May 25, 1926. 1,586,033

C. J. ERICKSON

ELECTRICAL SWITCHING APPARATUS FOR AUTOMATIC TELEPHONE EXCHANGE SYSTEMS

Filed Nov. 14, 1905 13 Sheets-Sheet 1

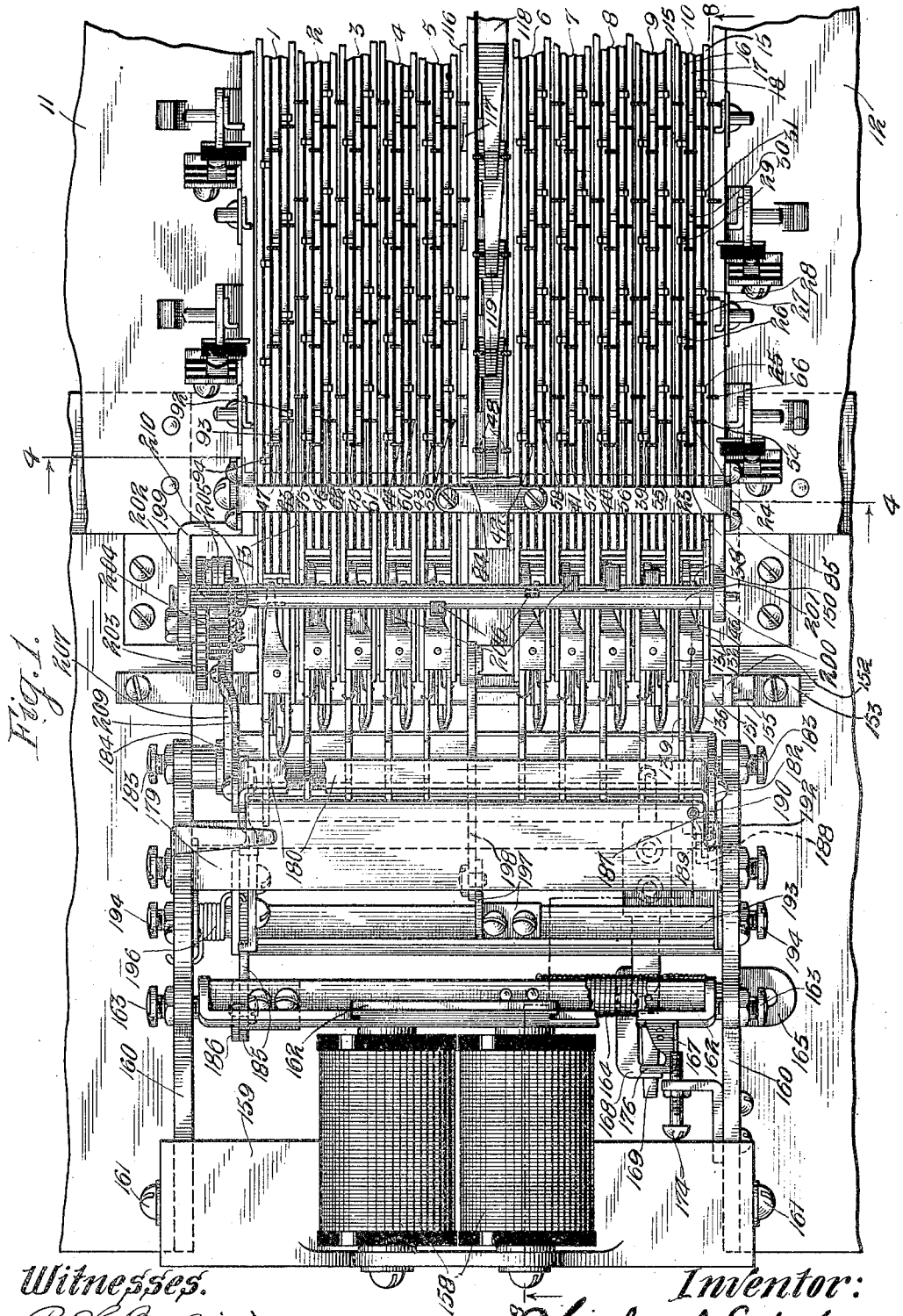

Fig. 1.

Witnesses.
R. H. Bumpind
A. Andersen.

Inventor:
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May 25, 1926. 1,586,033

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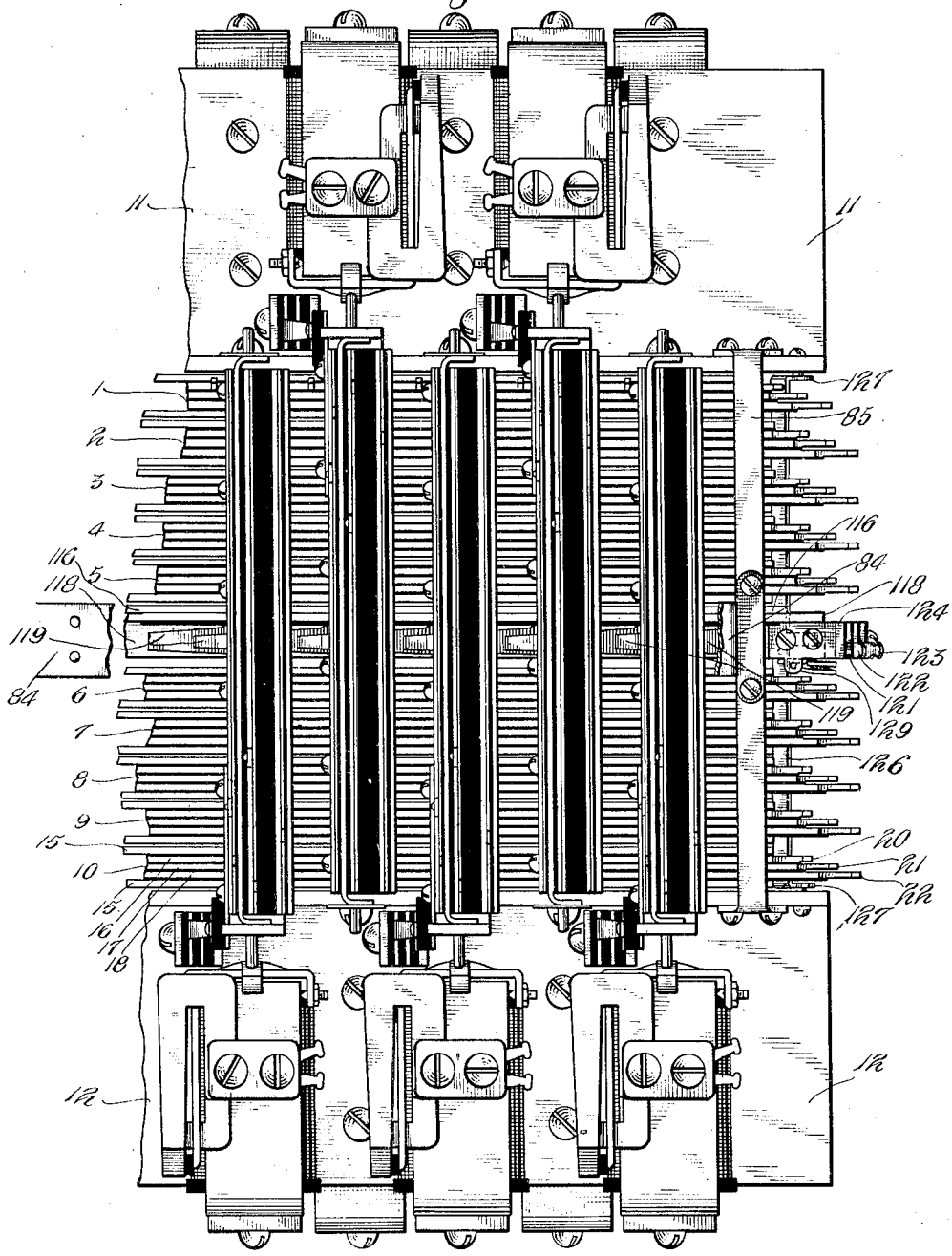
ELECTRICAL SWITCHING APPARATUS FOR AUTOMATIC TELEPHONE EXCHANGE SYSTEMS

Filed Nov. 14, 1905 13 Sheets-Sheet 2

Fig. 2.



Witnesses.
R. H. Burfind
A. Andersen.

Inventor:
Charles J. Erickson
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ELECTRICAL SWITCHING APPARATUS FOR AUTOMATIC TELEPHONE EXCHANGE SYSTEMS

Filed Nov. 14, 1905 13 Sheets-Sheet 3

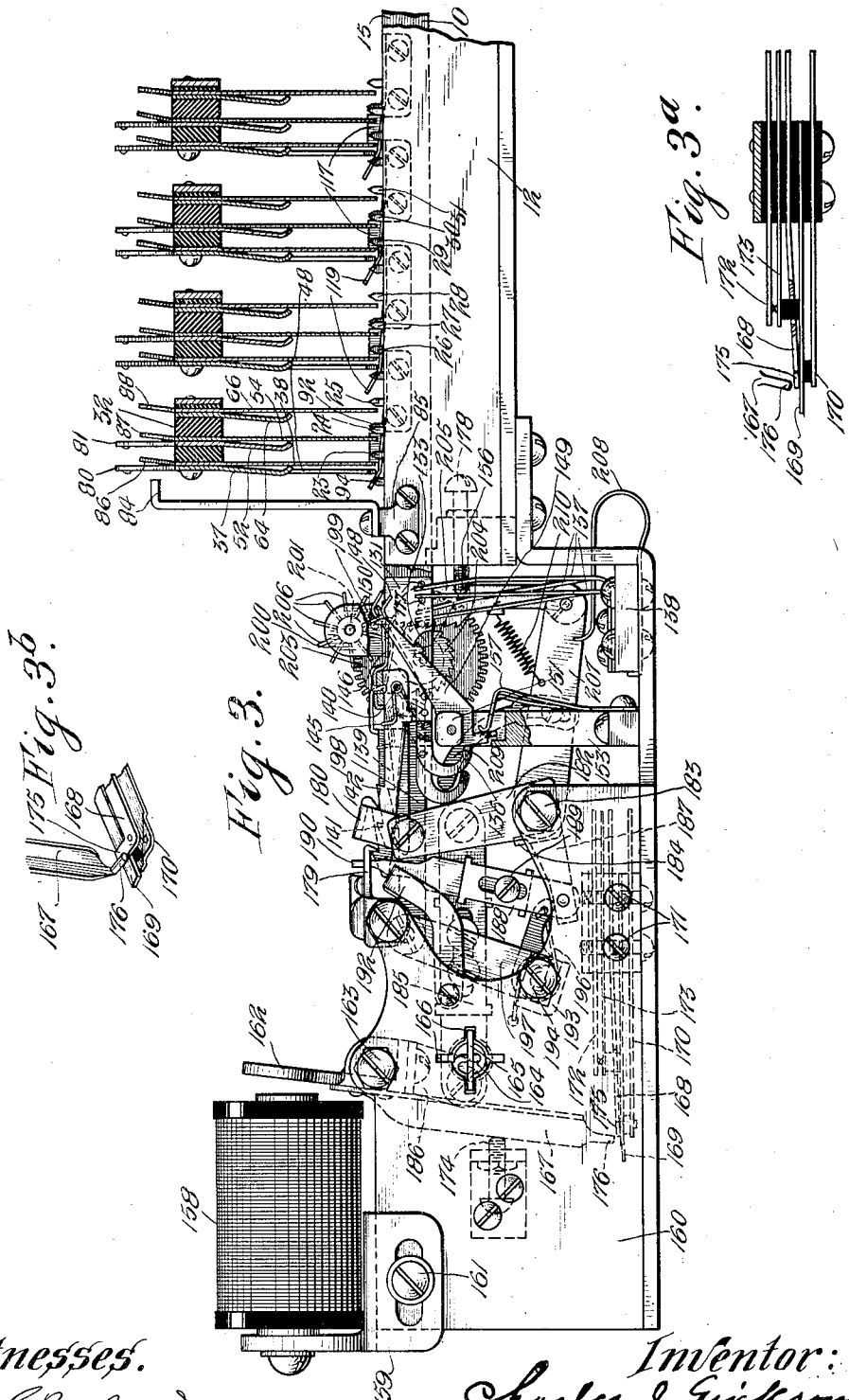

Fig. 3.

Fig. 3a.

Fig. 3b.

Witnesses.
P. H. Burfind
A. Andersen.

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May 25, 1926. 1,586,033

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ELECTRICAL SWITCHING APPARATUS FOR AUTOMATIC TELEPHONE EXCHANGE SYSTEMS

Filed Nov. 14, 1905 13 Sheets-Sheet 4

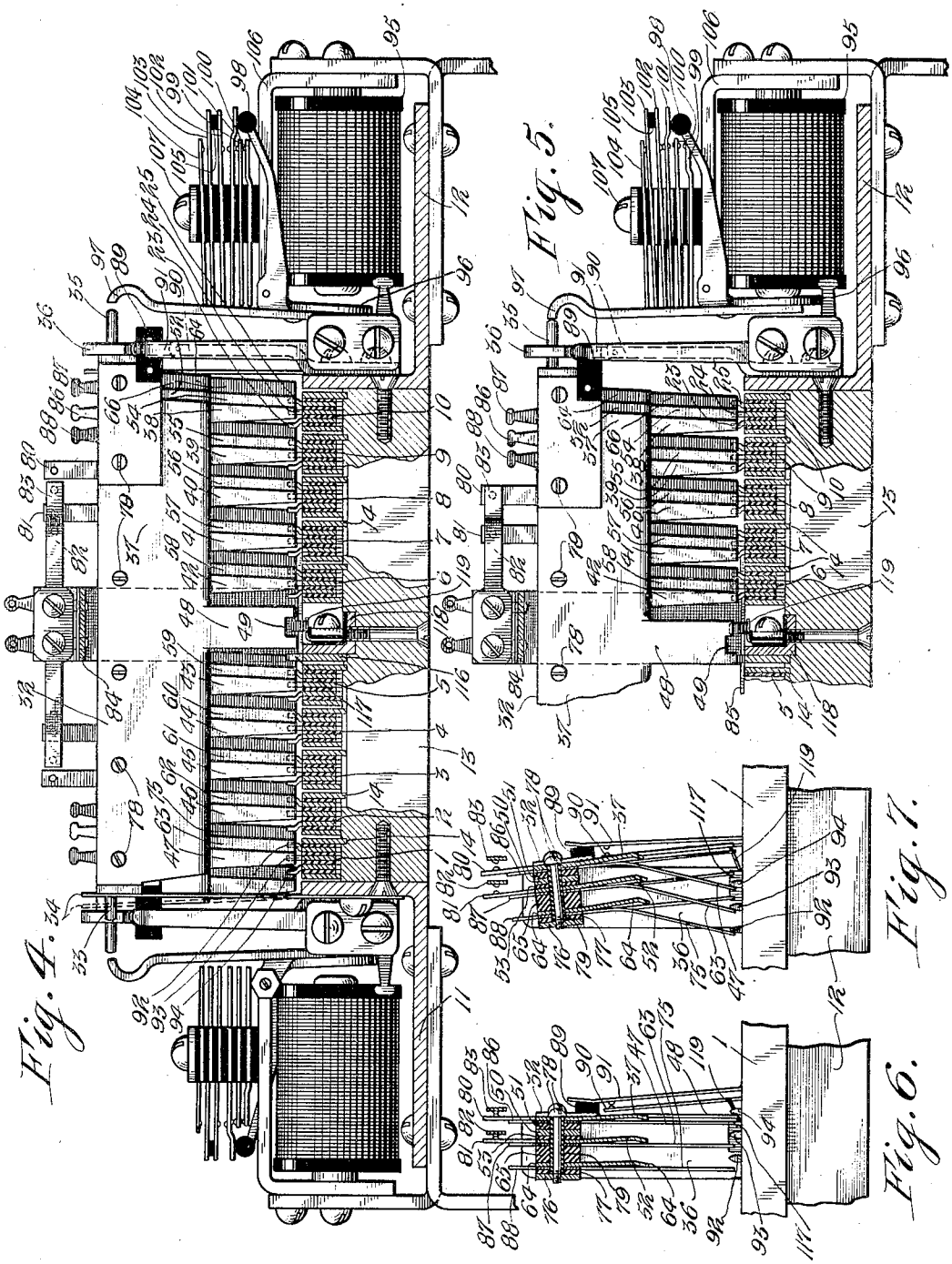

Fig. 4.

Fig. 5.

Fig. 7.

Fig. 6.

Witnesses.
R. L. Burfine
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May 25, 1926. 1,586,033

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ELECTRICAL SWITCHING APPARATUS FOR AUTOMATIC TELEPHONE EXCHANGE SYSTEMS

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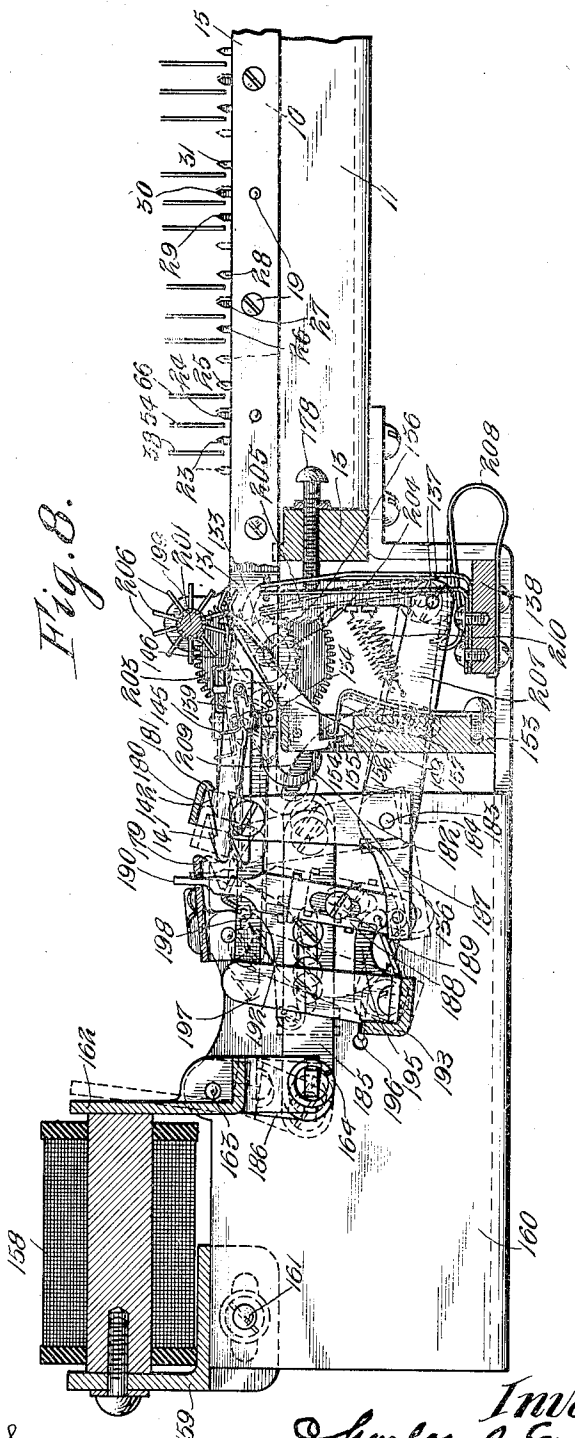
Fig. 8.



Witnesses.
P. H. Burfind
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May 25, 1926. 1,586,033

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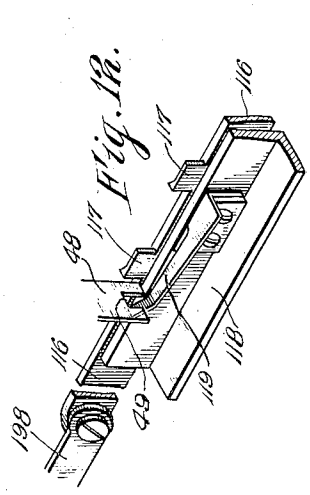
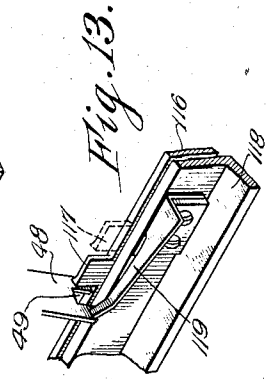
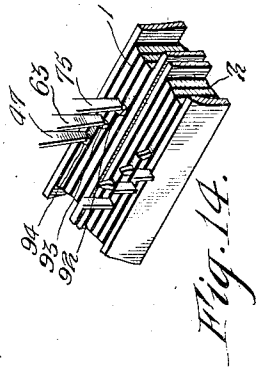
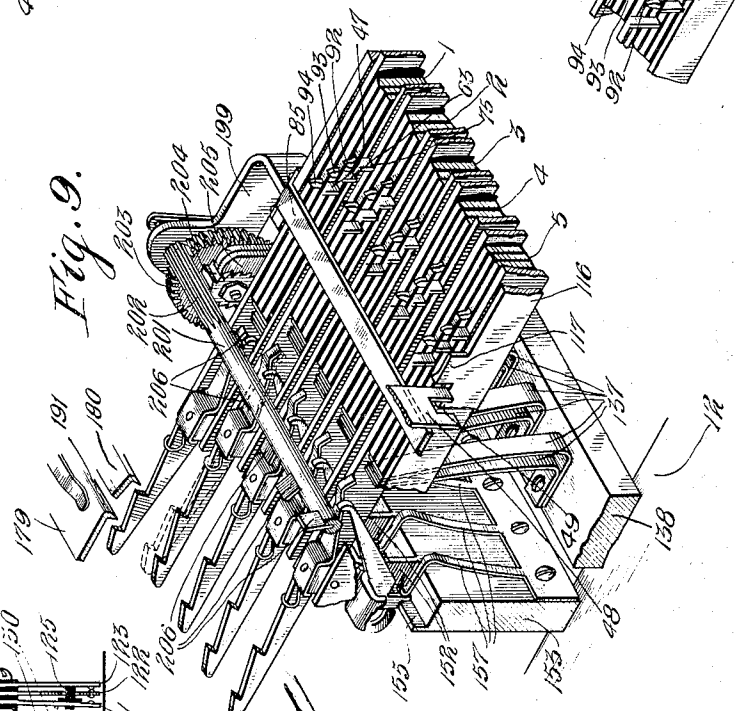
ELECTRICAL SWITCHING APPARATUS FOR AUTOMATIC TELEPHONE EXCHANGE SYSTEMS

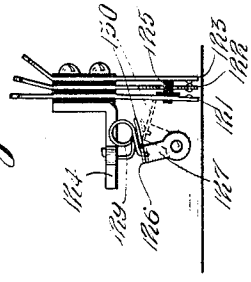
Filed Nov. 14, 1905 13 Sheets-Sheet 6

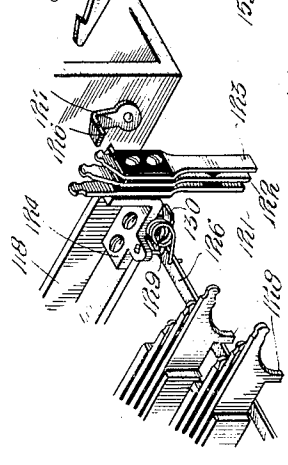












Witnesses.
P. H. Burfind.
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May 25, 1926. 1,586,033

C. J. ERICKSON

ELECTRICAL SWITCHING APPARATUS FOR AUTOMATIC TELEPHONE EXCHANGE SYSTEMS

Filed Nov. 14, 1905 13 Sheets-Sheet 7

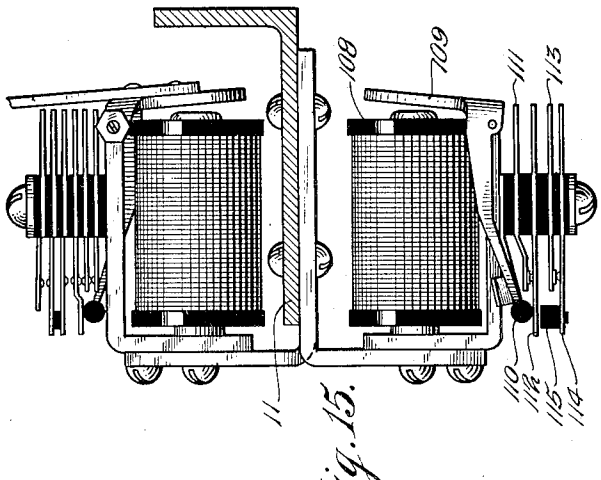

Fig. 15.

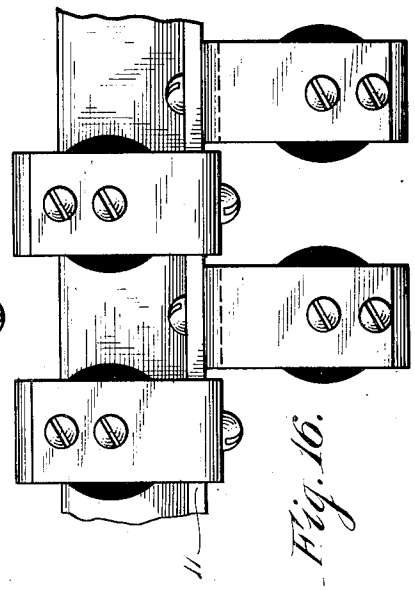

Fig. 16.

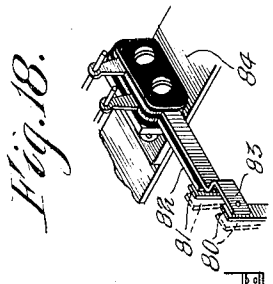

Fig. 18.

Fig. 17.

Witnesses.
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May 25, 1926. 1,586,033

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ELECTRICAL SWITCHING APPARATUS FOR AUTOMATIC TELEPHONE EXCHANGE SYSTEMS

Filed Nov. 14, 1905 13 Sheets-Sheet 8

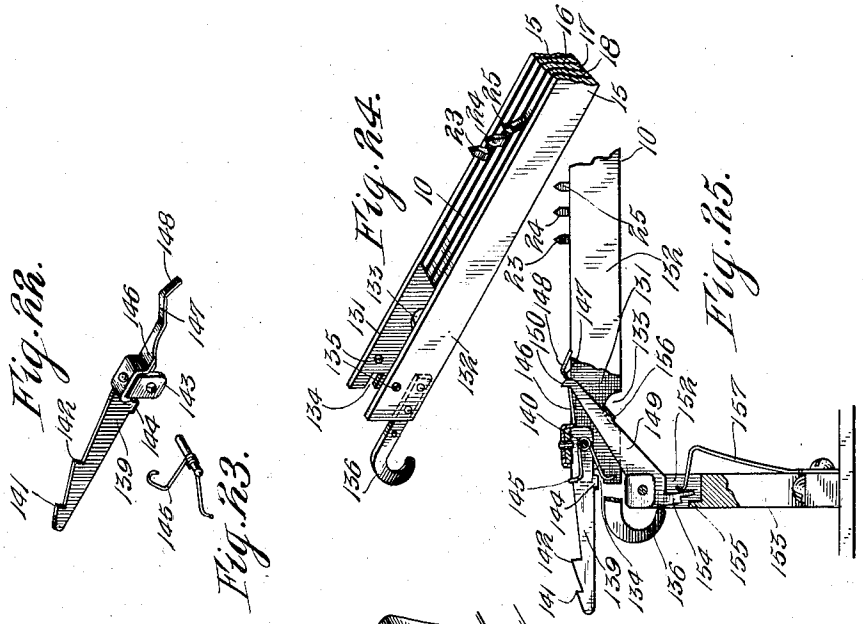

Fig. 22.

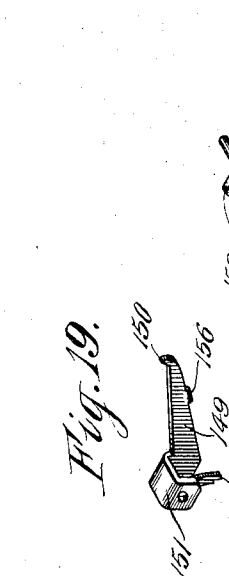

Fig. 23.

Fig. 24.

Fig. 25.

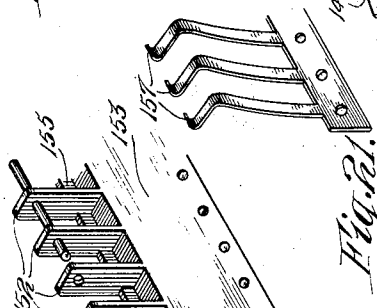

Fig. 21.

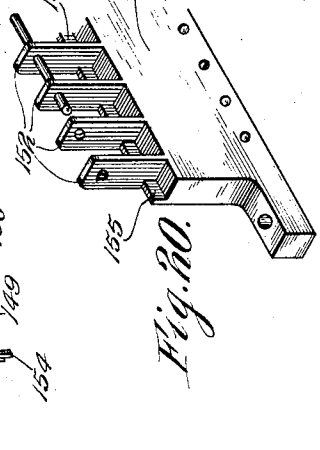

Fig. 20.

Fig. 19.

