

Aug. 9, 1927.

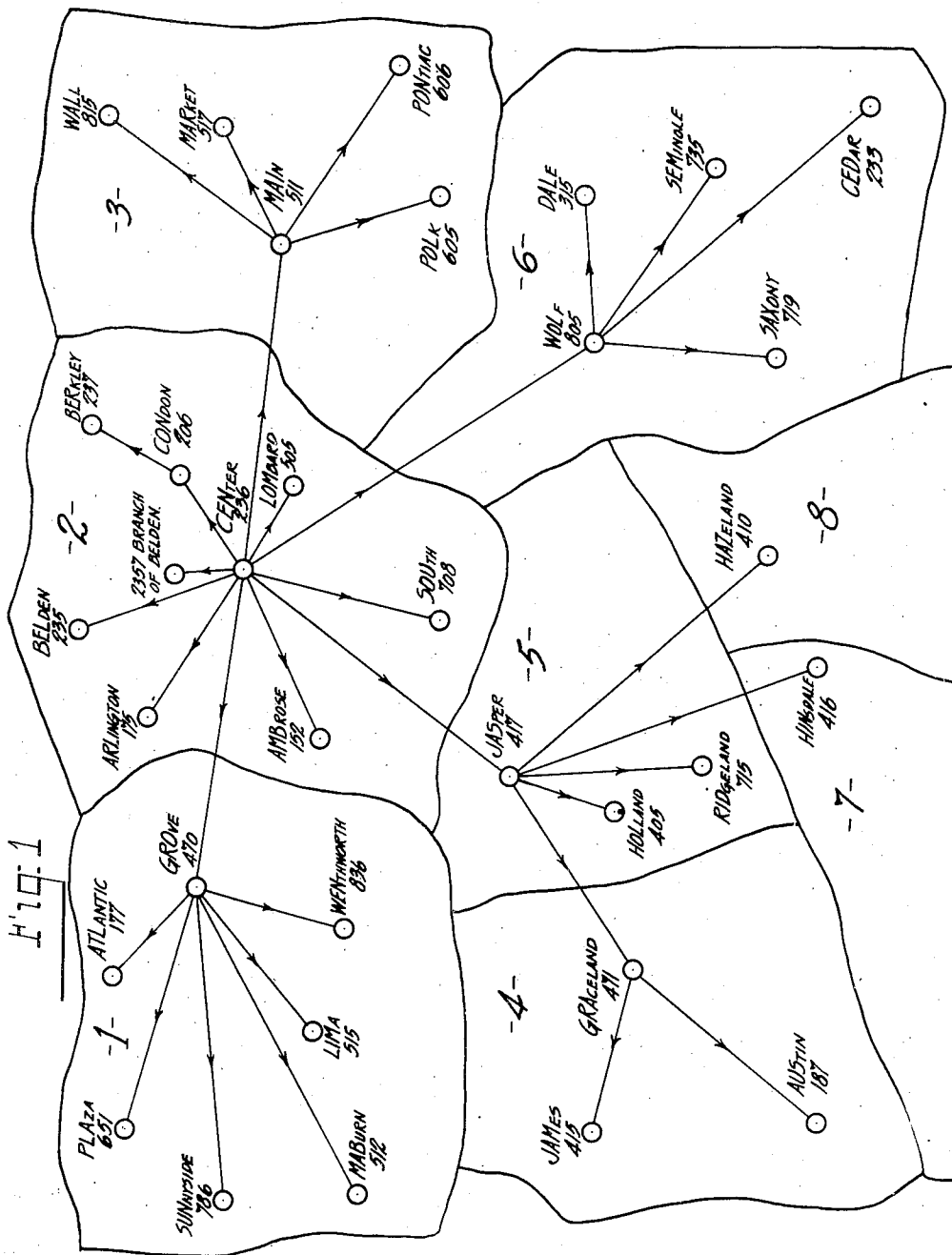
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1,638,331

MULTIOFFICE TELEPHONE SYSTEM

Original Filed Dec. 23, 1922

19 Sheets-Sheet 1



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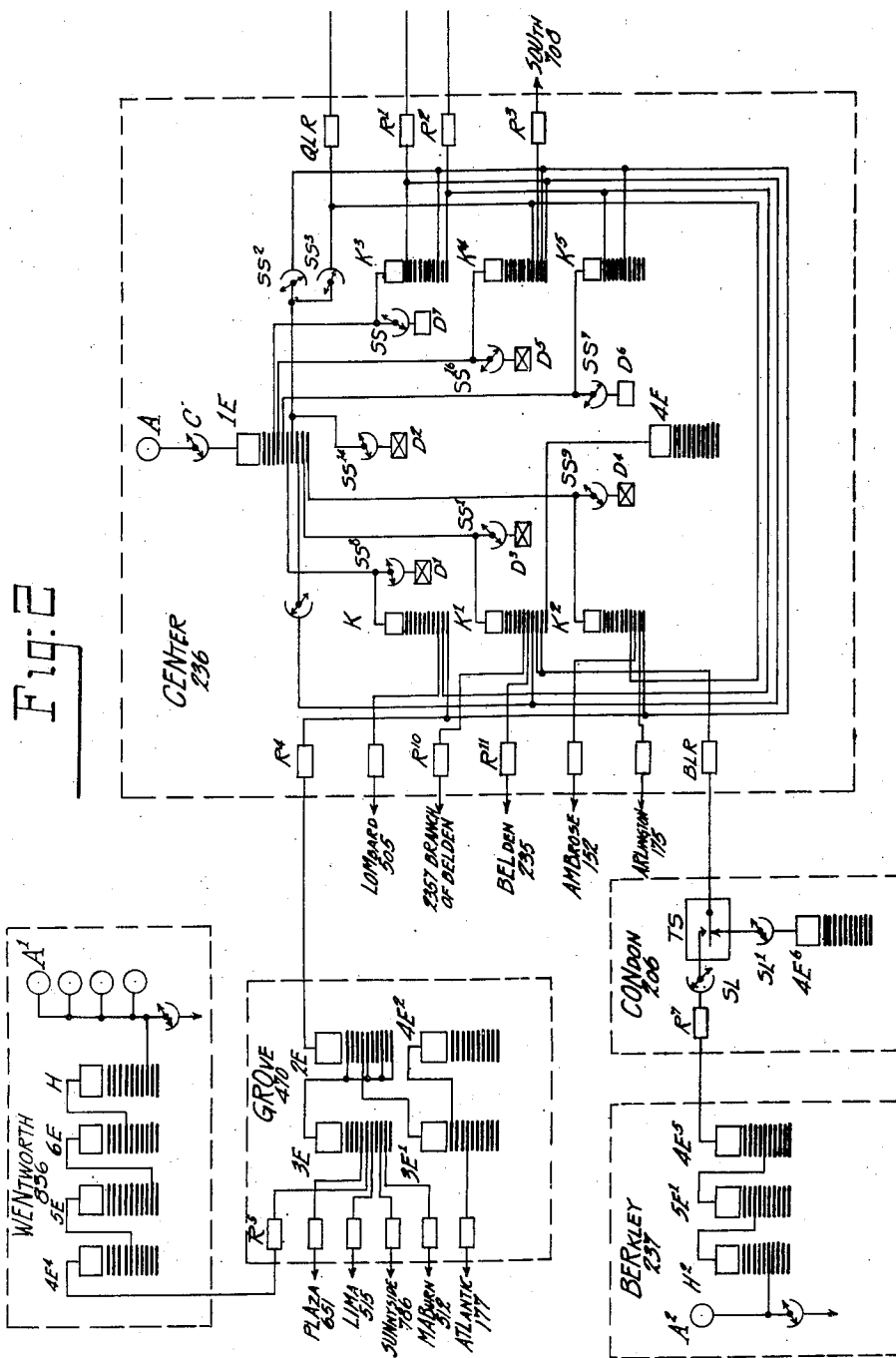
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MULTIOFFICE TELEPHONE SYSTEM

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19 Sheets-Sheet 2



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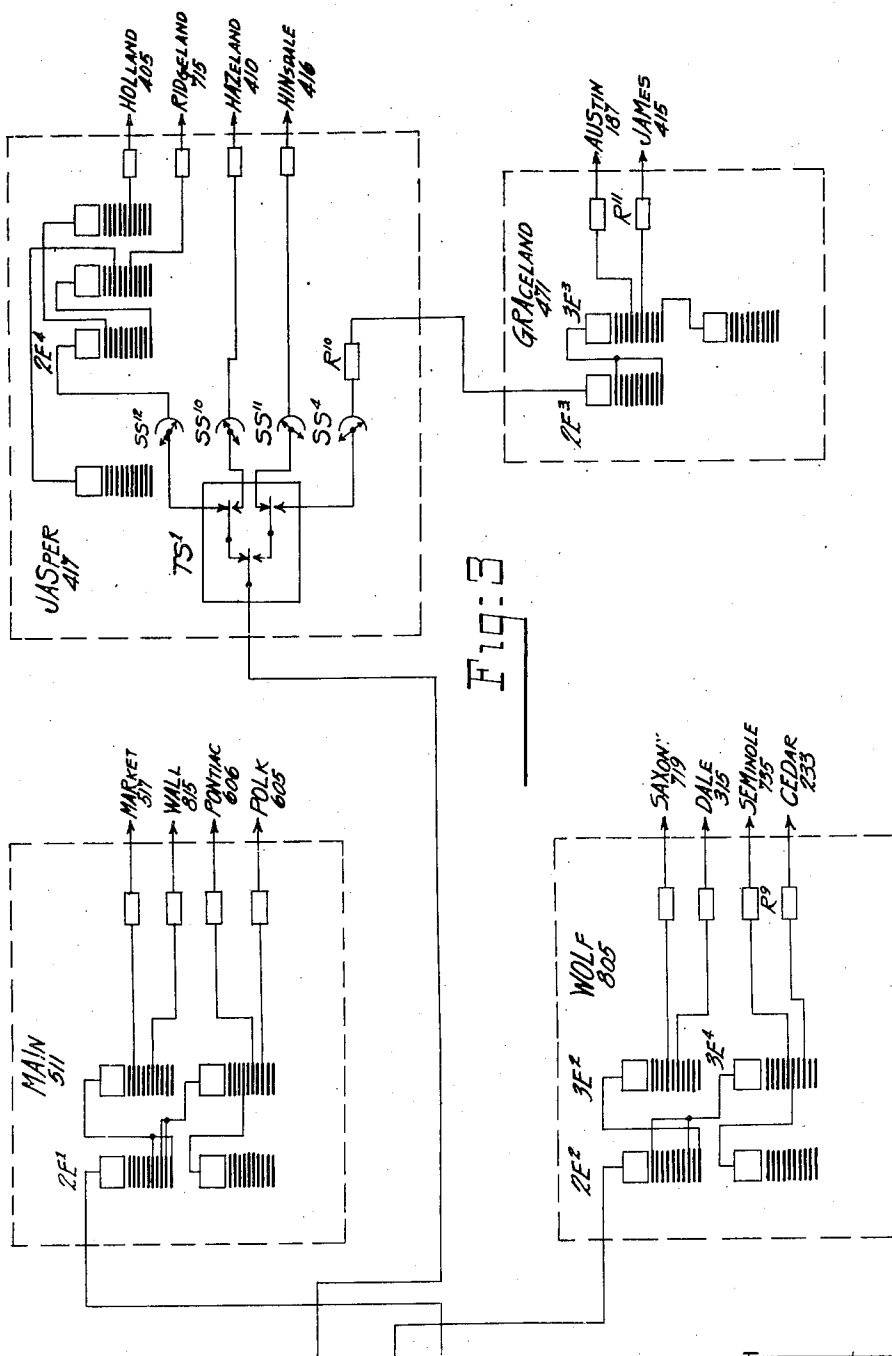
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MULTIOFFICE TELEPHONE SYSTEM

Original Filed Dec. 23, 1922 19 Sheets-Sheet 3



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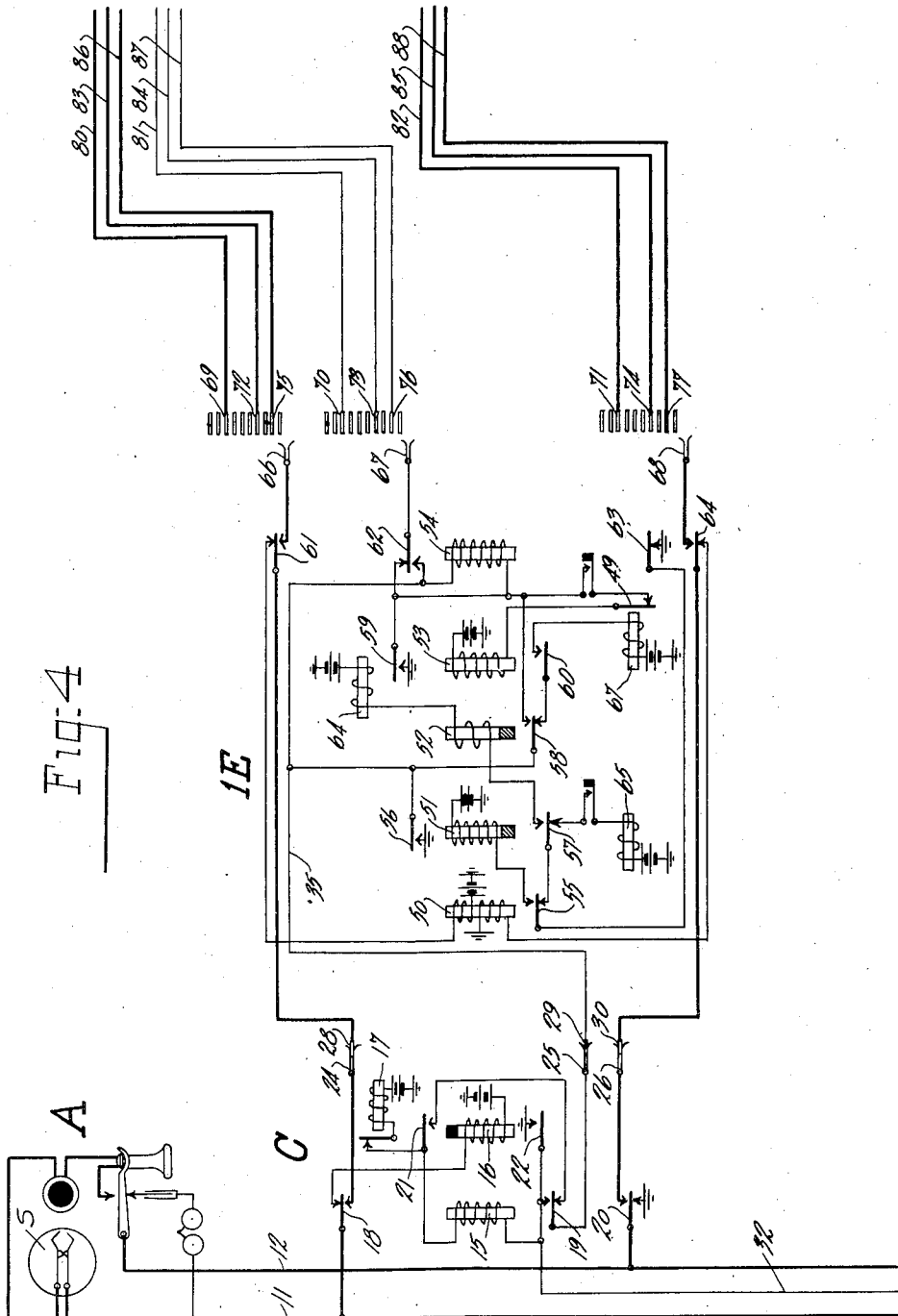
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MULTIOFFICE TELEPHONE SYSTEM

