a definite point in the operation of said switches, a release circuit for certain of said switches controlled by said relays, and means for maintaining said relays energized so as to prevent the completion of said release circuit.

95. In a telephone system, a calling and a called line, a talking circuit between said lines, a plurality of progressively movable switches for establishing said talking circuit, an operating magnet for one of said switches, a circuit for said magnet excluding said talking circuit, a relay for maintaining said talking circuit, a circuit for maintaining said relay energized, and means for releasing said switches responsive to the opening of either line.

96. In a telephone system, a calling and a called line, a talking circuit between said lines, a plurality of progressively movable switches for establishing said talking circuit, an operating magnet for one of said switches, a circuit for said magnet, a relay for controlling said circuit, a test circuit for controlling said relay, a second relay, said second relay for maintaining said talking circuit, a circuit for maintaining said second relay energized, and means for releasing said switches responsive to the opening of either line.

In testimony whereof, I have hereunto set my hand at Los Angeles, California this 16th day of December 1905.

HERBERT L. FISH.