Witnesses.
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May 25, 1926. 1,586,033

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ELECTRICAL SWITCHING APPARATUS FOR AUTOMATIC TELEPHONE EXCHANGE SYSTEMS

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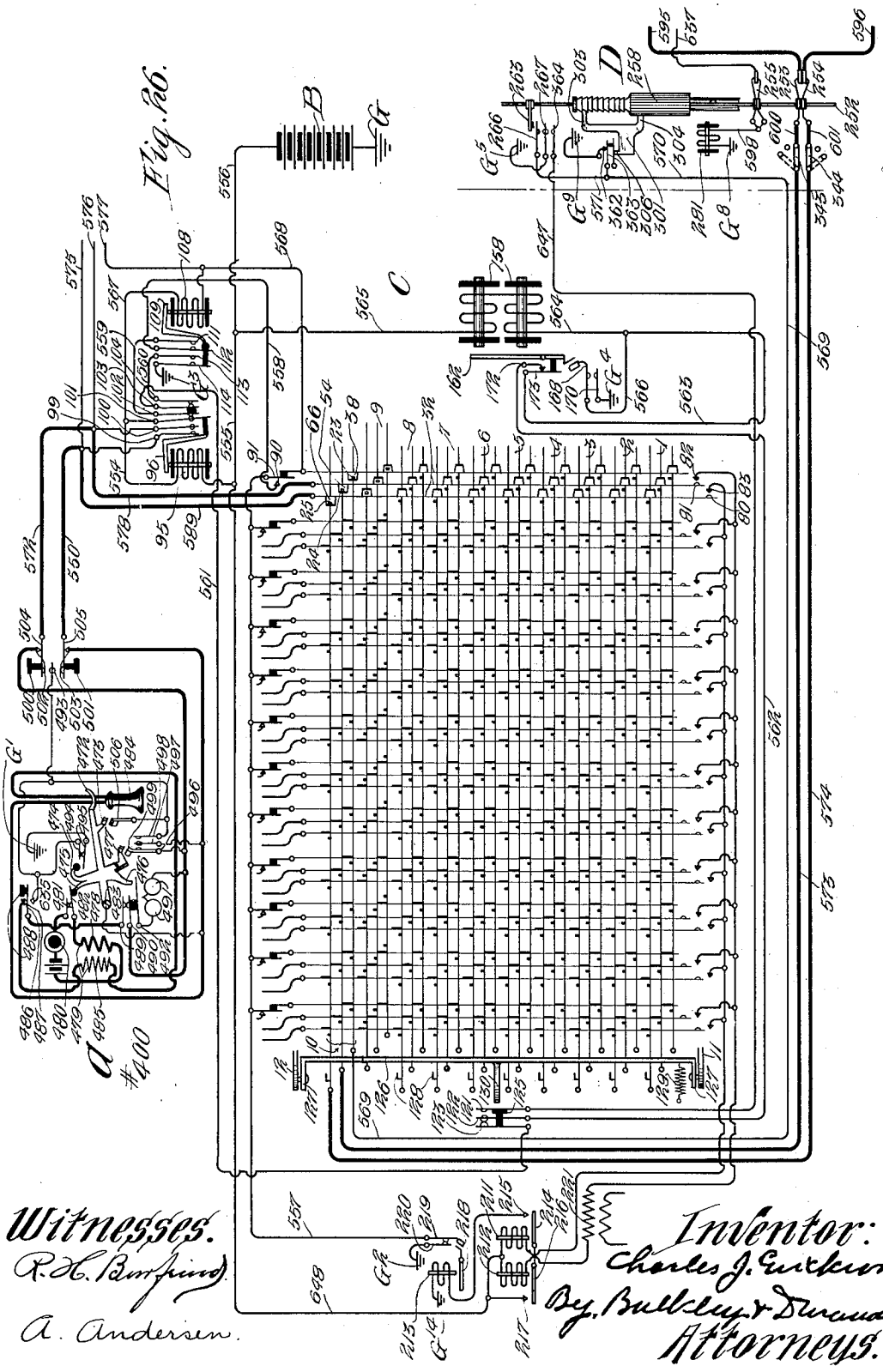

Witnesses.
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ELECTRICAL SWITCHING APPARATUS FOR AUTOMATIC TELEPHONE EXCHANGE SYSTEMS

Filed Nov. 14, 1905 13 Sheets-Sheet 10

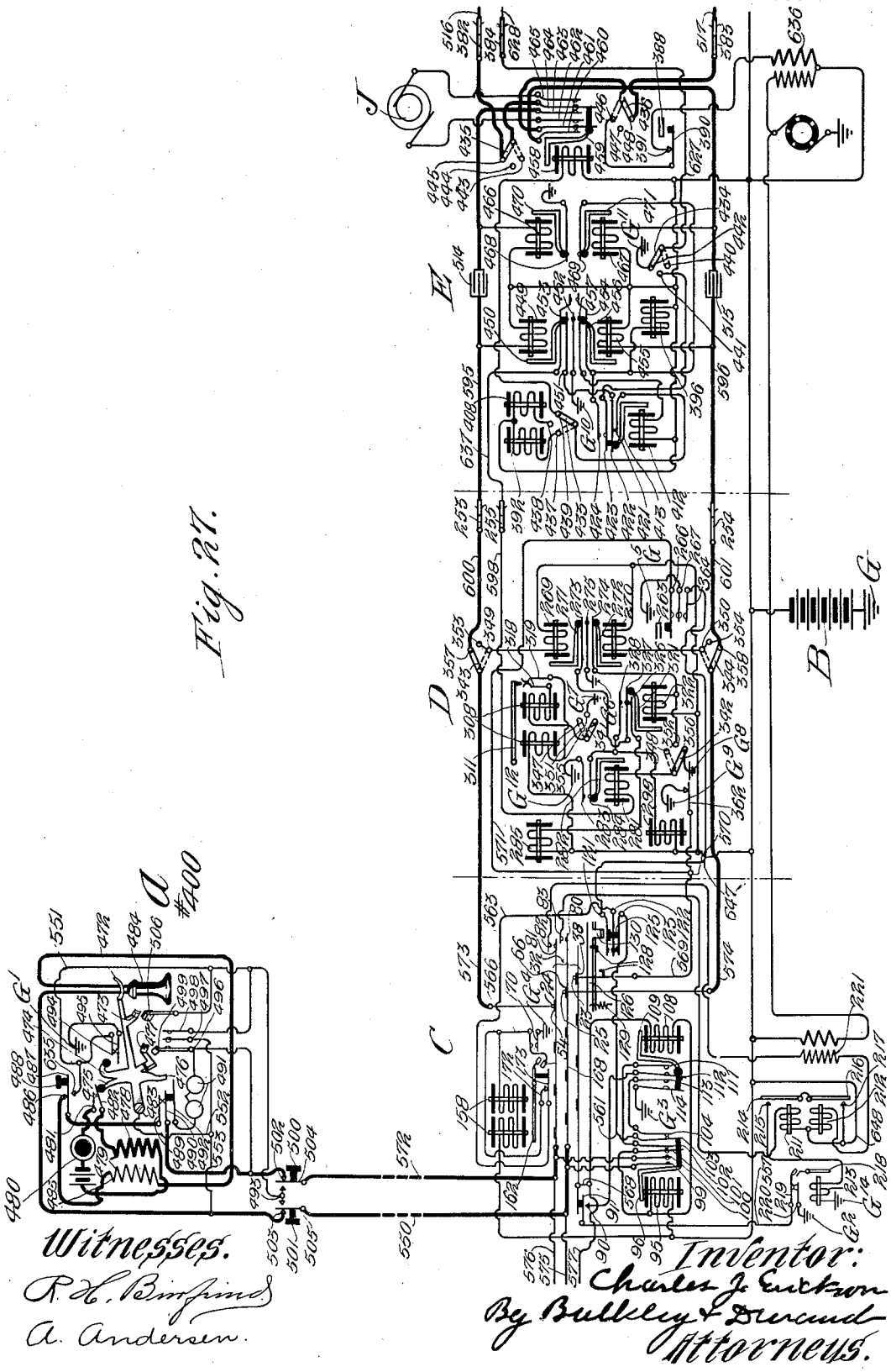

Fig. 27.

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ELECTRICAL SWITCHING APPARATUS FOR AUTOMATIC TELEPHONE EXCHANGE SYSTEMS

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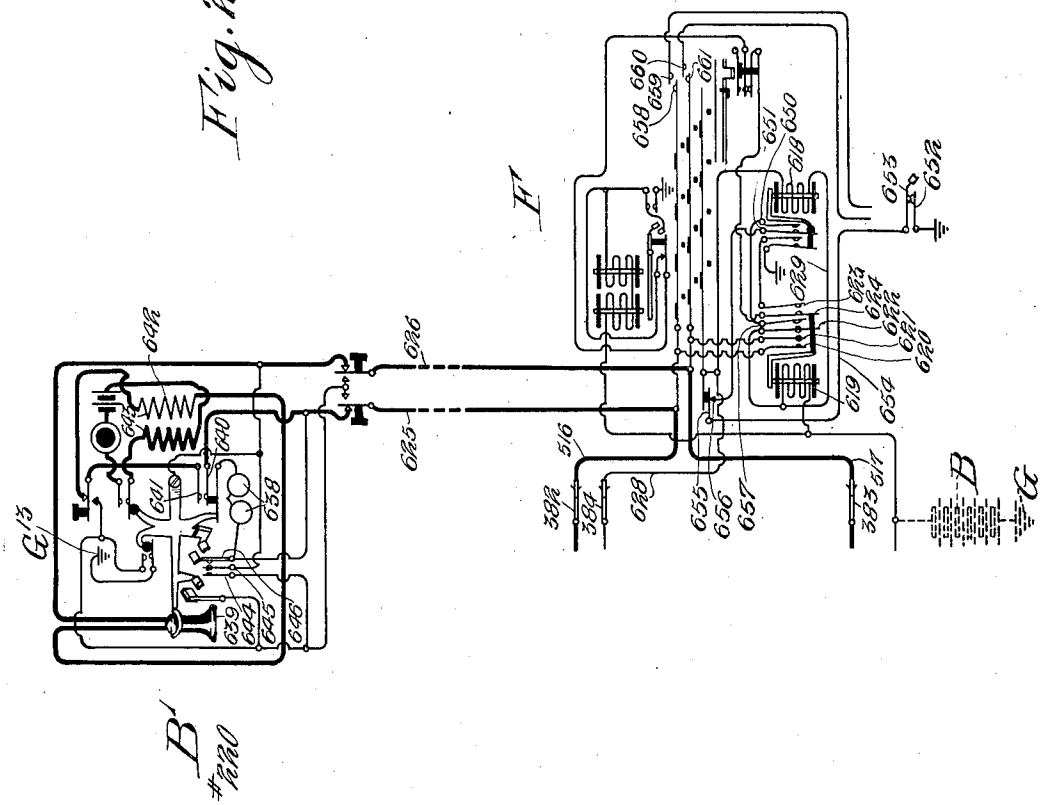
Fig. 28.



Witnesses.
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May 25, 1926. 1,586,033

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ELECTRICAL SWITCHING APPARATUS FOR AUTOMATIC TELEPHONE EXCHANGE SYSTEMS

Filed Nov. 14, 1905 13 Sheets-Sheet 12

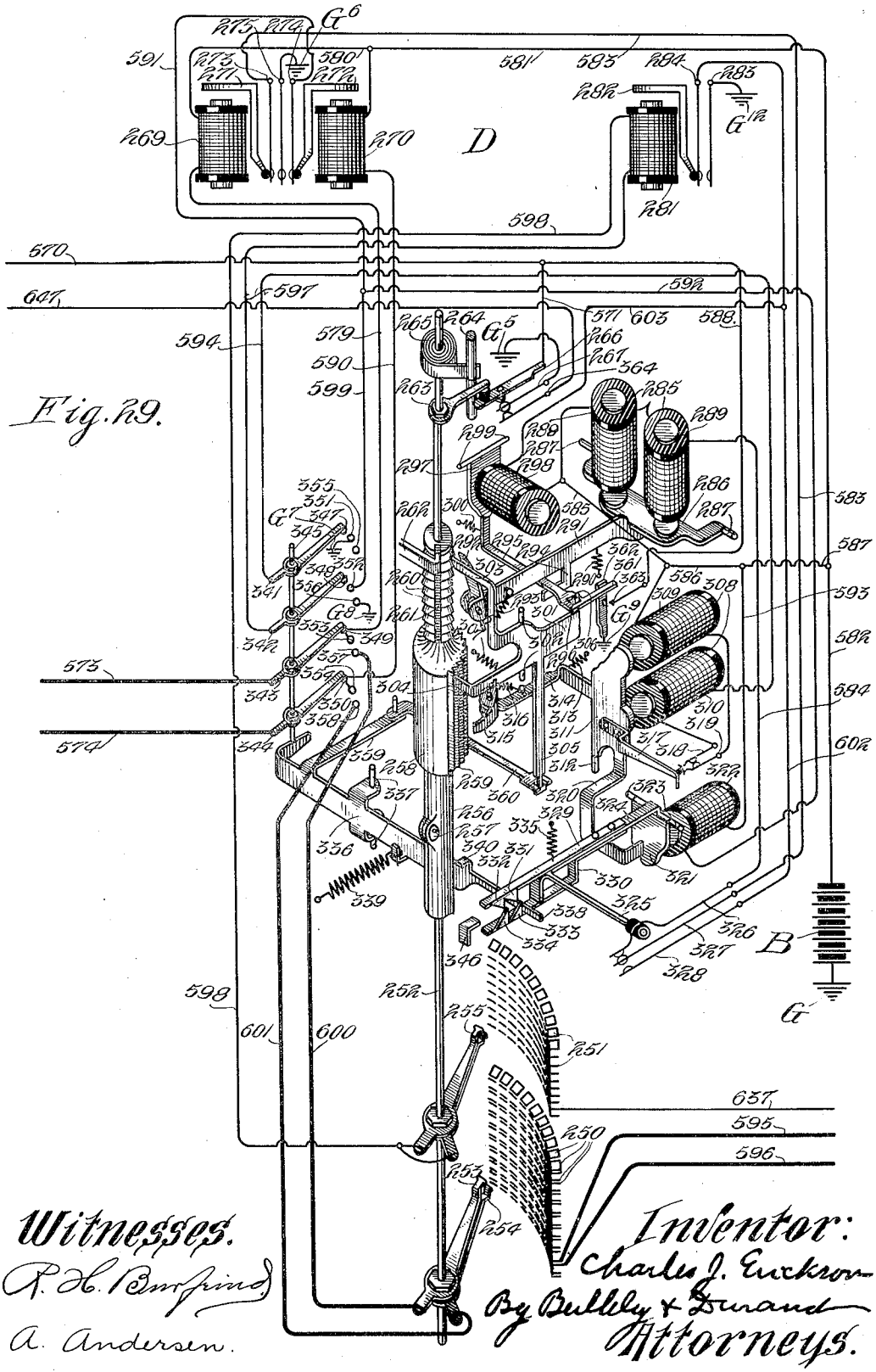

Fig. 89.

May 25, 1926. 1,586,033

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ELECTRICAL SWITCHING APPARATUS FOR AUTOMATIC TELEPHONE EXCHANGE SYSTEMS

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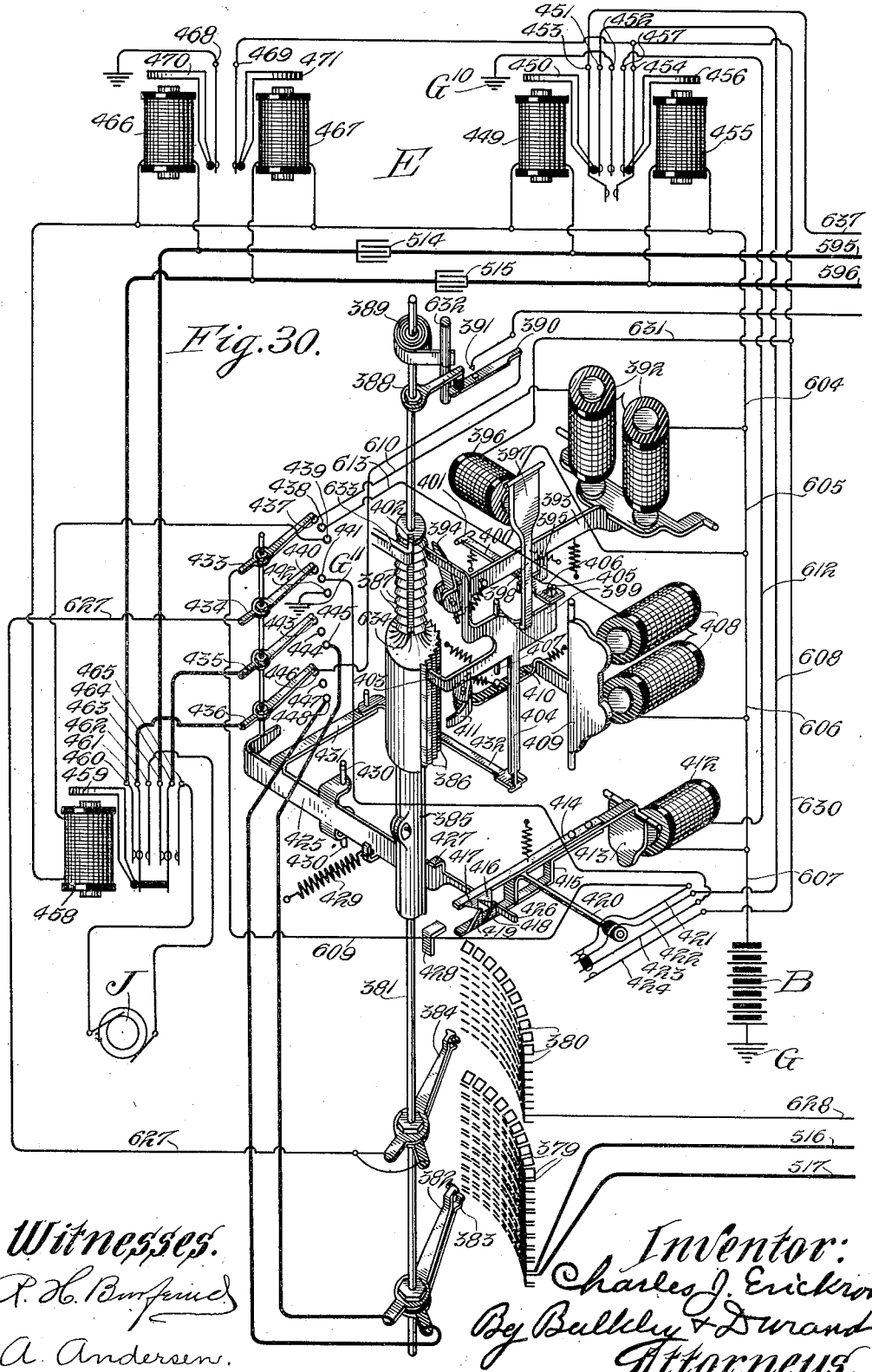
Fig. 30.



Witnesses.
R. H. Burford
A. Andersen.

Inventor:
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Attorneys.

Patented May 25, 1926. 1,586,033

UNITED STATES PATENT OFFICE.

CHARLES J. ERICKSON, OF CHICAGO, ILLINOIS, ASSIGNOR, BY MESNE ASSIGNMENTS, TO AUTOMATIC ELECTRIC INC., OF CHICAGO, ILLINOIS, A CORPORATION OF DELAWARE.

ELECTRICAL SWITCHING APPARATUS FOR AUTOMATIC TELEPHONE-EXCHANGE SYSTEMS.

Application filed November 14, 1905. Serial No. 287,336.

My invention relates to electrical switching machinery and apparatus in general, but more particularly to the switching machinery and apparatus employed in automatic or semi-automatic telephone systems, and through the medium of which the subscribers are enabled to establish connection between their lines without the assistance of switchboard operators—or at least to accomplish the operation of a certain proportion of the exchange or switchboard apparatus without the assistance of switchboard operators—and especially to automatic or semi-automatic telephone systems of that character in which the subscribers are provided with switching means for transmitting one or more electrical impulses—as by momentarily grounding either one or both sides of the line—for operating one or more electrically-propelled switching machines at the exchange or central station. In telephone exchange systems of this character, whether automatic or only semi-automatic, it is desirable to provide the exchange with a number of trunk-lines or other connections which are common to all the subscribers, or to all the members of a certain group of subscribers. For example, the exchange may be of considerable size and capacity, and may be divided into groups of one hundred subscribers each, and for each group of subscribers there may be allotted ten trunk-lines any one of which can be used by any subscriber in this group in establishing connection with any other subscriber of the same exchange, or with any subscriber of any other exchange having trunk-line connection with the exchange to which the said group of subscribers belongs. If the exchange to which this group of subscribers belongs is quite large it may be necessary for each calling subscriber to select from two or more groups of trunk-lines before obtaining connection with the called subscriber's line—that is to say, it may be necessary for the calling subscriber to first automatically select an idle trunk-line from the first group, to then automatically select an idle trunk-line from a second group of trunk-lines, and to then perhaps automatically select an idle trunk-line from a third group, thus putting in use three trunk-lines before connection is finally established directly with the line of the called subscriber. In each case, of course, any idle trunk-line in the first group will serve the purposes of the calling subscriber, and this is true of the second and third groups, and of the fourth and fifth groups, if the exchange is very large and includes a great number of subscribers. In telephone systems of this character which are very small, or which are of considerable size and operated only on a semi-automatic basis, it may then become necessary for each calling subscriber to automaticaly select only one trunk-line, or other similar connection, before the operation occurs by which the final connection is established directly with the called subscriber's line; but in any event, and regardless of whether the exchange is large or small, or automatic or semi-automatic in character, it is desirable that the central station or exchange apparatus be so constructed and arranged that any calling subscriber will necessarily and automatically select at least one idle trunk-line, or other suitable idle common connection, before connection is finally established with the line of the called subscriber; for with such arrangement, the calling subscriber actually operates either all or a part of the machinery or apparatus by which his line is connected with the line of the called subscriber, thus dispensing with either all or a certain proportion of the usual switchboard operators, and materially reducing the time in which the calling subscriber either obtains the desired connection or gets a signal indicating that the called subscriber's line is busy. In an automatic telephone system, the switching machine which picks out or selects the called subscriber's line and makes connection directly therewith is commonly known as a "connector"; and if the exchange is large enough to require it, these "connectors" are then arranged in groups and employed on a percentage basis—that is to say, they can be divided into groups of ten, and each group of "connectors" can be allotted to a group of one hundred subscribers. In such case, it is desirable to provide other switching machines which are commonly known as "selectors", and which are employed by calling subscribers in picking out idle trunk-lines. If the exchange is not very large, it will only be necessary for each

calling subscriber to use one "selector" and one "connector" in establishing connection with any called subscriber's line; but if the exchange is larger, it may then become necessary for any calling subscriber to operate a "first-selector", then a "second-selector", and finally a "connector", before establishing connection with the called subscriber's line.

The "first-selectors" can each be allotted to a subscriber's line, thus making the total number of "first-selectors" equal to the total number of subscribers in the exchange; then if "second-selectors" are necessary, these intermediate "selectors" or switching machines can be employed on a percentage basis, thus, for examp'e, making the total number of "second-selectors" only one-tenth of the total number of subscribers; and it will be understood that these "selectors" are preferably divided into groups. In any event, a "selector" is preferably a switching machine of such character that it can be controlled by the calling subscriber to the extent of causing it to pick out any particular group of switching machines, either "selectors" or "connectors," as the case may be, but which, after so doing, escapes momentarily from the control of the calling subscriber and proceeds automatically and by itself to pick out the first idle switching machine which it encounters in its operation, and which it finds in the group of switches arbitrarily selected by the calling subscriber. As distinguished from this, however, a "connector" is controlled by the calling subscriber throughout its operation of picking out and making connection with the called subscriber's line, inasmuch as the calling subscriber must not only select a certain number or group of subscriber's lines, but must then arbitrarily cause the "selector" to select and make connection with a certain member of such group of subscribers' lines. Take, for example, a system in which there are only "first-selectors" and "connectors," the exchange being of such size and capacity that second and third or other intermediate "selectors" are not necessary. In such case, the "first-selectors" may be each allotted to a single subscriber's line, and the "connectors" may be arranged in groups and employed upon a basis of ten per cent of the total number of subscribers, so that there will be only one-tenth as many "connectors" as the total number of subscribers' lines entering the exchange. With such arrangement, any calling subscriber will first operate his "first-selector" in such manner as to cause the same to arbitrarily pick out the particular group of "connectors" in which the called subscriber's line terminates; but after this, and as it is immaterial which one of these "connectors" is employed, the "selector" momentarily escapes from the control of the calling subscriber and proceeds automatically and by itself to pick out the first idle trunk-line which it encounters in its operation, and which it finds in the group of trunk-lines running to the group of "connectors" arbitrarily selected by the calling subscriber. After this, the calling subscriber then operates the selected "connector" in such manner as to cause it to select the particular group or division of subscribers' lines to which the called subscriber's line belongs, and the "connector" is capable of then resting in this position or at this point in its operation. Having thus caused the selected "connector" to pick out the desired group of subscribers' lines, the calling subscriber can then again operate the "connector" for the purpose of causing it to both select and make connection with the exact or particular subscriber's line with which connection is desired; thus, in a "connector," the selection of a group of lines and the selection of a certain member of such group are both arbitrary in character. In a "selector," however, as explained, the selection of any group of lines is always arbitrary in character, but the selection of any member of such group is not arbitrary, at least not in the sense that the calling subscriber wants connection with a certain one of such lines and will not accept any other. In other words, the calling subscriber must always select the exact or particular group of lines, whether it be a group of trunk-lines or a group of subscribers' lines, but is not called upon to arbitrarily select a certain line until after the selection has been made of the particular or desired group of subscribers' lines, and then, of course, the selection from this group of a certain subscriber's line must be arbitrary in character, as the calling subscriber wants a certain subscriber's line and no other. In systems of this character, and particularly in large exchanges, it has been found desirable to reduce the "first-selectors" to a percentage basis, thus making the total number of "first-selectors" considerably less than the total number of subscribers' lines entering the exchange. With this arrangement, both the "selectors" and "connectors" can be employed on an economical percentage basis, both the "selectors" and the "connectors" being common to the different subscribers. Under such circumstances, it is customary to provide each subscriber's line with what is commonly known as an individual-switch—that is to say, a comparatively simple and economical switching device by which a subscriber can automatically select an idle "first-selector." For example, the subscribers' lines can be arranged in groups of one hundred, each line terminating in an individual switching device, and there being only ten "first-selectors" allotted to this group of one hundred subscribers' lines; and it has been demonstrated that these one hun-

dred individual-switches and ten "first-selectors" constitute a more economical and more satisfactory arrangement than the one hundred "first-selectors" which would, with the old arrangement, ordinarily be allotted to such a group of subscribers; for each individual switching device may obviously be very simple in construction and operation, inasmuch as it is never called upon to do anything but merely automatically select one of the ten "first-selectors," thus dispensing at this time with the operation which corresponds to the first portion of the operation of an ordinary "selector," and practically reducing the whole operation of the individual-switch to a basis where it corresponds with only the second or automatic portion of the operation of a "selector." Consequently, in systems employing individual switching machinery, the calling subscriber first automatically selects an idle "first-selector," and then selects a second and even a third "selector," if the exchange is quite large, before finally and automatically selecting an idle "connector," and before causing such "connector" to arbitrarily pick out and make connection with the particular line of the called subscriber; but, as stated, this arrangement has been found to be much more economical, and to give as good and even better results, than the old arrangement in which a regular "first-selector" is provided for each subscriber's line. The current for operating the switching machinery at the exchange is preferably supplied from a storage battery or other suitable centralized source of supply located at the central station, while the current for talking purposes may be supplied from local batteries or from the said common source; and the current for ringing the bells at the subscribers' stations is preferably supplied from an alternating-current dynamo or other suitable source at the exchange or central station. As explained, the subscribers are each provided with the switching devices for operating the switching machinery at the exchange or central station. In some cases, the arrangement is such that the calling subscriber in removing his receiver from the usual switch-hook automatically grounds one side of his line, and thereby brings about the transmission of an electrical impulse which operates the individual switching device. After this, the calling subscriber operates his calling device in such manner as to transmit the required number of impulses—that is to say, the impulses which represent the number of the called subscriber, and which bring about the operation of the switching machinery that results in the establishment of connection with the called subscriber's line. When this has been done, the calling subscriber then presses a key or button, and this act results in a temporary transmission or supply of ringing-current to the called subscriber's line, sufficient to ring his bell. Many kinds of devices are, however, employed at the subscribers' stations of automatic telephone exchanges for enabling the subscribers to themselves operate either all or a portion of the exchange apparatus or switching machinery at the central station.

Generally stated, the object of my invention is the provision of improved switching machinery which can be operated electrically over subscribers' lines or other suitable line-circuits.

Special objects of my invention are the provision of an improved construction and arrangement whereby it is not necessary to provide each subscriber with a "first-selector", but whereby to the contrary it is only necessary to provide a comparatively small number—say ten—"first-selectors" for a group of subscribers—say one hundred in number; the provision of an improved construction and arrangement whereby each subscriber may be provided with a simple and comparatively inexpensive trunk-selecting switch mechanism, and whereby all of said subscribers' individual-switches may be operated by a single switch-operating machine or mechanism which is common to all of the different subscribers in the group to which such individual-switches belong, and the said switch-operating machine and its associated group of subscribers' individual-switches constituting the means whereby any subscriber in the group may obtain connection with an idle "first-selector" or with any other switching device adapted for performing a trunking operation corresponding to the first digit of any called number; the provision of an improved construction and arrangement whereby a comparatively small number of outgoing trunk-lines—say ten—can be allotted to a group of subscribers—say one hundred in number—and employed by them in calling other subscribers, and whereby each trunk-line can be provided with a plurality of multiple terminals, one for each subscriber's line in the group, and whereby connection between any subscriber's line and trunk-line may be established by positively shifting the terminal of such trunk-line into engagement with a terminal of the calling subscriber's line; the provision of an improved construction and arrangement whereby a group of trunk-lines may each be provided with a plurality of movable and rigidly-connected multiple terminals, one for each subscriber's line to which the group of trunk-lines is allotted, whereby connection between any particular trunk-line and any particular subscriber's line may be established by simultaneously shifting all of the multiple contacts or terminals of such trunk-line in a certain direction, and in such manner that only one of such trunk-line-terminals—the

one allotted to the calling subscriber—is brought into contactual relation with a subscriber's line, namely, the line of the calling subscriber; the provision of an improved construction and arrangement whereby each trunk-line allotted to a group of subscribers' individual-switches may be connected with a longitudinally-shifting bar having a plurality of multiple terminals for such trunk-line, said terminals being distributed along the length of their allotted bar, and each terminal being individual to a subscriber's line, and whereby all of said trunk-line terminal-bars may be arranged parallel with each other and connected at one end with the switch-operating machine or mechanism which is common to all of the subscribers in the group; the provision of an improved construction and arrangement whereby any subscriber in calling and obtaining connection with an idle trunk-line will, at the same time, automatically set the terminal-bar of the next idle trunk-line in position to be released for the purpose of effecting the connection between its trunk-line and the line of the subscriber making the next call; the provision of an improved construction and arrangement whereby the multiple terminals of the idle trunk-line next in order after the trunk-line last put in use are always held in readiness to be released and caused to shift in such direction as to complete a connection between their allotted trunk-line and the line of the subscriber making the next call; the provision of an improved construction and arrangement whereby all of the switch-contacts and other parts which are individual to a subscriber—that is to say, which are comprised in a subscriber's individual trunk-selecting switch mechanism—are not in any way subject to actuation or disturbance by other subscribers, with the one exception of the trunk-line-terminals which are individual to any such subscriber; the provision of an improved construction and arrangement involving movable trunk-line-terminals, and whereby each subscriber in making a call not only automatically obtains connection with the previously selected idle trunk-line, but also at the same time automatically sets all of the subscribers' individual switch mechanisms in selective relation to the next idle trunk-line; and the provision of certain details and features of improvement tending to increase the general efficiency and serviceability of electrical apparatus and devices of this particular character.

To the foregoing and other useful ends, my invention consists in matters hereinafter set forth and claimed.

In the accompanying drawings, Fig. 1 is a full-sized plan view of one end of my improved individual-switch apparatus, showing the switch-operating machine or mechanism by which the longitudinally-shifting trunk-line terminal-bars are actuated.

Fig. 2 is a plan view of the other end of the said apparatus—that is to say, the end at which the trunk-lines are attached to their respective terminal-bars.

Fig. 3 is a side elevation of the mechanism shown in Fig. 1, and showing in addition four of the subscribers' movable line-terminals.

Figs. 3^a and 3^b are detail views illustrating the switch-springs and actuating-finger therefor operated by the propelling or power magnet of the switch-operating machine.

Fig. 4 is a cross-section on line 4—4 in Fig. 1.

Fig. 5 shows the mechanism shown in the right hand half of Fig. 4, and shows the subscriber's line-relay energized.

Fig. 6 is a detail sectional view showing the normal position of the subscriber's movable line-terminals.

Fig. 7 is a view similar to Fig. 6, but shows the subscriber's movable line-terminal in connective relation to one of the multiple terminals of one of the trunk-line terminal-bars.

Fig. 8 is a longitudinal section on line 8—8 in Fig. 1.

Fig. 9 is a fragmentary perspective view of the ends of several of the trunk-line terminal-bars, and of the adjacent devices for actuating and controlling the operation of said bars.

Fig. 10 is a detail view of one of the circuit-controlling devices.

Fig. 11 is a fragmentary perspective view illustrating the circuit-controlling device shown in Fig. 10.