Original Filed Dec. 23, 1922 19 Sheets-Sheet 4



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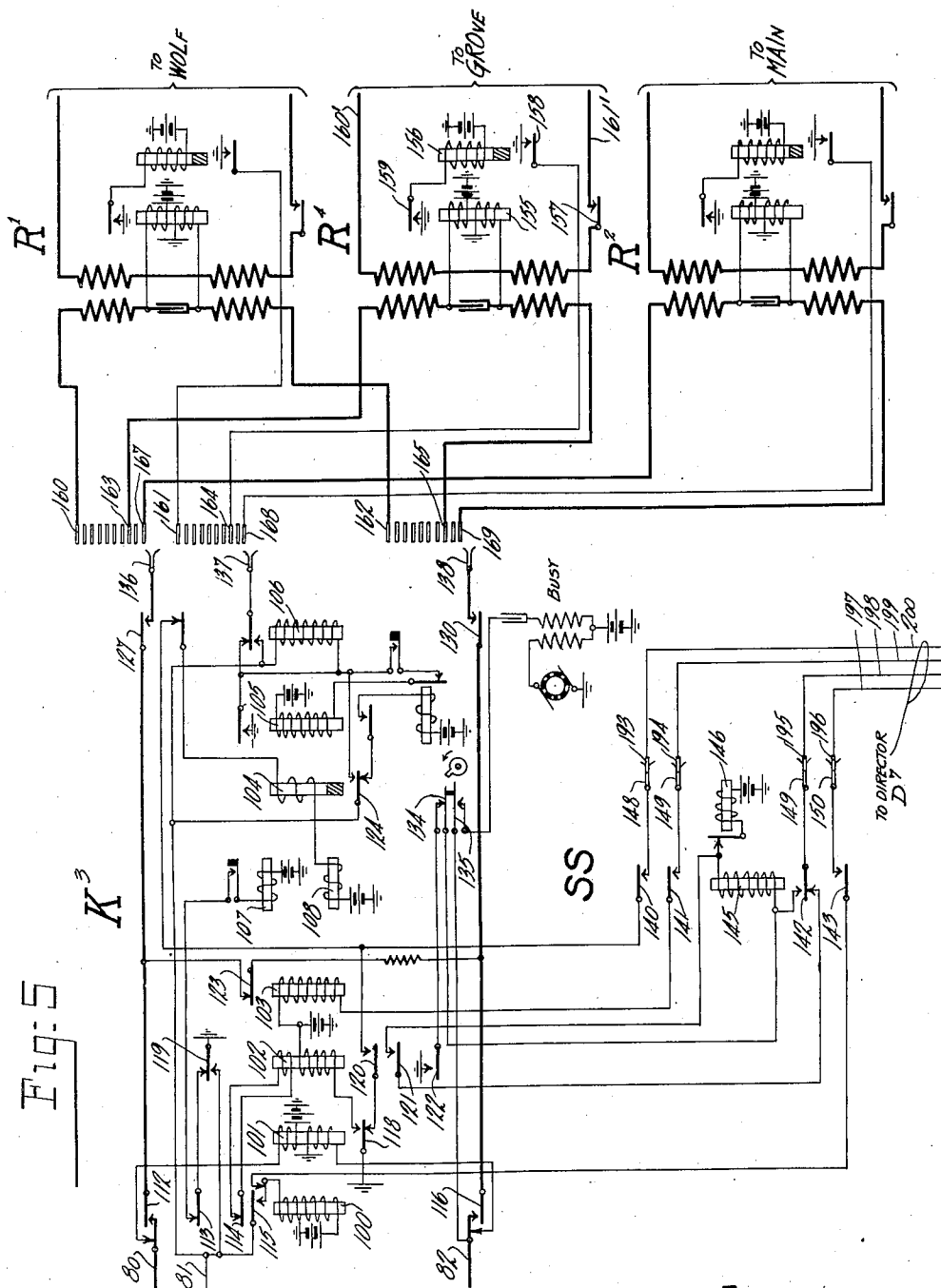
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MULTIOFFICE TELEPHONE SYSTEM

Original Filed Dec. 23, 1922

19 Sheets-Sheet 5



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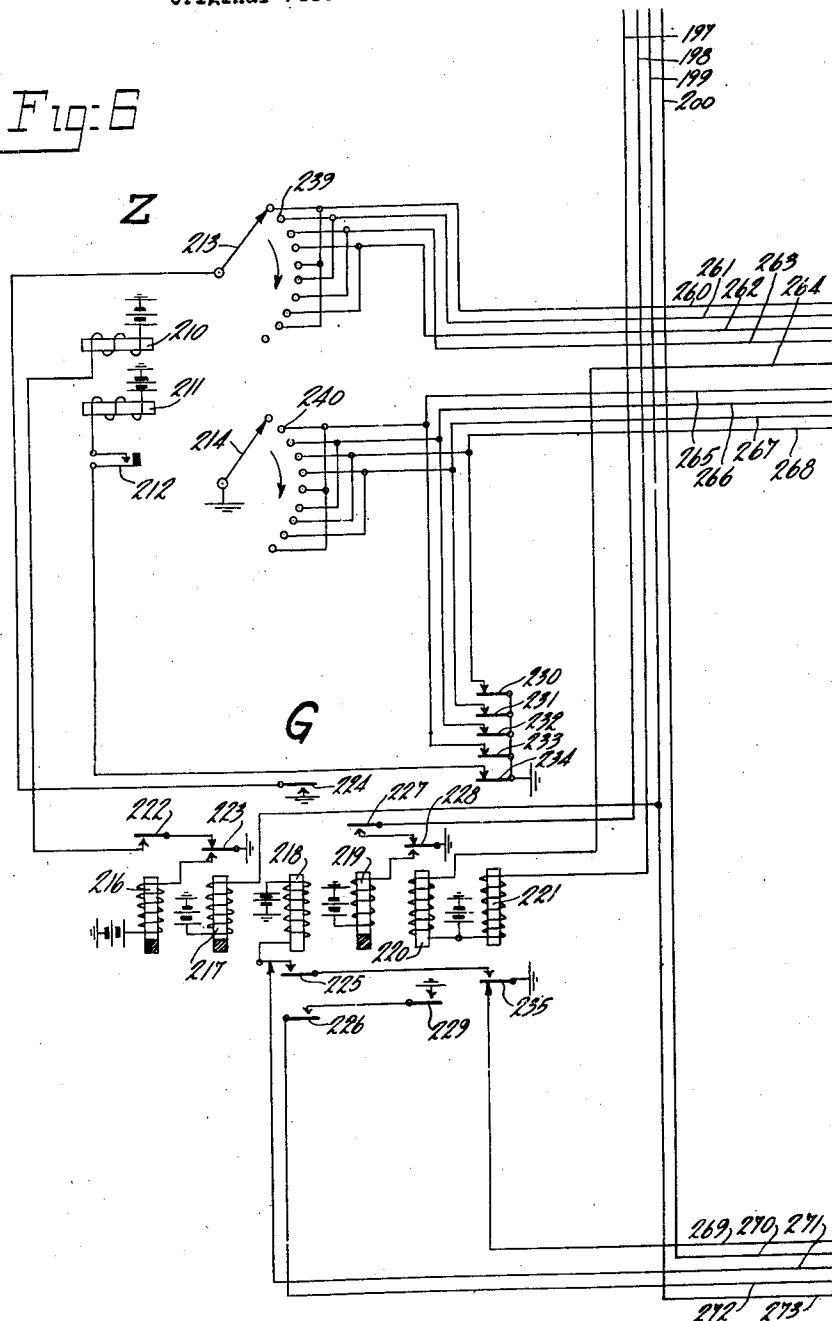
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MULTIOFFICE TELEPHONE SYSTEM

Original Filed Dec. 23, 1922

19 Sheets-Sheet 6

Fig. 6



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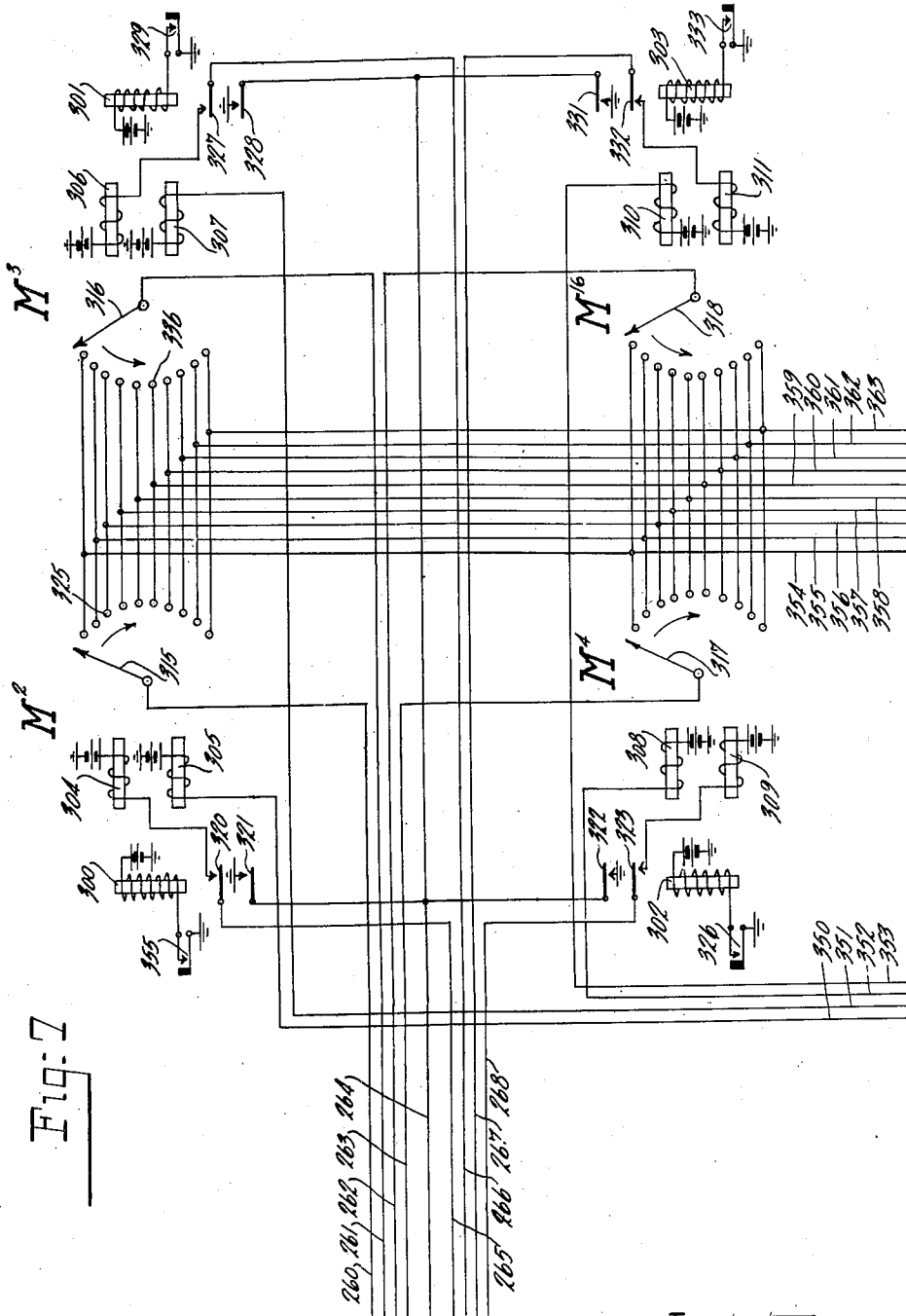
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MULTIOFFICE TELEPHONE SYSTEM

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MULTIOFFICE TELEPHONE SYSTEM

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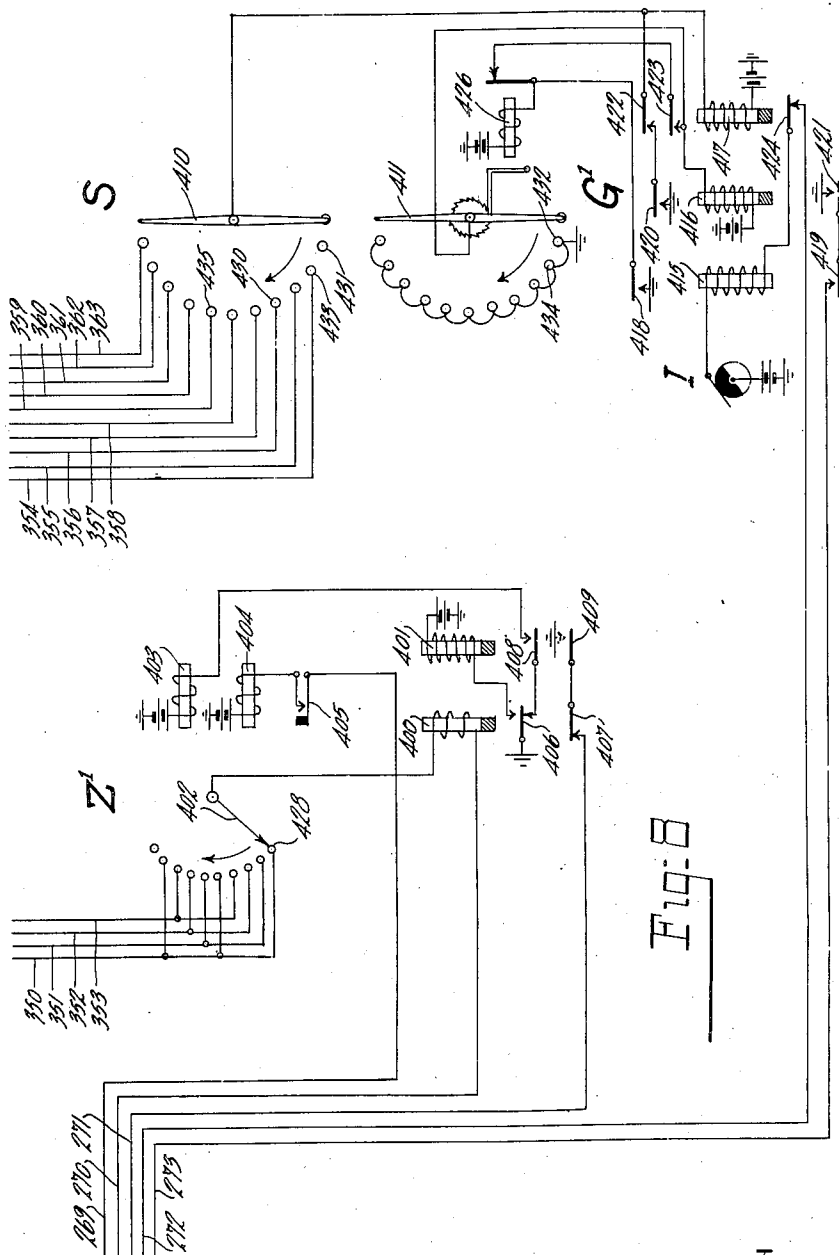


Fig. 8

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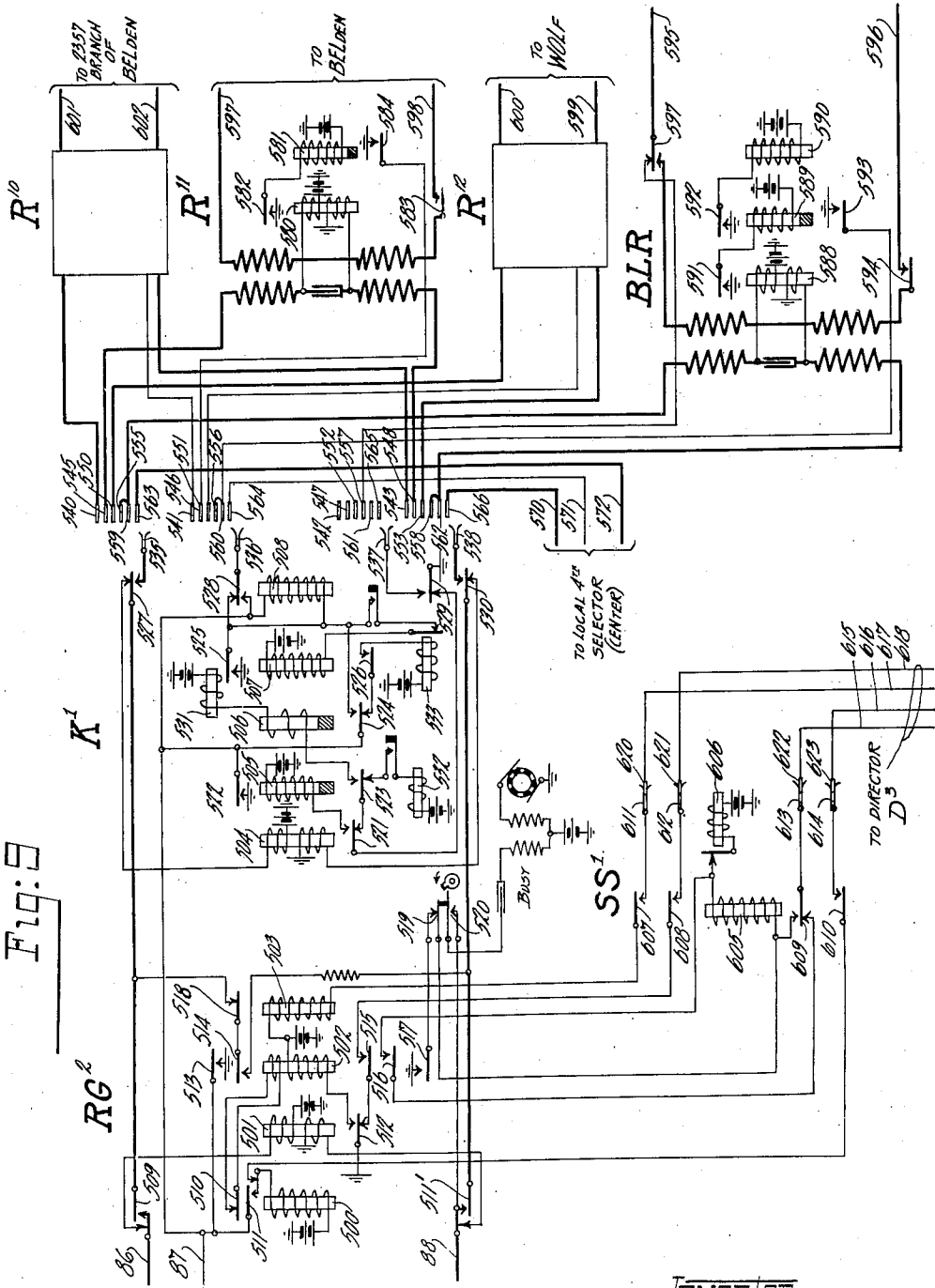
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MULTIOFFICE TELEPHONE SYSTEM

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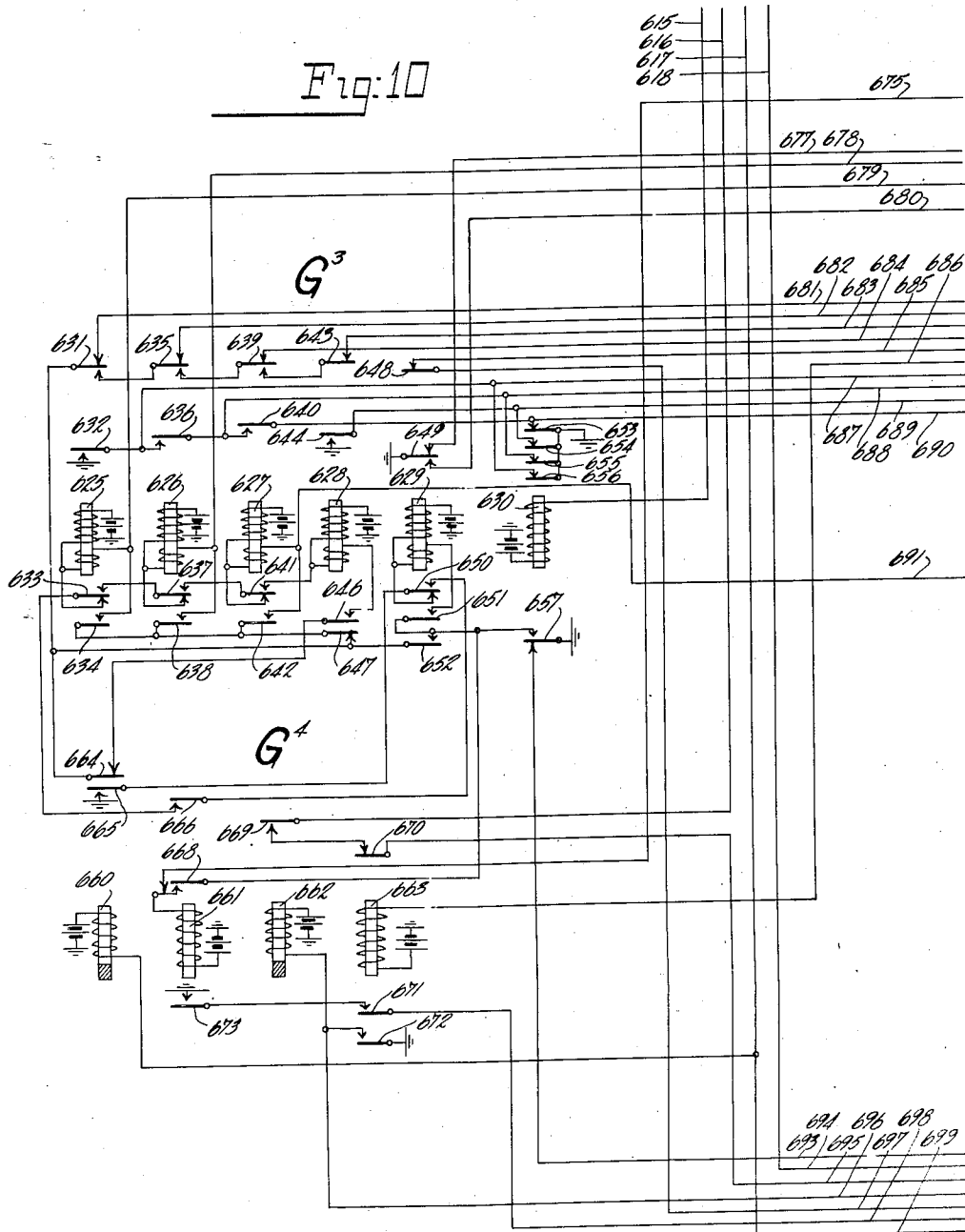
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MULTIOFFICE TELEPHONE SYSTEM

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Fig. 10



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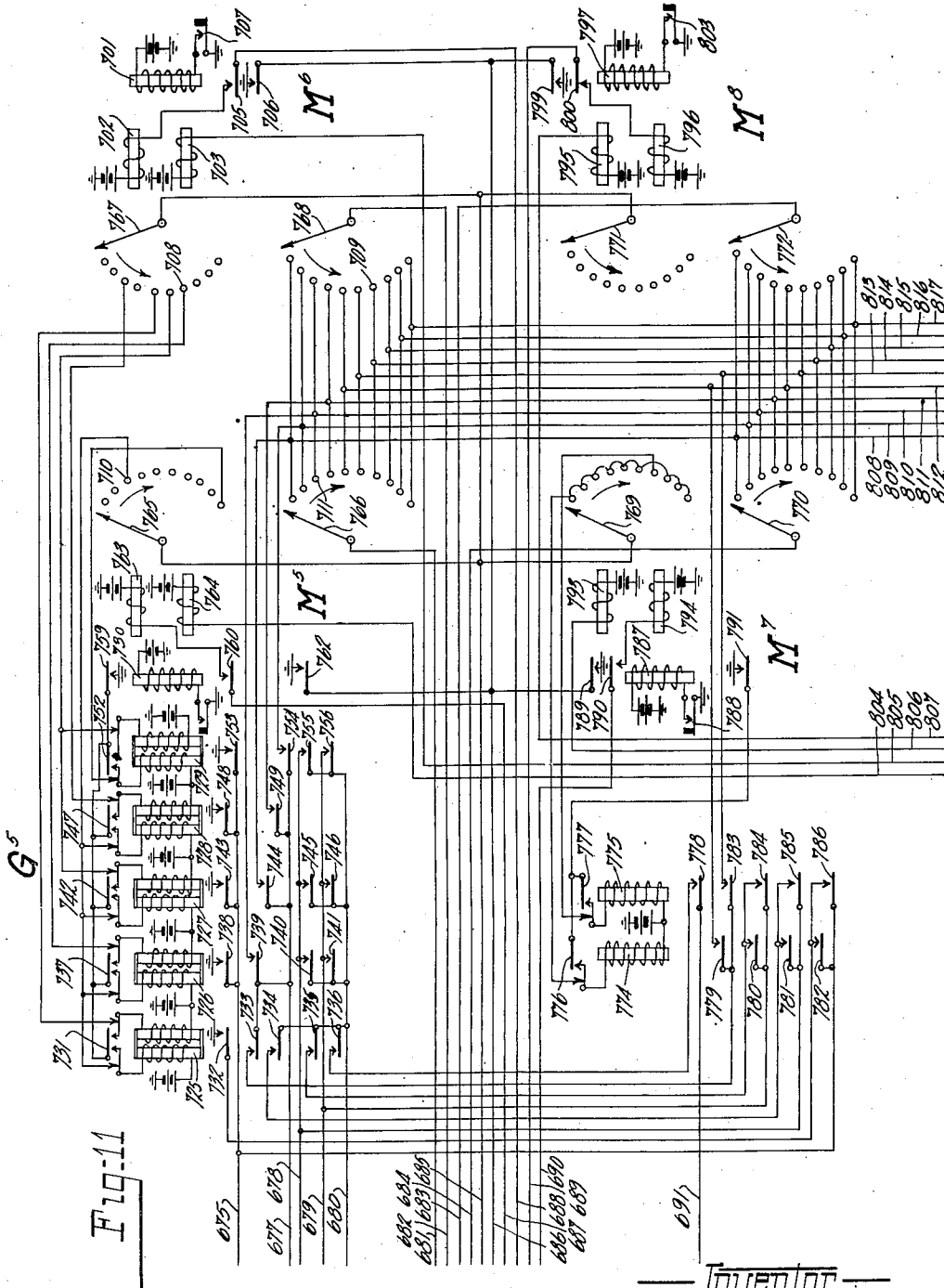
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MULTIOFFICE TELEPHONE SYSTEM

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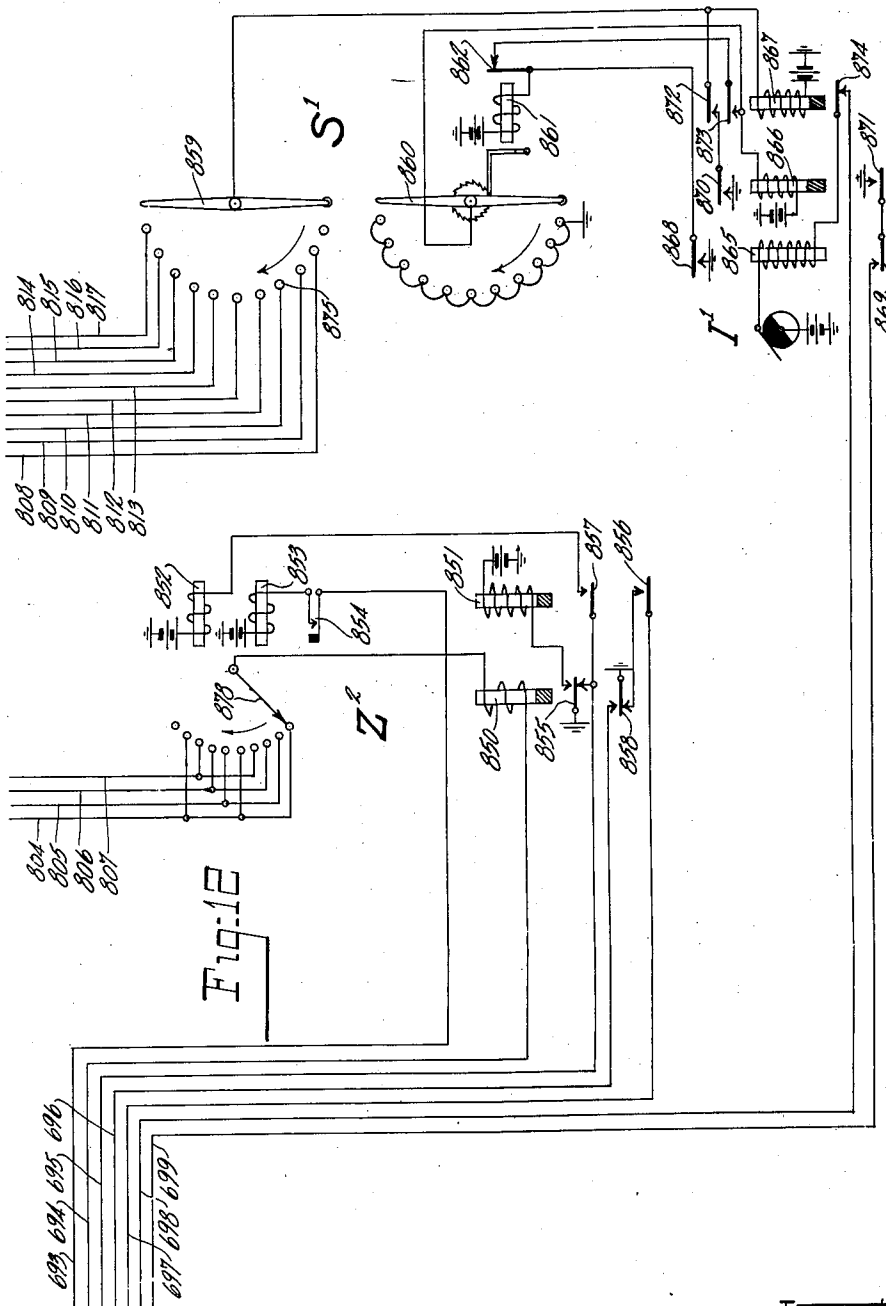
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MULTIOFFICE TELEPHONE SYSTEM