Fig. 12 is a detail perspective view illustrating a part of the means for bringing a subscriber's movable line-terminal into connective position.

Fig. 13 is a view similar to Fig. 12, except that it shows the manner in which a spring finger carried by the subscriber's line-terminal is caught and held by a spring finger carried by a longitudinally-shifting bar operated by the switch-operating machine.

Fig. 14 is a detail perspective view showing one of the multiple line-terminals of a subscriber's line in contact with one of the multiple terminals of a trunk-line, and showing another multiple terminal of the same subscriber's line out of engagement with one of the multiple terminals of another trunk-line.

Fig. 15 is a detail of the relays which are individual to a single subscriber's line.

Fig. 16 is a side elevation of a portion of the entire structure, showing the upper relays which are each individual to a subscriber's line, and showing two of the lower

relays which are also each individual to one of said subscribers' lines, one upper and one lower relay being allotted to each line.

Fig. 17 is a detail view illustrating the circuit controlling devices which are operated by the tops or upper ends of the subscribers' swinging line-terminal banks.

Fig. 18 is a detail perspective of one of the circuit-closing devices shown in Fig. 17.

Figs. 19 to 25, inclusive, are detail views illustrating different parts of the switch-operating machine—that is, the operating connections between the trunk-line terminal-bars and the means for actuating the same.

Fig. 26 is a simplified diagram illustrating the subscribers' individual apparatus and tracing, in dark lines, the line-circuit from a subscriber's line through the individual-switch mechanism, and over the temporarily connected trunk-line to a "first-selector".

Fig. 27 is a simplified diagrammatic view illustrating the line and auxiliary circuits formed by the calling subscriber in getting connection with a "connector", and with a terminal of the called subscriber's line.

Fig. 28 illustrates the called subscriber's line and auxiliary circuits, and also the called subscriber's individual trunk-selecting switch mechanism, it being observed that this diagram and that shown in Fig. 27 really constitute one complete diagram of the connections between a calling and called subscribers' stations.

Fig. 29 is a combined perspective and diagrammatic view of the "first-selector" shown in Figs. 26 and 27.

Fig. 30 is a similar view of the "connector" indicated in Fig. 27.

As thus illustrated, it will be seen that my improved trunk-selecting switch mechanism comprises a plurality of trunk-line terminal-bars 1, 2, 3, 4, 5, 6, 7, 8, 9 and 10. These bars are preferably arranged in parallel relation to each other, and in a horizontal position, as shown in Fig. 4. Each bar represents a trunk-line, and there are, therefore, as many trunk-line terminal-bars as there are trunk-lines allotted to the group of subscribers represented by the trunk-selecting switch mechanism as a whole. For example, there may be one hundred subscribers in each group and for each group there will then be ten trunk-lines to be used in common by the subscribers in the group in calling other subscribers. As shown, the said trunk-line terminal-bars are supported in a bed or frame composed of parallel angle-irons 11 and 12 which are connected by bars or cross-pieces 13. Preferably, each bar has its lower surface provided with a longitudinally-extending rib 14, and these ribs are adapted to slide longitudinally in notches or grooves provided in the upper surfaces of the cross-bars 13. It will be seen that the construction is such that the flat lower surfaces of the trunk-line terminal-bars are adapted to rest and slide smoothly upon the upper surfaces of the cross-bars 13. With this arrangement, the bars are held close together between the inner surfaces of the channel-irons 11 and 12, but are maintained just far enough apart to prevent undue friction. It will be understood that in accordance with the general scheme of my invention, these bars are preferably adapted for endwise shifting movement, each independently of the others, and for the purpose of effecting the automatic selection of idle trunk-lines, as well as the connection of the next idle trunk-line with the subscriber making the next call. Each of said longitudinally-shifting bars is composed of longitudinally-extending strips of conducting metal, such as brass, with interposed strips of insulation, such as rubber vulcanite. As shown, the said ribs 14 do not necessarily extend for the full length of the different bars, and are only provided for a short distance each side of the cross-bars 13, inasmuch as the said trunk-line terminal-bars are not engaged or supported in any way at points between these cross-bars 13. It will also be seen that each bar consists of two outside metal plates or side portions, together with three intermediate metal strips, all of said metal strips being insulated from each other by interposed strips of suitable insulation. In each trunk-line terminal-bar two of the intermediate metal strips are voice-current conductors, being connected with the so-called vertical and rotary line-conductors of the trunk-line allotted to the bar, while the third intermediate metal strip in each bar has various functions, as will hereinafter more fully appear. For example, in the terminal-bar 10 there are two outside metal strips 15, and three intermediate metal strips 16, 17 and 18, all of said metal strips being secured together by transverse clamping-screws 19 (see Fig. 8) and insulated from each other by longitudinal strips of insulation. At the rear end of the bar 10 these intermediate metal conducting-strips are provided with terminals or attaching portions 20, 21 and 22. The terminals 21 and 22 are attached, respectively, to the so-called vertical and rotary line-conductors of the trunk-line running to a "first-selector" or other switching apparatus, while the terminal or attaching portion 20 is attached to the third trunk-line-conductor running to the same "first-selector" or other suitable switching means. In this way, each trunk-line terminal-bar is connected with three trunk-line conductors running to a "selector", there being, therefore, as many "first-selectors" as there are trunk line terminal-bars in the subscribers' automatic trunk-selecting apparatus comprising such bars. Distributed

at regular intervals along their lengths, each terminal-bar is provided with as many multiple trunk-line-terminals as there are subscribers in the particular group to which the bars as a whole are allotted. For example, if there are one hundred subscribers in the group, the said trunk-line terminal-bars will then be of considerable length, and each bar will be provided with one hundred trunk-line-terminals which are, of course, connected in multiple and distributed at regular intervals along the length of such bar. These multiple trunk-line-terminals with which the trunk-line terminal-bars are provided consist, preferably, of small projections or switch-contacts located upon the upper edges of the intermediate or conducting metal strips of the said bars. For example, and referring more particularly to Figs. 1 and 4, it will be seen that the terminal-bar 10 has its forward end portion provided with a set of contacts 23, 24 and 25, the same being formed integral with the upper edges of the metal strips 16, 17 and 18, respectively. These contacts 23, 24 and 25 are individual to a single subscriber, and are arranged in a row extending obliquely across the bar 10, thus bringing each contact at a different point in the length of such bar. Farther along, the said bar 10 is provided with a similar set of contacts 26, 27 and 28, which are formed integral with the metal strips 16, 17 and 18, respectively, and which constitute a multiple trunk-line-terminal which is individual to another subscriber. At a point farther along, the said bar 10 is provided with a similar set of contacts 29, 30 and 31 constituting a third multiple trunk-line-terminal which is individual to a third subscriber. In this way, each bar is, as explained, provided on its upper surface with a plurality of small projections or switch-contacts, each set constituting a trunk-line-terminal which is individual to a single subscriber, and all of the different trunk-line-terminals thus distributed along the length of a terminal-bar being connected, of course, in multiple. With the construction shown and described, the multiple trunk-line-terminals of any particular trunk-line are not only electrically connected in multiple, but are also mechanically and rigidly connected together, whereby all of the multiple trunk-line-terminals of any particular trunk-line may be shifted in unison. Referring again to Fig. 1, it will be seen that all of the other trunk-line terminal-bars are provided on their upper surfaces with sets of contacts similar to those just described in connection with the bar 10, each terminal-bar being provided with a trunk-line-terminal which is individual to one of the subscribers of the group. With this arrangement, it will be seen that the practically smooth or flush upper surface composed of the upper surfaces of the different terminal-bars is provided with ten times as many trunk-line-terminals as there are subscribers in the group, these trunk-line-terminals being arranged in rows both longitudinally and transversely of the group of terminal-bars. All of the trunk-line-terminals which are allotted to a single trunk-line, but which are each individual to a different subscriber's line, are distributed along the length of a single terminal-bar. It will be seen, however, that all of the trunk-line-terminals which are individual to the same subscriber's line, but which are each individual to a different trunk-line, are arranged in a row extending transversely across the upper surface of the group of terminal-bars. In this way, there are allotted to each subscriber's line as many trunk-line-terminals as there are trunk-lines for the group, thus giving each subscriber in the group a bank of trunk-line-terminals each connected with a different trunk-line; but with my improved arrangement, the trunk-line-terminals of any given subscriber's bank are each movable independently of the others, and each connected both electrically and mechanically with all of its multiple trunk-line-terminals; and with this arrangement, the shifting of a trunk-line-terminal in any particular subscriber's bank necessarily results in a simultaneous and corresponding movement on the part of all of the multiples of such terminal which are distributed through the banks of the other subscribers. It will be seen, therefore, that each of the transverse rows of trunk-line-terminals, extending across the group of terminal-bars, is individual to a single subscriber, each of said rows constituting a bank of trunk-line-terminals each connected with a different trunk-line. Furthermore, with this arrangement, each subscriber's line is provided with a bank of swinging and endwise-movable multiple line-terminals, each subscriber's bank of line-terminals associated with the corresponding bank of trunk-line-terminals. In other words, in the trunk-selecting mechanism which is individual to a single subscriber there are included a bank of trunk-line-terminals each of which is connected with a different trunk-line, and a bank of subscriber's line-terminals each of which is connected with the subscriber's line, the two banks being arranged opposite each other and adapted to cooperate with each other in establishing connection between the subscriber's line and any one of the different trunk-lines. Consequently, the bank of subscriber's line-terminals of any individual switch is composed of terminals which are all multiples of the same subscriber's line, while the bank of trunk-line-terminals of the same individual-switch is composed of terminals which are all multiples of dif-

ferent trunk-lines. In other words, each subscriber's line is provided with as many line-terminals as there are trunk-lines, each subscriber's line-terminal being arranged to cooperate exclusively with a certain trunk-line-terminal. For example, and referring more particularly to Figs. 2, 3 and 4, it will be seen that the subscriber to whom is allotted the bank of trunk-line-terminals including the contacts 23, 24 and 25 is provided with a bank 32 of swinging and endwise-movable line-contacts arranged directly over the said transverse bank of trunk-line-terminals. This bank 32 is provided at one end with a pin 33 adapted to extend through an opening in the upright spring post 34, which latter is secured to the outside of the angle-iron 11. At its other end, the said bank 32 is provided with a similar pin or trunnion 35 adapted to extend through an opening in the rigid or non-swinging upright 36, which latter is secured to the outside of the angle-iron 12. The said bank 32 is, it will be seen, composed of a front plate 37 held in electrical contact with a thin metal plate provided with downwardly-extending spring fingers or contacts 38, 39, 40, 41, 42, 43, 44, 45, 46 and 47. The said front plate 37 is provided with a downwardly-extending arm 48 provided at its lower end with a notch 49.

A relatively thick bar or metal strip 50 is separated and insulated from the strip having the teeth 38, 39, etc., by a strip of insulation 51. Another plate 52, similar to the plate 37, is insulated from the strip 50 by insulation 53. A thin sheet-metal strip is maintained in electrical contact with the plate 52, and is provided with spring fingers or contacts 54, 55, 56, 57, 58, 59, 60, 61, 62 and 63. It will be observed that these spring fingers or downwardly-extending electrical contacts are, as a whole, shifted slightly to one side, so that they are out of line with the spring fingers 38 to 47, inclusive. A metal plate 64 is separated and insulated from the strip having the fingers 54 to 63, inclusive, by a strip of insulation 65. A third strip of sheet-metal having a third set of spring fingers 66 to 75, inclusive, is held in electrical contact with the plate 64. The back clamping-strip 76 is insulated from the spring fingers 66 to 75, inclusive, by a strip of insulation 77. The superimposed strips of metal and insulation thus provided are bound together by clamping-screws 78, each of which is preferably provided with a sleeve of insulation 79. In this way, the three conducting-plates of the subscriber's bank of line-contacts or multiple terminals are rigidly connected but thoroughly insulated from each other. The intermediate bar or metal strip 50 has its ends provided with the said pins or trunnions 33 and 35 previously referred to. Preferably, the plates 37 and 52 are provided, respectively, with circuit-controlling contacts 80 and 81 adapted to cooperate with the stationary contacts 82 and 83, which latter are insulated from each other and suitably mounted upon a bar or mounting-strip 84 extending longitudinally of the switching machine and just above all of the different subscribers' line-terminal banks (see Figs. 17 and 18). This longitudinally-extending bar or mounting 84 can be supported by transverse bridging bars 85 arranged at suitable intervals along the length of the machine, and in such manner as to extend across the longitudinally-reciprocating trunk-line terminal-bars. It will also be seen that the three sets of spring fingers or contacts, namely, 38 to 47, inclusive, and 54 to 63, inclusive, and 66 to 75, inclusive, are provided, respectively, with terminals 86, 87 and 88 to which are secured wires or other flexible conductors. The fingers or contacts of the first set are private-contacts, so to speak, and are never included in any talking-circuit, but are simply used for establishing a guarding potential, etc., as will hereinafter more fully appear. The second and third sets of spring fingers or contacts, namely, 54 to 63, inclusive, and 66 to 75, inclusive, are talking-contacts—that is to say, switch-contacts adapted to be included in talking-circuits for conducting the voice-currents from one subscriber's station to another. The second or intermediate set of spring fingers or contacts (54 to 63, inclusive) consists of ten spring fingers connected in multiple, and all connected with the so-called vertical-line-conductor of the subscriber's line to whom the bank is allotted. The outside or third set of spring fingers (66 to 75, inclusive) consists of ten spring fingers or contacts which are connected in multiple, and which are all connected with the so-called rotary line-conductor of the said subscriber's line. Thus each subscriber's endwise-shiftable and oscillating bank of line-contacts (the bank of multiple contacts which is connected with and individual to the subscriber's line) is composed of ten sets of contacts, each set constituting a multiple line-terminal. For example, the subscriber's line-bank 32 has ten sets of contacts, and these ten sets are connected together in such manner as to provide ten multiple line-terminals, each set or terminal including its allotted private-contact or terminal—that is to say, each terminal or set of contacts comprises two line-contacts which are used for transmitting the voice-currents, and a third contact which is employed as a private-contact in establishing a guarding potential for energizing certain relays, etc. Each subscriber's bank of multiple line-terminals comprises, therefore, ten so-called vertical-line-contacts arranged in a row and connected in multiple; a similar row of so-called rotary-line-contacts, con-

nected in multiple; and a third parallel row of so-called private-contacts. It will be seen that these three parallel rows of contacts, whereof the members of each row are multiples of each other, are maintained in proper condition by the lower edges of the plates 37, 52 and 64, which latter are perfectly straight and arranged to bear upon the spring fingers or contacts of the three rows. In other words, these plates 37, 52 and 64 have their lower edges adapted to hold the spring fingers of each row in alignment with each other. Each subscriber's multiple line-terminal—composed of three spring fingers—is adapted to cooperate with the three corresponding contacts of the trunk-line terminal-bar that corresponds to the said multiple line terminal, and which contacts constitute one of the multiple terminals of the trunk-line. For example, the three spring fingers 38, 54 and 66 constitute a multiple line-terminal of the line to which the line-bank 32 is allotted, and are adapted to co-operate with the contacts 23, 24 and 25, which latter are carried by the longitudinally-reciprocating terminal-bar 10. When the subscriber's line-bank 32 is out of use, all of its multiple terminals are out of engagement with all of the trunk-line-terminals in the transverse row of the latter allotted to the subscriber to whose line the said bank is individual. It will be understood, of course, that the spring fingers 39, 55 and 67 constitute a second multiple line-terminal, and are adapted to cooperate with three contacts on the bar 9; and each of the other eight multiple line-terminals with which the bank 32 is provided is adapted to cooperate with its allotted trunk-line-terminal on one of the other terminal-bars. Thus, for each subscriber there is a bank of ten multiple line-terminals and a bank of ten trunk-line-terminals, each subscriber's multiple line-terminal being adapted to cooperate with a different trunk-line-terminal, whereby the subscriber's line may be connected with one of the ten different trunk-lines. With my improved construction there is always one trunk-line terminal-bar which is slightly shifted in the direction of its forward end, and which is ready to be released as soon as any subscriber makes a call; and it is always the first idle bar next in order after the bar last put in use which is thus always held in readiness to be released by the next calling subscriber. In Fig. 1, the bar 1 is shown held shifted longitudinally in the direction of its forward end, so that the next calling subscriber will necessarily obtain automatic connection with the trunk-line connected with the rear end of this bar 1. In Fig. 26, however, as will hereinafter more fully appear, it is assumed that the subscriber to whom the bank 32 is allotted made a call, and that at such time the bar 10 was temporarily retained in a shifted position, so that the trunk-line running from this bar was immediately placed in connection with the calling subscriber's line—that is to say, so that the contacts 23, 24 and 25 were immediately placed in electrical engagement with the spring fingers 38, 54 and 66, respectively. In releasing the bar 10 and getting connection with its allotted trunk-line, the calling subscriber also shifted the bar 9 and thereby set its allotted trunk-line in selective relation to all of the subscribers' lines terminating at ths group of subscribers' individual trunk-selecting switches, as indicated in Fig. 26. The subscriber's line-bank 32 is provided with a piece of insulation 89 adapted for operating the normally-closed switch-springs 90 and 91, it being observed that when the bank is moved into the position shown in Fig. 7, the insulation 89 then moves the spring 91 out of electrical engagement with the spring 90. In Fig. 6 the mechanism is in the condition shown in Fig. 4; but in Fig. 7 it is assumed that the bar 1 has been released, and that its trunk-line terminal-contacts 92, 93 and 94 have become engaged, respectively, with the subscriber's line-bank terminal-contacts 75, 63 and 47. As will hereinafter more fully appear, a connection of this kind cannot take place until after the line-bank 32 has been shifted to the left, as shown in Fig. 5, by the energizing of the calling subscriber's line-relay 95. Normally, it will be seen that the spring 34 holds the line-bank 32 in such position that its multiple line-terminals are not in line with their respective trunk-line-terminals, and in such position that the releasing of any trunk-line terminal-bar cannot bring about a connection between a trunk-line and the subscriber's line leading from the bank 32. However, when the line-relay 95 is energized (this relay being individual to the subscriber's line, and to the line-bank 32), it attracts its armature 96, and causes its armature-finger 97 to engage the pin or trunnion 35. This, of course, brings about an endwise shift on the part of the subscriber's line-bank 32, which results in placing all of the multiple line-terminals of which this bank is composed in such relation to the trunk-line-terminals allotted to the calling subscriber that the release of the previously selected or waiting terminal-bar results in establishing a connection between the calling subscriber's line and the said previously selected trunk-line. This connection is retained as long as the calling subscriber desires, as will hereinafter more fully appear. The subscriber's line-relay 95 has its armature provided with a circuit-controlling finger 98 adapted for operating the circuit opening and closing switch-springs 99, 100, 101, 102, 103 and 104.

It will be observed that the springs 99, 100 and 101 are normally closed together and in electrical engagement with each other; that the switch-springs 102 and 103 are separated by insulation 105, and thus adapted to move in unison; and that the springs 101 and 102 are normally out of engagement with each other, while the springs 103 and 104 are also normally out of contact with each other. These springs are all suitably mounted and insulated from each other and secured to the relay-frame or body 106 by means of a screw 107, each spring being provided with a terminal or other suitable means by which it can be soldered or otherwise electrically connected with a circuit-wire. The springs 82 and 83 may, as well as the springs 90 and 91, be provided with suitable terminals or portions with which they can be attached to their respective attaching-wires. It will be seen that the subscriber's line-relay 95 is arranged opposite his line-bank 32, and is suitably mounted upon the angle-iron 12 or side portion of the frame or bed in which the terminal-bars slide, and upon which the different devices are mounted which are individual to the different subscribers. Each subscriber is also provided with an auxiliary relay 108 (see Fig. 15). These auxiliary relays are arranged in rows at opposite sides of the switching machinery, and are secured to the under surfaces of the angle-irons 11 and 12. Preferably, these auxiliary relays 108 are arranged opposite the spaces between the subscriber's line-relays. In this way, there is a row of subscribers' line-relays at each side of the switching machinery, and below such row of line-relays a row of auxiliary relays. Each auxiliary relay is provided with an armature 109 having a finger 110 adapted to control the switch-springs 111, 112, 113 and 114. It will be seen that the springs 111 and 112 are normally in engagement with each other, and that this is true of the springs 113 and 114; and it will also be seen that the finger 110 is adapted to operate the springs 112 and 114, these two springs being rigidly separated by a piece of insulation 115. It will be understood, of course, that the armatures of these line and auxiliary relays are pivotally mounted, and that the switch-springs which they control are adapted to serve also as retracting springs—that is to say, springs for retracting and holding said armatures in their normal positions. With this arrangement, each subscriber is provided with an individual trunk-selecting switch mechanism comprising a subscriber's line-bank, such as the bank 32; a subscriber's trunk-line terminal-bank composed of, say, ten trunk-line-terminals each connected with a different trunk-line; two switches operated by the endwise and tilting movements of the said line-bank, such, for example, as the switch composed of the normally separated contacts 80, 81, 82 and 83, and the switch composed of the normally closed contacts 90 and 91; a line-relay for producing the endwise shift on the part of said subscriber's line-bank, and for at the same time operating the line-relay-springs; and an auxiliary relay, the purpose of which will hereinafter more fully appear. It will also be seen at this juncture that there are certain other devices which are individual to the different subscribers' lines, as follows: Extending along the longitudinal center of the group of trunk-line terminal-bars, there is a longitudinally-reciprocating tripper-bar 116 having its upper edge provided at regular intervals with projections 117, it being observed that each projection is arranged in one of the transverse rows of trunk-line-terminals. In this way, the bar 116 is common to all of the subscribers in the group, while each of its projections 117 is individual to a single subscriber's line. Each projection 117 is so disposed that it is adapted to either pass at one side of the arm extending downwardly from its allotted subscriber's line-bank (such, for example, as the arm 48), or to engage the end of such arm and thereby swing the subscriber's line-bank about its axis—that is, the axis provided by the pins or trunnions mounted on the ends of the banks and supported in the upright bearings. For example, should one of the subscribers calling in thereby shift his line-bank in an endwise direction, it is evident that such movement will bring the arm 48 on his line-bank into the path of the projection 117 which is individual to his line, so that the endwise shiftable bar 116 will then cause the said projection 117 to engage the arm 48 and thereby tilt or swing the line-bank to the position, for example, shown in Fig. 7. Associated with the said tripper-bar 116 there is a stationary and longitudinally-extending angle-iron 118, in which is mounted a series of spring stops 119, said stops being insulated from the said angle-iron. Referring to Figs. 12 and 13, it will be seen that these spring stops are in the nature of spring fingers which are adapted to extend toward the forward end of the machine—that is, toward the forward end of the trunk-line terminal-bars—and which are slightly upturned at their forward ends. With this arrangement, the notches 49 in the lower ends of the line-bank-arms 48 are normally opposite or in line with the spring stops 119, as shown in Fig. 12. It will be observed that there is one of these spring stops 119 for each subscriber's line-bank, and, therefore, one for each subscriber's line. In this way, the endwise shifting of a subscriber's line-bank into operative relation to the trunk-line terminal-bars brings its arm 48 into such a position that it is en-

gaged at one side of the notch 49 by the projection 117 on the tripper-bar 116, and at the other side of such notch by the upper surface of the upturned portion of the subscriber's allotted spring stop 119. As soon as the bar 116 begins to move, however, it is evident that the projection 117 causes the arm 48 to move forward, thus pressing the spring stop 119 downward to permit the line-bank to assume the desired tilted or inclined position. As soon as the movement ceases, the spring stop 119 then springs up into the position shown in Fig. 13, and thus opposes its upturned end portion to the lower end of the arm 48, so as to temporarily retain the subscriber's line-bank in its said tilted or inclined position. Each spring stop 119 is, therefore, in the nature of a spring catch, and serves as a spring device which permits the movable part, namely, the arm 48 on its allotted subscriber's line-bank, to pass in one direction and not in the other. At this juncture, it will be seen that as soon as the subscriber's line-relay is de-energized, thus permitting his line-bank to shift endwise to its normal position, the notch 49 in the end of the arm 48 is then again brought opposite the upturned end portion of the stop 119, and in this way the line-bank is permitted to swing back to its normal position. When a line-bank is thus restored, it will be seen that it is the upright spring supporting member 34 which restores the line-bank in an endwise direction, while it is the switch-spring 91 which then moves the bank about its axis until it is restored rotatably to its normal position. While in use, a subscriber's line-bank is temporarily retained in the position necessary for maintaining connection between the subscriber's line and the selected trunk-line, by the cooperation of the line-relay-finger 97 and the spring stop 119, as illustrated in Figs. 5, 7 and 13. It may be stated at this juncture that both the subscriber's line-relay 95 and his auxiliary relay 108 are necessarily retained in magnetized or energized condition during the temporary connection of his line with that of any other subscriber, as will hereinafter be more clearly described in connection with the circuits and the operation of calling and obtaining connection with a subscriber's line. Referring to Figs. 1, 2 and 4, it will be seen that the subscribers' endwise shiftable and swinging line-banks are arranged transversely of the parallel trunk-line terminal-bars and at regular intervals in the length of the same. Preferably, the arrangement of such that the first subscriber's line-relay is at one side of the machine, so that his line-bank necessarily shifts toward the opposite side of the machine; then the second subscriber's line-relay is arranged at the opposite side of the machine, and his individual line-bank then, of course, arranged for endwise movement in a direction opposite to that of the first subscriber; and then the third subscriber's line-relay and movable line-bank are mounted and arranged in the same manner as those of the first subscriber, while the fourth subscriber's individual parts are mounted and arranged for operation similar to those of the second subscriber's line. In this way, the alternate subscribers' line-relays are all at one side of the machine, while the intermediate subscribers' line-relays are all at the other side of the machine, the said auxiliary relays 108 being, of course, arranged accordingly. With this construction, the subscribers' line-relays can be arranged quite close together, as shown more clearly in Fig. 2, and the subscribers' endwise shiftable and swinging line-banks can be arranged as close together as is convenient and consistent with good practice. At its rear end (the end where the trunk-lines are attached to the terminal-bars), the machine is provided with a small set of switch-springs 121, 122 and 123, the springs being insulated from each other and suitably secured to the angle-iron 118 by a bracket 124, as shown in Fig. 11. It will be seen that the spring-contacts 122 and 123 are normally in electrical contact with each other, as shown in Fig. 10, and that the spring-contacts 121 and 122 are normally out of electrical engagement with each other. The springs 121 and 123 are rigidly separated by a piece of insulation 125 whereby these two springs must necessarily move in unison.

A transverse and laterally-movable bar 126 has its end portions 127 pivotally mounted upon the angle-irons 11 and 12 of the frame or bed of the machine. As illustrated, this swinging bar or member 126 is disposed at a point just below the rear ends of the trunk-line terminal-bars. Each trunk-line terminal-bar has its rear end portion provided with a downwardly-extending projection 128 (see Fig. 11) adapted to engage the bar 126 and thereby move the latter away from the said switch-springs 121, 122 and 123. If there are any idle trunk-lines in the group, it necessarily follows that one of the trunk-line terminal-bars is at such time shifted toward the forward end of the machine, and in this event the projection 128 of such trunk-line terminal-bar retains the bar 126 in the position shown in full lines in Figs. 10 and 11. At this juncture, it will be seen that the bar 126 is connected by a spring 129 with the bracket 124, this spring being so tensioned as to tend constantly to force the bar forward against the switch-springs 121, 122 and 123. When released and allowed to act under the influence of said spring, the said bar 126 causes its projection 130 to engage the spring 121, as shown in dotted lines in Fig. 10. When this is done, the springs 122 and 123 are

separated, and the springs 121 and 122 are brought into electrical contact or engagement with each other. As will hereinafter more fully appear, however, this only happens when all of the trunk-lines are busy, or at just the instant that a waiting trunk-line terminal-bar is released and before the next idle terminal-bar springs into waiting position. The purpose and operation of this switching device will be better understood in connection with the description of the circuits and the general operation of the switching machinery.

For the broader purposes of my invention, the switch-operating machine or switch-operating mechanism which is common to all of the different trunk-line terminal-bars, and which is employed for operating the same, may be of any suitable or desired construction. In a general way, the only requisite of such a switch-operating machine or mechanism is that it be always at the service of a calling subscriber, so that he may use it for automatically releasing the previously selected or waiting trunk-line terminal-bar, and at the same time cause it to draw the terminal-bar of the next idle trunk-line into selected or waiting position, thus placing the said next idle trunk-line in selected relation to all of the different subscriber's individual-switches. Furthermore, it is this switch-operating mechanism which is relied upon for operating the tripper-bar 116, and for thus drawing the calling subscriber's line-bank into position to be operatively engaged by the contacts on the waiting terminal-bar as soon as the latter is released. In other words, a subscriber calls in and energizes his line-relay, thereby shifting his line-bank with all of its multiple line-terminals in a direction transversely of the machine. At the same time, the said switch-operating machine or mechanism is automatically actuated for the purpose of liberating or releasing the waiting terminal-bar (the bar which is ready and waiting and which was sprung into selective or waiting position by the subscriber who made the last call), so as to bring its trunk-line-terminal which is individual to the calling subscriber into engagement with one of the multiple terminals of the subscriber's line-bank; and practically simultaneously with this operation, the said tripper-bar is drawn forward for the purpose of tilting the subscriber's line-bank about its axis, as previously described; and then following close upon this part of the operation, the switch-operating machine automatically selects and draws another terminal-bar forward and into waiting position, the terminal-bar thus automatically selected being the one connected with the next idle trunk-line. Thus a momentary energizing of the calling subscriber's line-relay, by means hereinafter described, is sufficient to actuate his movable line-bank, automatically establish connection between his line and the trunk-line of the released or liberated terminal-bar, and thus automatically secure connection with a "first-selector", or with any other switching devices; and in thus automatically obtaining connection with an idle trunk-line, the calling subscriber automatically shifts the terminal-bar of the next idle trunk-line into waiting position, and thus sets the said next idle trunk-line in selective relation to all of the different subscriber's individual-switches; and, consequently, the subscriber who makes the next call will automatically establish connection between his line and the trunk-line thus automatically selected for him by the subscriber immediately preceding him. Consequently, as previously stated, and whether the switching machinery is at rest or in use, there is always one trunk-line terminal-bar held in readiness to be released or liberated as soon as the next call comes in, and with the arrangement shown, the bar which is always thus set in waiting or selective position is always the first idle bar next in order after the bar last put in use. Of course, if the said terminal-bars are all in use, so that all of the trunk-lines are busy, then there will be no waiting bar, inasmuch as there is no idle trunk-line. Ordinarily, however, as explained, the percentage of trunk-lines is large enough to practically insure against their all being put in use at the same time, and the said switch-operating machine or mechanism is of such character that upon letting go of one trunk-line terminal-bar, in response to a call, it immediately automatically selects and draws another terminal-bar into waiting or selective position, thus always keeping the terminal-bar of the next idle trunk-line ready and in waiting for the next calling subscriber. With a view to obtaining the desired results in a simple and efficient manner, the said switch-operating machine or mechanism may be constructed and operated as follows: Referring to Fig. 24, it will be seen that each trunk-line terminal-bar is provided at its forward ends with parallel end portions 131 and 132, these parallel end portions being merely end extensions of the side-bars or strips 15 with which the terminal-bar 10, for example, is provided, as previously explained. The end portion 131 has its lower edge provided with a notch 133, and its rear edge provided with a notch 134. The two end portions are provided with coincident or registering openings 135, and the end portion 132 is provided with a hook 136. Referring to Fig. 9, it will be seen that each terminal-bar is actuated, when released, by a couple of springs 137 having their lower ends attached to the

frame-bar 138. The upper ends of these actuating-springs are adapted to project upwardly between the side portions 131 and 132 of their respective trunk-line terminal-bars, and are adapted to there have suitable connection with the said terminal-bars. In this way, each terminal-bar is impelled by spring power as soon as it is released by the switch-operating machine in response to a call; but, as will hereinafter more fully appear, it is the pull of other spring means which serves to pull or shift each terminal-bar in the opposite direction. Each trunk-line terminal-bar is provided with a forwardly-extending double hook 139, such as the one shown in Fig. 22, these hooks being mounted on pivots 140 inserted through the openings 135. Each double hook has a forwardly-projecting portion provided with the two hooks or engaging portions 141 and 142, the rear end of each double hook being provided with the downwardly-bent portion 143 having some space between its inner surface and the inner surface of the other side of the double hook. In this way, the pivoted portion of each double hook fits snugly between the inner surfaces of the side portions 131 and 132, as shown more clearly in Fig. 9. It will also be seen that each double hook is provided with a projection 144 adapted to engage in the notch 134, thereby providing a stop device for limiting the up and down movements of each double hook. Each double hook is provided with a spring 145, such as the spring shown in Fig. 23, these springs tending to keep each double hook in its lowered position. As shown, each spring 145 has its middle portion coiled around the pivot of its allotted double hook, and has its end portions secured respectively to the double hook and the adjacent portion of the side portion 131 of the terminal-bar upon which the double hook is mounted. In addition, each double hook is provided with a rearwardly-extending spring arm 146, the end of each spring arm being bent slightly upward and then down, as shown more clearly in Fig. 22, thus providing the end of each spring arm with upwardly and oppositely inclined surfaces 147 and 148. Associated with each spring arm 146, there is a pivoted stop 149, each pivoted stop being preferably of the character shown in Fig. 19. When a terminal-bar is in its normal or idle position, its alloted stop 149 is adapted to have its extreme end portion 150 assume the position shown in Fig. 25, it being observed that such end portion 150 is, at such time, at one side of and projecting slightly above the inclined surface 147 of the associated spring arm 146. Each pivoted stop 149 has its mounted portion 151 adapted to fit a notch or recess 152 in the cross-bar 153, and is provided with a short downwardly-extending arm 154 adapted, when the conditions are as shown in Fig. 25, to be just out of engagement with the stationary stop 155. At such time, it will also be observed that the end of the hook portion 136 engages the arm 154, thus keeping the upper end portion 150 of the pivoted stop in proper relation to the associated spring arm 146. The upward movement of the pivoted stop 149 is limited by providing it with a projection 156 adapted to engage the inner or lower edge of the notch 133. Thus, when the terminal-bar 10, for example, is restored to its normal or idle position, its hook 136 strikes the lower portion of the pivoted stop 149, thus throwing the end portion 150 of the stop into its elevated or operative position.