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19 Sheets-Sheet 12



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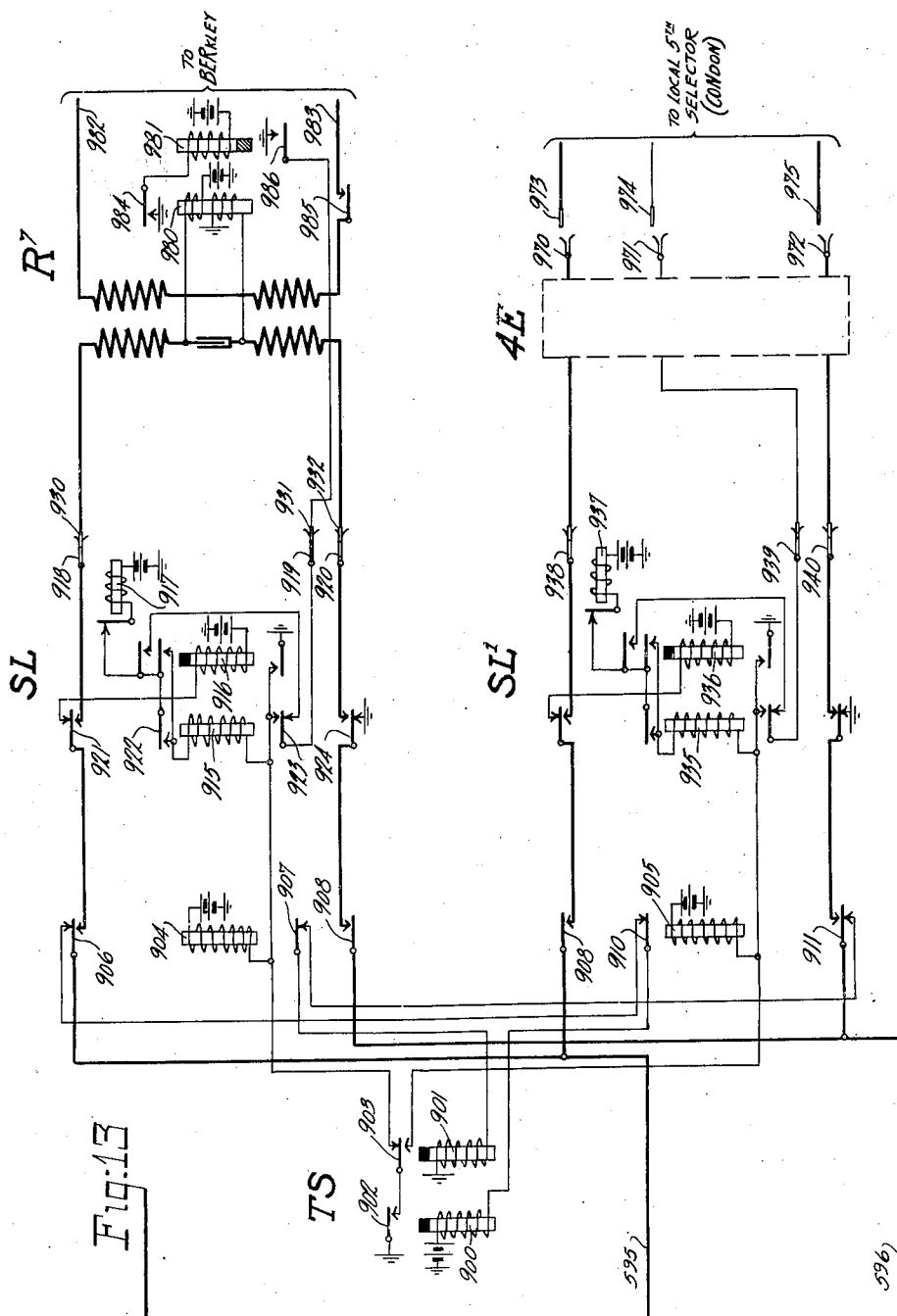
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MULTIOFFICE TELEPHONE SYSTEM

Original Filed Dec. 23, 1922 19 Sheets-Sheet 13



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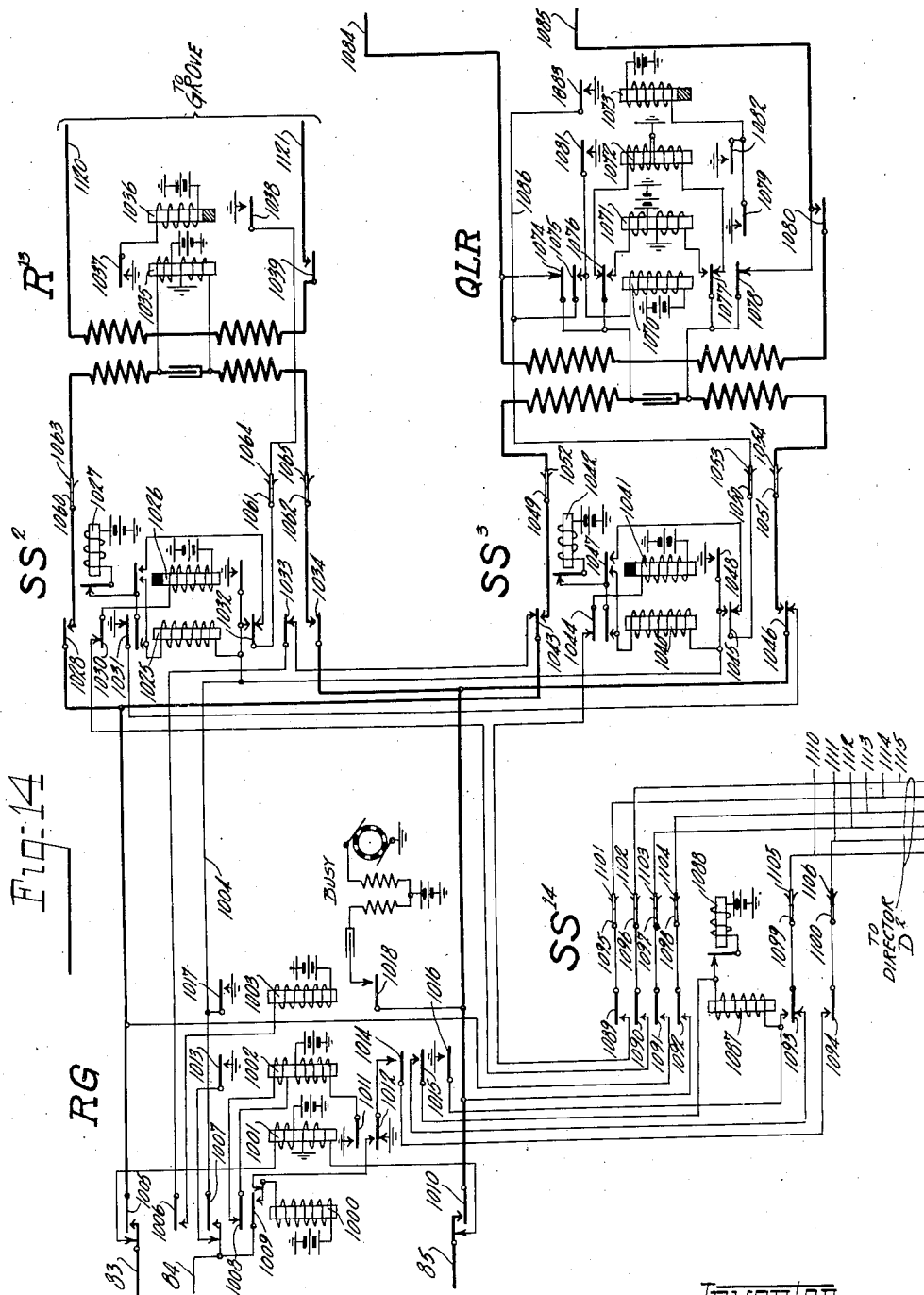
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MULTIOFFICE TELEPHONE SYSTEM

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19 Sheets-Sheet 14



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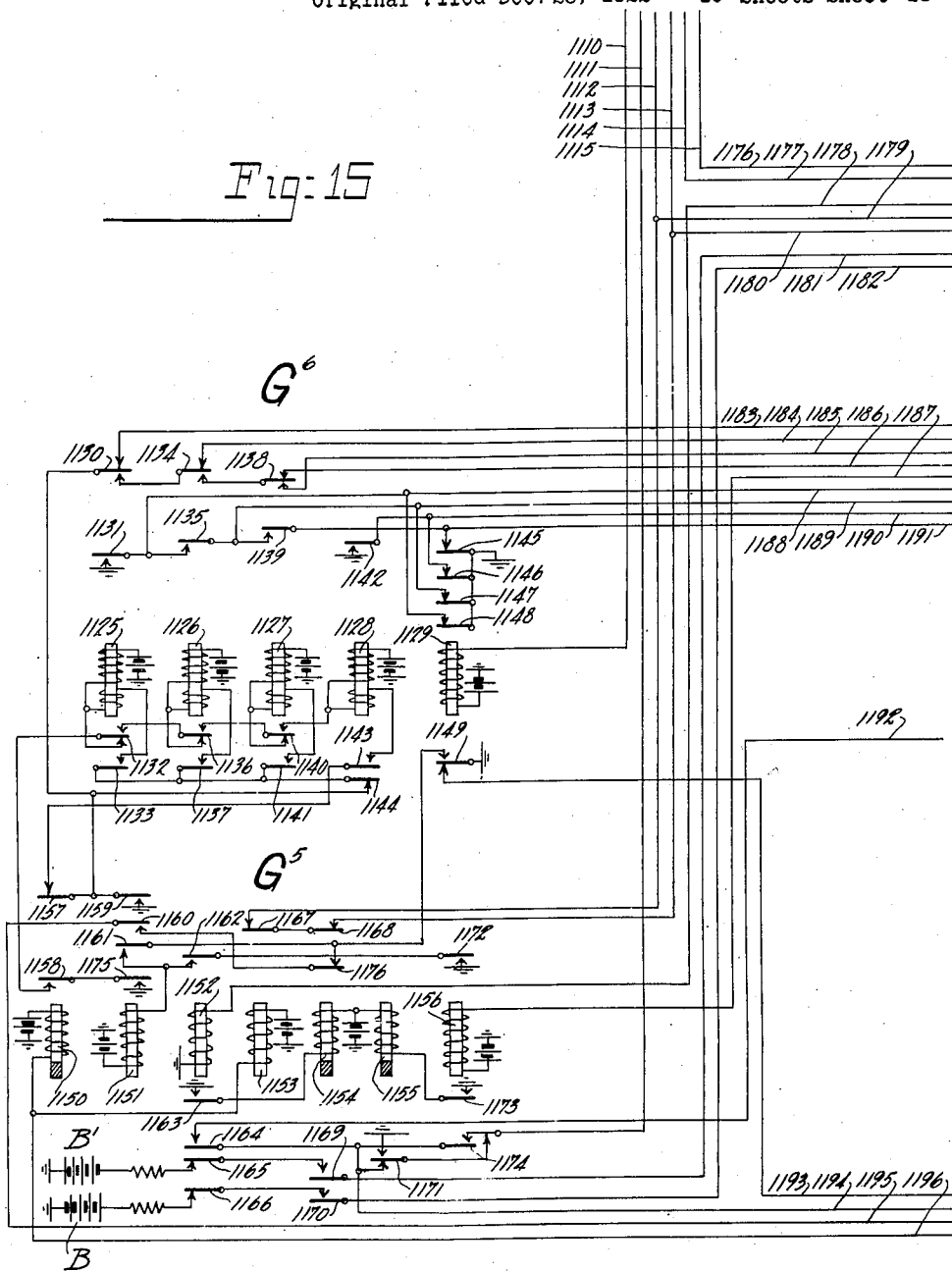
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MULTIOFFICE TELEPHONE SYSTEM

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19 Sheets-Sheet 15

Fig: 15



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MULTIOFFICE TELEPHONE SYSTEM

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G⁸

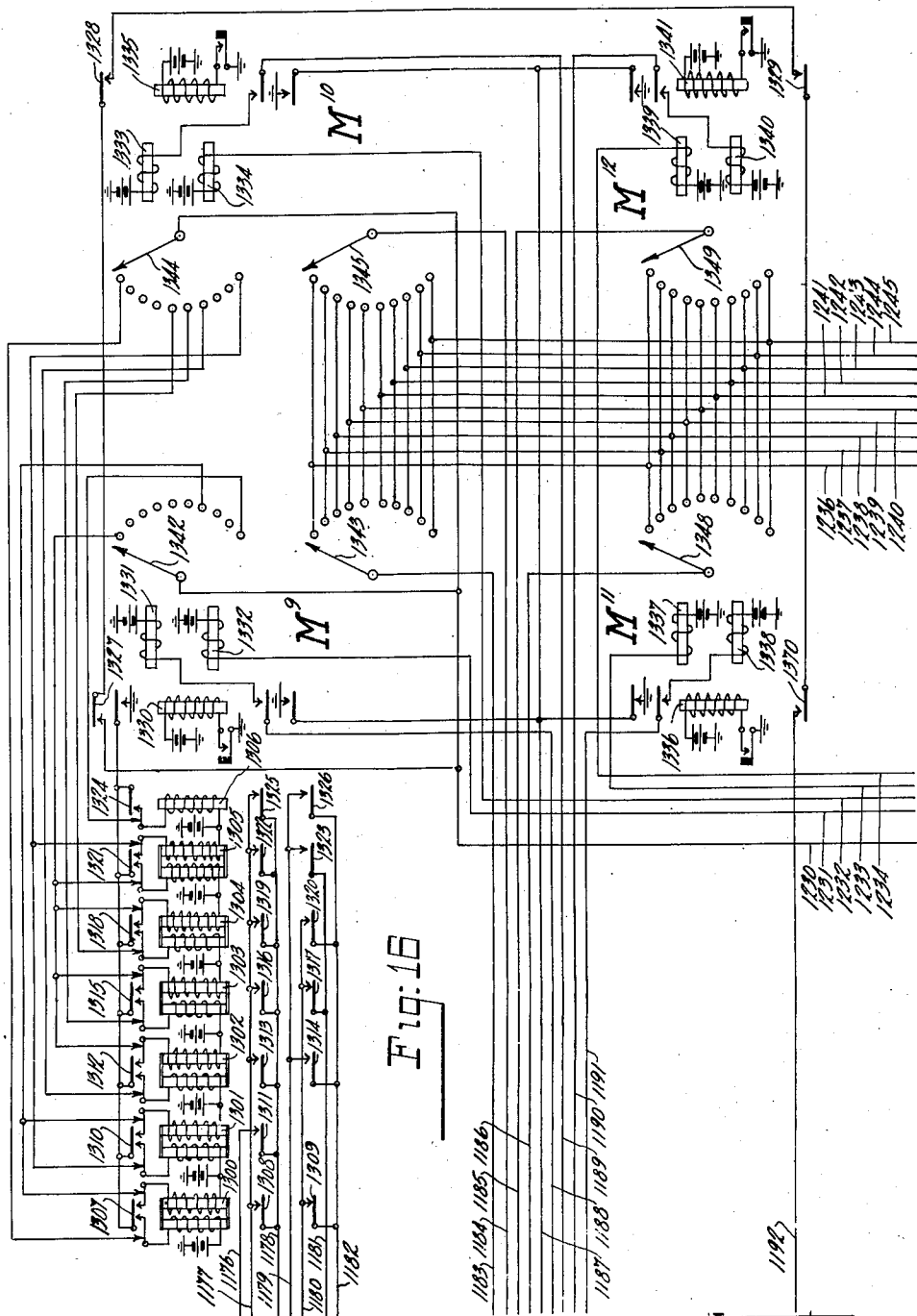


Fig. 16

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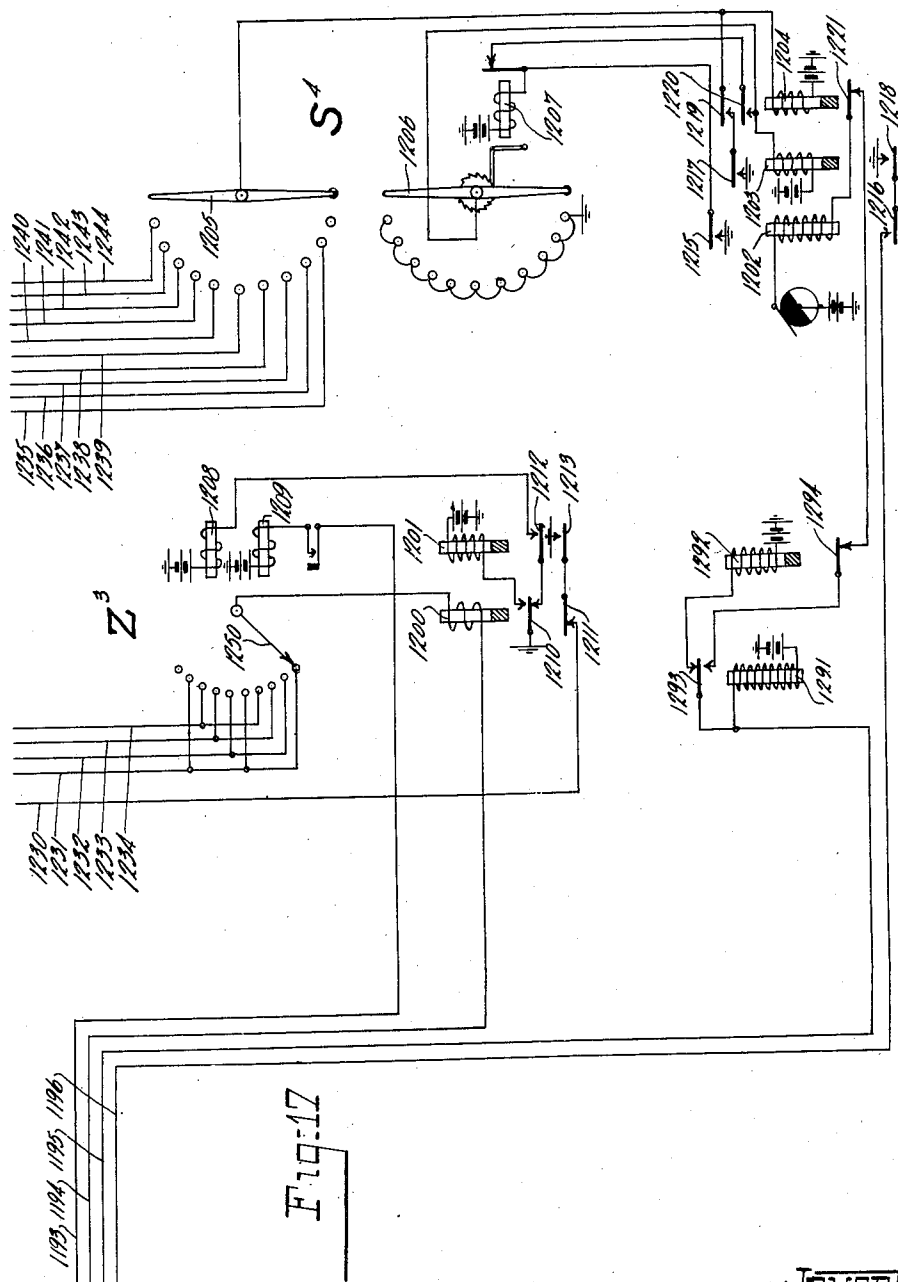
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MULTIOFFICE TELEPHONE SYSTEM

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19 Sheets-Sheet 17



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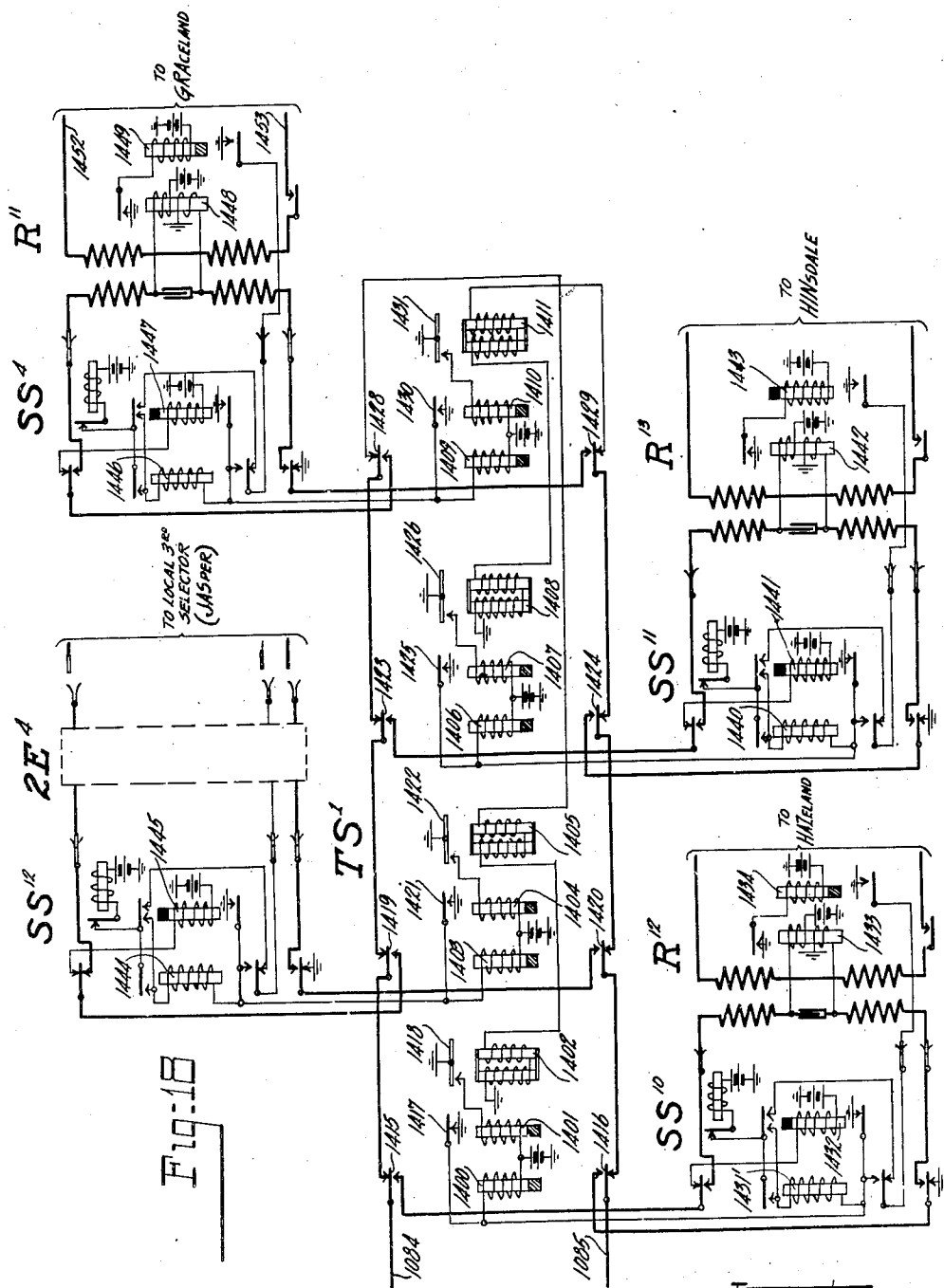
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MULTIOFFICE TELEPHONE SYSTEM

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19 Sheets-Sheet 18



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MULTIOFFICE TELEPHONE SYSTEM

Original Filed Dec. 23, 1922 19 Sheets-Sheet 19

Fig. 19

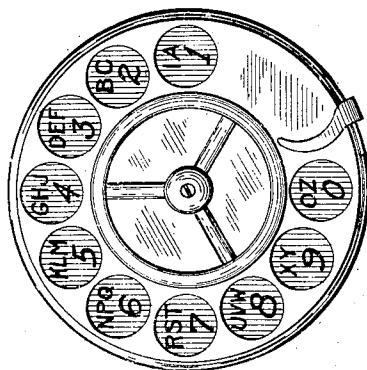


Fig. 20

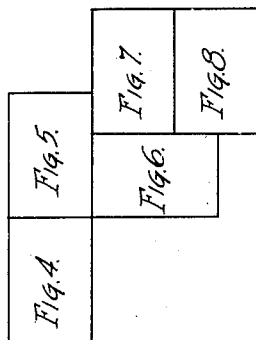


Fig. 21

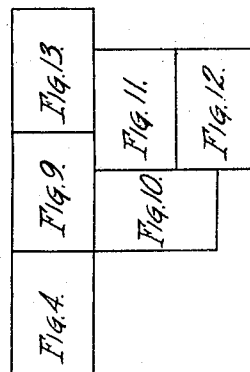
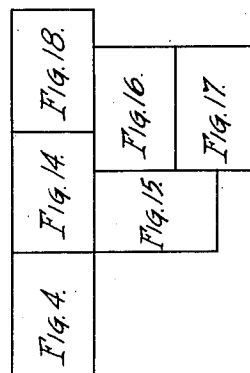


Fig. 22



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UNITED STATES PATENT OFFICE.

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MULTIOFFICE TELEPHONE SYSTEM.

Application filed December 23, 1922, Serial No. 608,741. Renewed December 15, 1926.

The present invention relates in general to multi-office telephone systems of the automatic type, and the broad general object of the invention is the provision of novel and improved trunking arrangements for a system of this character whereby the inter-office trunking facilities are rendered more flexible.

More specifically, the present invention comprehends a new and improved director of simplified construction for increasing the efficiency and flexibility of the inter-office trunking in automatic multi-office systems using step by stem switches of the Strowger type. It is well known that in multi-office systems of this type the designation of the office or the office name bears a definite relation to the geographical districts. The invention allows the names or the numbers of offices in a multi-office system to be assigned without regard to their geographical districts. That is, in a multi-office system comprising a number of districts, offices having conflicting names may be located in different districts, if desired, instead of it being necessary to locate them in the same geographical district, as is the usual practice. The invention also provides means for routing calls thru a plurality of offices in series, which may or may not have any relation to the numerical designation of the desired exchange, in order to increase the efficiency of the inter-office trunk groups. This arrangement is commonly called tandem trunking.

Another feature of the invention provides means for eliminating certain switches in the connection when it is not necessary for the call to be extended through a plurality of exchanges.

Another feature of the invention provides means for releasing the director after the office code has been set up provided the controlling impulses of the director catch up with the dialing operations of the calling subscriber. This arrangement allows the director to be released and to revert to common use. In addition, by this arrangement the number of digits in subscribers' numbers do not have to be uniform, and yet the same number of register switches suffice in all cases.

A further feature of the invention relates to an arrangement of controlling circuits so that the registering switches of the director

may be used over and over again, thus lessening the number of register switches necessary for registering subscribers' directory numbers.

It is especially desirable to accomplish the above result of enabling office designations to be assigned without regard to the geographical location of the offices, in view of the fact that many large manual multi-office systems are being changed to automatic operation and in view of the fact that when such changes are made, it is both desirable and advisable to retain the old manual exchange names as well as the subscribers' numbers in order to avoid undue confusion. Following this scheme, when the automatic system is installed, the calling devices have letter combinations in the finger holes in addition to the usual digits, so that the calls may be routed to the desired offices in accordance with the office names, that is, the first two or three letters of each office name, may be dialed by the calling subscriber, these letters forming part of the directory numbers. In the changing of a large multi-office manual system to automatic it is usually necessary to employ the first three letters of the exchange names as part of the directory number of the subscribers, in order to secure proper selection of the exchanges, the remaining portion of the number consisting of four numerals. It will at once be appreciated that, as in majority of cases the manual exchange names have been promiscuously assigned, situations are encountered where there is confliction in the first one or two letters in the names of the exchanges in different districts, the letters of these names being in the same finger holes on the calling device dial, and it consequently becomes necessary to provide trunking arrangements of the kind indicated above to complete connections to the various exchanges of the system. The present invention handles these trunking connections quite economically.

In addition to the above, there are a number of other objects of the invention, all of which will be described hereinafter with reference to the accompanying drawings forming a part of this specification.

General description of drawings.

Referring now to the drawings comprising Figs. 1-22, inclusive, Fig. 1 is a map of

certain exchanges in the system and the trunk lines over which a call is routed from the center exchange to any of the exchanges shown. Figs. 2 and 3 show the trunking and switches involved in typical connections shown in accordance with the map of the exchanges, Fig. 1. Figs. 5-18, inclusive, show by means of the conventional circuit diagrams sufficient of the apparatus to enable the invention to be readily explained and understood. Fig. 19 is a view of the calling device dial. Figs. 20-22, inclusive show the manner in which the various sheets of drawings are to be placed in order that the description may be followed conveniently.

Of course, the invention is applicable to various sizes of multi-office telephone systems; however, in the present case, it has been illustrated in connection with a seven digit system, or one the ultimate capacity of which does not exceed 10,000,000 lines. In the directory each complete number comprises the first three letters of an office name and four or sometimes five digits, for example, CENter 1234, the first three letters of an office name, or the ones that are to be dialled, being capitalized in order to make them conspicuous.

In a large system of this size, the main offices are commonly interconnected by trunks in groups of ten or less. Such a group is termed a district. The offices of each district, of course, are those that lie close together, and each main office is connected to every other main office in the same district by direct trunks; thus each district forms a complete trunking network.

To handle calls between the various districts, each main office in every district is connected by trunk lines to the nearest or one of the nearest offices in every other district of the system, these last mentioned serving as switching centers for inter-district calls. Arriving at these so-called switching centers, the incoming calls are then routed through the local inter-office trunking system in the same manner as a local call. Since the first three letters dialed are required to determine to what exchange the call is going, if the first two letters of the names of offices in different districts are the same, it will be necessary to provide means for determining to which of these two offices the call is going before routing the call to either of the two districts in question.

The trunking scheme, above set forth, is generally followed, through in certain instances, particularly where the trunk groups are small or the distances great, each main exchange in every district does not have a group of direct trunks to a main office in every other district, but rather the calls from certain offices to certain districts

are routed through an office in an intermediate district in order to increase the trunking efficiency.

In order to take care of the above pointed out confliction between office names; in order to perform the above mentioned special inter-district switching; and in order to take care of various other irregularities of a more or less similar nature which will be explained fully hereinafter, directors which include registering and controlling equipment are provided for directing the setting up of the connections where such control is necessary.

To describe the drawings, the general layout of the system will first be explained with reference to the map of exchanges, Fig. 1. In Fig. 1, there are shown eight districts, which have been indicated by the reference characters, 1-8, inclusive.

Although, as pointed out above, there are direct trunks from each main office to every other main office in the same district, and direct trunks from each main office to each district, with the exception of certain special cases, only the trunk groups that are used in completing calls that originate in the office Center are indicated on this map. The other trunk groups are omitted for the purpose of avoiding complicating the drawing with unnecessary details. Also, not all of the offices in the districts shown are indicated and not all the districts are shown. In this drawing a circle indicates an office; a line connecting two offices represents a group of trunks; and the arrow heads show the direction of traffic over each group. The name of each office shown is written close to the circle representing it, the first three letters, or the one dialled by the subscribers, being shown larger than the rest. The number which each set of letters to be dialled represents is written underneath each office named in order to enable the conflicting office names to be seen more readily, it being understood, of course, that a confliction occurs not only where the first one or two office letters are the same, but also when these letters appear in the same hole or holes on the calling device dials, which are lettered as shown in Fig. 19.

It will be seen that there is a group of trunks extending from Center to each of the other offices in the same district, with the exception of the office Berkley which is reached by way of Condon. It will be seen also that there is a group of trunks extending from Center to each district except the districts 7 and 8, which are reached by way of Jasper which is located in district 5.