When the bar 10 is pulled forward by the switch-operating machine or mechanism, the spring 157, which is arranged to act on the arm 154, then moves the stop 149 about its pivot or axis, and thus brings the end portion 150 of said stop into its lower or inoperative position. The stops 149 are each provided with a spring 157, these springs being formed of one integral piece of springy sheet-metal, such as shown in Fig. 21. The actuating magnets 158 of the switch-operating machine or mechanism can be of any size or construction, and there may be as many of these electro-magnets as are necessary for any particular case—that is to say, the power required of these magnets will depend, of course, upon the number of subscribers in the group and the consequent length of the trunk-line terminal-bars. These operating magnets are preferably mounted upon a transverse bracket-plate 159 which is adjustably secured to the side plates 160 by means of screws 161 (see Fig. 3). The armature 162, with which the magnets 158 are provided, is mounted to swing about a horizontal axis provided by the bearing screws 163 which extend through the side plates 160 and engage the ends of said armature. A retracting-spring 164 is provided and connected between the said armature and the adjacent side plate 160, said spring being quite powerful and so tensioned that it tends always to hold the said armature away from the magnets. As illustrated, this spring is simply an ordinary coil-spring adapted to have its tension regulated by a key or thumb-piece 165, which latter works in the side wall 160, and is adapted to engage notches in such wall for the purpose of holding the spring in a wound-up or tensioned condition. With this arrangement, the device 165 can be partially rotated, so as to give the spring the desired tension, and the notches 166 will then engage the thumb-piece 165 and thereby prevent the spring from unwinding. The said armature is preferably provided with a down-

wardly-extending interrupter-arm 167 adapted to operate the interrupter-springs 168, 169 and 170, which springs are suitably secured to the side plate 160 by means of screws 171, it being understood that the said springs are all suitably insulated from each other. Above the said interrupter-springs there is arranged a couple of switch-springs 172 and 173. The stroke of the armature is limited in one direction by its engagement with the pole-pieces of the magnets, and in the other direction by the engagement of the interrupter-arm 167 with a stop screw 174, the latter being adjustable. With this arrangement, and referring more particularly to Figs. 3[a] and 3[b], it will be seen that the switch-springs 168 and 170 are normally out of electrical contact with each other, while the switch-springs 172 and 173 are normally in electrical engagement with each other. When the armature 162 is attracted, its arm 167 bears for a minute upon the lateral projection 175 of the spring 168, and then slips off of the same and onto the spring 169, thus causing the latter to bear down upon the spring 170. The initial pressure of the arm 167 upon the spring 168 is sufficient to bring it into electrical engagement with the spring 170, but this engagement is only momentary, as the arm immediately slips off and bears upon the spring 169, thus separating the springs 168 and 170. When the armature is restored to its normal position, the lateral projection 176 on the end of the arm 167 passes between the springs 168 and 169, and thus prevents the two springs 168 and 170 from engaging each other during the restoring movement of the armature. When the armature is attracted, and as soon as the interrupter-arm 167 engages the spring 169, the downward movement of the latter then draws the spring 173 out of engagement with the spring 172, and with the construction shown, these two springs do not reengage each other until after the armature is fully restored to its normal position. Referring more particularly to Fig. 3, it will be seen that of the two springs 137, the one nearest the terminal-bars is preferably the weaker, while the other is somewhat stronger and adapted not to be brought into play until after the terminal-bar has shifted slightly in a forward direction, the two upper ends of the pair of springs being preferably held between pins 177 which are secured to their allotted terminal-bar, and having some space between them. With this arrangement, the outermost of the springs 137 is adapted to exert its power in shifting the terminal-bar in a forward direction until it meets the end of the stop-screw 178, which latter extends through the cross-bar 13, and also through the inner of the two springs 137. From this point on, the shifting movement of the terminal-bar is due entirely to the force of the inner spring 137, and such final movement is only limited by the pressure of the hook 136 against the arm 154, and by the consequent engagement of the projection 156 with the lower edge of the notch 133. Thus, each trunk-line terminal-bar is adapted to shift in a forward direction, and for a short distance in opposition to only a comparatively weak spring pressure, while for the balance of such forward movement each bar is opposed by the spring pressure or resistance of both of its restoring springs 137. It will be remembered that when a terminal-bar is in use, it is held in a slightly advanced position by the spring fingers or contacts on the bank of the calling subscriber, and it is at this time that the inner of the two springs 137 is too weak to overcome the resistance afforded by the subscriber's line-bank-springs, but is strong enough to then completely restore the terminal-bar as soon as the subscribers' line-bank is restored to its normal position. Obviously, the said springs 137 must not be allowed to make contact with the intermediate conducting-strips of their allotted trunk-line terminal-bar, as this would short-circuit the said conductors. Thus, for each trunk-line terminal-bar there is a pair of restoring springs 137 and a stop-screw 178. The double hooks 139 are in the nature of ratchet devices, and their teeth 141 and 142 are in the nature of ratchet-teeth adapted to be engaged respectively by the pivoted locking-dog 179 and the swinging actuating-pawl 180. The said actuating-pawl 180 consists preferably of a horizontal bar having its forward edge bent downwardly to provide a rib or engaging portion 181 adapted to engage the teeth 142 on the double hooks or ratchet-arms 139. This bar is secured at its ends to the swinging arms 182, which latter are pivotally mounted upon the side plates 160, as, for example, by means of pivot-screws 183, these two vertically-disposed and backwardly and forwardly swinging arms being rigidly connected at their lower ends by cross-bars or angle-irons 184. The operative connection between the armature 162 and the actuating-pawl 180 consists preferably of a link 185, which connects one of the arms 182 with an arm 186 projecting downwardly from the said armature. In this way, the armature 162 and the actuating-pawl 180 are connected to swing or move in opposite directions—that is to say, the pawl moves toward the trunk-line terminal-bars when the armature is attracted, and the pawl then makes its operative or forward stroke under the influence of the spring 164 when the armature is released. The operative connection between said armature and the locking-dog 179 consists of an arm 187 which is rigid with one of the arms 182, and which has a pivotal

connection with the lower end of a vertically-reciprocating member 188, this member preferably consisting of two flat portions which are secured together by a screw and slot connection 189, whereby the member as a whole is adjustable endwise for the purpose of varying its length. At its upper end, the said member is provided with a finger 190 which works in an opening in the locking-dog 179, it being observed that the latter consists of a transverse flat strip provided at its forward edge with a depending rib or engaging portion 191, the latter being adapted to cooperate with the hooks or ratchet-teeth 141 in locking the trunk-line terminal-bars in their waiting or selective positions. Immediately below the locking-dog 179, there is a guide-bar or cam device 192 adapted to be engaged by the extreme forward end portions of the double hooks or ratchet-arms 139, as shown more clearly in Fig. 3. This cross-bar 192 presents a transversely-extending and inclined or beveled contact surface to the ends of said double hooks or ratchet devices 139, and is adapted to crowd the said double hooks upward, when they are moved forward, so as to bring the teeth or hooks 141 into engagement with the engaging portion 191 of the said locking-dog—that is, so as to effectively retain the locking connection necessary between any trunk-line terminal-bar and the said locking-dog when such bar is to be temporarily retained in a waiting or selective position.

When the armature is attracted, the locking-dog 179 rises from engagement with the tooth 141 connected with the terminal-bar which had been temporarily retained in a shifted position, and at the same time the actuating-pawl 180 moves forward into engagement with the tooth 142 carried by the next idle terminal-bar; and then when the operating-magnets 158 are de-energized, and the armature allowed to resume its normal position, the actuating-pawl 180 then draws the said next idle trunk-line terminal-bar into its forwardly shifted or waiting position, and just as the bar reaches the end of its forward or longitudinal shift, the locking-dog 179 swings down and into engagement with the tooth 141 carried by the said bar, thus locking the latter in its shifted position. At this juncture, it will be observed that while the thus selected trunk-line terminal-bar is temporarily retained in its shifted position, the actuating-pawl 180 remains in engagement with the tooth 142 carried by such bar; but as soon as the armature is again retracted, said pawl is permitted to move toward the terminal-bars without at once releasing the said temporarily retained terminal-bar, this release not occurring until after the actuating-pawl is completely out of engagement with the tooth 142. However, as soon as the locking-dog 179 is lifted sufficiently, the previously selected and temporarily retained trunk-line terminal-bar is released, and the actuating-pawl 180 then completes its stroke and moves on and into engagement with the tooth 142 carried by the terminal-bar of the next idle trunk-line. After this, as explained, the armature is retracted, causing the actuating-pawl 180 to move back to its normal position, and to draw the newly selected trunk-line terminal-bar back with it, leaving the released bar in electrical connection with the line of the calling subscriber. It will also be seen that the vibratory movements of the armature 162 are utilized for actuating the tripper-bar 116. The connections for so doing comprise the rock-shaft 193 arranged transversely of the machine and having its ends suitably supported in the side plates 160, as, for example, by means of bearing-screws 194. This rock-shaft is provided with an arm 195 adapted to bear upon one of the arms 187, and is subject to the tension of a spring 196, said spring tending always to press the arm 195 downwardly upon the said arm 187. In addition, the said rock-shaft is provided with an upwardly-extending arm 197 having its upper end connected by a link 198 with the forward end of the tripper-bar 116, as shown more clearly in Figs. 1, 3 and 12. With this arrangement, the forward stroke of the armature 162, when it is attracted, not only effects the release of the temporarily retained or previously selected trunk-line terminal-bar, and the engagement of the pawl 180 with the bar of the next idle trunk-line, but also serves to draw the tripper-bar 116 in a forward direction, thus causing one of its upper projections 117 to swing the calling subscriber's line-bar about its axis, as previously described. When the armature 162 is released, and its retracting-spring 164 allowed to return the pawl 180 and locking-dog 179 to their normal positions, the spring 196 then serves to return the tripper-bar 116 to its normal position. The automatic selection of the next idle trunk-line terminal-bar is preferably mechanical in character, and the mechanical selecting mechanism may be as follows: A couple of bearings 199 and 200 are arranged at opposite sides of the machine as a whole and in such relation to each other as to properly support the rotary shaft 201 transversely of the machine and at a point immediately above the end portions 148 and 150 of the previously described spring fingers 146 and the pivoted stops 149, as shown more clearly in Figs. 8 and 9. At one end this shaft is provided with gear-teeth 202 which, in effect, provide the end of the shaft with a pinion adapted to engage a gear-wheel 203 mounted at a point below upon the bearing-bracket 199. Rigidly secured with said gear-wheel, and mounted to rotate in unison there-

with, there is a ratchet-wheel 204 adapted to be engaged by the vertically-reciprocating pawl 205, which latter is, it will be observed, provided on its face with a series of ratchet-teeth adapted to engage the ratchet-teeth of the said ratchet-wheel. The arrangement is such that the said ratchet-wheel is rotated when the pawl 205 moves upward, but remains stationary when the said pawl moves downward. Furthermore, the construction and relative arrangement are such that should the pawl 205 be given its full or maximum stroke in an upward direction, the shaft 201 will then be given substantially a full or complete rotation. As there are ten trunk-line terminal-bars, and in view of the principle upon which the selecting mechanism operates, it is desirable that the said shaft 201 be capable of a step-by-step rotation comprising ten rotary steps. Consequently, the said shaft is provided with ten escapement-teeth 206, these teeth being arranged, of course, on a spiral line extending around the shaft, whereby they are evenly spaced both circumferentially and longitudinally of the said shaft, there being a tooth for and opposite each trunk-line terminal-bar. The actuating-pawl 205 has its lower end pivotally connected with a supporting arm 207, the latter being pivotally mounted upon the axis of the adjacent swinging arm 182. A spring 208 is so applied to the arm 207 that it tends constantly to raise the pawl 205 and rotate the ratchet-wheel and pinion, as well as the shaft 201. In addition, the said arm 207 is provided with an adjustable stop device 209 which is in the nature of a curved arm having its lower end adjustably secured to the side of said arm 207. The upper or curved end of this adjustable stop device 209 is adapted to engage the edge of the arm 182, thus in effect limiting the upward stroke of the said pawl 205. Suppose, for example, that all of the trunk-lines were busy, and consequently that upon the next call being sent in the ratchet 205 is given its maximum or full upward stroke, thus bringing the end of the arm or stop device 209 against the adjacent arm 182. In such case, the attraction of the armature 162, and the consequent forward movement of the pawl 180, will restore the pawl 205 to its lowered or normal position, thus in effect winding up the actuating-spring 208 which constitutes the spring means for actuating the pawl and thereby rotating the shaft 201. It will be seen that the said pawl 205 is connected with the arm 207 by a spring 210, whereby the pawl is yieldingly held against the ratchet-wheel. Now with this construction and arrangement, it will be seen that the teeth 206 are not only adapted to engage the spring fingers 146 for the purpose of tilting up the forward ends of the double hooks or ratchet-arms 139, but are also adapted to engage the end portions 150 of the pivoted stops 149 for the purpose of intermittently interrupting the rotation of the shaft 201. While the machinery is not in operation, and whether any of the subscribers' individual-switches are in use or not, one of the pivoted stops 149 of the next idle trunk-line terminal-bar has its end in engagement with one of the teeth on the shaft 201, and the pivoted stop thus temporarily serving to prevent further rotation of the shaft 201 under the pressure or influence of the spring 208 is always the pivoted stop allotted to the bar next in order after the one which was last drawn into a waiting or selective position by the de-energizing of the magnets 158 and the consequent restoration of the armature 162. As shown in Fig. 1, for example, the trunk-line terminal-bar 1 is temporarily retained in its shifted or waiting position, and consequently the pivoted stop 149 allotted to the bar 10 is in engagement with its allotted tooth on the shaft 201, and the said tooth is engaging the spring finger 148 of the double hook 139 allotted to the said bar 10. Under such conditions, all of the double hooks are in their depressed positions except the hooks allotted to the bars 1 and 10, the hook or ratchet-arm 139 of the bar 1 being held in locking engagement with the locking-dog 179, and the hook or ratchet-arm 139 of the bar 10 being held in its raised position and in readiness to be engaged by the pawl 180 as soon as the next call comes in and the magnets 158 are energized. As soon as another subscriber does make a call, the bar 1 is released in the manner described, and the deenergizing of the magnet 158 permits the restoration of its armature to draw the bar 10 into its selective or waiting position—that is to say, into such position as to be held in readiness for use by the next calling subscriber.

It will be seen that as soon as the bar 10 is thus shifted to its waiting or selective position, by the pawl 180, the pivoted stop 149 allotted to this bar is drawn out of engagement with its allotted tooth on the shaft 201, thus permitting the latter to rotate until the next tooth engages the pivoted stop allotted to the bar 9, providing, of course, that this bar 9 is not being used by some other subscriber. Should the bar 9 be in use, and thus temporarily connected with the line of some subscriber in the group, its allotted pivoted stop 149 will be in a lowered or depressed position, and its allotted tooth on the shaft 201 will not be able to engage it when the shaft is released by the forward shift of the bar 10. Consequently, the shaft 201 will skip the bar 9, so to speak, and if the bar 8 is not busy, its allotted pivoted stop 149 will be in position to be engaged by its allotted escapement-tooth on the shaft 201. In this

way, the shaft 201 is rotated by spring power, and it is released a step at a time, and given a uniform step-by-step rotation, providing it does not encounter any busy trunk-line terminal-bars; for when a busy trunk-line terminal-bar is encountered, the shaft will rotate two steps, thus skipping the busy bar; and if several of the bars are busy in succession, the shaft 201 will continue to rotate until it is stopped or interrupted by the stop on the next idle terminal-bar. In this way, and if the trunk-lines are not all busy, there will always be one trunk-line terminal-bar which is temporarily retained in selective relation to the different subscribers' line-banks, and there will always be another terminal-bar which is temporarily held in selective relation to the actuating-pawl 180—that is to say, one bar which is selected for use by the next calling subscriber, and another bar which is selected and destined to be immediately substituted for the first or waiting bar as soon as the latter is put in use. With the arrangement shown, the pawl 205 is always restored to its normal position when the armature 162 is attracted, regardless of whether it has only advanced upwardly one step or for the full extent of its upward movement. The pawl 205 moves down when the armature 162 is attracted, and then moves upwardly and actuates the shaft 201 as soon as the said armature is released; and consequently the mechanical and automatic selection of the two trunk-line terminal-bars (the one assigned and held in readiness for the next call, and the one to be substituted therefor as soon as the next call materializes) always occurs upon the de-energizing of the magnets 158 and the consequent restoration or retraction of the armature 162. The terminal-bar automatically selected for use by the next calling subscriber is always the first idle bar next in order after the terminal-bar last put in use; and in a similar manner the terminal-bar selected and retained in readiness to be substituted for the said endwise-shifted or waiting bar, as soon as the latter is released, is always the first idle terminal-bar next in order after the one thus temporarily retained in its endwise-shifted or waiting position. The electro-magnets 158 not only operate the trunk-line terminal-bars, through the medium of the mechanical selecting mechanism, but also operate the subscribers' line-banks—that is to say, it is the armature 162 which, through the medium of the tripper-bar 116, tilts the calling subscriber's line-bank about its axis for the purpose of bringing it into operative or connective relation to the automatically released trunk-line terminal-bar. In this way, each subscriber's individual-switch, or individual trunk-selecting switch mechanism, comprises movable trunk-line-terminals as well as movable subscriber's line-terminals, and both the trunk-line-terminals and subscriber's line-terminals are operated by the switch-operating machine or mechanism which is common to all of the different individual-switches. It will be seen, however, that inasmuch as the subscribers' line-terminal-banks are mounted for both endwise and swinging movement, it follows that each subscriber's line-relay constitutes not only the means for opening and closing certain line and auxiliary circuits, but also the means for positively operating or actuating the subscribers' line-terminals. With this arrangement, the subscribers' line-banks are operated by the subscribers' line-relays, and it is also true that these subscribers' line-banks are operated by the said stationary operating machine or mechanism, as previously explained. Associated in addition with each of the group of trunk-selecting mechanisms or individual-switches above described, there are three relays 211, 212 and 213, known as the rotary, vertical and auxiliary busy-release-coils, respectively, which come into play during the release of the mechanism allotted to each individual line if all the trunk-lines allotted to one group of individual-switches are in use. The relay 211 when energized operates its armature 214, so as to draw it into engagement with a contact-point 215, while the armature 216 of the relay 212 is likewise operated to engage the contact-point 217. The said armatures 216 and 214, when in engagement with their respective contact-points, are included in circuits that will hereinafter be disclosed. The relay 213, by its armature 218, when the latter is attracted by said relay, forces an adjacent spring 219 from a second spring 220, which latter is permanently connected to ground. The use of these springs 219 and 220 and of the relay 213 will be made plain. For the purpose of notifying the calling subscriber when all the trunk-lines are busy, a busy signaling apparatus, of any suitable design, is provided, comprising a coil 221, which latter is in a series circuit with the relays 212 and 211; and by said coil certain releasing operations take place under certain unusual conditions. Both the construction and mode of operation of my improved trunk-selecting switch mechanism will, however, be more clearly understood in connection with the hereinafter described operation of connecting one subscriber's line with another.

As shown in Figs. 27 and 28, the calling subscriber's station A is connected with the called subscriber's station B^1 through the medium of suitable trunk-line connection, and through the medium of the hereinafter described subscriber's individual trunk-selecting switch mechanism C, the so-called "selector" D, and the so-called "connector"

E. It will be understood that in making the call the said subscriber's individual trunk-selecting switch mechanism performs a trunking operation preliminary to the taking place of the trunking operation which corresponds to the first digit of the called number. The trunking operation which corresponds to the first digit of the called number is performed by the "selector" D, while the selecting and connecting operation corresponding to the last two digits of the called number is performed by the "connector" E. In other words, the subscriber's individual trunk-selecting mechanism automatically puts his line in connection with a regular "first-selector", and the impulses representing the first digit of the called number then cause the said "selector" to perform a trunking operation corresponding to such first digit of the called number. After this, the two groups of impulses representing the second and third digits of the called number cause the "connector" E to first pick out a certain group of subscribers' lines, and to then pick out the line of the exact or particular subscriber with whom the calling subscriber desires to communicate. In this way, the said subscriber's individual trunk-selecting switch mechanism may give the calling subscriber any one of a certain group of trunk-lines—that is to say, any one of a certain number of trunk-lines running to a particular class or group of "first-selectors", as any "first-selector" in this particular group will serve the calling subscriber's purpose. After this, the said "selector" then gives the calling subscriber any one of a number of trunk-lines running to a certain group of "connectors", inasmuch as any one of such "connectors" will serve the purposes of the calling subscriber. After this, however, the "connector" not only picks out a certain group of subscribers' lines, or a certain level of subscribers' lines, as it is called, but also then proceeds to pick out a particular member of such group of subscribers' lines, inasmuch as the calling subscriber must now have this particular line and no other. In other words, and up to the time that the calling subscriber begins operating the "connector", the operations consist entirely in the automatic selection by trunk-selecting machinery of various idle trunk-lines which are all common to different subscribers of the exchange; but as soon as the automatic machinery has given the calling subscriber trunk-line connection with a "connector", the operation is then completely under the control of the calling subscriber, and consists in picking out and making connection with the line of the particular subscriber with whom the calling subscriber desires to communicate. In a general way, and as far as the mechanical construction is concerned, the said "selector" may be of the type shown and described in Patent No. 815,321, granted March 13, 1906, to Keith, Erickson & Erickson. A "selector" of this character is shown more or less diagrammatically in Fig. 29, the frame of the "selector" being omitted for convenience of illustration, and certain switch-contacts and other devices being shown in a simplified form with a view to more clearly illustrating the operation.

In the "selector" which is shown in Fig. 29, and which is indicated in a still more simple manner in Figs. 26 and 27, there are some novel features, such as special circuits, relays and contacts, but these will be pointed out and explained in connection with the operation of connecting one subscriber's line with another. The elements and construction of the said "selector" will be readily understood by those skilled in the art, and in a general way are as follows: In Fig. 29 the "first-selector" D is shown with the bank 250 of trunk-line-terminals beneath it, while the private-bank 251 is located just above the latter. The switch-shaft 252 is vertically disposed on the front of the switch-frame, and is retained connected therewith by bearings which are not shown. The shaft may be moved longitudinally in said bearings and then rotatively by ratchet and pawl electro-magnetically-operated mechanism, the vertical or longitudinal movements occurring first. Among the functions of the shaft an important one is that of holding the line-wipers 253 and 254 and the private-wiper 255. The first two wipers comprise a set distinct from the latter, but both sets are located within range of the contacts of their respective banks 250 and 251. Said wipers are not only insulated from the shaft, but from each other as well. Among the details that are associated with the shaft is a cam piece 256 which is of a split sleeve design and secured to the shaft by a screw 257. The general shape of said cam, in section at right angles to the shaft, is that of an oval with the smaller end thereof on the side farthest away from the said screw. Said cam abuts on a hub 258 which is shrunk to the shaft near the middle of the latter. This hub carries a set of longitudinal teeth 259 that serve, as will be disclosed, to enable the forward rotation of the shaft and as a locking means against backward rotation of same. On the neck portion of said hub there is formed a set of circular teeth 260 that serve in turn as a means through which the raising of the shaft is accomplished, and for locking it when raised. These circular teeth are traversed by a groove 261 into which the end of a so-called shaft-rest 262 normally projects; but when the shaft is rotated, any one of the said circular teeth which may be at the proper height slides onto the end

of said rest. The end of said rest is, of course, adapted to fit the circular grooves between said circular teeth. The upper surface of the engaging end of the rest is level, but the under side is chamfered to form a bevel that corresponds to the upper slope of the circular teeth. Above the hub 258 the shaft carries an arm 263, known as the normal-post-arm, which, while the switch-shaft is at rest, and while the shaft-rest occupies the slot 261, is retained against the normal-post 264 by the coil-spring 265. The said normal-post-arm normally retains a shaft-controlled spring 266 in contact with a contact-point 267 located beneath it; but when the shaft is raised said spring flexes out of contact with it. Among the magnets allotted to the "first-selector" some are used as relays and others as operative magnets. The magnets 269 and 270 are among the former kind and are known as the vertical and rotary line-relays. By means of their respective armatures 271 and 272, the springs 273 and 274 are controlled with respect to the ground-spring 275. Said springs are comprised in energizing circuits of operative magnets that raise and rotate the shaft. The magnet 281 with its armature 282 and springs 283 and 284 constitute the back-release-relay which is used for restoring the switch after it has seized a trunk-line, when such release is desired. Of the operative magnets the magnet 285 is known as the vertical-magnet and has allotted to it a so-called vertical-armature 286 supported by pivots 287 beneath the vertical-magnet. Whenever the coils 288 and 289 of said magnet become energized, the armature 286 is attracted; and when the magnetism ceases the retracting-spring 290 restores said armature to its normal position. The upward movement of the armature is limited by the pole-pieces of the magnet-coils 288 and 289, and the lower limit is marked by a section of the switch-frame that passes under the arm 291. Said arm is known as the vertical-arm and extends forwardly from the vertical-armature 286, of which latter it is a part. The vertical-arm carries on its end a so-called vertical-pawl 292 which, when the vertical-armature is attracted, meshes with some one of the circular teeth 260 to raise the shaft. Normally, the under surface of the upper section of said pawl rests against a piece that is secured to the switch-frame and that retains the pawl away from the circular teeth. When the vertical-armature is attracted, as the pawl rises, a retracting-spring 293 thrusts the forward side of the pawl towards the circular teeth 260. As soon as said pawl clears its normal-rest and by the time that the vertical-armature strikes the pole-pieces the vertical-pawl strikes, with the rear surface of its upper section, a bumper piece, which latter constitutes a part of the switch-frame. Therefore, the shaft is prevented from being raised more than one notch at a time by its own momentum. It is clear then that the pawl 292 not only raises the shaft, but that it also acts as a lock at the end of each stroke. The vertical-arm has also an L-shaped piece 294 on its under edge that engages a so-called release-link 295 of flexible spring material. Said link carries an aperture 296 on its front end, and is secured to the armature 297 of one of the operative magnets 298, known as the release-magnets. Said armature is suspended from the frame by the supports 299, and is normally retained by the spring 300 away from the pole-piece of the release-magnet. A stop is suitably provided behind said armature to limit its movement when retracted. The "first-selector" is provided with a peculiarly shaped mechanism 301, known as the double-dog. It is pivoted so that it may swivel about a vertical axis that passes through the pivots 302. On its front side said double-dog divides into two dogs 303 and 304, so situated and constructed that the dog 303 may cooperate with the circular teeth 260 while the switch-shaft is raised and in normal rotary position, and so that the dog 304 may engage the longitudinal teeth 259 when the shaft is rotated. To the left of the pivots 302 the body of the double-dog extends rearwardly, and projecting down therefrom is an arm 305 that comes into play during the releasing of the switch. Near the extremity of and on the upper side of said body a pin or lug 306 projects upwardly. Said lug is normally caught in the aperture 296 of the release-link 295, and because of the tension in the spring 300 the dogs 303 and 304 are retained away from the shaft. At the first stroke of the vertical-armature, the link 295 is drawn away from the lug 306 by the piece 294, and then the double-dog is rotated by the retracting-spring 307 so that the dog 303 falls under the first circular tooth, and so that when the vertical-armature returns to its normal position the said shaft is retained by said dog in its new position. The release-link 295, while the double-dog is free, rests with its end upon the lug 306, but out of locking engagement therewith. When the vertical-armature is energized a second time, the shaft is raised a second step, and the dog 303 at the second stroke passes from under the first tooth to a position under the second tooth, holding the shaft again, as explained. The release-magnet 298 is composed of two coils like the vertical-magnet 285, but, for convenience of illustration, only one coil is shown. If, while the shaft is raised, the said release-magnet should be energized, the release-armature 297 is attracted, and the release-

link 295 is thrust forward to catch the lug 306 in the aperture 296. Upon the de-energization of the release-magnet the retracting-spring 300 then withdraws the dogs 303 and 304 from the shaft, which latter, being deprived of its temporary support, then falls to normal position by its own weight. After the shaft is once raised it may be rotated by a second operative magnet 308, known as the rotary-magnet. Said magnet has two coils 309 and 310 and, unlike the vertical-magnet, has its armature 311 pivoted in a vertical plane. Said armature may be moved about a vertical axis that passes through the pivots 312. The limit of the movement of said armature toward the rotary-magnet is determined by the pole-pieces of said magnet, which movement is produced by the rotary-magnet itself. The motion of the armature in the opposite direction is produced by the retracting-spring 313, and is limited by a switch-stop behind the so-called rotary-arm 314. This arm, like the vertical-arm, carries a so-called rotary-pawl 315. Similar to the vertical-pawl, said rotary-pawl normally rests against a stop that retains it away from the longitudinal teeth, and when the rotary-armature is attracted it is drawn into engagement with the longitudinal teeth by a spring 316 that is attached between the rotary-arm and the rear of said pawl. By the time that the rotary-armature strikes the pole-pieces of the rotary-magnet, the rotary-pawl also strikes a bumping-post, as does the vertical-pawl, and locks the shaft against further advance by the force of its own momentum. At the end of the first rotary step the dog 304 falls behind the first longitudinal tooth, so that when the rotary-pawl falls back the shaft is retained. It should be evident that as the shaft is rotated the vertical-dog 303 is withdrawn from the groove of the circular tooth below which it has been resting by the passage of the rotary-dog 304 over the longitudinal tooth over which it has to slide at the time; but at the beginning of the rotation the tooth which has been caught by the vertical-dog slides onto the shaft-rest 262, and in this way the shaft is still held raised after the rotation begins.