In each of the above pointed out exceptional cases, an extra digit would be required to be dialled by the subscriber in order to trunk the calls through the extra switching office, if it were not for the work

performed by the directors in addition to their work of sorting out calls intended for one of two or more conflicting offices.

Referring now to the trunking diagram of Figs. 2 and 3, which shows various trains of switches involved in typical connections in the trunking situation shown in the map, Fig. 1, in order to give a general explanation of the operation of the system, the manner in which calls are extended from the office Center in district No. 2, to the other offices will now be described.

General description of operation.

For the purpose of this general description, it will first be assumed that the subscriber at substation A, Fig. 2, whose line terminates in center office desires to converse with the subscriber at substation A¹ whose line terminates at Wentworth of the district 1. To accomplish this result, the subscriber at substation A will remove his receiver and operate his calling device for the directory number of the subscriber at substation A¹, which in this case is Wentworth 6273X. The letter X, as used in this combination of characters, and as it will be used subsequently, simply indicates that the final digit may be any digit from 1-0, so far as the diagram is concerned, the individual bank contacts of the connector levels not being shown. When the receiver is removed at substation A, the individual line switch C operates to seize a first selector switch 1E. Responsive to the first operation of the calling device for the letter W, the wipers of the first selector 1E are raised to the eighth level of bank contacts and are then rotated to seize a trunk line extending to the idle trunking selector K³. It will be noted that there are three exchanges shown having the first letter W, namely, the exchange Wentworth in district 1, the main exchange Wall in district 3, and the main exchange Wolf in district 6. In this particular case the confliction is only on the first letter, the second letters being different in all cases. It is thus possible to discriminate between the various exchanges upon the dialling of the second digit. Returning now to the description of the connection, responsive to the seizure of the trunk line leading to the trunk selector K³, the secondary switch SS operates to seize idle director D⁷. When the next letter E is dialed the wipers of the trunking selector K³ are raised to the third level whereupon the automatic trunking selecting operation takes place and an idle trunk is selected extending to an incoming second selector 2E in the Grove exchange thru a repeater R⁴. The first register switch of the director D⁷ is operated in synchronism with the trunking selector K³. When the next digit N is dialed the second register switch in the director D⁷ operates to register this digit. As soon as

the first register switch of the director finishes its operation, the sending device in the director starts operating and causes the wipers of the incoming second selector 2E in the Grove exchange to be raised opposite the third level of bank contacts. The selector 2E now operates to select a trunk line leading to an idle third selector 3E in the Grove office. The first and second digits of the called number are registered by the third and fourth register switches in the director responsive to the operation of the calling device at the calling substation. The director D⁷ now controls the operation of the third, fourth, and fifth selector switches such as 3E, 4E⁴, and 5E to the sixth, sixth, and second levels, respectively. It should be mentioned immediately upon the sending out of the first digit register in the director D⁷ by the first register switch that this switch is released and likewise the second, third, and fourth register switches responsive to the sending out of the second, third and fourth impulse series, respectively. When the next digit 6 is dialed by the subscriber at substation A the first register switch of the director D⁷ is reoperated. In accordance with the last two digits of the called number the second, and third register switches of the director D⁷ are operated to register these digits. In the same manner as before the director now sends out the stored digits to operate a sixth selector such as 6E and a connector such as H to extend the connection to the desired called line, that of the substation A¹. It will be noted that the subscriber at substation A¹ is a subscriber on a party line and that the selector 6E is included in the connection only to select a particular frequency of ringing current by picking out a particular group of connectors so that the desired party at substation A¹ on the party line is signalled. This is, the number of the party line subscriber at substation A¹ has one more digit in it for selecting the desired party on the party line than an ordinary number. From the fact that the register switches of the director D⁷ are used over again, it will be seen that the number of digits in the called number is immaterial so far as the director is concerned. This result is attained by the peculiar switching arrangement of the director D⁷, which is so arranged that when the sending device of the director catches up with the operation of the calling subscriber's dial, the director is released and reverts to common use. In case the director catches up and switches before the complete number is dialed, the subscriber at substation A will directly operate the remaining switches to set up the connection. If the operation of a director does not catch up during the calling of the number, the director is released in the same way when it does catch up. It will be noted that the

function of the director D' is to dial the extra digit in the number of the subscriber at substation A' which is necessary in order to discriminate between the exchanges Wentworth, Wall, and Wolf, the trunking selector K³ being the extra switch operated and having access to trunk line extending to all of these exchanges.

Should the subscriber at substation A have desired to call a subscriber whose line terminates in the Wall exchange, the operation up to the seizing of the trunking selector K³ and the director D' will be the same as before. However, as the second character of the called number will be A the wipers of the trunking selector K³ will be raised opposite of the first level of bank contacts and then rotated to seize a trunk line extending to an idle second selector 2E¹ in the main exchange by way of the repeater R². The remaining operations will be the same as hereinbefore described, the director D' in this case adding the digit 1 to the called number in order to discriminate between the conflicting exchange names. If an ordinary private line subscriber were to be called, the directory number would only consist of seven digits instead of eight as in the previous case.

Should the subscriber at substation A desire to connect with the line of a subscriber in the Wolf exchange, the second character of the called number would be O and the wipers of the trunking selector K³ would be raised opposite the tenth level of bank contacts. In this case, the director D' would operate to add the digit 0 to the directory number of the subscriber called in order to secure the proper differentiation.

We will now assume that the subscriber at substation A of Center exchange desires to call the subscriber at substation A² whose line terminates in the Berkley exchange. To accomplish this result, the calling subscriber will remove his receiver and operate his calling device for the number Berkley 685X. When the receiver is removed, a first selector 1E is seized as before. Upon the calling device being operated for the first character B, the wipers of the first selector are raised to the second level of bank contacts and are then rotated to seize an idle trunk line extending to a trunking selector such as K¹. Immediately upon the seizure of this trunking selector, the secondary switch SS¹ operates to seize an idle director such as D³. By referring to the map Fig. 1 it will be seen that there is a confliction between the exchange names Belden, the 2357 branch of Belden, the exchange Berkley, the exchange Condon, the exchange Center, and the exchange Cedar, and that this confliction in the case of Belden, Cedar, Berkley and Center takes place not only the first but also on

the second character. Thus, it will be impossible to distinguish as to what exchange the call is going until the third digit is dialed and in the case of Belden and its branch it will be impossible to distinguish to which of the exchanges the call is going until the fourth character. The reason that the 2357 branch of Belden has a separate group of trunk lines from Center exchange is that this branch has a good deal of traffic and consequently it is more economical to handle calls direct to the branch than to trunk through Belden itself. Responsive to the second and third characters ER of the called number the first and second register switches of the director D³ are operated to register these digits. By the operation of these register switches it is determined that the call is going to Berkley exchange and not to any of the other exchanges above mentioned. The controlling mechanism is now operated in the director to raise the wipers of the trunking selector K¹ to the second level of bank contacts, whereupon the wipers are rotated until engagement is made with an idle trunk line extending through the bi-level repeater, BLR in Center exchange and the traffic separator TS in the Condon exchange to the Condon and Berkley exchanges. As the operation of the first and second register switches have determined that the Berkley exchange is being called, it is unnecessary to send out the second and third digits of the called number as there are direct trunks from Center to Condon and Berkley, and the call comes into either Condon or Berkley on an incoming fourth selector. It is not possible to do this in ordinary calls for the reason that the second and third digits are used for trunking to the desired exchange after the district has been selected. By the operation of the trunking selector K¹, to the second level, a certain potential is placed upon the seized trunk line whereby the traffic separator TS is operated to route the call to an idle incoming fourth selector 4E³ in the Berkley exchange by way of the secondary line switch SL and the repeater R⁷. By the operation of the controlling apparatus in the director D³, the first and second register switches are directly released and have no function other than that above described. Responsive to the remaining four digits of the number of the substation A², the director D³ controls the operation of the fourth selector 4E³, the fifth selector 5E¹ and a connector H² to complete the connection. The third and fourth register switches as well as the first and second of the director D³ control the operation of the selectors and connector, provided, of course, that the sending apparatus of the director does not catch up with the dialing. Should this occur the director D³ is released

and the selector and connector switches in the Berkley office are operated directly under the control of the calling dial.

Should the subscriber at substation A have desired to connect with the line of a party in the Condon exchange, the operation of the first and second register switches of the director D^3 would cause the controlling apparatus of the director to raise the wipers of the trunking selector K^1 opposite the third level of bank contacts. In this case, as before, the second, and third digits dialed would be absorbed and as there would be no potential placed upon the seized trunk line the connection would be extended to the fourth selector $4E^3$ in the Condon exchange. Responsive to the four remaining digits of the called number, the connection is completed in the usual manner.

If the subscriber at the calling substation A desires to call a subscriber in the exchange Cedar of district 6, he will remove his receiver and operate his calling device for the directory number of the desired subscriber. In response to these operations, the line switch C and a first selector such as $1E$ are operated to extend a connection to the idle trunking selector such as K^1 . An idle director D^3 is associated with the seized trunk line by the operation of the secondary switch SS^1 . The second and third digits of the called number are stored as before and the controlling apparatus of the director is operated to bring the wipers of the selector K^1 to the fourth level of bank contacts. The trunk selecting operation of the selector is now started and continues until an idle trunk is found, such as the one extending by way of the repeater R^1 to the incoming second selector $2E^2$. The second and third stored digits are now sent out by the director and the second selector $2E^2$ and a third selector $3E^2$ are operated to extend the connection by way of the repeater R^3 to an incoming fourth selector in the Cedar exchange. The further extension of the connection takes place in the usual manner.

If, in the previous connection, the calling subscriber had desired to connect with the line of a party in Belden exchange, the operation as far as the seizing of the trunking selector K^1 and the director D^3 would be the same as before. Responsive to the second and third operations of the calling device at substation A the first and second register switches of the director D^3 would be operated. By these operations, it would be determined that the Belden exchange is being called, but the dialing of the first, second, and third digits would not definitely decide whether Belden main or Belden branch exchange is being called as there is special groups of trunks from the Center exchange to the Belden branch. If the next

digit dialed is one other than seven, the wipers of the trunking selector K^1 would be brought opposite the fifth level of bank contacts and would then be automatically rotated to seize a trunk line extending to the idle fourth selector in Belden exchange. In this case the second and third digits dialed into the director D^3 would be absorbed though the fourth digit would be sent out.

If the fourth digit would have been the wipers of the trunking selector K^1 would have been brought opposite the sixth level of bank contacts and would be rotated to seize an idle fifth selector in the 2357 branch of Belden. In this case as the Belden branch exchange would be picked out it would be possible to absorb the second, third, and fourth digits. The further extension of the connection would take place in the usual manner.

If the subscriber at substation A should desire to call another subscriber in his own office, the extension of the connection as far as the trunking selector K^1 would proceed as before described. The operation of the first and second register switches of the director D^3 would cause the controlling apparatus of the director to raise the wipers of the trunking selector K^1 opposite the first level of bank contacts. The wipers of the selector would now be rotated until they would be brought into engagement with an idle trunk line extending to the fourth selector in the Center exchange. In this case the second and third digits would be absorbed.

It will now be assumed that the subscriber at substation A wishes to communicate with a subscriber whose line terminates in James exchange. To do this the calling subscriber will remove his receiver and operate his calling device for the directory number of the called subscriber. Responsive to the removal of the receiver, the line switch C operates to seize a first selector $1E$. When the first digit of the called number is dialed, the wipers of the first selector are brought opposite the fourth level of bank contacts and are then rotated until engagement is made with an idle trunk line extending to the secondary switches SS^2 and SS^3 . The rotary switch SS^{14} operates to associate an idle director D^2 with the seized trunk line. When the second and third digits of the called number are dialed, the first and second register switches of the director D^2 are operated. As before, these operations determine to what exchange the call is going. The controlling apparatus in the director now causes the operation of the secondary switch SS^3 to seize a trunk line extending to Jasper exchange by way of the quad-level repeater QLR. The controlling apparatus of the director also places a certain poten-

tial upon the seized trunk line so that mechanism in the traffic separator TS¹ at Jasper exchange is operated to extend the call by way of the secondary switch SS⁴ and a repeater R¹⁰ to an incoming second selector 2E³. The second and third digits stored are now sent out. By these operations, the wipers of the second selector 2E³ in Graceland, are raised opposite the first level of bank contacts and the connection is extended to the idle third selector 3E⁸. In response to the sending out of the third digit by the director, the switch wipers of the selector 3E⁸ are brought opposite the fifth level of bank contacts and are then rotated to seize a trunk line extending by way of repeater R¹¹ to an incoming fourth selector in the James exchange. The remainder of the connection is completed in the usual manner.

Should the calling subscriber have desired to obtain connection with a subscriber in the Jasper or Holland exchange, the completion of the connection would take place in substantially the same manner above described. That is, the director D² would operate the secondary switch SS³ and thereafter place a potential upon the seized trunk line and cause the operation of the secondary switch SS¹² to extend a connection to an idle second selector 2E⁴ in Jasper office. The director now controls the operation of the selector and connector switches to complete the connection in the usual manner.

Should the calling subscriber have desired a connection with a subscriber in any of the exchanges in the districts of which Hazeland or Hinsdale are switching centers, a different potential is placed upon the seized trunk line extending to the Jasper exchange whereby the traffic separator TS¹ is caused to selectively seize the trunk line to either Hazeland or Hinsdale, the connection being thereafter completed under the control of the director and the calling subscriber's dial in the usual manner.

Should the subscriber at substantion A desire to call a subscriber in the Ridgeland, Saxony, Seminole, or Sunnyside, the wipers of the first selector such as 1E would be raised to the seventh level of bank contacts and would then be automatically rotated until engagement is made with an idle trunk line terminating in a trunking selector such as K⁴. By the operation of the secondary switch such as SS¹⁰, an idle director D⁸ is associated with the trunk line. By the operation of the director D⁸ responsive to the adjusting of the called number, the wipers of the selector K⁴ are raised to the proper level of bank contacts and the connection is completed in an ordinary manner.

It will now be assumed that the subscriber at substantion A desires to obtain connection with a subscriber in the Grove office.

In this case the connection proceeds as before described except that the secondary switch SS² in Center exchange is operated to seize a trunk line extending to an idle incoming second selector such as 2E in the Grove exchange. The connection is completed in the usual manner.

The operation when a call is extended to Pontiac, Polk, or Plaza exchanges will now be briefly described. In this case the sixth level of the first selector is used and an idle trunk line is seized which extends to the trunking selector K⁵. By the operation of the switch SS⁷, the director D⁶ is associated with the trunk line. It will be seen that in the three exchanges named the confliction only occurs on the first digit and therefore the director D⁶ will function in a manner similar to the director D⁷, which has been before described. That is, the director D⁶ merely operates to add another digit to the called number to properly select the desired exchange.

The manner in which the exchanges Main, Market, Lima, Maburn, and Lombard are reached will now be explained. In this case the wipers of the first selector are brought to the fifth level of bank contacts and are then rotated to seize a trunk line extending to an idle trunking selector K. By the operation of the secondary switch SS⁸ an idle director D¹ is associated with the seized trunk line. The trunking selector K is operated under the control of the director D¹ after the first three digits have been dialed to select the proper level thus seizing a trunk line going to the desired exchange. The director D¹ then sends out the stored digits to control the automatic switches in the usual manner. When the Lombard exchange is being called, the second and third digits are absorbed, as before, as it is unnecessary to trunk through any intervening exchanges, all that is necessary being to pick a direct trunk from Center to Lombard exchange.