The rotary-armature is provided with a so-called interrupter-finger 317 that separates the interrupter-springs 318 and 319 whenever the rotary-armature is attracted, and also with a rotary-armature-finger 320 that exercises certain controlling influences over the armature 321 of one of the operative magnets, namely, the private-magnet 322. The said private-armature 321 works in a vibratory manner about a horizontal axis that passes through the supporting points 323. This armature is formed with a forwardly-projecting arm 324, the latter having two flat surfaces in an approximately horizontal plane. Furthermore, the end of said arm is bent downwardly at a right angle and carries certain mechanical details, namely, a lateral arm 325 which is designed to control circuits comprising the private-springs 326, 327 and 328, and a tooth-escapement which includes two flexible springs 329 and 330, each of which is riveted by one end to the arm 324, one on the upper side and the other on the lower. The upper spring is straight and has formed on its end two tooth projections 331 and 332 which extend downwardly, while the lower one is bent down and at a right angle again to the front. This double angle on the lower spring is so designed that the latter may clear the bent portion of the private-arm, against which portion the said spring rests with a degree of tension, and so that space is afforded in front of said bent portion to receive two other tooth-shaped upwardly-projecting pieces 333 and 334 that are formed on the forward end of the escapement-spring 329, and which are sustained in juxtaposition to the upper teeth, but slightly to the rearward of them. A retracting-spring 335, suitably located, holds said armature normally away from the private-magnet pole-piece. A well-known auxiliary switching mechanism common to such switches is the so-called side-switch. It is shown in connection with the "first-selector" D and comprises an arm 336 which is secured to the switch-frame in such a manner that it may be made to swivel in a vertical plane about the pivots 337. The right extremity of said arm is drawn out into a finger 338 that works in conjunction with the escapement-teeth previously described. Said teeth, in a manner to be explained, reduce the outward movement of the side-switch to a step-by-step motion, which movement is produced by a retracting-spring 339. At the base of the finger 338 a lug 340, which is bent to the front, is adapted to strike the cam 256 at a suitable time. Whenever the shaft is rotated, however, said cam is carried beyond the reach of said lug, and after that the finger 338 simply falls against the tooth 334. Near its left extremity the arm 336 carries a number of wipers 341, 342, 343 and 344 suitably mounted upon a pin 345 and insulated therefrom and from each other. Said wipers are known as the side-switch-wipers, and are adapted to be operated by the private-magnet and escapement device previously explained. If the private-magnet is energized once, the private-armature is then drawn down once and then restored to its normal position. The escapement-finger 338 then passes from behind the tooth 333 onto the rear of the tooth 331, upon the downward stroke of the private-armature 321, and from behind the latter tooth upon the return stroke. As soon as

the escapement-finger clears the latter tooth, the retracting-spring 339 draws the side-switch to the second position, where it is stopped by the lug 340 when it strikes the cam 256. Immediately, then, the rotary-magnet becomes energized, the shaft is rotated, and the cam passes away from reach of the lug 340; then the finger 338 of necessity falls against the tooth 334, because of the tension in the spring 339. The rotation of the shaft results when the rotary-armature 311 is attracted by the rotary-magnet; and, at the same time, the rotary-armature-finger 320 depresses the private-armature 321 and causes the finger 338 to disengage from the tooth 334 and to advance against the tooth 332; then, as the rotary-armature returns to normal position, when the rotary-magnet de-energizes, the private-armature, upon following the finger 320, permits the escapement-finger 338 to escape from the last tooth 332, at which instant the side-switch passes to third position with the said finger 338 resting against the side-switch-stop 346. In their normal positions the side-switch-wipers 341, 342, 343 and 344 engage, respectively, with the contact-points 347, 348, 349 and 350. This position is known as the first position of the side-switch, at which time it will be clear that the finger 338 is held behind the escapement-tooth 333. In the second position, while the said finger is between the teeth 333 and 334, the said side-switch-wipers engage instead with the contact-points 351, 352, 353 and 354, respectively; and when the said finger 338 falls against the stop 346, the wipers change their positions into contact with the contact-points 355, 356, 357 and 358, respectively. Between the pivots 337 and the wiper supporting-pin 345, a rearwardly-extending arm 359 on the side-switch-arm 336 supports on its end, pivotally, one end of a link 360, the other end of which latter, being bifurcated, engages with the lower end of the double-dog-arm 305 which is constructed somewhat in the shape of an inverted T. Should the release-magnet be energized while the side-switch is in third position, and, of course, while the shaft is rotated, the release-link 295, being attached to the release-armature 297, is thrust forward when the release-armature is attracted and catches the lug 306 in the aperture 296. Then when said release-armature is restored, the spring 300, as before described, withdraws the dog 303 from the circular teeth 260. At the same time, the arm 305 drives back the link 360, which latter then rotates the side-switch-arm 336 about the pivots 337, against the tension of the side-switch retracting-spring 339, and thus drives the finger 338 between the springs 329 and 330 to a position behind the tooth 333, locking the side-switch in the first or normal position. The switch-shaft being unlocked by the removal of the dog-support 304, and being thus left free, is rotated by the coil-spring 265 until the end of the shaft-rest enters the slot 261, at which time the shaft drops to its normal position. Therefore, after the switch has been operated, the energization and de-energization of the release-magnet is sufficient to restore the switch completely to its normal position. Since the line and private banks are each provided with ten rows of contact-terminals, each row consisting of ten sets of contacts, the shaft is so constructed that it may be raised to any one of ten levels, and at each level it may be rotated ten successive steps in order that the wipers which it carries may be placed in connection with any one of the terminals of the ten sets of contact-terminals in each level. It will be noticed that the release-link 295 is made with a laterally-projecting extension 361. This extension is designed to operate a ground-spring 362 with respect to a contact-point 363, as follows: When the link 295 is withdrawn from the lug 306, the said member 361 passes out of normal engagement with the spring 362, and permits the latter to fall against the contact-point 363. The said contact-point, it will be noticed, is connected directly with the shaft-controlled spring 266. Now when the release-magnet 298 is energized, the link 295 is thrust forward and falls over the lug 306, and then the arm 361 falls in front of the said spring 362. Therefore, when the release-armature is retracted, the said spring is withdrawn from contact with the contact-point 363. The object of this construction, and of the shaft-springs 266 and 267, will be clearly described.

The "connector" E may be of any suitable, known or approved type or character, but is preferably of the general type shown and described in Patent No. 815,176, granted March 13, 1906, to Keith, Erickson & Erickson. This "connector" is shown more or less diagrammatically in Fig. 30, the essential mechanical elements being shown in perspective, and the frame of the machine being omitted for convenience of illustration. Also, in this simplified illustration of a "connector" of a well-known type, certain of the parts, such as switches, contacts and other devices, have been shown in a simplified form, so as to more clearly illustrate the circuits and mode of operation. The essential elements and the construction of the said "connector" will be readily understood by those skilled in the art, and in a general way are as follows: Fig. 30 shows the "connector" E, which has many of its parts and circuits very similar to those of the "first-selector." The line and private banks 379 and 380 will be recognized. The switch-shaft 381 is identical with the "first-selector.

shaft" and is, therefore, provided with the line-wipers 382 and 383, the private-wiper 384, the cam 385, longitudinal and circular teeth 386 and 387, respectively, the normal-post-arm 388, and the coil-spring 389. The said normal-post-arm 388 has under its control a spring 390 which, while the shaft is down, is kept out of contact with the contact-point 391, but with which latter it engages when the switch is in operation. The vertical movement of the shaft is, of course, produced through the medium of the vertical-magnet 392, vertical-arm 393 and vertical-pawl 394, the said vertical-arm 393 being supplied with the L-shaped piece 395, as usual. The release-magnet 396, however, has its armature 397 on the right instead of on the left side, which armature is constructed with an elongated front extremity 398 that reaches as far as the middle section of the body of the double-dog 399. The release-link 400 is under the control of the L-shaped piece 395, but it is permanently secured to the switch-frame by the pin 401. The double-dog has the usual vertical and rotary locking-dogs 402 and 403, respectively, and the side-switch releasing-arm 404; while on the upper side of the body of the double-dog the lug 405 that is caught by the release-link 400, in the aperture 406, is in its usual position. When the release-magnet of the "connector" is energized, the release-link 400, instead of being thrust forward to catch the said lug 405, remains where it is, and the double-dog 399 is struck by the armature 397—at a point to the right of the bearings 407—by the end 398 of the release-armature 397; so that the lug 405 is driven under the aperture 406, in which latter the lug is caught and held by the release-link 400. The double-dog 399 is thus prevented from returning to its operative position when the release-magnet becomes de-energized. The rotary-magnet 408 has a rotary-armature 409 that is quite simple. This latter is provided with only a vertical-arm 410 upon the extremity of which the rotary-pawl 411 is located. The rotation of the shaft is produced in a manner similar to that described in connection with the "first-selector", each time that the rotary-magnet is energized. The private-magnet 412, the private-armature 413, springs 414 and 415, escapement-teeth 416, 417, 418 and 419 and the arm 420 are identical with the similar parts of the "first-selector." The said arm 420, however, controls the private-springs 421, 422, 423 and 424, so that when the private-armature 413 is down the first two of said springs are separated and the last two brought into contact; and when the said armature is up the reverse takes place—that is, the springs 421 and 422 close, and the springs 423 and 424 separate. In the side-switch of the "connector" the side-switch-arm 425, escapement-finger 426, cam-lug 427, side-switch-stop 428 and retracting-spring 429 on one side of the pivots 430, and the member 431, link 432, side-switch-wipers 433, 434, 435 and 436, together with their corresponding contact-points 437, 438 and 439; 440, 441 and 442; 443, 444 and 445; and 446, 447 and 448 on the other side, conform to like parts of the "first-selector" side-switch. Among the relays of the "connector" the vertical-line-relay 449, by its armature 450, can flex the spring 451 against the ground-spring 452, and the spring 453 toward the spring 454, when said relay is energized. The rotary-line-relay 455 in the same manner, by its armature 456, when the relay is magnetized, forces the spring 457 against the same ground-spring 452, and permits the spring 454 in turn to bend toward the spring 453. Said two springs 454 and 453 are so adjusted that they then come into contact when the two armatures 450 and 456 are attracted at the same time. The ringer-relay 458 is a feature common to all "connectors" of the type under consideration, and is adapted when magnetized to disconnect the terminals of the called line from those of the calling line, and to place across the former the terminals of the ringer-generator J. This operation is accomplished through the medium of the armature 459 and the ringer-relay-springs 460, 461, 462, 463, 464 and 465. It will be more clearly pointed out in the description to follow that when one subscriber calls another subscriber his (the calling subscriber's) individual apparatus is rendered inactive and, therefore, is withdrawn from his direct control for purposes that will be made clear. Evidently, then, when one subscriber has called another, the called subscriber is unable to make a call unless he is furnished with some means by which he may destroy the connection that has been established with his line. With the end in view of attaining this object, the "connector" is provided in addition with a so-called back-release-relay comprised of two coils 466 and 467. These two coils have under their control two springs 468 and 469, and when the armature 470 of the coil 466 is attracted by said coil, when it is energized, the spring 468 is forced in the direction of the spring 469, while the armature 471, when the other coil 467 is energized, forces the spring 469 toward the spring 468. The adjustment is such, however, that only when the two coils become energized simultaneously do the said springs 468 and 469 come into engagement. The back-release-relay is designed to control circuits that comprise the release-magnet of the "connector", and by means of which a called subscriber may destroy connection with his own line. The release of the "first-selec-

tor", it has been pointed out, does not occur until the de-energization of the release-magnet; but the release of the "connector" occurs immediately upon the energization of the release-magnet of the latter. Should the "connector-shaft" 381 be raised at the time when the release-magnet is energized, the release-armature 397, as above stated, kicks the double-dog 399 under the release-link, which latter then catches the lug 405 and holds the said double-dog out of engagement with the shaft. The shaft being free, in the same manner described in connection with the "first-selector", returns to its normal position.

Referring to Figs. 27 and 28, it will be understood that the individual trunk-selecting mechanism C, associated with the calling line of the sub-station A, is identical with the individual trunk-selecting mechanism F associated with the called line that leads to the sub-station B^1, and needs no explanation since like parts are likewise represented. When reference is made to parts of the individual trunk-selecting mechanism F of the called line, it will be understood that their functions and connections are the same as those already described in connection with the individual-switch C.

It will also be understood that the subscriber's substation equipment may be of any suitable, known or approved character, it being essential that each subscriber be provided not only with means for transmitting the electrical impulses necessary for operating the automatic trunk-selecting switching machinery, but also with means for effecting the ringing of the bell at the called subscriber's station, and for then carrying on telephonic communication with the called subscriber as soon as the latter answers. As shown in Figs. 27 and 28, the subscribers' equipments at the calling and called sub-stations A and B^1 comprise an arrangement whereby the removal of the receiver from the switch-hook causes the transmission of a preliminary electrical impulse for operating the subscriber's individual trunk-selecting switch mechanism. Consequently, as soon as the subscriber begins transmitting the electrical impulses which represent the different digits of the called number, a "first-selector" is then ready and in waiting to receive these impulses. Also, as shown, the arrangement is such that the hanging up of the receivers will operate to automatically restore all of the switching machinery, and thus disconnect the calling subscriber's line from that of the called subscriber. It will be understood that the different instrumentalities embodied in the sub-station equipment can be of any suitable, known or approved character, and that the drawings are shown simply in diagram; and as thus illustrated, the construction of the sub-station equipment is as follows: At sub-station A the switch-hook 472, recognized by its peculiar construction, is made with a number of cam-like arms 473, 474, 475, 476 and 477. The primary circuit at said station comprises the primary winding 478 of the induction-coil 479, a transmitter 480, and a couple of springs 481 and 482 through the medium of which the said circuit is maintained closed or open, depending upon whether the hook is up or down. Said hook is held pivoted by one end to the screw 483, and is forced to rise, whenever the weight of the receiver 484 is removed from it, by a suitable switch-hook-spring not shown. The secondary circuit comprises the said receiver 484 in series with the secondary winding 485 of the induction-coil 479, two springs 486 and 487 identified with the signaling-button 488, and two secondary circuit-springs 489 and 490. The ringer circuit at said sub-station includes the ringer 491, the ringer circuit-spring 492, with which latter the switch-hook 472 closes contact, while it is down, by means of the cam-arm 476. The said ringer circuit is normally bridged across the main line; but while the hook is up, however, the said bridge is open, because the said spring 492 and the cam-arm 476 are removed apart. The cam-arm 474 controls the continuity of a ground circuit between the so-called ground-post 493 and the ground terminal G^1 through the medium of two springs 494 and 495 that are included in said circuit. The sub-station has three other springs 496, 497 and 498 which are known as the release-springs and by means of which the main line-conductors may be grounded simultaneously for the purpose of restoring the exchange apparatus, in a manner that will be fully explained. When the hook is depressed, as it descends, the said release-springs are forced together by the cam-arm 477, which latter then engages the laterally-projecting extremity 499 upon the spring 496. The engaging portions of the cam 477 and spring 496 are constructed with their surfaces at an angle to each other, so that as the hook goes down one surface of the projection 499 is engaged by the cam-arm, and when it rises the opposite surface is met. In this way, when the hook goes down, the spring 496 is forced into electrical connection with the springs 497 and 498, and when the hook rises it is shoved in the opposite direction. It will be seen that at the limit of each stroke of the hook, both up and down, the cam-arm 477 clears the spring 496. The calling device employed by the subscriber comprises two push-buttons 500 and 501, two contact-points 502 and 503, two springs 504 and 505 and the so-called ground-post 493. The spring 504 and contact 502 are normally in contact, as well as the spring 505 and contact 503; but when

the button 500 is pressed, the spring 504 is separated from the contact-point 502 and connected with the ground-post 493, and when the button 501 is pressed the second spring 505 is pressed onto the same ground-post after leaving the contact-point 503. There is an additional spring 506 which, when the switch-hook is raised, is connected to ground at the ground point G^1, and with which the cam-arm 473 engages when the switch-hook rises. One surface of this spring is insulated, while the other presents a metallic surface, and it is this metallic surface that the cam-arm 473 meets when the switch-hook rises. When the switch-hook descends, however, the cam-arm 473 passes over the insulated surface without making electrical connection with the said spring. The said cam-arm 473 is electrically attached to the switch-hook itself, while the switch-hook in turn is connected with the rotary side of the main line. The adjustment of the ground circuit-springs 494 and 495 is such that as the switch-hook rises, the said ground springs close contact before the cam-arm 473 leaves the ground spring 506. With such an adjustment, it will be evident that a ground impulse will be sent over the rotary side of the main line, as already stated, when the subscriber removes his receiver from the switch-hook.

While in the diagrams only two subscribers' lines have been indicated, namely, the calling subscriber's line and the called subscriber's line, it will be understood that the exchange may include any suitable number of subscribers' lines, according to the size and capacity of the exchange. As illustrated, each subscriber's line not only terminates in his individual trunk-selecting switch mechanism, but also has permanent connection with the multiple line-terminals of the different "connectors", any one of which can be used for obtaining connection with his line. The resistances of the different relays can be changed or varied to suit the requirements of different cases, but, as shown, the relays and electro-magnets of my improved automatic trunk-selecting switch mechanism, comprising the different subscribers' individual trunk-selecting switches, may have their different resistances adjusted as follows: The line-relay 95 may be of 500 ohms resistance; the auxiliary-relay 108 of 1000 ohms; each of the coils of the operative magnet 158 of 20 ohms; the busy-release-relay-coils 211 and 212 of 500 ohms each; and the auxiliary-busy-release-relay 213 of about 100 ohms.

With the foregoing construction and circuit arrangement, the operation by which the subscriber at sub-station A obtains connection with the sub-station B^1 is as follows: It will be assumed that sub-station A is sub-station #400 and that sub-station B^1 is #220. Then, if the subscriber at the first sub-station wishes to establish connection with the sub-station #220 he will remove his receiver 484 from its resting place, thereby permitting the switch-hook 472 to rise. As a direct result, the ground springs 494 and 495 close into contact, as well as the secondary circuit-springs 489 and 490. The ringer circuit is broken at the instant that the cam-arm 476 leaves the ringer spring 492, after which the cam-arm 473, by engaging with the conducting part of the spring 506, sends a ground impulse over the rotary-line-conductor 550. The grounding of said line-conductor energizes the line-relay 95 through the following circuit: from ground G^1 through the ground springs 495 and 494, conductor 551, preliminary impulse spring 506, cam-arm 473, switch-hook 472, conductors 552 and 553, contact-point 503, spring 505, rotary-line-conductor 550, line-relay-springs 99, 100 and 101, conductor 554, line-relay 95, conductors 555 and 556 to the non-grounded terminal of battery B and to ground G. As soon as the said line-relay 95 becomes magnetized, its armature 96 operates the line-relay-springs in such manner that the spring 101 is separated from the springs 99 and 100 and forced into contact with the spring 102. At the same time, the springs 103 and 104 are forced into contact, and the springs 99 and 100 spring out of engagement with each other. Furthermore, the operation of the said armature 96 shifts the subscriber's line-bank 32, so that the line-spring terminals of said bank are shifted opposite their corresponding trunk-line-contacts. At the same time, the spring-contacts 80 and 81 are moved into engagement with the busy circuit contact-points 83 and 82, respectively. The adjustment of the line-relay-springs is such that when the line-relay 95 is energized, the line-relay-spring 101 engages the adjacent spring 102 before it leaves the spring 100. Therefore, the energizing circuit through the said line-relay is changed even while the said relay is energized. After the line-relay-springs have been shifted, the energizing circuit through said relay extends from ground G^2 through the circuit-breaking springs 220 and 219, conductor 557, spring 91, contact-point 90, conductor 558, auxiliary-relay-springs 112 and 111, conductor 559, line-relay-springs 102 and 101, conductor 554, through the said relay 95 to the non-grounded terminal of battery B and to ground G. At the same time that the shifting of this circuit through the line-relay occurs, a second circuit is established that comprises the individual-switch operative magnet 158. This circuit is completed as soon as the line-relay-springs 103 and 104 become engaged, and the current passes from ground G^3 through the auxiliary-relay-springs 114 and

113, conductor 560, springs 104 and 103, conductor 561, off-normal springs 123 and 122, conductor 562, operative magnet springs 172 and 173, conductors 563 and 564, magnet 158, conductors 565 and 556 to the non-grounded terminal of battery B and to ground G. As an immediate result, the armature 162 of the magnet 158 becomes attracted, and the tripper-bar 116, in a manner explained, tilts the bank 32, since the downwardly-extending arm 48 has been shifted in front of its corresponding tripper-bar lug 117. As a result, the arm 48 is forced beyond the locking-spring 119, so that as long as the magnet 95 is retained magnetized the bank 32 will remain tilted. It will be evident, from the construction already described, that as soon as the armature 162 is attracted, the latter then forces the spring 173 from the spring 172. The separation of said two springs will, of course, destroy the original energizing circuit through the magnet 158, but said springs are so adjusted that they do not separate until after the armature 162 forces the interrupter-springs 168 and 170 into engagement. The energizing circuit through the magnet 158 is then changed, even while the said magnet is energized, and the current in the last circuit established passes from ground G^4 through the springs 170 and 168, conductors 566 and 564, through the said magnet 158 to the non-grounded terminal of battery B and to ground G. As shown more clearly in Fig. 3, the said springs 168 and 170 are cleared by the armature 162 just about the time that the said armature strikes the pole-pieces of the magnet 158, at which instant the energizing circuit through the said magnet is destroyed and the armature 162, by suitable retracting-springs, is restored to its normal position. Assuming that at the time the subscriber goes to make his call the trunk-line terminal-bar 10 is drawn up in readiness for connection; then when the armature 162 is attracted by the magnet 158, the said bar is released by the locking-dog 179, which former is restored by its corresponding restoring-springs 137. It will be clear, then, that as the said bar 10 returns toward its normal position, the springs 66, 54 and 38 engage with the contact projections 25, 24 and 23, respectively. At the same time, the locking-dog 180 catches the bar 9 in the ratchet 142, so that when the armature 162 is released the bar 9 is drawn into selective position and placed in readiness to be seized by the next calling subscriber. At the instant that the contact-point 23 closes in connection with the spring 38 of the subscriber's terminal-bar 32, the auxiliary-relay 108 is short-circuited through ground for an instant. This short-circuit extends from ground G^2 through the springs 220 and 219, conductor 557, springs 91 and 90, conductor 558, auxiliary-relay-springs 112 and 111, conductor 559, springs 102 and 101, conductor 567, auxiliary-relay 108, conductor 568, to the spring 38, and thence through the contact-point 23 to the conductor 569 and through the conductors 570 and 571, springs 266 and 267 of the "first-selector" and to ground G^5. It will be understood, of course, that the individual-switch-springs 90 and 91 are so adjusted that the locking-dog 179 releases the trunk-line terminal-bar 10 before the said springs are separated; but as soon as the said springs do separate, the energizing circuit through the line-relay 95 is again changed and established in series with the auxiliary-relay 108. The current through this last established circuit passes from ground G^5 of the selected "first-selector" D, through the springs 267 and 266, conductors 571 and 570, conductor 569 to the contact-point 23, and through the spring 38 to the conductor 568, through the auxiliary-relay 108, conductors 567 and 554, line-relay 95 to the non-grounded terminal of battery B and to ground G. The current that passes through the line-relay 95 in this last circuit is considerably weaker than the current that originally flowed through said coil, since it is connected in series with the auxiliary-relay 108; but since the armature 96 is in its attracted position, this last current is sufficiently strong to maintain the said armature against the pole-piece of the relay. However, the winding in the auxiliary-relay 108 develops sufficient strength at said relay for the operation of its armature 109. When the auxiliary-relay 108 attracts its armature 109, the springs 114 and 112 are forced away from their corresponding springs 113 and 111. It might be expected that when the armature 162 of the main operative magnet 158 returns to its normal position, the energizing circuit through said magnet would be re-established as soon as the operative magnet-springs 172 and 173 re-engage; but the energizing of the auxiliary-relay 108 follows so quickly upon the attraction of the armature 162 that the original circuit, comprising the auxiliary-relay-springs 114 and 113, is destroyed by the operation of the auxiliary-relay-armature 109, and as a consequence the magnet 158 is energized but once. It will no doubt be evident that the provision of the interrupter-springs 168 and 170, in connection with the magnet 158, is designed to maintain the energized condition of the magnet 158 after the springs 172 and 173 are forced apart, and to render positive the action of the magnet 158 upon the armature 162. At the instant that the subscriber's bank terminal springs 66 and 54 engage the projecting contacts 25 and 24, respectively, the subscriber's line-conductors 572 and 550 are extended to the

trunk-conductors 573 and 574, and thence to the "first-selector" D, which is connected with said trunk. Since the busy circuit contact-points 80 and 81 are rigid with the subscriber's line-bank terminal 32, and since the corresponding contact-points 83 and 82 are rigid with the frame of the individual-switch as a whole it follows that when the tripper-bar 116 tilts the carriage 32 the contact-points 80 and 81 are thereby removed from engagement with the corresponding points 83 and 82. Whenever all the trunk-line bars from 1 to 10 are busy, however, if an eleventh subscriber attempts to make a call, the busy contact-points are not separated; and in a manner that will be explained later on, a busy signaling current is then sent to the calling subscriber's line.

When the trunk-line bar 10 is released it shifts, as stated, against the springs 66, 54 and 38, and the said bar is retained sufficiently out of normal position by the tension in said springs to keep the hooked arm 136 (Fig. 25), which controls the position of the stop 149, temporarily out of engagement with the said stop 149, and the end 154 of said stop is retained against the back stop 155 by the spring 157. As a result, the end 150 of the stop 149 then falls below the surface of the trunk terminal-bar 10, and if ten other subscribers of this group in succession bring their individual-switches into use, the tenth subscriber will not be able to seize the trunk-line that terminates in the bar 10—that is, after the bar 1 comes into use, the escapement-tooth 206 allotted to the bar 10 will not be able to engage the tooth 150 for the purpose of being held in engagement with the spring finger 146 and so raising the ratchet-arm 139 that it may be caught by the dog 180 at the next operation of the magnet 158; but instead the shaft 201 will rotate until one of the succeeding escapement-teeth finds a bar that is not in use, the stop-arm 149 of which, of course, will be raised to a position to catch its corresponding escapement-tooth in the position already described. The so-called normal-line-conductors 575 and 576 are connected directly with the line of the sub-station #400, and they terminate in "connector-banks" associated with "connectors" of the hundred to which the sub-station in question belongs. Therefore, when any subscriber calls the subscriber #400, the connection is made through one of the said "connectors" over the said normal-conductors 575 and 576. Associated with said normal-line-conductors is a private-normal-conductor 577 which, when the said sub-station #400 is making a call, is connected to ground. Said private-normal-conductor terminates at the "connector-private-banks" in contacts that correspond to the terminals of the normal-conductors 575 and 576. It will be pointed out that while the private-bank-contact corresponding to a given line is grounded, no "connector" can establish connection with the line over which the said ground is acting as a guarding potential. It will be remembered that when the contact-point 23 engaged the spring 38, the conductor 568 then becomes connected to ground G^5 at the "first-selector" D. This ground connection, in addition to retaining the relays 108 and 95 energized, provides a guarding potential at the connector by way of the private normal conductor 577 to protect the calling line #400 from interference by other calling subscribers while the said subscriber #400 is making a call. The subscriber's line having been extended to the "first-selector" D, in the manner explained, the next operation of the subscriber will be directed to the said "first-selector". Since the number to be called is #220, the calling subscriber, after having removed his receiver, as explained, presses the button 500 twice, and then the button 501 once. When the said button 500 forces the spring 504 against the ground-post 493 twice in succession, two momentary ground impulses are sent to the vertical-line-conductor 572 that produce two momentary energizations of the vertical-line-relay 269. The current through this circuit passes from the ground terminal G^1 at the sub-station #400 to the ground-post 493, and thence to the vertical-line-conductor 572, through the conductor 578, individual-switch line-spring 54, contact-point 24, conductor 573, side-switch-wiper 343, contact-point 349, conductor 579, vertical-line-relay 269, conductors 580, 581 and 582 to the non-grounded terminal of battery B and to ground G. The vertical-line-relay, upon attracting its armature 271, places the springs 273 and 275 in contact with each other, thus causing the magnetization of the vertical-magnet 285 each time that the said armature is attracted. The energizing circuit through the said vertical-magnet 285 extends from ground G^6 through the line-relay-springs 275 and 273, conductor 583, private-springs 327 and 326, conductor 584 vertical magnet 285, conductors 585, 586, 587 and 582 to the non-grounded terminal of battery B and to ground G. Upon the first operation of the vertical-magnet, the switch-shaft is raised one step, and at the same time, and just before the raising of the shaft occurs, the L-shaped piece 294 on the vertical-arm 291 lifts the release-link 295 from over the lug 306 and permits the double-dog to assume its operative position with the vertical-dog 303 against the circular teeth 260. Thus when the said link 295 is raised, the arm 361 clears the ground spring 362, which latter then falls against the contact-point 363 and maintains the conductor 570 in connection with ground, even

after the shaft permits the springs 266 and 267 to separate. Upon the second energization of the vertical-magnet, the shaft is raised a second step and retained thus raised by the vertical-dog 303. As soon as the shaft-spring 266 passes out of engagement with the contact-point 267, the energizing current that maintains the line-relay 95 and the auxiliary-relay 108 at the individual-switch C changes its circuit and, instead of passing to ground G^5 at the "first-selector" D, reaches the battery over the conductor 588 and through the contact-point 363 and spring 362 to ground G^9. The shaft having been raised two steps, the line-wipers 253 and 254 and the private-wiper 255, of course, are on a level with the first contact of the second level of their respective banks. Having pressed his button 500 twice, the subscriber then presses the button 501 once, as stated. As a result, the rotary-line-conductor 550 is grounded once, and the rotary-line-relay 270 of the "first-selector" D becomes magnetized by the current that then flows from the ground terminal G^1 at the sub-station #400 to the ground-post 493, thence through the spring 505 to the rotary-line-conductor 550, conductor 589, individual-switch-spring 66, contact-point 25, conductor 574, side-switch-wiper 344, conductor 590, rotary-line-relay 270, conductor 581 to the non-grounded terminal of battery B and to ground G. The rotary-line-relay, by attracting its armature, forces the spring 274 onto the ground-spring 275, and thereby causes the private-magnet 322 to become active. A current is established through said private-magnet from the ground terminal G^6 through the springs 275 and 274, conductors 591 and 592 to the said private-magnet, thence through the conductors 593, 587 and 582 to the non-grounded terminal of battery B and to ground G. The private-magnet being energized momentarily, the private-armature is attracted once and then restored. At the downward stroke of said private-armature, the escapement-tooth 336 clears the escapement-finger 338, which latter then falls against the escapement-tooth 331 immediately above. Since the said tooth 331 is slightly in front of the lower tooth 336, it follows that when the private-armature returns to its normal position the escapement-finger also clears the said tooth 331, at which instant the retracting-spring 339 draws the side-switch to the second position where it is stopped by the lug 340 striking the cam 256. The side-switch-finger 338 will then, of course, be found between the escapement-teeth 336 and 334, and the side-switch-wiper 341 will be in engagement with the side-switch contact-point 351. As soon as the side-switch-wiper and contact-point close connection, an energizing circuit is established through the rotary-magnet 308, and the current flows from ground G^7 to the contact-point 351, thence through the side-switch-wiper 341 and conductor 594 to the rotary-magnet coil 310, after passing through which it reaches the interrupter-springs 318 and 319 and the second rotary-magnet-coil 309, passing thence to the conductors 586, 587 and 582 to the non-grounded terminal of battery B and to ground G. The rotary-magnet 308 then attracts the rotary-armature 311 and forces the rotary-pawl 315 into engagement with one of the longitudinal teeth 259, causing the shaft to rotate one step. Just at the instant before the rotary-armature strikes the rotary-magnet pole-pieces, the rotary-dog 304 falls behind the first one of the longitudinal teeth, in a manner already described, to prevent the shaft from returning to its normal position when the rotary-magnet becomes de-energized at the instant that the interrupter-finger 317 forces the interrupter-springs apart and destroys the energizing circuit through said magnet. This interruption occurs just at the time when the rotary-armature strikes the pole-pieces. When the rotary-pawl 315 advances to engage the longitudinal teeth 259, the rotary-armature-finger 320 comes into contact with the private-armature 321, producing a depression of the latter at the same time that the rotary-pawl produces a rotation of the shaft. As the shaft begins to rotate, the cam 256 very soon passes out of reach of the cam-lug 340, and permits the escapement-finger 338 to fall against the tooth 334 before the rotary-armature-finger 320 has depressed the private-armature 321 too far. Very soon, however, the said tooth 334 is carried below the finger, which latter then falls against the upper tooth 332 just at about the time that the shaft-wipers are rotated onto the first contact of the second level of their respective banks.

As soon as the energizing circuit through the rotary-magnet is interrupted, the rotary-armature then begins to return to its normal position, and the private-armature follows up the receding movement of the rotary-armature-finger 320. The tooth 332 clears the escapement-finger 338 also, and the side-switch springs into third position with the escapement-finger 338 against the side-switch-stop 346. The shifting of the side-switch takes place just before the interrupter-finger permits the interrupter-springs 318 and 319 to re-engage, so that by the time they do re-engage the energizing circuit that has been described through the rotary-magnet has been destroyed between the side-switch-wiper 341 and the contact-point 351. When the motion of the rotary-armature ceases permanently, the operation of the "first-selector" comes to an end, the line-wipers 253 and 254 having

seized upon an idle trunk-line, similar to the trunk-line whose conductors 595 and 596 terminate at the tenth set of contacts of the second level of the same line-bank. The seized line is protected from further seizure by a guarding potential at the private-wiper and, therefore, at the first contact of the second level of the private-bank 251, and to all other private-contacts in multiple. Said guarding potential is established by reason of the connection between the grounded terminal of the battery B and said private-contacts, through the ground terminal G^8, side-switch-wiper 342, conductor 597 back-release-relay 281, conductor 598 and the private-wiper 255. Similarly, should any "first-selector" temporarily appropriate to its use the second trunk-line of the same level, a guarding potential will appear at the second private-bank-contact of the second level of the private-bank 251, as well as at all other private-banks in multiple; and should a third "first-selector" seize the third trunk on the same level, a guarding potential will appear also at the third private-contact of the second level; and should the fourth, fifth, etc., and ninth trunks be occupied, guarding potentials would be found at the fourth, fifth, etc., as well as at the ninth private-contact-terminals of the second level of the private-bank. Therefore, if the first nine trunk-lines of the second level are busy, a guarding potential is present at each one of the first nine private-contacts of the second level of the private-bank 251. If this condition exists at the time that the calling subscriber grounds his rotary-line-conductor by pressing the button 501, the rotation of the shaft will not terminate as soon as the wipers have engaged the first terminal of the level to which they have been raised. The first nine private-contacts being grounded, then when the calling subscriber grounds the rotary side of the line the side-switch trips into second position, in the manner described; but then the rotation of the shaft will begin, not to cease until the wipers have been carried beyond the last of the busy trunk-lines—in this case onto the tenth terminal of the second level of the banks in question. This operation takes place in the following manner: The energizing circuit through the rotary-magnet being closed, as pointed out, at the juncture when the side-switch-wiper 341 engages with the contact-point 351, the rotary-armature is attracted by the rotary-magnet 308, and the shaft is rotated one step, in the manner described, so that the line and private wipers are rotated into engagement with the first terminal of the second level of their respective banks. At the same time, the private-armature is depressed by the rotary-armature-finger, and the interrupter-springs 318 and 319, at the end of the stroke, are separated by the interrupter-finger 317. There being a guarding potential at the first contact which the private-wiper meets, a circuit is completed through the private-magnet 322, which extends from the grounded terminal G of the battery B, through the private-wiper of whatever "first-selector" is occupying the first trunk of the second level in question, through the bank-multipling conductors to the contact-point with which the private-wiper 255 has engaged, thence through said private-wiper 255, conductor 598, winding of the back-release-relay 281, conductor 597, side-switch-wiper 342, contact-point 352, conductors 599 and 592 and private-magnet 322 to the non-grounded terminal of battery B and to ground G. The private-armature is thereby retained in the depressed condition, even after the energizing circuit is broken at the interrupter-springs, and while the rotary-armature-finger 320 returns to its normal position in response to the retracting tension of the rotary-armature retracting-spring 313, since the escapement-finger 338 is held by the upper foremost escapement-tooth 332. The side-switch-wiper 341 being, therefore, retained in engagement with the grounded contact-point 351, as soon as the interrupter-springs re-engage, the energizing circuit is once more completed through the rotary-magnet 308. As a result, the rotary-armature is again attracted, the shaft is rotated one more step, and the private-wiper 255 is slid onto the second terminal of the second level of the private-bank 251. Said second contact also being grounded, the energizing circuit through the private-magnet is still maintained, so that the side-switch is still not liberated when the rotary-armature again returns to its normal position. Clearly, then, the shaft will be rotated in a step-by-step manner as long as the private-wiper continues to meet with grounded private-contacts. After having rotated onto the ninth contact, the private-wiper is rotated one more step and brought into engagement with the tenth contact of the second level of the private-bank; but this last contact being without guarding potentials, as soon as the said wiper leaves the ninth contact the magnetizing circuit through the private-magnet that has up to this time maintained the private-magnet energized is broken. This occurs at just about the time when the rotary-armature is at the end of its attractive or forward stroke, so that the private-armature which has up to this time held the side-switch in its second position, by reason of the magnetizing force that has now disappeared from the private-magnet, falls back upon the rotary-armature-finger and follows said finger as the rotary-arma-

ture returns to its normal position. Between the time that the rotary-armature is released by the private-magnet and the time that the rotary-armature fully regains its normal position, the escapement-finger 338 which, during the rotation of the shaft, has been resting against the foremost tooth of the upper escapement-spring disengages from said tooth and permits the side-switch to pass into the third position. It is then that the side-switch-wiper 341 leaves the contact-point 351 and passes onto the contact-point 355. This disengagement occurs just before the interrupter-springs 318 and 319 re-engage, so that the circuit through the rotary-magnet is permanently broken in order that no further rotation of the shaft may take place during its operation. The side-switch-wipers 343 and 344 having engaged with the contact-points 357 and 358, the subscriber's extended line-conductors 573 and 574 are then extended through the respective wipers and over the conductors 600 and 601 to the vertical and rotary line-wipers 253 and 254, respectively. Said wipers being at the time in engagement with the tenth contact of the second level of the line-bank, the calling subscriber is thus placed in connection with the "connector." It will be understood, of course, that the seized or appropriated line is protected by a guarding potential as soon as the side-switch-wiper 342 engages the contact-point 356, as previously explained. It may be stated at this point that if, after the subscriber has begun to call, and before the "first-selector" has trunked to the "connector," he should desire to discontinue his call, he may interrupt the operation of the "first-selector" and restore it by simply hanging up his receiver on the switch-hook 472. This may occur while the side-switch is either in the first or second position—it matters not. As a result of restoring the receiver both sides of the main line will be grounded simultaneously. The vertical and rotary line-relays 269 and 270 will be magnetized at the same time, and as a result the release-magnet 298 of the "first-selector" will be energized, and the "first-selector" will be restored. It has been explained that in its action the release cam-arm 477, as it passes down, when the receiver is restored, flexes the release-springs 496, 497 and 498 into contact for a moment. Of these springs the release-springs 496 and 497 are connected, respectively, with the vertical and rotary line-conductors, while the third release-spring 498 is connected to ground G^1. Therefore, as a natural result, the temporary union of these three springs sends a ground impulse over each of the main line-conductors, with the effect upon the "first-selector" line-relays already mentioned. The current through the vertical-line-relay during this release passes from ground G^1 through the ground springs 495 and 494, conductor 551, release-springs 498, 497 and 496 to the vertical-line-conductor 572, thence to the conductor 578, individual-switch-spring 54, contact-point 24, conductor 573, thence through the said relay to the non-grounded terminal of battery B and to ground G.

Through the rotary-line-relay 270 the current flows from the same ground terminal G^1 to the release-spring 498, thence through the release-spring 497 and to the rotary-line-conductor 550, conductor 589, individual-switch-spring 66, contact-point 25, conductor 574, thence through the rotary-line-relay 270 to the non-grounded terminal of battery B and to ground G. Since the contact-points 349 and 353, associated with the vertical-side-switch-wiper 343, are connected together, and as the contact-points 350 and 354 of the rotary-side-switch-wiper 344 are connected together, it will be evident that it makes no difference whether the side-switch is in first or second position; for the energizing circuits during the release, as pointed out in the conditions under consideration, will be the same. It is already evident that when the rotary-line-relay is energized the private-magnet 322 is energized as a result, which latter, during its energizing, maintains the private-springs 327 and 328 in contact. It is also obvious that when the vertical-line-relay is magnetized the private-spring 327 is connected with ground G^6 at the line-relay-springs. It was shown that when said private-spring 327 was grounded, and while in contact with the spring 326, the vertical-magnet 285 was energized; but in this case, since said springs 327 and 326 are not in contact, while the springs 327 and 328 are in engagement, a different circuit is established that comprises the release-magnet 298. The energizing current in this circuit passes from the ground G^6 to the private-springs 327 and 328, thence through the conductors 602 and 603 and the release-magnet 298, conductors 585, 586, 587 and 582 to the non-grounded terminal of battery B and to ground G. When the cam-arm 477 clears the release-springs, the line-relays 269 and 270 become de-energized. As a result, the release-magnet 298 becomes de-energized, and the armature of the latter, in regaining its normal position, restores the "first-selector-switch" in a well-known manner. As soon as the release-magnet 298 releases the release-armature 297, the lateral projection 361 on the release-link 295 withdraws the spring 362 from the contact-point 363, and this occurs before the switch-shaft 252 reaches its lowest position. Evidently then, from the time that the release-magnet 298 is de-energized to the time when the switch-

shaft 252 is restored, there is a short interval of time in which the conductor 570 is disconnected from both the ground terminals G^5 and G^9. The disconnection of said conductor 570 from ground destroys the energizing circuit through the auxiliary-relay 108 and the line-relay 95, both of which relays are then restored to their normal conditions. Evidently, as a result, the line-terminal bank 32, individual to the line #400, and controlled by the line-relay 95, is restored to its normal position with the springs 66, 54 and 38 out of engagement with the contact-points 25, 24 and 23, respectively. At the same time, the tilting lock-arm 48 clears the locking-spring 119, at which time the bank off-normal-springs 91 and 90 are restored in engagement with each other. It is thus, then, that not only the individual apparatus of the line #400 is fully restored, but the "first-selector" D as well. However, if the switches are not released, the switching of the "first-selector" line-wipers 253 and 254 onto the trunk-conductors 595 and 596 places the sub-station #400 in direct communication with the "connector" E, which latter will in turn be operated when the calling subscriber next presses his push-button 500. The grounding of the vertical-line-conductor twice will cause the vertical-line-relay 449 to be energized twice. The current will flow in this case from the ground terminal G^1 to the vertical-line-conductor 572, thence through the conductor 578 to the vertical-trunk-conductor 573, through the side-switch-wiper 343 of the "first-selector", contact-point 357, conductor 600, vertical-line-wiper 253, vertical-trunk-conductor 595 to the vertical-line-relay 449, after passing through which it extends through the conductors 604, 605, 606 and 607 to the non-grounded terminal of battery B and to ground G. The vertical-line-relay, after attracting its armature 450, closes the springs 451 and 452 in electrical contact and establishes an energizing circuit through the vertical-magnet 392 of the "connector". In this last case, the current passes from ground G^{10} through the springs 452 and 451, conductor 608, private-springs 422 and 421, conductor 609, side-switch-wiper 433, contact-point 437, conductor 610, vertical-magnet 392, conductor 605 to the non-grounded terminal of battery B and to ground G. The vertical-magnet, upon attracting its armature twice, in the same manner that the previous "selector" operated its shaft, raises the shaft 381 two steps and places the "connector-wipers" 382, 383 and 384 opposite the first contact of the second level of their corresponding banks. The calling subscriber then presses the rotary-button 501 once, grounds the rotary-line-conductor 550, and energizes the rotary-line-relay 455 once, which in turn closes another circuit in the "connector," to be described. The energizing current through the said rotary line-relay passes from ground G^1 to the rotary-line-conductor 550, thence to the rotary-trunk-conductor 574 and to the "first-selector" side-switch-wiper 344, after reaching which it passes through the contact-point 358, conductor 601, rotary-line-wiper 254, trunk-conductor 596, rotary-line-relay 455, conductors 604, 605, 606 and 607 to the non-grounded terminal of battery B and to ground G. The rotary-line-relay when energized forces the line-relay-springs 457 and 452 into contact and, as a result, energizes the private-magnet 412. The current through this circuit may be traced from ground G^{10} through the springs 452 and 457, conductor 612, private-magnet 412, conductor 607 to the non-grounded terminal of battery B and to ground G. The "connector" private-magnet, being energized once, attracts its armature once, which latter permits the "connector" side-switch to pass to second position. The side-switch-wiper 433 then passes from the contact-point 437 onto the contact-point 438, and the side-switch-wiper 434 passes from the contact-point 440 to the contact-point 441. The shifting of the side-switch-wiper 433 produces a change in circuits in the "connector" that includes said wiper. Then when the vertical-button 500 is pressed ten times for the last digit, causing the energization of the vertical-line-relay 449 ten times, as a result, over a circuit already pointed out, the rotary-magnet 408, instead of the vertical-magnet 392, is operated when the springs 451 and 452 are forced into contact. Each time that the springs 452 and 451 are brought into engagement, a current passes from the ground terminal G^{10} through the said springs, through the private-springs 422 and 421 and through the conductor 609 to the side-switch-wiper 433, passing through which latter it then extends through the contact-point 438, conductor 613, thence through the rotary-magnet 408 to the non-grounded terminal of battery B and to ground G. At each pulsation, the rotary-magnet attracts its armature 409, rotating the shaft 381 one step at a time, and sliding the shaft-wipers 382, 383 and 384 along the second level of the banks with which they engage. At the end of the tenth pulsation the said wipers are landed on the tenth contact-terminals of the second level. For the last time the rotary-push-button 501 is pressed once, and the rotary-line-relay 455 is energized once. Again the private-magnet 412 is energized once, and the side-switch passes into third position with the side-switch-wipers 433, 434, 435 and 436 in contact with the contact-points 439, 442, 445 and 448, respectively. The

engagement of the side-switch-wiper 434 with the contact-point 442 establishes a guarding potential at the private-wiper 384 and, therefore, at the tenth private-contact of the second level of the private-bank 380, to preclude any other "connector" from entering into connection with the called line #220. It will be understood, of course, that the same guarding potential exists at all other private-bank-contacts in multiple with the private-bank-contact mentioned. The closure of contact by the side-switch-wipers 435 and 436 with the contact-points 445 and 448, respectively, connects the extended subscriber's lines 595 and 596 through the condensers 514 and 515 with the vertical and rotary line-wipers 382 and 383 and, therefore, with the normal-conductors 516 and 517 that constitute the terminals of the called sub-station #220. The individual-switch, it will be remembered, places a guarding potential over the calling line at the "connector" private-bank-contacts that correspond to the sub-station #400 at the instant that the said individual-switch trunks the calling subscriber's line through to a "first-selector." Later, and at the instant that the "connector" seizes the called subscriber's normal-conductors 516 and 517, the calling "connector" places a guarding potential over the called line at the instant that the side-switch-wiper 434 engages with the contact-point 442. Evidently, then, a line is protected from seizure by guarding potentials either when it is calling or when it has been called. The establishment of the guarding potential for the called line #220 not only protects it from further seizure, but forces a current through the auxiliary and line relays 618 and 619 which are individual to the line of the sub-station #220. This current energizes the said relays, but the armature of relay 619 is attracted just enough to separate the line-relay-springs 620, 621 and 622. Since the relay 619 is energized in series with the relay 618, the current that passes through the former is not sufficient to operate the carriage or bank of line-terminals, individual to the line of the sub-station #220, against the restoring tension of the spring 34, Fig. 4, but is only sufficient to separate the springs already pointed out.

Referring to Fig 4, it will be noticed that the arm 97 upon the armature 96, when the relay 95 is not energized, is withdrawn a small distance from the pin-bearing 35 of the bank or carriage 32. Therefore, the armature 96 may be attracted by a weak current sufficiently to separate the springs 99, 100 and 101, but which current is not sufficiently strong to carry the armature beyond the point where the pin 97 strikes the bearing 35. This is the case with the line-relay 619 in Fig. 28. It should be noted that the spring 623 is so adjusted that the spring 624 does not engage with it when the armature of the relay 619 is attracted to the extent described. The object in energizing the relay 619 when a subscriber calls the line #220 is to remove a short-circuit from across the line-conductors 625 and 626 that exists normally through the springs 620 and 621 when said springs are in contact. The energizing circuit through the said relays 618 and 619 extends from ground G^{11} to the side-switch-wiper 434, conductor 627, private-wiper 384, private-normal-conductor 628, auxiliary-relay 618, conductor 629, line-relay 619 to the non-grounded terminal of battery B and to ground G. The connection between the calling and the called line having been established, the calling party is in a position to signal the called line by means of the signaling-button 488. Before going any further it may be explained that if for any reason the called line is busy at the time that the calling subscriber grounds the rotary-line-conductor 550 for the last time to transfer the "connector" side-switch from the second to third position, the "connector" is released. For instance, if the line #220 has been called by another "connector" there would be a guarding potential at the tenth private-contact of the second level of the private-bank 380 corresponding to the line of the called station #220. Or, on the other hand, if the called line is making the call the same private-bank-contact will be connected to ground from the instant that the individual-switch mechanism trunks the calling line through to a "first-selector", as previously explained. Said guarding potential, in the last case, will reach the private-bank of the "connector" by way of the private-normal-conductor 628. At any rate, if the private-wiper 384 finds a guarding potential at the tenth contact of the second level of the private-bank 380, at the instant that the calling subscriber grounds the rotary-line-conductor for the last time, instead of the side-switch being tripped to the third position, the release-magnet of the "connector" is energized. The grounding of the rotary line operates the "connector" rotary-line-relay 455, and the rotary-line-relay in turn causes the private-magnet 412 to become magnetized. This last magnet, when it attracts its armature, separates the private-springs 421 and 422 and closes a connection between the private-springs 423 and 424. The energizing circuit through the release-magnet flows from the ground terminal of the battery B to the tenth contact of the second level of the "connector" private-bank 380, through the private-wiper 384, conductor 627, side-switch-wiper 434, contact-point 441, private-springs 423 and 424, conductors 630 and 631,

release-magnet 396, conductor 606 to the non-grounded terminal of battery B and to ground G. The "connector" release-magnet becoming energized, the release-armature 397 kicks the double-dog 399 in such manner that the lug 405 is caught and held in the aperture 406 on the end of the release-link 400. Of course, when the double-dog is thus rotated, the locking-arm 403 is withdrawn from the longitudinal teeth 386. The shaft is then free to rotate back to its normal position, owing to the tension of the coil-spring 389, until the normal-post-arm 388 strikes the normal-post 632. At that instant the shaft-support 633 projects into the slot 634, and the said shaft of necessity falls to its normal position. The release-armature, when it rotates the double-dog 399, drives the side-switch to its first position about the pivots 430 through means of the side-switch-link 432 and the release-arm 404. This latter, by pressing the former back, forces the escapement-finger 426 back between the escapement-springs where it is caught behind the rearmost lower tooth 418. The restoration of the "connector-shaft" takes place while the release-magnet 396 is energized; but since the energizing circuit through said armature comprises the private-wiper 384 and the side-switch-wiper 434, it will be evident that as soon as the shaft begins to rotate toward its normal position the energizing circuit through the release-magnet will be broken as soon as the said private-wiper leaves the private-contact-point with which it has been engaged. The same energizing circuit is also interrupted when the side-switch-wiper 434 is forced toward its first position. The subscriber, thinking that he has established connection, presses the signaling-button 488 at his station, with the result that the spring 487 is separated from the contact-point 486 and closed in connection with the grounded contact-point 635. The said spring 635 being in direct communication with the vertical-line-conductor 572 through the springs 489 and 490, the pressing of the button 488. as a result, grounds the vertical side of the line. The energizing of the "connector" vertical-line-relay 449 follows in the usual manner, and since the "connector" side-switch is in the first position the "connector" vertical-magnet 392 is energized when the line-relay-springs 451 and 452 are pressed into contact. The energizing circuit through the vertical-magnet is already familiar, and as a final result of energizing the said vertical-magnet the "connector-shaft" 381 is raised. When the normal-post-arm 388 leaves the spring 390, the latter falls against the contact-point 391 and a busy signaling current is then transmitted to the calling subscriber's station. The busy signaling machine may be of any suitable type, and as indicated in Fig. 27 comprises the coil 636 in which the current that produces the busy signal is generated. From this coil the current passes to the contact-point 391 and through the spring 390 to the contact-point 446, thence through the side-switch-wiper 436 and through the condenser 515 to the trunk-conductor 596, rotary-line-wiper 254 of the "first-selector", side-switch-wiper 344, conductor 574, individual-switch contact-point 25, spring 66, rotary-line-conductor 550 through the receiver 484 and back to the vertical-line-conductor 572, individual-switch-spring 54, contact-point 24, conductor 573, side-switch-wiper 343 of the "first-selector", vertical-line-wiper 253, conductor 595, vertical-line-relay 449 and back to the coil 636. The subscriber will then restore his receiver to its switch-hook, thereby grounding both line-conductors 572 and 550, as before described. The grounding of these two conductors causes simultaneous energization of the rotary and vertical line-relays of the "connector", which relays, attracting their armatures simultaneously, permit the "connector" trunk-release-springs 453 and 454 to come into contact. The contact of these release-springs establishes an energizing circuit through the "connector" release-magnet 396 and through the "first-selector" back-release-relay 281. The current in this circuit flows from the ground terminal G^8 to the side-switch-wiper 342, through the back-release-relay 281 to the private-wiper 255, and over the trunk-conductor 637 through the trunk-release-springs 453 and 454 to the release-magnet 396, and to the non-grounded terminal of battery B and to ground G. When the release-magnet of the "connector" is energized, the "connector", of course, is released, and when the back-release-relay 281 of the "first-selector" attracts its armature 282 the release-magnet 298 of the "first-selector" becomes energized also. The current through said release-magnet passes from ground G^{12} to the back-release-relay-springs 283 and 284 to the conductor 603, and through the said release-magnet 298 to the non-grounded terminal of battery B and to ground G. The release of the "first-selector", however, does not occur until after the release-springs at the substation #400 disengage, at which time the line-relays of the "connector" become de-energized and destroy the circuit through the "connector" release-magnet and through the "first-selector" back-release-relay. Of course, the armature of the "connector" release-magnet is restored, and as soon as the back-release-relay-springs 284 and 283 fall apart, the "first-selector" release-magnet becomes de-energized, restoring said switch in a well-known manner, and producing at the same time the restoration of the individual-switch mechanism individual to the line

#400, as soon as the release-link 295 separates the ground spring 362 from the contact-point 363, in a manner already pointed out. But it has been described that the calling subscriber does not find the line #220 busy and that he has completed the desired connection. Having done so, he presses the signaling-button, as already stated, grounding the vertical-line-conductor and energizing the "connector" vertical-line-relay 449 as a result. In such a case, the engagement of the springs 451 and 452 causes the energization of the ringer-relay 458, since the side-switch-wiper 433 is in its third position in engagement with the contact-point 439. The current through said ringer-relay passes from ground G^{10} through the line-relay-springs 452 and 451 to the side-switch-wiper 433, and then through the ringer-relay 458 to the non-grounded terminal of battery B and to ground G.

When the ringer-relay 458 attracts its armature 459, the ringer-generator J is thrown across the normal-conductors 516 and 517, when the ringer-relay-springs 461 and 464 come into contact with the ringer-relay-springs 462 and 465, respectively. The ringing current passes from the normal-conductors 516 and 517 to the line-conductors 625 and 626, reaching the sub-station #220, and passing through the ringer 638 energizing the latter. The two sub-stations being connected, the subscribers may then communicate with each other in a well-known manner over the circuits that have been established between the two stations. The receiver 484 at sub-station #400 is in series with the receiver 639 at the sub-station #220. This circuit may be traced from the receiver 484 through the secondary winding 485 of the induction-coil 479 to the vertical-line-conductor 572, conductor 578, individual-switch-spring 54, contact-point 24, trunk-conductor 573, side-switch-wiper 343, line-wiper 253, trunk-conductor 595, condenser 514, ringer-relay-springs 463 and 464, side-switch-wiper 435, vertical-line-wiper 382, normal-conductor 516, vertical-line-conductor 625, through the springs 640 and 641, secondary winding 642 of the induction-coil 643, receiver 639 to the rotary-line-conductor 626, conductor 517, rotary-line-wiper 383, side-switch-wiper 436, ringer-relay-springs 461 and 460, condenser 515, conductor 596, rotary-wiper 254, side-switch-wiper 344, conductor 574, contact-point 25 and spring 66, conductor 589, rotary-line-conductor 550 to the receiver 484. After the two subscribers have communicated, if the called subscriber restores his receiver to the switch-hook first, he grounds both the line-conductors 625 and 626 simultaneously, and thereby energizes the back-release-relay-coils 466 and 467. The current through the coil 466 passes from ground G^{13} at the sub-station #220 to the release-springs 644, 645 and 646, after which it reaches the vertical-line-conductor 625, vertical-line-wiper 382, side-switch-wiper 435, ringer-relay-springs 464 and 463, said coil 466, and passes on to the non-grounded terminal of battery B and to ground G. The current through the coil 467 passes from ground G^{13} to the release-spring 644, after which it passes through the release-spring 645 to the rotary-line-conductor 626, rotary-wiper 383, side-switch-wiper 436, ringer-relay-springs 461 and 460 to the coil 467 and to the non-ground terminal of battery B and to ground G. The armatures 470 and 471 being attracted simultaneously, the release-magnet 396 of the "connector" becomes energized, and as a result the "connector" is released. But if the calling subscriber restores his receiver first, the line-conductors 572 and 550 become grounded at the same time, and the line-relays 449 and 455 of the "connector" attract their armatures 450 and 456 at the same time. When the trunk-release-springs 453 and 454 come into contact, the "connector" release-magnet and the "first-selector" back-release-relay become magnetized through a circuit previously described, at which time the "connector" is released and the "first-selector" release-magnet is energized at the instant that the back-release-relay 281 closes the springs 284 and 283 together. When the release-cam 477 at the sub-station #400 clears the release-springs, the ground connection to the line is destroyed, and the "first-selector" release-magnet becomes de-energized, with the result that the "first-selector" is released, the "connector" release-armature is restored, and the individual-switch mechanism individual to the line #400 is restored, as before, as soon as the connection through the auxiliary and line relays 108 and 95 is destroyed at the instant that the release-link 295 separates the grounded spring 362 from the contact-point 363. If it should happen at any time that all of the trunk-line bars from 1 to 10, inclusive, are in use, all of the projections 128 at the end of said bars will have receded from the pivoted cross-piece 126, and the latter is then drawn forward by the retracting-spring 129, so that the projecting finger 130 separates the spring 122 from the spring 123 and closes the spring 121 in contact with the former spring 122 instead. That being the case, the contact-point 172 is connected directly with the conductor 647, which conductor has connected to it in multiple all the springs 364 of the "first-selectors" which are connected with the bars 1 to 10, inclusive. It will be evident that as long as any one of the ten "first-selectors" is out of use, the conductor 647 will be connected to ground through the springs 364 and 267, and that when all of the shafts of the ten "first-selectors" in question are raised, the

ten paths that the conductor 647 has to ground are destroyed. Therefore, after the ten trunk-bars have become busy, as soon as one of the ten busy "first-selectors" is released, the operative magnet 158 will be energized by current passing from ground at the said released "first-selector" to the conductor 647, through the contact-points 121 and 122, conductor 562, contact-point 172, spring 173, magnet 158 to the non-grounded terminal of battery B and to ground G. At the first stroke of the armature 162, the spring 208 that furnishes power for rotating the escapement-bar 201 is wound up, when the arm 207 that carries the ratchet-dogs 205 is depressed by means of the arm 209. As soon as said spring 208 acquires tension, the escapement-bar 201 rotates until the escapement-tooth that corresponds to the trunk bar that has been restored to use when the first of the ten busy "first-selectors" is released strikes the stop-arm 149 of the said bar. As a result, the ratchet-arm 139 of the released bar is raised into a position that will enable the dog 180 to catch said ratchet-arm at the next stroke of the armature 162. At the second stroke of the armature 162, the released bar is caught and drawn into a selective position to be used by the next subscriber who makes a call. At the instant that the said bar is drawn up, the finger 130 is withdrawn from the off-normal-spring 121, which latter then breaks away from the spring 122, while the spring 122 comes into engagement again with the spring 123. In this way, the conductor 561 is again restored in connection with the conductor 562, so that the next subscriber upon making a call will cause the magnet 158 to be operated directly and only once. If the subscriber should attempt to make a call while the ten trunk-lines leading from the individual-switch are busy, the operative magnet 158 will not become energized, but the trunk-line terminal-bank or carriage of the said calling line will be simply shifted forward without being tilted, and the line-conductors of the calling line will be connected with a busy signaling apparatus to notify the subscriber that the apparatus is busy. For instance, assuming that the subscriber #400 attempts to make a call after all the trunk bars are in use, upon grounding the rotary-line-conductor 550 when he removes his receiver from the switch-hook the line-relay 95 will be energized as usual; but since the off-normal-springs 122 and 123 are out of contact, as explained, because all the trunk bars are in use, the closure of the line-relay-springs 103 and 104 does not produce an energization of the operative magnet 158 as would be the case ordinarily. The relay 95 will be retained energized as long as the subscriber retains his receiver off of the switch-hook, and the circuit through the said line-relay will extend, as before, from the ground terminal G^2 through the interrupter-springs 220 and 219, the line-bank off-normal-springs 91 and 90, auxiliary-relay-springs 112 and 111, line-relay-springs 102 and 101, through the said line-relay 95 to the non-grounded terminal of battery B. When the line-bank or carriage 32 is shifted by the energization of the line-relay 95, the busy contact-springs 80 and 81 are placed in connection with their corresponding contact-points 83 and 82, and a busy signaling current is sent to the calling sub-station from the coil 221 in which the busy current is generated. The path of this current may be traced from the coil 221 through the relays 212 and 211 to the contact-point 83, thence through the contact-point 80 to the conductor 589, line-conductor 550, through the receiver 484 back to the vertical-line-conductor 572, to the conductor 578 and to the spring 81, after which it passes to the contact-point 82 and back to the busy coil 221. The subscriber, upon operating his calling device, will ground the vertical and rotary line-conductors in the systematic order well known, but the only effect produced upon the central office exchange apparatus is the alternate actuation of the armatures 214 and 216 of the relays 211 and 212, respectively. Each time that the vertical line is grounded, the vertical-busy-release-relay 212 becomes energized by a current passing from ground G^1 to the vertical-line-conductor 572, through the said coil 212, after passing through which it branches to the conductors 648 and 556 and to the non-grounded terminal of battery B and to ground G. No result of importance is produced by the armature 216 meeting the contact-point 217 at this stage. When the rotary-line-conductor 550 is grounded, the rotary-busy-release-coil 211 in turn becomes magnetized, through which coil the current passes from ground G^1 to the conductors 648 and 556 to the battery B and to ground G.