When it is necessary to call any of the exchanges Atlantic, Austin, Ambrose or Arlington from the Center exchange the wipers of the first selector such as 1E are raised to the first level of bank contacts and are then rotated to seize an idle trunking selector K². The secondary switch SS⁹ operates to associate an idle director D⁴ with the trunk line. The second and third digits are now stored by the director D⁴, after which the trunking selector is operated to the proper level of bank contacts, whereupon it rotates to seize a trunk line extending to the proper exchange. The connection is completed in the usual manner by the operation of the calling subscriber's dial and by the director D⁴. Whenever Austin exchange is being called a certain potential is placed

upon the trunk line seized so as to cause the proper operation of the traffic separator TS¹ in Jasper exchange to trunk through to Graceland. Whenever the Ambrose or Arlington exchange is called the second and third digits are absorbed in the manner similar to that described.

To reach the exchange Dale from Center exchange, the wipers of the first selector 1E are brought to the third level of bank contacts and the connection is completed in the usual Strowger manner there being no director operated in this connection as there is no conflicting exchange names in different districts or any other special operation which the director ordinarily controls.

From the above it will be seen that a great number of departures may be made from the usual Strowger trunking scheme and that the flexibility and efficiency of the trunking system may be greatly increased.

Detailed description of drawings.

Referring now more particularly to the detailed circuit drawings shown in Figs. 4-18, inclusive, in Fig. 4 there is shown in the upper left hand corner of the drawing an automatic substation A having the usual talking instrumentalities and a calling device S. The line conductors 11 and 12 of the substation A terminate at the exchange in the individual line or trunk selecting switch C.

The line switch C is of the usual rotary type, whose wipers move in the forward direction only, always remaining in engagement with the bank contacts associated with the trunk line last used. The line switch C, in common with a plurality of other line switches has access to trunk lines extending to first selector switches, such as the first selector 1E, the trunk line extending to it terminating in the bank contacts 28-30, inclusive, in the line switch C.

The first selector 1E is of the usual Strowger, vertical and rotary type and has access to trunk lines extending to trunking selectors such as K³ and to trunk lines extending to selectors in Wolf office from the third level of bank contacts.

The trunking selector K³, Fig. 5, is a vertical and rotary type switch somewhat similar to the first selector 1E, the circuits of which have been modified slightly in order to enable it to function with the invention. The trunking selector K³ has access to trunk lines extending to Wolf exchange, to Grove exchange and to Main exchange from the tenth, third and first levels of bank contacts, respectively.

The secondary switch SS associated with the trunking selector K³ is of the same mechanical construction as the individual rotary line switch C, Fig. 4, described. The

secondary switch SS has connection to directors such as the director D⁷ shown in Figs. 6, 7, and 8.

The portion of the director shown in Fig. 6 comprises a sequence switch Z and a group of controlling relays G. The sequence switch Z is commonly called a minor switch and is a switch of the rotary type having two wipers and an operating and release magnet.

The portion of the director shown in Fig. 7 comprises four of the so-called minor switches, which are denoted by the characters M², M³, M⁴, and M⁵, which are the register switches of the director.

The part of the director shown in Fig. 8 comprises a sequence switch Z¹ and a sending switch S. The sequence switch Z¹ is of the same mechanical construction as the sequence switch Z. The sender switch S may be of the same construction as an ordinary rotary line switch, though for convenience, instead of showing the full set of twenty-five bank contacts only twelve have been shown. The relay group G¹ controls the sender switch S as will appear later.

The repeater R¹, Fig. 5, is a simple repeater having the usual line and release relays and a repeating coil, and operates to repeat the impulses over the trunk line extending to the Wolf exchange.

The repeaters R⁴ and R² are similar to the repeater R¹ above described.

In Fig. 9 is shown a trunking selector K¹, which is accessible from the second level of bank contacts in the first selector 1E. The trunking selector K¹ is similar to the trunking selector K³ before described, though the circuits have been modified somewhat to enable the selector K¹ to function properly.

The trunking selector K¹ has access to trunk lines extending to the 2357 branch of Belden, to Belden, Wolf, and to Berkley and Condon exchanges. In the trunk line extending to the first three exchanges mentioned are repeaters similar to the repeater R¹ already described.

The bi-level repeater BLR is included in trunk lines extending to the Condon and Berkley exchanges and functions in a slightly different manner from the repeater R¹. The trunking selector K¹ also has access to local fourth selectors in Center exchange for completing connections in Center.

The secondary switch SS¹ is similar to the secondary switch SS, before described, and has access to trunk lines extending to directors such as the director D³, Figs. 10, 11, and 12.

The portion of the director shown in Fig. 10 consists of two groups of controlling relays G³ and G⁴ for the director.

In Fig. 11 is shown the register switches

M⁶, M⁶, M⁷, and M⁸ of the director, together with certain controlling relays G⁵.

The equipment shown in Fig. 12 consists of the sequence switch Z² and a sender switch S¹, both of which are similar to ones hereinbefore described.

In Fig. 13 is shown a traffic separator, TS and the associated secondary line switches SL and SL¹.

The line switch SL is similar to the line switch C, Fig. 4, and has access to trunk lines extending by way of repeaters such as the repeater R⁷ to incoming fourth selectors in the Berkley exchange.

The secondary line switch SL¹ is similar to the line switch SL and has access to the fourth selectors such as the fourth selector 4E⁵.

While the selector 4E⁵ has only been indicated in the drawings, it will be understood that this selector is similar to the selector 1E, above described, and has access to trunk lines leading to local fifth selectors in the Condon exchange.

In Fig. 14, there is shown a relay group RG for controlling the director that is associated with the trunk.

The secondary switch SS² is of the usual rotary type and has access to trunk lines extending to Grove exchange by way of repeaters such as R¹³.

The repeater R¹³ is similar to the repeater R¹ before described.

The secondary switch SS³ is similar to the switch SS² and has access to trunk lines extending to Jasper exchange by way of quad-level repeater QLR.

The quad-level repeater QLR is somewhat similar to reepater R¹ though its circuits have been somewhat modified in accordance with the features of the invention.

The secondary switch SS¹⁴ associated with the relay group RG has access to directors such as the director D² shown in Figs. 15, 16, and 17.

The portion of the director shown in Fig. 15 consists of a group of counting relays G⁶ and a group of controlling relays G⁵.

The part of the director shown in Fig. 16 comprises the minor switches M⁹-M¹², inclusive, which are the register switches of the director. There is also a group of relays G⁸ for controlling the certain functions of the director.

The part of the director shown in Fig. 17 consists of the sequence switch Z³ and a sender S⁴, both of these being of the same type as described hereinbefore.

In Fig. 18 there is shown a traffic separator TS¹ having the associated secondary switches SS¹², SS⁴, SS¹⁰, and SS¹¹. These switches are of the usual rotary type. The switch SS¹² has access to a local second selector in Jasper exchange such as the second selector 2E⁴, which is indicated in the drawings by

a rectangle. The secondary switch SS⁴ has access through repeaters such as R¹¹ to incoming second selectors in a Graceland exchange. The secondary switch SS¹⁰ has access through repeaters such as R¹² to incoming second selectors in Hazeland exchange. The secondary switch SS¹¹ has access through repeaters such as R¹³ to incoming second selectors in Hinsdale exchange.

The repeaters R¹¹, R¹², and R¹³ are similar to the repeater R¹ which has been described before.

In Fig. 19 is shown a view of the calling device dial showing the numerical and alphabetical characters.

Figs. 20, 21 and 22 show the manner in which the various sheets of drawings are to be placed to follow up the description of various typical connections in the system.

Detailed description—Call from Center to Wentworth.

The apparatus shown in the drawings having been briefly described, the detailed operation of the system will now be explained, first with reference to Figs. 4-8, inclusive. These drawings should be laid out in the manner shown in Fig. 20 to follow the description. To describe this arrangement, it will first be assumed that the subscriber at substation A in Center exchange desires to call the subscriber at substation A¹ in Wentworth exchange. To accomplish this result, the subscriber at substation A will remove his receiver and operate his calling device for the directory number of the subscriber at substation A¹, which is WENTworth 6273X.

When the receiver is removed at substation A, a circuit is completed over the line conductors 11 and 12 for the line relay 16 of the line switch C. Upon operating, relay 16 closes at armature 22 a circuit for the switching relay 15 in series with the stepping magnet 17, and at its armature 21 connects the test wiper 25 to a point midway between the switching relay and the motor magnet in the above circuit. The trunk selecting operation of the line switch now takes place in the usual manner, the rotary magnet 17 operating as a buzzer to advance the switch wipers 24-26, inclusive, step by step, until the said wipers are brought into engagement with a set of bank contacts associated with an idle trunk line. The above is the normal operation of the line switch C in case the wipers of the switch are associated with a busy trunk line when the receiver is removed. However, should the switch wipers be in engagement with an idle trunk line, the trunk line terminating in bank contacts 28-30, inclusive, for example, upon the removal of the receiver, the switching relay 15 is immediately energized, as it is not short-circuited by ground upon the test contact of the associated trunk line. Relay 15, 130

upon operating, prepares a holding circuit for itself at armature 19 and at armatures 18 and 20 disconnects the line conductors 11 and 12 from the winding of the relay 16 and from ground, respectively, and extends them by way of front contacts of these armatures, wipers 24 and 26, bank contacts 28 and 30, to the upper and lower windings of the line relay 50 of the first selector 1E.

The line relay 50 of the first selector is energized over the line conductors of the calling line. Upon operating, relay 50 at its armature 55 closes a circuit for the slow acting relay 51. The latter relay, upon attracting its armature, prepares the impulsing circuit of the first selector 1E at armature 57 and at armature 56 places ground upon the release trunk conductor 35, whereby a holding circuit is established for the switching relay 15 of the line switch C. This holding circuit extends from the said grounded release trunk conductor by way of bank contact 29, test wiper 25, armature 19 and its front contact, through the winding of the switching relay 15, and through the winding of the motor magnet 17 to battery. This holding circuit serves to maintain the switching relay operated throughout the connection and it will be understood that it is established before slow acting line relay 16 has time to deenergize. A branch of this holding circuit also extends by way of the private normal conductor 32 to multiply connected test contacts in the banks of the connector switches which have access to the line of the substation A, whereby the said line is protected from intrusion throughout the existence of the connection.

The calling subscriber may now operate his calling device S in accordance with the first digit of the desired number. By this operation a series of interruptions is produced in the circuit of the line relay 50 of the first selector 1E, which retracts its armature a plurality of times in response thereto. At each deenergization, an impulse of current is sent to the vertical magnet 64 in series with the slow acting relay 52. Magnet 64 operates to raise the wipers 66-68, inclusive, step by step until the said wipers are brought opposite the eighth level of bank contacts. The slow acting relay 52 is energized in series with the vertical magnet and, upon the first vertical step of the switch shaft, when the off normal springs are shifted, completes a circuit, at armature 58 and its front contact, for the stepping relay 53. Upon operating, the latter relay, at its armature 59 closes a locking circuit for itself and at its armature 60 prepares a circuit for the rotary magnet 67. Shortly after the vertical movement of the switch, the slow acting relay 52 deenergizes and closes a circuit for the rotary magnet 67. The rotary magnet 67 operates to rotate the

wipers of the switch one step into engagement with the first set of bank contacts on the eighth level and at its armature 49 opens the circuit of the stepping relay 53, which deenergizes, opening the circuit of the rotary magnet, which deenergizes also. Assuming now that the trunk line with which the wipers 66-68, inclusive, are in engagement is busy, there will be a ground potential upon the test contact engaged by the test wiper 67 and the stepping relay 53 will be again energized. Relay 53 operates to establish a locking circuit for itself at armature 59 and to close the circuit of the rotary magnet at armature 60. Magnet 67 operates to rotate the switch wipers into engagement with the next set of bank contacts on the eighth level and at its armature 49, opens the circuit of the stepping relay 53, which deenergizes to open the circuit of the rotary magnet 67, which also deenergizes. The alternate operation of the stepping relay 53 and the rotary magnet 67 continues until the switch wipers are brought into engagement with a set of bank contacts associated with an idle trunk line, which, we will assume, are the bank contacts 69-71, inclusive. When the switch wipers are rotated into engagement with this set of bank contacts, the switching relay 54, which has been short circuited during the preceding operations of the switch, is energized and, upon operating, at its armature 62 places ground upon the test contact 70 of the seized trunk line to busy it, opens the circuit of the slow acting relay 51 at armature 63, and at armatures 61 and 64 disconnects the line relay 50 from the line conductors 11 and 12 and extends these conductors by way of wipers 66 and 68, bank contacts 69 and 71, trunk conductors 80 and 82, normally closed springs controlled by armatures 112 and 116 to the upper and lower windings of the line relay 101 of the trunking selector K^a.

The line relay 101 operates over the calling line loop and closes a circuit at its armature 118 for the slow acting relay 102. It may be said at this time that the relay 102 is slow acting on account of its short circuited winding. Relay 102, upon energizing, places ground upon the release conductor 81 at armature 119, thereby establishing a holding circuit for the switches 1E and C, at its armature 120 prepares a certain impulsing circuit, at its armature 122 closes a circuit for the switching relay 145 of the secondary switch SS in series with the motor magnet 146, and its armature 121 connects the test wiper 149 to the above circuit at a point midway between the switching relay and the said motor magnet. The secondary switch SS now operates to select a trunk line leading to the idle director in the same manner as the rotary line switch C selects a trunk line leading to the idle selector.

When the switch wipers are rotated into engagement with the bank contacts associated with an idle trunk line, which, we will assume, are the bank contacts 193-196, inclusive, the operation of the rotary magnet 146 ceases and the switching relay 145, which has been short circuited during the preceding operations of the secondary switch, is energized in series with the motor magnet 146. Upon operating, relay 145 at its armature 142 places ground upon the test contact 195 of the seized trunk line, at armature 141 prepares a circuit for the relay 103, prepares a circuit for the relay 100 at armature 143, and at armature 140 prepares an impulsing circuit to the seized director. The grounding of test contact 195 places ground upon conductor 198 thereby completing a circuit for the relay 221 of the relay group G. Upon operating, relay 221, at armature 235 opens the release magnet circuit of the sequence switch Z^1 , at armature 234 opens the release magnet circuit of sequence switch Z and at armatures 230, 231, 232, and 233 opens the circuits of the release magnets of the register switches M^4 , M^5 , M^6 , and M^2 , respectively.