The subscriber, hearing the busy signal, learns he has no connection, restores his receiver, and thereby grounds both the vertical and rotary line-conductors simultaneously. In this case, both the vertical and the rotary-busy-release-relays 212 and 211 become magnetized, and both the armatures 216 and 214 become attracted simultaneously. The operation of the said two armatures at the same time completes a circuit through the busy-release-auxiliary-relay 213 from ground G^{14}, through the coil 213 to the contact-point 215, through the armatures 214 and 216, contact-point 217, conductors 648 and 556 to the non-grounded terminal of battery B and to ground G. The armature 218 being attracted, the springs 219 and 220 are forced apart, and the energizing circuit through the line-relay 95 being destroyed the said relay and

the corresponding carriage or bank of subscriber's line-contacts are restored. Of course, it will be clear that if the number 220 called by the sub-station #400 should be one of the sub-stations the line of which is connected with the individual-switch mechanism C, the individual-switch represented at F (Fig. 28) would be instead the individual-switch C. Representations of the individual-switches at C and F in Figs. 27 and 28 do not comprise in either case the full individual-switch, but simply those parts that are essential to an understanding of the operations as described. A fuller diagrammatic representation is found at C, Fig. 26.

It will be seen that as soon as the "connector-shaft" is released by either the calling or called subscriber, the private-wiper 384 and the side-switch-wiper 434 are restored to normal position; then, of course, the energizing circuit through the tenth contact of the second level of the private-bank 380 that comprises the auxiliary and line relays 618 and 619 at the individual-switch mechanism F is destroyed, at which time, then, said relays are restored to normal condition, restoring the normal short-circuit already pointed out. This short-circuit is maintained, normally, in order that both sides of the line may be balanced, as it would be noisy were only the rotary-line-conductor 626 connected to the spring 622. It will be noticed that the energization of the auxiliary-relay 618 is necessary, at this stage, to the successful operation of the system, for reasons as follows: Under the control of said relay are the springs 650 and 651, corresponding, of course, to the auxiliary-relay-springs 111 and 112 of Fig. 26. Said springs 650 and 651 are comprised in a normally-open circuit through the line-relay 619. It is essential that said auxiliary-relay be energized at the same time that the line-relay 619 is energized, in order to prevent the energization of the said line-relay through a local circuit from ground to the auixilary-busy-release-relay-springs 652 and 653, conductor 654, spring 655, contact-point 656, auxiliary-relay-springs 651 and 650, line-relay-springs 657 and 622, line-relay 619 to the battery B. In such case the line-relay 619 would be magnetized strongly enough to shift the line-bank-terminal-carriage onto the busy circuit contact-points 658, 659, 660 and 661. This operation would be undesirable, since the busy signal would be thrown across the normal-conductors 516 and 517. However, when the springs 650 and 651 are forced apart the said local circuit is maintained open and the line-relay is kept energized as long as the "connector" is connected with the called line by the energizing circuit already traced.

Thus it will be seen that my invention contemplates broadly the provision of movable trunk-line-terminals, the preferred embodiment consisting of multiple trunk-line-terminals whereof all of the terminals allotted to any one line are rigidly connected and thereby shiftable in unison with each other. It also contemplates broadly the provision of a bank of multiple line-terminals for a subscriber's line. Again, my invention contemplates broadly the mechanical selection of the next idle trunk-line, as distinguished from the heretofore employed electrical selection of trunk-lines. In other words, the trunk-lines are selected in succession, and by purely mechanical means, and the skipping of a busy trunk-line by the selecting mechanism is not due to any electrical action, but is due to a mechanical action pure and simple. For example, with the construction shown, the mechanical selecting mechanism embodying the shaft 201 will always skip any trunk-line terminal-bars which are connected with busy trunk-lines, simply by reason of the slightly off-normal positions which the said busy terminal-bars must necessarily occupy. As shown, the subscribers' shiftable line-banks or carriages, as they may be called, not only cooperate with the trunk-line-terminals, but are also adapted to operate auxiliary switches, as previously described. In addition, each subscriber's line-relay is adapted when energized to operate its switch-springs before it operates its allotted line-bank. In this way, each relay, when initially energized over its line-circuit, has the advantage of being able to substitute a local circuit for such line-circuit before it is called upon to actuate its line-bank. With this arrangement, and as previously explained, a comparatively weak current can be employed for energizing each line-relay to close its local circuit; and then when its local circuit is closed, a more powerful energizing of the relay-coil is afforded by the local circuit, so as to shift the line-bank and maintain the latter in its shifted position. Furthermore, it will be seen that with the arrangement described and shown, each trunk-line is provided at one end with a plurality of rigidly-connected and bodily-shiftable multiple terminals, and at its other end with movable terminals or switch-contacts. Other broadly novel features, as previously explained and as hereinafter claimed, together with additional advantages, will be obvious to those skilled in the art.

It is evident that my improved trunk-selecting switch mechanism is applicable to either automatic or semi-automatic telephone systems. In other words, my improved electrical selecting machine or apparatus can be employed for automatically selecting idle connections of any suitable or desired character.

It will be seen that each subscriber's tele-

phone line is normally short-circuited by the contacts 99 and 100, and that the battery B is normally connected with such bridge or short-circuit connection through the winding of the relay 95. This relay, therefore, not only controls the continuity of the said bridge or low-resistance connection across the subscriber's line, but also controls its own energizing circuits, as previously explained. When a subscriber calls he removes the bridge or low-resistance from across his line, seizing the waiting or preselected trunk line, and at the same time selects another idle trunk line for the next call. The normal short-circuiting of the lines tends, I find, to materially reduce induction and disturbing influences on the lines, as the short-circuits or bridges which are closed on the idle lines tend to protect the busy lines against the encroachment of disturbing influences, giving more satisfactory service to the subscribers.

What I claim as my invention is:—

1. In a telephone system, the combination of a subscriber's line, a plurality of multiple line-terminals for said subscriber's line, a plurality of trunk-line-terminals individual to the subscriber's line and each adapted for movement independently of the others, means under the control of the subscriber for operating the trunk-line-terminals, and means under the control of the subscriber for operating the multiple line-terminals upon the removal of the subscriber's receiver.

2. In a telephone system, the combination of a subscriber's line, a plurality of multiple line-terminals connected with said line, a plurality of trunk-lines, normally at rest trunk-line-terminals cooperating with said subscriber's line-terminals in establishing connection with any one of said trunk-lines, and means under the control of the subscriber for simultaneously shifting the said multiple line-terminals upon the removal of the subscriber's receiver.

3. In a telephone system, the combination of a subscriber's line, a plurality of multiple line-terminals for said line, said terminals being connected for simultaneous shift in one direction, but each terminal being adapted for some movement independently of the others, a plurality of trunk-lines, trunk-line-terminals adapted to cooperate with said subscriber's line-terminals in establishing connecton with any one of said trunk-lines, and means under the control of the subscriber for operating the multiple line-terminals upon the removal of the subscriber's receiver.

4. In a telephone system, the combination of a subscriber's line, a bank of multiple line-terminals connected with said line, means under the control of the subscriber for shifting said bank of terminals in one direction, shifting trunk-line-terminals for moving the said bank of line-terminals in another direction, and trunk-lines connected with said trunk-line-terminals.

5. A telephone system comprising a subscriber's individual trunk-selecting switching means comprising a bank of multiple subscriber's line-terminals mounted for both endwise shift and swinging or vibratory movement about a longitudinal axis, and trunk terminals to be engaged by said line terminals.

6. In a telephone system, the combination of a subscriber's line, a movable line-terminal connected with said subscriber's line, a trunk-line, a movable trunk-line-terminal connected with the trunk-line, and means under the control of the subscriber for moving said terminals toward each other and into contact upon the removal of the subscriber's receiver.

7. In a telephone system, the combination of three parallel and associated trunk-line-conductors each provided with a plurality of multiple contacts, subscribers' line-terminals, and means under the control of the subscribers for moving said trunk-line-contacts toward and into engagement with the subscribers' line-terminals in response to a non-numerical impulse sending operation at the subscriber's telephone.

8. In a telephone system, the combination of a plurality of trunk-lines, parallel trunk-line terminal-bars each connected with one of said trunk-lines, and each carrying a plurality of multiple terminals of its allotted trunk-line, electro-magnetically-actuated mechanism for operating said bars by producing endwise shift thereof, and a plurality of subscribers' lines provided with terminals adapted to be engaged with the trunk-line-terminals by the endwise shifting movement of said terminal-bars in response to a non-numerical impulse sending operation at the subscriber's telephone.

9. In a telephone system, a plurality of trunk-lines, and a trunk-selecting switch mechanism comprising a plurality of parallel endwise-shiftable trunk-line terminal-bars, each bar being connected with one of said trunk-lines, and each bar carrying a plurality of rigidly-connected multiple terminals of its allotted trunk-line.

10. In a telephone system, the combination of a plurality of trunk-lines, and a trunk-selecting switch mechanism comprising a plurality of endwise shiftable members each connected with one of said trunk-lines, and electro-magnetically-actuated mechanism for operating said members, each said member being provided with a plurality of rigidly-connected terminals of its allotted trunk-line.

11. In a telephone system, the combina-

tion of a plurality of trunk-lines, and a trunk-selecting switch mechanism therefor, said mechanism comprising a plurality of parallel endwise-shiftable terminal-bars, and electro-magnetically-actuated mechanism for operating said bars, a plurality of subscribers' individual-switch members arranged transversely of the said parallel bars, each terminal-bar being provided with a plurality of rigidly-connected multiple terminals of its allotted trunk-line, and the multiple terminals of the different trunk-lines being arranged in transverse rows, each row of trunk-line-terminals being allotted to and cooperating with one of said subscriber's individual-switch members.

12. In a telephone system, the combination of a plurality of trunk-lines, and a trunk-selecting switch mechanism therefor, said trunk-selecting switch mechanism comprising a plurality of relatively and endwise movable terminal members each connected with one of said trunk-lines and provided with a plurality of multiple terminals thereof, a plurality of subscribers' individual line-terminal members associated with said trunk-line terminal members, and selecting mechanism for operating said trunk-line terminal members.

13. In a telephone system, the combination of a plurality of trunk-lines, a plurality of endwise-shiftable terminal-bars each connected with one of said trunk-lines, and each provided with a plurality of multiple terminals of its allotted trunk-line, and electro-magnetically-actuated selective mechanism for mechanically selecting and successively actuating said terminal-bars, there being suitable mechanical provisions for insuring a mechanical skipping of any temporarily busy bar or bars.

14. In a telephone system, the combination of a plurality of trunk-lines, and an automatic trunk-selecting switch mechanism therefor, said switch mechanism comprising electro-magnetically-actuated selecting and actuating devices for successively selecting the different trunk-lines, adapted to select another idle trunk line for the next call each time one is seized by a calling subscriber, and suitable purely mechanical provisions for permitting the said selecting and actuating devices to skip any temporarily busy line or lines.

15. In a telephone system, the combination of a plurality of trunk-lines, a group of lines, a movable trunk-line terminal member for each trunk-line having a separate terminal for each of said lines, electro-magnetically-actuated selecting and actuating devices for selectively operating said terminal members, adapted to select another idle trunk line for the next call each time one is seized by a calling subscriber, and devices for permitting the said selecting and actuating devices to always skip any of said members which are connected with busy trunk-lines.

16. In a telephone system, the combination of a plurality of trunk-lines, a plurality of shiftable members each connected with one of said trunk-lines and provided with a plurality of multiple terminals thereof, subscribers' line-terminal switch members adapted to cooperate with said trunk-line-terminals, electro-magnetically-actuated selecting and actuating devices controlled by subscribers and adapted for successively operating the different trunk-line terminal members, adapted to select another idle trunk line for the next call each time one is seized by a calling subscriber, there being suitable provisions for causing said selecting and actuating devices to always skip any of said trunk-line members which are connected with busy trunk-lines, and thereby always select the first idle trunk-line next in order after the trunk-line last put in use.

17. In a telephone system, the combination of a plurality of trunk-lines, a plurality of movable trunk-line terminal members each connected with one of said trunk-lines and provided with a plurality of multiple terminals thereof, electro-magnetically-operated mechanism for actuating said trunk-line terminal members, electro-magnetically-operated selecting mechanism adapted to cause said trunk-line terminal members to be actuated successively, and means cooperating with said selecting mechanism for causing the same to always skip any terminal members which are connected with busy trunk-lines, and to thereby always select the first idle trunk-line next in order after the one last put in use.

18. In a telephone system, the combination of a plurality of trunk-lines, a plurality of parallel and endwise-shiftable terminal-bars each connected with one of said trunk-lines, and each provided with a plurality of multiple terminals of its allotted trunk-line, electro-magnetically-operated connections for actuating said terminal-bars, a step-by-step-actuated rotary selecting member extending across the end of said group of bars and adapted to cooperate with said connections in causing the bars to be actuated successively, and means operated by the bars themselves for causing said rotary selecting member to always skip any bars which are connected with busy trunk-lines, and to thereby cause the said electro-magnetically-actuated connections to always operate the first idle bar next in order after the one last put in use.

19. In a telephone system, a plurality of trunk-lines, and an automatic trunk-selecting switch mechanism therefor, said switch

mechanism comprising a plurality of parallel and endwise-shiftable terminal-bars each connected with one of said trunk-lines and provided with a plurality of multiple terminals thereof, a plurality of subscribers' line-banks arranged transversely of the said trunk-line terminal-bars, subscribers' individual line-relay means for operating each subscriber's line-bank in one direction, an endwise-shiftable tripper-bar provided with means for actuating the subscribers' line-banks in another direction, both directions of motion being necessary before any subscriber's line-bank can be electrically connected with any trunk-line, stop devices for temporarily retaining the subscribers' line-banks in position for maintaining connection with a trunk-line, electro-magnetically-actuated devices for successively drawing said trunk-line terminal-bars into a selective or waiting position, selecting mechanism adapted for causing the said bars to be operated successively, skipping devices for causing said selecting mechanism to always skip the bars which are connected with any busy trunk-lines, and subscriber's impulse-transmitting means and suitable circuits for controlling the operations of said line-banks and trunk-line terminal-bars.

20. In a telephone system, the combination of a plurality of trunk-lines, a plurality of trunk-line terminal-bars each connected with one of said trunk-lines and provided with a plurality of multiple terminals thereof, electro-magnetically-operated actuating and selecting devices for successively shifting said bars endwise to a selective or waiting position, adapted to always skip any bars which are connected with busy trunk-lines, and spring means for restoring said bars to their normal postions.

21. In a telephone system, the combination of a plurality of trunk-lines, a plurality of trunk-line terminal-bars each connected with one of said trunk-lines and provided with a plurality of multiple terminals thereof, an electro-magnet, suitable connections and devices whereby the previously selected or waiting bar is always released whenever the said magnet is energized, and whereby the terminal-bar of the first idle trunk-line next in order after the one last put in use is always drawn into a selective or waiting position each time the said magnet is de-energized.

22. In a telephone system, the combination of a plurality of trunk-lines, and a trunk-selecting switch mechanism therefor, said switch mechanism comprising a plurality of trunk-line terminal-bars each connected with one of said trunk-lines and provided with a plurality of multiple terminals thereof, cooperating electro-magnetic and spring means, and suitable connections whereby the previously selected or waiting terminal-bar is released by the energizing of said electro-magnetic means, and whereby the bar of the next idle trunk-line is always drawn by spring power into a selective or waiting position whenever the said electro-magnetic means is de-energized.

23. In a telephone system, the combination of a subscriber's line, a swinging and bodily movable bank of multiple line-terminals connected with and allotted to said line, and means under the control of the subscriber for shifting the said bank of line-terminals in the direction of its axis.

24. In a telephone system, the combination of a line, a plurality of swinging multiple terminals connected with and allotted to said line, and subscriber-controlled means for shifting said group of multiple terminals in unison in the direction of its axis.

25. In a telephone system, the combination of a plurality of trunk-lines, shiftable terminal-bars each secured to one of said trunk-lines and provided with a plurality of rigidly connected multiple terminals thereof, mechanism for actuating said bars longitudinally, subscriber's line-terminals adapted to cooperate with said trunk-line-terminals, auxiliary switching means and circuits operated and controlled by the movements of said terminal-bars, and means for finding the called subscriber's line.

26. In a telephone system, the combination of a plurality of trunk-lines, a plurality of subscribers' individual-switches, actuating and selecting mechanism for operating said individual-switches, and busy-release-relay means common to all of said individual-switches, suitably connected therewith, and adapted for effecting a release of any subscriber's individual-switch when the trunk-lines are all busy.

27. In a telephone system, the combination of a plurality of trunk-lines, a shifting trunk-line terminal-bar connected with the end of each trunk-line, mechanism for operating said bars endwise, subscribers' line-terminals adapted to cooperate with said terminal-bars in establishing connection with any one of said trunk-lines, and busy-release mechanism or means adapted for effecting the restoration of any calling subscriber's line-terminals when all of the trunk-lines are busy.

28. In a telephone system, the combination of a plurality of trunk-lines, trunk-line terminal-bars connected with said trunk-lines, each bar being provided with a plurality of multiple terminals of its allotted line, an electro-magnet, selecting and actuating devices intermediate of the said electro-magnet and trunk-line terminal-bars, adapted for automatically selecting and actuating the bars in succession, and for skipping any

bars which are in use, and auxiliary switching means also operated by the said electro-magnet.

29. In a telephone system, the combination of a plurality of trunk-lines, trunk-line terminal-bars connected with said trunk-lines, each bar being provided with a plurality of multiple terminals of its allotted line, an electro-magnet, selecting and actuating devices intermediate of the said electro-magnet and trunk-line terminal-bars, adapted for automatically selecting and actuating the bars in succession, and for skipping any bars which are in use, and normally-open and normally-closed auxiliary spring-switches operated by said electro-magnet.

30. In a telephone system, the combination of a subscriber's line, a subscriber's line-relay, an auxiliary-relay, and three energizing circuits for said line-relay, the first energizing circuit including a line, the second energizing circuit being local, and the third energizing circuit including a winding of said auxiliary-relay.

31. In a telephone system, the combination of a subscriber's line, trunk-selecting means including a line-relay individual to the said line, an auxiliary-relay individual to the said line, and suitable means for connecting the windings of the two relays in series and maintaining the same in an energized condition during use of the line for talking purposes, said windings excluded from the path of the voice currents.

32. In a telephone system, the combination of a plurality of trunk-lines, each trunk-line consisting of three parallel conductors, a plurality of subscribers' lines, trunk-selecting switch mechanism for establishing connection between any subscriber's line and any trunk-line, a line-relay for each subscriber's line, and a plurality of energizing circuits for each line-relay, one of the said energizing circuits for each line-relay including the third trunk-line-conductor of any trunk-line with which a subscriber's line may be temporarily connected.

33. In a telephone system, the combination of a calling subscriber's line, a line-relay for said line, selecting means controlled by said relay, trunk-selecting switch mechanism, a plurality of trunk-lines, and a plurality of energizing circuits for said line-relay, one of said circuits including one side of any trunk-line with which the calling subscriber's line may be connected.

34. In a telephone system, the combination of trunk-lines, a trunk-selecting switch mechanism provided with an actuating-magnet and a release-magnet, a normally-open switch adapted to be conjointly controlled by said electro-magnets, responsive to a calling subscriber, and to be closed by the energizing of the actuating-magnet, but reopened by the energizing and de-energizing of the said release-magnet, and a circuit controlled by said switch.

35. In a telephone system, the combination of a "selector" provided with a rotatable and endwise-shiftable switch-shaft, a vertical-magnet, a release-magnet, three normally-closed switch-springs adapted to be opened by the initial endwise movement of the switch-shaft, and a normally-open switch adapted to be conjointly controlled by the said vertical and release magnets, said normally-open switch being adapted to be closed by the energizing of the said vertical-magnet, and to be reopened by the energizing and de-energizing of the said release-magnet.

36. In a telephone system, the combination of a plurality of trunk-lines, a shifting terminal-bar connected with each line and provided with a plurality of multiple terminals thereof, a plurality of subscribers' lines, subscribers' line-terminals adapted to cooperate with said trunk-line-terminals, subscribers' line-relays, energizing circuits for said line-relays, and "first-selectors" adapted to cooperate with said trunk-line terminal-bars in controlling the said energizing circuits.

37. In a telephone system, the combination of a plurality of trunk-lines, endwise-shiftable terminal-bars each connected with one of said trunk-lines and provided with a plurality of multiple terminals thereof, a plurality of subscribers' lines, a bank of multiple terminals for each subscriber's line, each of said banks comprising flexible spring fingers adapted to be engaged by the trunk-line-terminals, and selecting and actuating mechanism for operating said trunk-line terminal-bars.

38. In a telephone system, the combination of a subscriber's line, a plurality of movable multiple terminals for said line, each terminal including a third contact connected in multiple with the corresponding contacts of the other terminals, a plurality of "connectors" each provided with a terminal connected with the said subscriber's line, each "connector" terminal having a third contact connected in multiple with the corresponding contacts of the other "connector" terminals, and the said third contacts of the said "connector" terminals being permanently connected with the said third contacts of the said subscriber's line-terminals.

39. In a telephone system, the combination of a subscriber's line, a subscriber's individual trunk-selecting switching device provided with a plurality of multiple terminals of said subscriber's line, and a plurality of "connectors", each provided with a terminal connected with said subscriber's line, the said "connector" terminals all being connected in multiple and permanently connected with the said multiple line-terminals.

40. In a telephone system, the combination

of a plurality of trunk-lines, a corresponding number of endwise movable terminal-bars connected with the said trunk-lines at one end, a corresponding number of "first-selectors" connected with the said trunk-lines at the other end, and suitable selecting and actuating mechanism for selectively operating the different trunk-line terminal-bars.

41. In a telephone system, the combination of a plurality of trunk-lines, a plurality of movable multiple terminals connected with the trunk-lines at one end, a corresponding number of "first-selectors" connected with the trunk-lines at the other ends thereof, and trunks leading from said first-selectors.

42. In a telephone system, the combination of a subscriber's line, trunk-selecting means including a line-relay individual to said line, an auxiliary-relay, an energizing circuit for energizing and connecting said relays in series, and means whereby said relays remain thus energized while the line is in use for talking purposes, both when the subscriber calls and is called, said relays excluded from the path of the voice-currents.

43. In a telephone system, the combination of a subscriber's line, a line-relay individual to the line, an auxiliary-relay, and a normally-closed low resistance bridge across said line, said bridge excluding the winding of said line-relay, but including normally-closed contacts thereof.

44. In a telephone system, the combination of a subscriber's line, a line-relay individual to said line, and a normally-closed low resistance bridge extending across said line, said bridge excluding the winding of said line-relay, but including normally-closed contacts thereof.

45. In a telephone system, a group of lines, a trunk-line, a movable member for said trunk line, a plurality of multiple terminals for said trunk-line rigidly attached to said member, mechanism common to said lines for shifting all of said terminals in unison when a connection with a line is desired, and release circuits for effecting a restoration of the apparatus.

46. In a telephone system, a group of lines, a trunk-line, mechanism common to said lines for establishing a connection between the trunk and a line, movable switch-contacts in which one end of the trunk line terminates, a plurality of relatively fixed multiple terminals connected with the other end of said line, and a movable member upon which said multiple terminals are mounted, and release circuits for effecting the restoration of the apparatus.

47. In a telephone system, a group of lines, a trunk-line provided at each end with movable switch-contacts, the contact or contacts connected with one end of said trunk line being individual to a single subscriber, mechanism common to said lines for establishing a connection between the trunk and a line, a movable member upon which the contacts at said one end are mounted, and release circuits for effecting the restoration of the apparatus.

48. In a telephone system, a subscriber's individual trunk-selecting switch mechanism comprising a plurality of trunk-line-terminals, each terminal being movable independently of the others, a trunk-line connected with each terminal, a subscriber's bank of multiple line-terminals adapted to cooperate with said trunk-line terminals in establishing connection with any one of said trunk-lines, and release circuits for effecting a restoration of the apparatus.

49. In a telephone system, the combination of a subscriber's line, a plurality of multiple line-terminals for said subscriber's line, a plurality of trunk-line-terminals individual to the subscriber's line and each adapted for movement independently of the others, means under the control of the subscriber for operating the trunk-line-terminals, means under the control of the subscriber for operating the multiple line-terminals, and release circuits for effecting a restoration of the apparatus.

50. In a telephone system, the combination of a subscriber's line, a plurality of multiple line-terminals for said line, said terminals being connected for simultaneous shift in one direction, but each terminal being adapted for some movement independently of the others, a plurality of trunk-lines, trunk-line-terminals adapted to cooperate with said subscriber's line-terminals in establishing connection with any one of said trunk-lines, means under the control of the subscriber for operating the multiple line-terminals, and release circuits for effecting a restoration of of the apparatus.

51. In a telephone system, the combination of a subscriber's line, a bank of multiple line-terminals connected with said line, means under the control of the subscriber for shifting said bank of terminals in one direction, shifting trunk-line-terminals for moving the said bank of line-terminals in another direction, trunk-lines connected with said trunk-line-terminals, and release circuits for effecting a restoration of the apparatus.

52. In a telephone system, a subscriber's individual trunk-selecting switching means comprising a bank of multiple subscriber's line-terminals mounted for both endwise shift and swinging or vibratory movement about a longitudinal axis, and release circuits for effecting a restoration of the apparatus.

53. In a telephone system, the combination of a subscriber's line, an automatic trunking switch associated with said line, a movable line-terminal connected with said

subscriber's line, a trunk-line, a movable trunk-line-terminal connected with the trunk-line, said switch comprising means under the control of the subscriber for moving said line and said trunk terminals together, and release circuits for effecting a restoration of the apparatus, and a test circuit for said subscriber's line controlled by said switch for indicating that the line is busy or idle.

54. In a telephone system, the combination of a trunk line comprising three parallel and associated trunk-line-conductors each provided with a plurality of multiple contacts in permanent fixed relation to each other, subscribers' line-terminals, means under the control of the subscribers for moving said multiple contacts simultaneously to establish connection with the subscribers' line-terminals, and release circuits for effecting a restoration of the apparatus.

55. In a telephone system, the combination of a plurality of trunk-lines, parallel trunk-line terminal-bars each connected with one of said trunk-lines, and each carrying a plurality of multiple terminals of its allotted trunk-line, electro-magnetically-actuated mechanism for operating said bars by producing endwise shift thereof, a plurality of subscribers' lines provided with terminals adapted to be engaged with the trunk-line-terminals by the endwise shifting movement of said terminal-bars, and release circuits for effecting a restoration of the apparatus.

56. In a telephone system, a plurality of trunk-lines, a trunk-selecting switch mechanism comprising a plurality of parallel endwise-shiftable trunk-line terminal-bars, each bar being connected with one of said trunk-lines, and each bar carrying a plurality of rigidly-connected multiple terminals of its allotted trunk-line, and release circuits for effecting a restoration of the apparatus.

57. In a telephone system, a group of lines, the combination of a plurality of trunk-lines, a trunk-selecting switch mechanism comprising a plurality of shiftable members each connected with one of said trunk-lines, electro-magnetically-actuated mechanism common to said lines for operating said members, each said member being provided with a plurality of rigidly-connected terminals of its allotted trunk-line, and release circuits for effecting a restoration of the apparatus.

58. In a telephone system, the combination of a plurality of trunk-lines, and a trunk-selecting switch mechanism therefor, said mechanism comprising a plurality of parallel endwise-shiftable terminal-bars, electro-magnetically-actuated mechanism for operating said bars, a plurality of subscribers' individual-switch members arranged transversely of the said parallel bars, each terminal-bar being provided with a plurality of rigidly-connected multiple terminals of its allotted trunk-line, the multiple terminals of the different trunk-lines being arranged in transverse rows, each row of trunk-line-terminals being allotted to and cooperating with one of said subscriber's individual-switch members, and release circuits for effecting a restoration of the apparatus.

59. In a telephone system, the combination of a plurality of trunk-lines, and a trunk-selecting switch mechanism therefor, said trunk-selecting switch mechanism comprising a plurality of relatively movable terminal members each connected with one of said trunk-lines and provided with a plurality of multiple terminals thereof, a plurality of subscribers' individual line-terminal members associated with said trunk-line terminal members, selecting mechanism for operating said trunk-line terminal members, and release circuits for effecting a restoration of the apparatus.

60. In a telephone system, the combination of a plurality of trunk-lines, a plurality of endwise-shiftable terminal-bars each connected with one of said trunk-lines, and each provided with a plurality of multiple terminals of its allotted trunk-line, electro-magnetically-actuated selective mechanism for mechanically selecting and successively actuating said terminal-bars, there being suitable mechanical provisions for insuring a mechanical skipping of any temporarily busy bar or bars, and release circuits for effecting a restoration of the apparatus.

61. In a telephone system, a group of lines, the combination of a plurality of trunk-lines, a plurality of shiftable members each connected with one of said trunk-lines and provided with a plurality of multiple terminals thereof, subscribers' line-terminals switch members adapted to cooperate with said trunk-line-terminals, electro-magnetically actuated selecting and actuating devices common to said lines controlled by subscribers and adapted for successively operating the different trunk-line terminal members, there being suitable provisions for causing said selecting and actuating devices to always skip any of said trunk-line members which are connected with busy trunk-lines, and thereby always select the first idle trunk-line next in order after the trunk-line last put in use, and release circuits for effecting a restoration of the apparatus.

62. In a telephone system, the combination of a plurality of trunk-lines, a plurality of movable trunk-line terminal members each connected with one of said trunk-lines and provided with a plurality of multiple terminals thereof, electro-magnetically-operated mechanism for actuating said trunk-line terminal members, electro-magnetically-operated selecting mechanism adapted to

cause said trunk-line terminal members to be actuated successively, means cooperating with said selecting mechanism for causing the same to always skip any terminal members which are connected with busy trunk-lines, and to thereby always select the first idle trunk-line next in order after the one last put in use, whenever a trunk-line is desired for use by a calling subscriber, and release circuits for effecting a restoration of the apparatus.

63. In a telephone system, the combination of a plurality of trunk-lines, a plurality of parallel and endwise-shiftable terminal-bars each connected with one of said trunk-lines, and each provided with a plurality of multiple terminals of its allotted trunk-line, electro-magnetically-operated connections for actuating said terminal-bars, a step-by-step-actuated rotary selecting member extending across the end of said group of bars and adapted to cooperate with said connections in causing the bars to be actuated successively, means operated by the bars themselves for causing said rotary selecting member to always skip any bars which are connected with busy trunk-lines, and to thereby cause the said electro-magnetically-actuated connections to always operate the first idle bar next in order after the one last put in use, whenever a trunk-line is desired for use by a calling subscriber, and release circuits for effecting a restoration of the apparatus.

64. In a telephone system, a plurality of trunk-lines, and an automatic trunk-selecting switch mechanism therefor, said switch mechanism comprising a plurality of parallel and endwise-shiftable terminal-bars each connected with one of said trunk-lines and provided with a plurality of multiple terminals thereof, a plurality of subscribers' line-banks arranged transversely of the said trunk-line terminal-bars, subscribers' individual line-relay means for operating each subscriber's line-bank in one direction, an endwise-shiftable tripper-bar provided with means for actuating the subscribers' line-banks in another direction, both directions of motion being necessary before any subscriber's line-bank can be electrically connected with any trunk-line, stop devices for temporarily retaining the subscribers' line-banks in position for maintaining connection with a trunk-line, electro-magnetically-actuated devices for successively drawing said trunk-line terminal-bars into a selective or waiting position, selecting mechanism adapted for causing the said bars to be operated successively, skipping devices for causing said selecting mechanism to always skip the bars which are connected with any busy trunk-lines, subscriber's impulse-transmitting means and suitable circuits for controlling the operations of said line-banks and trunk-line terminal-bars, and release circuits for effecting a restoration of the apparatus.

65. In a telephone system, the combination of a plurality of trunk-lines, a plurality of trunk-line terminal-bars each connected with one of said trunk-lines and provided with a plurality of multiple terminals thereof, electro-magnetically-operated actuating and selecting devices for successively shifting said bars to a selective or waiting position, adapted to always skip any bars which are connected with busy trunk-lines, spring means for restoring said bars to their normal positions, and release circuits for effecting a restoration of the apparatus.

66. In a telephone system, the combination of a plurality of trunk-lines, a plurality of trunk-line terminal-bars each connected with one of said trunk-lines and provided with a plurality of multiple terminals thereof, an electro-magnet, suitable connections and devices whereby the previously selected or waiting bar is always released whenever the said magnet is energized, and whereby the terminal-bar of the first idle trunk-line next in order after the one last put in use is always drawn into a selective or waiting position each time the said magnet is de-energized, and release circuits for effecting a restoration of the apparatus.

67. In a telephone system, the combination of a plurality of trunk-lines, and a trunk-selecting switch mechanism therefor, said switch mechanism comprising a plurality of trunk-line terminal-bars each connected with one of said trunk-lines and provided with a plurality of multiple terminals thereof, co-operating electro-magnetic and spring means, suitable connections whereby the previously selected or waiting terminal-bar is released by the energizing of said electro-magnetic means, and whereby the bar of the next idle trunk-line is always drawn by spring power into a selective or waiting position whenever the said electro-magnetic means is de-energized, and release circuits for effecting a restoration of the apparatus.

68. In a telephone system, the combination of a plurality of trunk-lines, trunk-line-terminals, a plurality of subscribers' shiftable line-banks, each provided with multiple terminals adapted to cooperate with said trunk-line-terminals in establishing connection between any subscriber's line and any trunk-line, subscribers' indivdual line-relays for operating said line-banks, auxiliary-switches adapted to be operated by the shifting movements of said line-banks, and release circuits for effecting a restoration of the apparatus.

69. In a telephone system, the combination of a plurality of subscribers' shiftable line-banks, subscribers' individual line-re-

lays for operating said line-banks, spring means for restoring said line-banks to their normal positions, trunk-line-terminals adapted to cooperate with said line-banks, each line-bank being provided with a plurality of multiple terminals of its allotted line, and release circuits for effecting a restoration of the apparatus.

70. In a telephone system the combination of a subscriber's line, a plurality of multiple terminals of said subscriber's line, a subscriber's individual line-relay means for shifting said multiple line-terminals in unison, spring means for returning said group of multiple line-terminals to its normal position, and release circuits for effecting a restoration of the apparatus.

71. In a telephone system, the combination of a plurality of trunk-lines, shiftable, terminal-bars each secured to one of said trunk-lines and provided with a plurality of multiple terminals thereof, mechanism for actuating said bars, movable subscriber's line-terminals adapted to cooperate with said trunk-line-terminals, auxiliary switching means and circuits operated and controlled by said terminal-bars, and release circuits for effecting a restoration of the apparatus.

72. In a telephone system, the combination of a plurality of trunk-lines, a plurality of subscribers' individual-switches, actuating and selecting mechanism for operating said individual-switches, busy-release-relay means common to all of said individual-switches, suitably connected therewith, and adapted for effecting a release of any subscriber's individual-switch when the trunk-lines are all busy, and release circuits for effecting a restoration of the apparatus.

73. In a telephone system, the combination of a plurality of trunk-lines, shiftable trunk-line terminal-bar connected with the end of each trunk-line, mechanism for operating said bars, subscribers' line-terminals adapted to cooperate with said terminal-bars in establishing connection with any one of said trunk-lines, busy-release mechanism or means adapted for effecting the restoration of any subscriber's line-terminals when all of the trunk-lines are busy, and release circuits for effecting a restoration of the apparatus.

74. In a telephone system, the combination of a plurality of trunk-lines, trunk-line terminal-bars connected with said trunk-lines, each bar being provided with a plurality of multiple terminals of its allotted line, an electro-magnet, selecting and actuating devices intermediate of the said electro-magnet and trunk-line terminal-bars, adapted for automatically selecting and actuating the bars in succession, and for skipping any bars which are in use, auxiliary switching means also operated by the said electro-magnet, and release circuits for effecting a restoration of the apparatus.

75. In a telephone system, the combination of a plurality of trunk-lines, trunk-line terminal-bars connected with said trunk-lines, each bar being provided with a plurality of multiple terminals of its allotted line, an electro-magnet, selecting and actuating devices intermediate of the said electro-magnet and trunk-line terminal-bars, adapted for automatically selecting and actuating the bars in succession, and for skipping any bars which are in use, normally-open and normally-closed auxiliary spring-switches operated by said electro-magnet, and release circuits for effecting a restoration of the apparatus.

76. In a telephone system, the combination of a subscriber's line, a subscriber's line-relay, an auxiliary-relay, three energizing circuits for said line-relay, the first energizing circuit including a line, the second energizing circuit being local, and the third energizing circuit including a winding of said auxiliary-relay, and release circuits for effecting a restoration of the apparatus.

77. In a telephone system, the combination of a subscriber's line, a line-relay individual to the said line, an auxiliary-relay individual to the said line, suitable means and local circuits for connecting the windings of the two relays in series and maintaining the same in an energized condition during use of the line for talking purposes, and release circuits for effecting a restoration of the apparatus, and means controlled by said relays to connect the line with another line.

78. In a telephone system, the combination of a plurality of trunk-lines, each trunk-line consisting of three parallel conductors, a plurality of subscribers' lines, trunk-selecting switch mechanism for establishing connection between any subscriber's line and any trunk-line, a line-relay for each subscriber's line, a plurality of energizing circuits for each line-relay, one of the said energizing circuits for each line-relay including the third trunk-line-conductor of any trunk-line with which a subscriber's line may be temporarily connected, and release circuits for effecting a restoration of the apparatus.

79. In a telephone system, the combination of a subscriber's line, a line-relay for said line, trunk-selecting switch mechanism, a plurality of trunk-lines, a plurality of energizing circuits for said line-relay, one of said circuits including a conductor of any trunk-line with which the subscriber's line may be connected, and release circuits for effecting a restoration of the apparatus.

80. In a telephone system, the combination of trunk-lines, a trunk-selecting switch mechanism provided with an actuating-magnet

and a release-magnet, a normally-open switch adapted to be conjointly controlled by said electro-magnets, responsive to a calling subscriber, and to be closed by the energizing of the actuating-magnet, and reopened by the energizing and de-energizing of the said release-magnet, and release circuits for effecting a restoration of the apparatus.

81. In a telephone system, the combination of a "selector" provided with a rotatable and endwise-shiftable switch-shaft, a vertical-magnet, a release-magnet, three normally-closed switch-springs adapted to be opened by the initial endwise movement of the switch-shaft, a normally-open switch adapted to be conjointly controlled by the said vertical and release magnets, said normally-open switch being adapted to be closed by the energizing of the said vertical-magnet, and to be reopened by the energizing and de-energizing of the said release-magnet, and release circuits for effecting a restoration of the apparatus.

82. In a telephone system, the combination of a plurality of trunk-lines, a shifting terminal-bar connected with each line and provided with a plurality of multiple terminals thereof, a plurality of subscribers' lines, subscribers' line-terminals adapted to cooperate with said trunk-line-terminals, subscribers' line-relays, energizing circuits for said line-relays, "first-selectors" adapted to cooperate with said trunk-line terminal-bars in controlling the said energizing circuits, and release circuits for effecting a restoration of the apparatus.

83. In a telephone system, the combination of a plurality of trunk-lines, a plurality of metal plates connected with each trunk-line, the plates allotted to any trunk-line being rigidly connected together but insulated from each other, each plate being provided with a plurality of electrical contacts, and means whereby the metal contact plates connected with any one line may be and are shifted independently of the plates connected with the other trunk-line, subscribers' lines, subscribers' line-relay means, subscribers' line-terminals adapted to cooperate with the said electrical contacts formed on the said metal plates connected with the trunk-lines, whereby any subscriber's line can be connected with any idle trunk-line, and release circuits for effecting a restoration of the apparatus.

84. In a telephone system, the combination of a plurality of trunk-lines, endwise-shiftable terminal-bars each connected with one of said trunk-lines and provided with a plurality of multiple terminals thereof, a plurality of subscribers' lines, a bank of multiple terminals for each subscriber's line, each of said banks comprising flexible spring fingers adapted to be engaged by the trunk-line-terminals, selecting and actuating mechanism for operating said trunk-line terminal-bars, and release circuits for effecting a restoration of the apparatus.

85. In a telephone system, the combination of a subscriber's line, a plurality of movable multiple terminals for said line and individual thereto, each terminal including a third contact connected in multiple with the corresponding contacts of the other terminals, a plurality of "connectors" each provided with a terminal connected with the said subscriber's line, each "connector" terminal having a third contact connected in multiple with the corresponding contacts of the other "connector" terminals, the said third contacts of the said "connector" terminals being permanently connected with the said third contacts of the said subscriber's line-terminals, and release circuits for effecting a restoration of the apparatus.

86. In a telephone system, the combination of a subscriber's line, a subscriber's individual trunk-selecting switching device provided with a plurality of multiple terminals of said subscriber's line, a plurality of "connectors", each provided with a terminal connected with said subscriber's line, the said "connector" terminals all being connected in multiple and permanently connected with the said multiple line-terminals, and release circuits for effecting a restoration of the apparatus.

87. In a telephone system, the combination of a subscriber's line, a plurality of movable line-terminals individual to the line connected in multiple and adapted for use in calling-out over said line, means for moving said line terminals, a plurality of line-terminals connected in multiple and adapted for use in calling-in over said line, and release circuits for effecting a restoration of the apparatus.

88. In a telephone system, the combination of a plurality of trunk-lines, a corresponding number of terminal-bars connected with the said trunk-lines at one end, a corresponding number of "first-selectors" connected with the said trunk-lines at the other end, suitable selecting and actuating mechanism for selectively operating the different trunk-line terminal-bars in a predetermined order, and release circuits for effecting a restoration of the apparatus.

89. In a telephone system, the combination of a subscriber's line, a line-relay individual to said line, an auxiliary-relay, a local energizing circuit for energizing and connecting said relays in series, means whereby said relays remain thus energized while the line is in use for talking purposes, both when the subscriber calls and is called, and release circuits for effecting a

restoration of the apparatus, and means controlled by said relays to connect the line with another line.

90. In a telephone system, the combination of a subscriber's line, a line-relay individual to the line, an auxiliary-relay, a normally-closed low resistance bridge across said line, said bridge excluding the winding of said line-relay, but including normally-closed contacts thereof, and release circuits for effecting a restoration of the apparatus.

91. In a telephone system, the combination of a subscriber's line, a line-relay individual to said line, a normally-closed low resistance bridge extending across said line, said bridge excluding the winding of said line-relay, but including normally-closed contacts thereof, and release circuits for effecting a restoration of the apparatus.

92. In a telephone exchange system, the combination of telephone lines, automatic means for trunking calling lines into connection with the called lines, including first selectors less in number than the telephone lines, and means for normally short-circuiting said lines.

93. In a telephone exchange system, the combination of a metallic telephone line, a normally closed low resistance bridge across the line, a battery having one pole grounded, a relay provided with a winding via which the other pole of said battery is connected with the said bridge, means for grounding the said line, and a local energizing circuit for said relay, the said relay provided with normally closed contacts controlling said bridge, and with normally open contacts controlling said local circuit.

94. In a telephone exchange system, the combination of trunk lines, subscribers' telephone lines, automatic means by which each calling subscriber seizes a preselected idle trunk line and selects another idle trunk for the next call, means for normally short-circuiting the telephone lines, and automatic means by which a calling subscriber removes the short-circuit from his line.

95. In a telephone exchange system, the combination of subscribers' telephone lines, trunk lines, automatic means for selecting idle trunks for calling subscribers, means for normally short-circuiting the said telephone lines, and means for removing the short-circuit from a line when the subscriber calls.

96. In a telephone exchange system, the combination of telephone lines, trunk lines provided with movable terminals, means by which a calling subscriber connects his line with a preselected movable trunk line terminal, and automatic means by which the terminal of another trunk line is moved into position for the next call.

97. In a telephone exchange system, the combination of telephone lines, trunks provided with movable terminals, automatic means for moving an idle terminal into position for the next call before the call is made, and automatic means for moving the selected or displaced terminal into connection with a calling telephone line.

98. In a telephone exchange system, the combination of trunk terminals, automatic means for moving a trunk line terminal into connection with a calling substation, and means responsive to the call for moving the terminal of another trunk line into position for the next call.

99. In a telephone system, a subscriber's line provided with means for grounding it at the substation thereof, a normally closed bridge of practically no resistance across the line at the exchange terminal thereof, a battery having one pole grounded, a relay normally connected in series between said battery and the normally closed point of said bridge, and means for opening said bridge and disconnecting said relay therefrom when the subscriber calls.

100. In a telephone system, a subscriber's line, a bridge of practically no resistance across the line at the exchange or central station terminal thereof, and a relay adapted to open said bridge when energized, together with means for energizing said relay over a portion of said bridge.

101. In a telephone system, a plurality of parallel endwise-movable bars each connected to a different trunk line, and means for selecting idle trunks by the endwise movements of said bars.

102. In a telephone system, a plurality of parallel endwise-movable bars each forming the terminal of a different trunk-line, and means for connecting calling subscribers' lines with idle trunks by the endwise movements of said bars.

103. In a telephone system, subscribers' lines divided into groups, automatic switching apparatus responsive to the calling subscriber, a low resistance bridge normally closed across the subscriber's line to prevent talking current from passing over the subscriber's line, means for opening or cutting off said bridge during use of the line for talking purposes, and means having one motion for finding a group and another motion for finding the called line in said group.

104. In a telephone system, a switching device comprising three members, means for setting the first member to pick out and operate the third member, and means for operating the second member to contact with the selected third member to thereby complete a connection said third member being movable.

105. In a telephone system, a switching device comprising three members, means for automatically setting the first member to pick out and operate the third member, and means for operating the second member to contact with the selected third member when said third member is released to thereby complete a connection said third member being movable.

106. In a telephone system, the combination of a group of trunk lines, trunk selecting mechanism, said mechanism comprising a plurality of terminals for each trunk line, the terminals being movable bodily, and means for moving said terminals, a line and an impulse sending device for said line for controlling the operation of said terminals over said line to establish connection with said line upon the removal of the receiver.

107. In a telephone system, a trunk line provided at each end with a movable contact, the contact at one end of said trunk being individual to a single subscriber, and means for moving the same to close connection therefrom to the subscriber's line, the other of said contacts individual to said trunk and means for extending connection therefrom.

108. In a telephone system, a subscriber's line and individual switch comprising a plurality of trunk line terminals, means for moving each terminal independently of the other, a trunk line for each terminal, subscribers' line terminals associated with said trunk terminals, means for establishing connection between the line and any one of said trunk lines in response to an impulse from the line.

109. In a telephone system, a subscriber's line, a switch individual to said line comprising a plurality of normally at rest movable trunk line terminals, a trunk line connected with each terminal, a plurality of subscribers' line terminals co-operating with said trunk line terminals, and means for establishing connection between said lines and any one of said trunk lines in response to an impulse from the line.

110. In a telephone system, a subscriber's line and individual switch comprising a plurality of trunk line terminals, means for moving each terminal independently of the other, a trunk line connected with each terminal and subscribers' line terminals adapted to co-operate with said trunk terminals in establishing connection between the line and any one of said trunk lines in response to a non-numerical impulse sending operation from the line upon the removal of the receiver.

111. A telephone system comprising a subscriber's individual switching means comprising a bank of multiple subscriber's line-terminals mounted for both end-wise shift and swinging or vibratory movement about a longitudinal axis, and trunk terminals to be engaged by said line terminals.

112. In a telephone system, the combination of a subscriber's line, a movable line-terminal connected with said subscriber's line, a trunk-line, a movable trunk-line-terminal connected with the trunk-line, and means under the control of the subscriber for moving said terminals toward each other and into contact in response to a non-numerical impulse sending operation at the subscriber's telephone.

113. In a telephone system, the combination of a subscriber's line, a subscriber's individual switching device provided with a plurality of multiple terminals for said subscriber's line, a plurality of connectors each provided with a terminal connected with said subscriber's line, the said connector terminals all being connected in multiple and permanently connected with the said multiple line terminals.

114. In a telephone system, a subscriber's telephone station, a line for said station, an automatic switch for said line, including a line magnet for controlling said switch, a shunt for the conductors of said line between the telephone and the switch, and means for opening and closing said shunt to connect and disconnect said conductors via the shunt.

115. In a telephone system, a subscriber's telephone station, a line for said station, an automatic switch for said line, including a line magnet for controlling said switch, a shunt for the conductors of said line between the telephone and the switch, and means for opening and closing said shunt to connect and disconnect said conductors via the shunt, and a battery normally connected with said line via said shunt when the shunt is closed.

116. In a telephone system, a subscriber's telephone station, a line for said station, an automatic switch for said line, including a line magnet for controlling said switch, a shunt for the conductors of said line between the telephone and the switch, means for opening and closing said shunt to connect and disconnect said conductors via the shunt, and a battery normally connected with said line via said shunt when the shunt is closed, and means for disconnecting the battery on the line at the shunt when the shunt is opened.

117. In a telephone system, a telephone line, magnets associated with said line and a circuit for shunting said magnets from said line, and automatic means for opening said shunt when a call is made from the telephone.

118. In a telephone system, a telephone, a line, an automatic switch responsive to the calling subscriber, magnets associated with said line, a bridge closed across said line

for shunting said magnets from the line, and means controlled over the line for opening up said bridge.

119. In a telephone system, a group of calling lines, a trunk line, a movable member for said trunk line, as many terminals on said member as there are calling lines, mechanism common to said calling lines for establishing connections between said terminals and said calling lines, said mechanism provided with means for moving said member for making the connections.

120. In a telephone system, a subscriber's line and individual switch comprising a plurality of trunk line terminals, means for moving each terminal independently of the other, a trunk line connected with each terminal and subscribers' line terminals adapted to co-operate with said trunk terminals in establishing connection between the line and any one of said trunk lines in response to an impulse from the line upon the removal of the receiver.

121. A telephone exchange system comprising subscribers' lines, a "selector" switch individual to each line for extending its circuit, a plurality of link-circuits connected to each "selector" switch and available for connection to its line, and means for sending a characteristic signal over the calling line in case all of the link-circuits available to said line are in use.

122. In a switch, the combination of sets of intersecting bars, contact sets at the intersections of said bars, a common locking device for holding any bar of one of the sets normally displaced, means for displacing any bar of the other set, and means effective upon such conjoint displacement for operating a contact set.

123. A telephone exchange system comprising a subscriber's telephone line, a plurality of link-circuits extending therefrom, automatic switching means for establishing connection between said line and an idle one of said link-circuits, means for restoring said switching means to normal position, and means for placing said restoring means under the control of the subscriber in case all of said link-circuits are in use.

124. A telephone exchange system comprising subscribers' telephone lines, a plurality of link-circuits extending therefrom, automatic switching means for establishing connection between said lines and an idle one of said link-circuits, means for restoring said switching means to normal position, means for sending a characteristic signal to the subscriber and for placing said restoring means under his control in case all of said link-circuits are in use.

125. A telephone exchange system comprising subscribers' telephone lines, "selector" switches responsive to removal of the receiver at a calling substation for extending the circuits of calling lines, a plurality of link-circuits connected to each "selector" switch and available for connection with a calling line, and means for sending a characteristic signal over the calling line in case all of the link-circuits available to said line are in use.

126. A telephone exchange system comprising subscribers' telephone lines, "selector" switches for extending the circuits of calling lines, a plurality of link-circuits connected to each "selector" switch and available for connection with a calling line, means for restoring an actuated "selector" switch to normal, and means for placing said restoring means under the control of the calling party in case all of the link-circuits available to his line are in use.

127. A telephone exchange system comprising subscribers' lines, a "selector" switch individual to each line and responsive to the removal of the receiver at the substation thereof for extending its circuit, a plurality of link-circuits connected to each "selector" switch and available for connection to its line, and means for sending a characteristic signal over the calling line in case all of the link-circuits available to said line are in use.

128. A telephone exchange system comprising subscribers' lines, a "selector" switch individual to each line for extending its circuit, a plurality of link-circuits connected to each "selector" switch and available for connection to its line, means for restoring an actuated "selector" switch to normal, and means for placing said restoring means under the control of the calling party in case all of the link-circuits available to his line are in use.

129. A telephone system including a telephone line, selective switching mechanism at the exchange, contacts individual to said line at said mechanism, first selectors at the exchange, multiple terminals of said selectors at said mechanism, means effective on removal of the receiver at the substation of said line to connect contacts thereof with contacts of an idle selector, and apparatus effective to extend a busy signal over said line in case said selectors are busy.

130. A telephone system including a telephone line, a plurality of link-circuits at the exchange, means responsive to removal of the receiver at the substation of said line to automatically connect an idle one of said circuits with said line, and apparatus for extending a busy signal over said line when said circuits are all busy on initiation of a call.

131. The combination with a telephone station, and a switching mechanism connected thereto, of means responsive to the removal of the receiver at the calling substation for operating said switching mechanism so as to automatically connect said station

to an idle member of a group of similar switching mechanism, a pair of contact members through which said connection is completed and through which any talking circuit for said station must pass, and means by which upon no idle switch being found by said operation a busy signal current will flow through said contact members to said station.

132. A telephone system comprising telephone substation lines, individual switches for said lines, and link circuits multiply connected to said switches and adapted for extending the circuit of said line responsive to the removal of the receiver at the calling substation which causes the switch to attempt to establish connection with an idle one of said circuits, and means for sending a characteristic signal over the calling line in case all of said link circuits are in use.

133. A telephone exchange system comprising subscribers' lines, a plurality of trunk circuits available for connection to a wanted line, automatic selecting mechanism for extending the circuit of a calling line to an idle trunk circuit, and means for sending a characteristic signal over the two sides of calling line in series in case all of the trunk circuits available for connection to said wanted line are in use.

134. In a telephone switch, a plurality of sets of contacts arranged in a row, each set of contacts comprising a plurality of flexible springs, a plurality of other contacts arranged in rows, means for operating a row of individual flexible contacts, and means for operating the second mentioned contacts for cooperating with an individual set of flexible contacts independent of the other contacts in the row.

135. In a telephone switch, a plurality of rows of contacts, each row comprising a set of flexible springs, a plurality of other rows of contacts arranged at right angles to the first mentioned rows, and means for causing the cooperation between said contacts by first operating a row of flexible springs and thereafter operating a row of the second mentioned contacts.

136. In a telephone switch, a row of contacts comprising a plurality of sets of flexible contacts, a plurality of rows of secondary contacts, means for operating said row of flexible contacts whereby all of said sets are brought into alignment with all the rows of secondary contacts at the same time, and means for operating any one of said rows of secondary contacts for engaging the particular set of flexible contacts with which it is aligned, the operation of said rows of secondary contacts being in a longitudinal direction only.

137. In a telephone switch, a plurality of rows of contacts, each row comprising a plurality of sets of flexible contacts, a plurality of rows of secondary contacts, means for operating a particular row of flexible contacts whereby each set of said row is brought into alignment with a particular row of secondary contacts, and means for operating any row of secondary contacts to engage the set of flexible contacts with which it is aligned, the operation of said rows of secondary contacts being in a longitudinal direction only.

138. In a telephone switch, the combination of a plurality of sets of primary contacts arranged in a row, a plurality of rows of secondary contacts, each row of said secondary contacts being allotted to a particular set of primary contacts, means for operating the flow of primary contacts for bringing each individual set into alignment with its allotted row of secondary contacts, and means for operating a row of secondary contacts for engaging the set of primary contacts with which it is aligned.

139. In a telephone switch, the combination of a plurality of rows of primary contacts, each row comprising a plurality of sets of contacts, a plurality of rows of secondary contacts, each of said rows of secondary contacts having access to a particular set of individual primary contacts of each row, means for operating any row of said primary contacts whereby each set of the row is brought into alignment at the same time with a row of secondary contacts, and means for operating any row of secondary contacts for engaging the set of primary contacts with which it is aligned.

140. In a telephone switch, the combination of a plurality of rows of primary contacts, each row comprising a plurality of sets of contact springs fastened at one end, a plurality of rows of secondary contacts extending at right angles to the rows of primary contacts and adapted to engage the free ends thereof, each row of secondary contacts arranged to have access to a particular set of primary contacts of each row, means for operating said primary contacts whereby the free ends of each set of the row is brought into alignment at the same time with a row of secondary contacts, and means for operating any row of secondary contacts for engaging the set of primary contacts with which it is aligned.

141. In a telephone switch, a row of primary contacts, an electromagnet common to and for operating said row of contacts, a plurality of sets of secondary contacts arranged at right angles to said row, an electromagnet for operating said secondary contacts, means for causing the engagement of a particular set of primary contacts with said secondary contacts, and means for energizing said electromagnets, a single energization of said electromagnets serving to cause the engagement of said contacts.

142. In a telephone switch, the combination of a plurality of sets of primary contacts arranged in a row, a movable element, said element controlling the movement of said primary contacts, a plurality of secondary contacts, means for operating said movable element to move said primary contacts into alignment with said secondary contacts, and means for operating a particular secondary contact for engaging the primary contact with which it is aligned.

143. In a telephone switch, a plurality of primary contacts, arranged in a row, an electromagnet for said row of contacts, a plurality of secondary contacts, an electromagnet for said secondary contact, means for energizing said electromagnets, a single energization of said electromagnets serving to cause the cooperation of said primary and secondary contacts.

144. In a switching device for interconnecting lines and trunk lines, a row of trunk contacts individual to each trunk line, the number of contacts in each row being equal to the number of lines, a row of line contacts individual to each line, the number of contacts in each row being equal to the number of trunk lines, and means for connecting any line with any trunk line by effecting engagement of the corresponding contacts.

145. The combination in a system employing normally deenergized individual relays for the subscribers' lines, of an idle subscriber's line, an idle trunk line, mechanism for preselecting said trunk line, a switch individual to said subscriber's line for use in making any one of a number of possible connections therefrom, means for temporarily retaining said switch in selected position to make connection between said lines when the subscriber calls, and relay means for said switch adapted to remain temporarily energized during the use of the switching means for talking purposes.

146. The combination, in a system employing normally deenergized individual relays for the subscribers' lines, of a subscriber's line, a switch individual to said subscriber's line, a series of trunk-line-terminals for said switch, and a trunk line for each terminal, means for always having some one of said trunk-line-terminals selected and ready for use by said switch when out of use, said selected trunk-line-terminal always being the terminal next in order after the terminal connected with the trunk-line last put in use, and relay means for said switch adapted to remain temporarily energized during the use of the switching means for talking purposes.

147. In a system for automatically trunking telephone lines into connection with other lines, the combination of a group of telephone lines, a plurality of trunk lines less in number than said telephone lines, trunk-connecting means individual to each telephone line, adapted to close connection between calling telephone lines and preselected trunk lines, and automatic trunk-selecting means common to all of the telephone lines, comprising a ratchet or step-by-step mechanism actuated automatically whenever connection is made with a preselected trunk line, adapted to select an idle trunk line each time a preselected trunk line is seized by a calling telephone line.

148. The combination of telephone lines, a plurality of automatic switches, trunks leading to said switches, a set of multiple trunk-terminals for each telephone line, means for connecting calling telephone lines with preselected automatic switches, including a movable circuit-closing member for each set of terminals, and automatic means for selecting an idle switch each time a preselected automatic switch is seized by a calling telephone line.

149. The combination of telephone lines, a plurality of trunks, a set of multiple trunk-terminals for each telephone line, a movable device for each telephone line, common means for selecting another idle trunk each time one is seized by a calling telephone line, and means for causing the movable device of any calling telephone line to engage the terminal of the preselected trunk.

150. The combination of telephone lines, a plurality of trunks, a set of multiple trunk-terminals for each telephone line, automatic means for selecting the first idle trunk next in order after the one last in use each time a trunk is seized by a calling telephone line, and means individual to each telephone line for connecting the same with the terminal of the preselected trunk.

151. The combination of trunks, automatic means for selecting the first idle trunk next in order after the one last in use, and subscribers' individual devices for connecting with the preselected idle trunk.

152. The combination of telephone lines, trunks less in number than the said telephone lines, a set or series of multiple trunk-terminals for each telephone line, means for connecting a calling telephone line with the terminal of a preselected trunk, and automatic means actuated in the seizure of a preselected trunk for selecting a new trunk for the next call.

153. The combination of telephone lines, subscriber-controlled or operated apparatus for automatically trunking and finally connecting in accordance with the digits of any called number, trunk lines leading to said apparatus, a set or series of trunk-line terminals for each telephone line, means for connecting a calling telephone line with the terminal of a preselected trunk-line, and automatic means for selecting a new or idle trunk-line for the next call.

154. The combination of trunks, telephone lines, automatic means by which a calling subscriber selects an idle trunk for the next calling subscriber, and means individual to the telephone lines for connecting with the preselected trunks.

155. In a telephone system having selectors and connectors, means for selecting idle first selectors ahead of the calls, subscribers' individual switches for seizing the preselected idle selectors, and means for operating connectors to find the called lines.

Signed by me at Chicago, Cook county, Illinois, this 9th day of November, 1905.

CHARLES J. ERICKSON.