The calling subscriber at substation A may now operate his calling device for the next letter E of the called number. By this operation, three interruptions are produced in the circuit of the line relay 101 of the trunking selector K^3 , which deenergizes three times in response thereto. At each deenergization, relay 101 at its armature 118 sends an impulse of current to the vertical magnet 108 of the selector K^3 in series with the slow acting relay 104. Magnet 108 operates to raise the wipers 136-138, inclusive, to the third level of bank contacts. The slow acting relay 104 is energized in series with the vertical magnet and when the normal springs are shifted, which occurs upon the first vertical step of the switch, closes a circuit for the stepping relay 105. At the termination of the vertical movement, the trunk selecting operation of the selector K^3 occurs in substantially the same manner as the trunk selecting operation of the first selector 1E. It will be assumed in the present case that the switch wipers are brought to rest in engagement with bank contacts 163-165, inclusive. In this case, the energization of the switching relay 106 follows the trunk selecting operation and extends the connection to the line relay 155 of the repeater R^4 . Relay 155 is immediately energized over a circuit which extends from ground through the lower winding of relay 155, through the lower left hand winding of the repeating coil, bank contact 165, wiper 138, front contact and armature 130, armature 123 and its back contact, armature 127 and its front contact, wiper 136, bank contact 163, upper left hand winding of the repeating coil and to the upper winding of relay 155 to battery. Upon operating, relay 155, at armature 159 closes a circuit for the slow acting relay 156, and places a bridge across the trunk conductors 160' and 161', extending to the incoming second selector in the Grove exchange, at armature 157. The energization of the slow acting relay 158 serves to complete a holding circuit for the switching relay 106 of the selector K^3 . By the closure of the bridge across conductors 160' and 161' the line relay of the incoming second selector such as 2E in the Grove exchange is energized. Upon operating, the line relay of this selector closes a circuit for its associated slow acting release relay. The latter relay operates to prepare the operating circuits of the selector in the usual manner. In addition to causing the operation of the vertical magnet 108, the operation of armature 118 on the line relay 101 also causes three impulses of current to be sent to the director D^7 in response to the second digit of the called number. The circuit over which these three impulses are sent extends from ground by way of armature 118 and its back contact, armature 120 and its front contact, armature 140 and its front contact, wiper 148, bank contact 193, conductor 200, conductor 270, through the winding of the slow acting relay 400, wiper 402 of the sequence switch Z^1 , bank contact 428, conductor 350, and through the winding of the operating magnet 305 of the minor switch M^2 to battery. Magnet 305 operates to rotate the wiper 315 into engagement with the third bank contact 325. At the first movement of the wiper-carrying shaft the off normal spring 335 engages its working contact and the relay 300 is energized. Upon operating, relay 300, at its armature 320 prepares a circuit for the release magnet 304 and places ground upon the conductor 264 at armature 321. The grounding of conductor 264 closes a circuit for the relay 220. Relay 220, upon operating, closes a circuit for the slow acting relay 219 at armature 228 and at armature 229 prepares an operating circuit for the sending switch S. Relay 219 operates at its armature 227 to prepare a circuit for the switching relay 100 of the trunking selector K^3 . The slow acting relay 400 is energized in series with the operating magnet 305 of the register switch M^2 and operates at its armature 406 to close a circuit for the slow acting relay 401, and at its armature 407 opens one point in the circuit extending to relay 218. Relay 401, upon attracting its armatures, prepares a circuit for the operating magnet 403 of the sequence switch Z^1 at armature 408 and at armature 409 prepares one point in the circuit of the relay 218. Shortly after the termination of the operation of the line relay 101 of the trunking selector K^3 , the slow acting relay 400 deenergizes and opens the circuit of the

slow acting relay 401 at armature 406, at the back contact of this armature completes a circuit for the operating magnet 403 of the sequence switch Z^1 , and at armature 407 completes a circuit extending from ground by way of front contact and armature 409, armature 407 and its back contact, conductor 271, normally closed springs controlled by armature 225, and through the winding of relay 218 to battery. Magnet 402 operates to advance the switch wiper 402 of the sequence switch Z^1 into its second position, this circuit being opened by the deenergization of the slow acting relay 401. Relay 218, upon energizing, at its armature 225 establishes a locking circuit for itself, at armature 224 closes a circuit which extends from ground by way of front contact and said armature, wiper 213 of the sequence switch Z in its first position, conductor 260, wiper 315 of the register switch M^2 , bank contact 325, conductor 356, to bank contact 430 in the sending switch S . A further result of the energization of relay 218 is that at armature 226 a circuit is completed which extends from ground by way of front contact and armature 229, front contact and armature 226, conductor 272, back contact and armature 424, through the winding of the relay 415, and to battery by way of the interrupter I . The interrupter I is being constantly rotated and consequently the relay 415 is intermittently operated when ground is placed on the conductor 272. Upon the first operation of relay 415, a circuit is completed by way of armature 418 and its front contact for the stepping magnet 426 of the rotary switch S . When the interrupter reaches the position where the circuit of the relay 415 is opened, this relay deenergizes to open a circuit of the stepping magnet 426. Magnet 426 deenergizes and advances the switch 410 and 411 into engagement with bank contacts 431 and 432. Upon the wiper 411 engaging the bank contact 432, a circuit is completed for the slow acting relay 416. Relay 416, upon operating, at its armature 420 prepares a locking circuit, as will appear later, and at its armature 421 prepares an impulsing circuit. When the relay 415 again energizes, the operation of armature 418 closes a circuit for the magnet 426 and the operation of armature 419 closes a circuit, which may be traced from ground by way of front contact and armature 421, armature 419 and its front contact, conductor 273, conductor 199, bank contact 194, wiper 149, front contact and armature 141, and through the winding of the relay 103 to battery. Relay 103 of the trunking selector K^3 is energized over this circuit and operates at its armature 123 to open the previously traced circuit of the line relay 155 of the repeater R^4 . The deenergization of relay 155 opens a previously traced bridge across the trunk conductors 160' and 161' extending to the incoming second selector in the Grove exchange. Upon the deenergization of the relay 415 in the relay group G^1 the previously traced circuit for the relay 103 is opened and this relay again deenergizes to close the circuit of the line relay 155, which operates to close the circuit of the line relay of the incoming second selector in Grove exchange. The intermittent operation of the relays 415, 103, 155 and the line relay of the incoming second selector in the Grove exchange continues until the wiper 410 of the sending switch S is rotated into engagement with the bank contact 430. When this occurs, a circuit is completed from the grounded bank contact 430, by way of wiper 410 and through the winding of the slow-acting relay 417 to battery. Upon operating, relay 417, opens the circuit of the relay 415 at armature 424, establishes a locking circuit for itself at armature 422, and at armature 423 closes an interrupter circuit for the stepping magnet 426 to the wiper 411. Magnet 426 now intermittently operates to rotate the wipers 410 and 411 step by step until they reach their normal position, whereupon the circuit of relay 416 is opened and this relay deenergizes after a short interval. Upon deenergizing relay 416 opens the circuit of relay 417 at armature 420, and relay 417 deenergizes after an interval. By the intermittent operation of relay 103, it will be seen that three interruptions are produced in the circuit of the line relay of the incoming second selector in Grove exchange. This series of impulses is the same as has been registered by the first register switch M^2 and is the numerical equivalent of the second letter E in the called number. The slow acting relay 217 of the relay group G is energized during this series of impulses in multiple with the relay 103 of the trunking selector K^3 . Relay 217, upon operating, at its armature 223 closes a circuit for the slow-acting relay 216. At the termination of the impulse series, the slow-acting relay 217 deenergizes, thereby opening a circuit of the slow-acting relay 216 and completing a circuit for the operating magnet 210 of the sequence switch Z . Magnet 210 operates to rotate the wipers 213 and 214 into engagement with bank contacts 239 and 240. By the engagement of wiper 214 with bank contact 240 a circuit is completed from ground by way of said wiper, bank contact 240, conductor 265, armature 320 and its front contact and through the winding of release magnet 304 of the first register M^2 to battery. Magnet 304 operates to restore the wiper 315 to its normal position. Upon reaching its normal position, the circuit of the relay 300 is opened and this relay deenergizes to open the release magnet circuit and to remove ground from the conductor 264. By the engagement of wiper 213 with the

bank contact 239 ground is placed upon the conductor 261 which extends to wiper 316 of the second register switch M^3 . During the interval that the sender switch S was operating under the control of the register switch M^2 the calling subscriber is able to operate his calling device for the next digit N of the called number.

When the calling device at the calling station is operated in accordance with the digit N, six interruptions are produced in the circuit of the line relay 101 of the trunking selector K^3 . The deenergization of the line relay 101, responsive to the interruptions in its circuit, sends six impulses over the following circuit: From ground by way of armature 118 and its back contact, and armature 120 and its front contact, armature 140 and its front contact, wiper 148, bank contact 193, conductor 200, conductor 270, through the winding of the slow acting relay 400, wiper 402 of the sequence switch D^1 in its second position, conductor 351, and through the winding of magnet 307 of the second register switch M^3 to battery. Magnet 307 operates to rotate the wiper 316 into engagement with bank contact 336. Now when the wiper 316 is grounded as above described, ground is placed by way of conductor 359 on the bank 435 of the sender switch S. The same operations as before are now repeated, the wipers of the sender switch S being stepped until the wiper 410 engages bank contact 435, whereupon the circuit of the slow acting relay 417 is again closed and the wipers 410 and 411 rotate to normal. The relay 103 in the trunking selector K^3 is operated as before, the only difference in this case being that its circuit is closed six times and consequently six interruptions are produced in the circuit of the line relay 155 of the repeater R^4 . The relay 155 operates to repeat interruptions to the line relay of the third selector in the Grove office, it being understood of course, that the incoming second selector 2E responded to the three interruptions produced in its circuit by raising its wipers to the third level of bank contacts and then rotating them to seize a trunk line extending to an idle third selector. The wipers of this third selector are now raised opposite the sixth level of bank contacts and are then rotated to seize a trunk line extending to an incoming fourth selector in Wentworth exchange by way of a repeater such as the repeater R^5 , (see trunking diagram Fig. 2). The slow acting relay 400 is energized in series with the operating magnet 307 of the register switch M^3 and closes the circuit of the slow acting relay 401. The deenergization of the relay 400, following the termination of the impulse series causes the magnet 403 of the sequence switch Z^1 to be operated. The wiper 402 of the sequence switch is now advanced into

its third position. When the relay 103 of the trunking selector K^3 is controlled by the sender S, the slow acting relay 217 of the relay group G is again energized to close the circuit of the slow acting relay 216. Upon the termination of the second series of impulses sent out by the director, the relay 217 deenergizes and closes the circuit of the operating magnet 210 of the sequence switch Z. The magnet 210 operates to advance the wipers 213 and 214 into engagement with the next set of bank contacts, its circuit being opened by the deenergization of the slow acting relay 216, which occurs after a short interval. The operation of the wiper 214 places ground upon conductor 266 thereby completing the circuit of the release magnet 306 of the second register switch M^3 . The operation of the release magnet 306 restores register switch M^3 to normal. Upon the second register switch being restored to normal, the off normal spring 329 is forced away from its working contact and the circuit of the relay 301 is opened. This relay deenergizes to open the circuit of the release magnet and to remove one ground from conductor 264. The operation of wiper 213 of the sequence switch Z into engagement with its bank contact causes ground to be placed upon the conductor 263 extending to the wiper 317 of the third register switch M^4 . This register switch will be in its operated position, having been operated by the operation of the line relay 101 of the trunking selector K^3 , responsive to the fourth digit 6 of the called number, the wiper of the sequence switch Z^1 being in its third position. The relays 400 and 401 of the sequence switch Z^1 , are of course, operated to cause the sequence switch wiper 402 to be advanced into its fourth position at the termination of the operation of the line relay 101 responsive to the fourth digit in the called number. When the director sends out this digit, as above described, the relays 217 and 216 operate in the usual manner to cause the operating magnet 210 to advance the wipers 213 and 214 into their fourth position. Upon the wiper 214 engaging the fourth bank contact in its set, ground is placed upon conductor 268 and the release magnet 309 of register switch M^4 is energized and operates to release the register to normal. The relay 302 deenergizes when the register switch reaches its normal position and opens the circuit of the release magnet 309.

In the meanwhile, the calling device at the calling substation will be operated for the fifth digit 2 of the desired number and, by the operation of the line relay 101 of the trunking selector K^3 , this digit will be stored on the fourth register switch M^5 in the usual manner. By the movement of the sequence switch Z to its fifth position ground is

placed upon the wiper 318 of the register switch M^5 and the sender S operates to send two impulses to the relay 103. The relay 103 operates to repeat these interruptions to the line relay of the fifth selector such as 5E (Fig. 2) in the Wentworth exchange. As soon as these impulses have been sent the sequence switch Z is operated as before and its wipers 213 and 214 are advanced to their fifth position.

It will be apparent that the wiper 402 of the sequence switch Z^1 is advanced to its fifth position at the termination of the fifth digit and by this operation the operating magnet 305 of the first register switch is connected up. The register switches M^2 , M^3 , and M^4 , are now operated successively, responsive to the sixth, seventh, and eighth digits of the directory number of the called subscriber at substation A^1 in Wentworth exchange. The sending switch S is controlled by the operation of the register switches and the sequence switch Z in the same manner as before described to send out the sixth, seventh and eighth digits of the called number. All the above operations take place in substantially the same manner as has been previously described and it has consequently been thought unnecessary to repeat the description of these operations.

It will of course, be understood that a sixth selector and a connector switch is operated in the Wentworth exchange to complete the desired connection.

When the eighth and final digit is finally sent out by the sender S of the director all the register switches M^2 , M^3 , M^4 and M^5 will be in their normal positions, the register switch M^4 being released by the movement of the sequence switch wiper 214 into its eighth position, and ground will be removed finally from the conductor 264, thereby opening the circuit of the relay 220. Upon deenergizing, relay 220, removes ground from conductor 272 thereby opening the operating circuit of the impulsing relay 415 of the group of relays G^1 , whereby the operation of the sender switch S is terminated. Another result of the deenergization of relay 220, is that the circuit of the slow acting relay 219 is opened at armature 228 and at the back contact of this armature the following circuit is closed: From ground by way of armature 228 and its back contact, front contact and armature 227, conductor 197, bank contact 196, wiper 150, front contact and armature 143, normally closed springs controlled by armature 115, and through the winding of the relay 100 to battery. The relay 100 is energized over its circuit and, upon operating, at its armature 115 opens its original energizing circuit and establishes a locking circuit for itself, opens the short circuit around the winding of relay 102 at armature 114, and at armatures 112 and 116 disconnects the line

relay 101 and connects the trunk conductors 80 and 82 to the windings of the line relay 155 of the repeater R^4 . Another result of the energization of relay 100 is that a point in the circuit of the release magnet 107 is opened to provide against the deenergization of relays 101 and 102. The circuit of the line relay 101 being open, this relay deenergizes to open the circuit of the relay 102, which immediately deenergizes. The deenergization of relay 102 removes one ground connection from the release trunk conductor 81 at armature 119, at armature 120 opens the impulsing circuit to the director, and at armature 122 opens the circuit of the switching relay 145 of the secondary switch SS and also the circuit of the relay 221 in the group of relays G. The deenergization of relay 145 disconnects the director from the trunking selector K^3 . The deenergization of relay 221 closes the circuit of the release magnets of the sequence switches Z and Z^1 and also of the register switches M^2 , M^3 , M^4 and M^5 . The closure of the release magnet circuit of the register switches, of course will have no particular function at the present time so these switches have already been released. However, the release magnets of the sequence switches Z and Z^1 operate to restore these switches to normal. The deenergization of relay 221 also opens the locking circuit of the relay 218, which deenergizes, opening certain circuits and restoring them to their normal condition. The director shown on Figs. 6, 7 and 8 may now be seized and operated for another connection.

The above is the normal operation of the director D^1 in case the sending out of the digits by the director does not catch up with the calling subscriber's dial before all the digits have been sent. However, should the director at any time of its operation catch up with the dialing of the digits by the calling subscriber, it will be seen that all the register switches such as M^2 - M^5 , inclusive, will be in their normal position and ground will be removed from the conductor 264. The circuit of relay 220 will thereby be opened and the relay 100 in the trunking selector K^3 will be energized. The operation of the relay 100 has the same results as before, among which is the extension of the trunk conductors 80 and 82 directly to the winding of the line relay 155 of the repeater R^4 . The relay 155 of the repeater R^4 now responds directly to the calling device at the calling substation to control the switches in the distant exchange to complete the desired connection. The director is released by the deenergization of the relay 221 in the same manner as before. This cutting out of the director may take place at any time. It will be seen that this arrangement causes the director to be released and revert to common use just as soon as it has performed its func-

tion, that of introducing an extra digit in the called number for the proper selection of the exchange.

If the calling subscriber hangs up before he has completed dialing the connection, the line relay 101 deenergizes to open the circuit of the relay 102. The deenergization of the latter relay brings about the release of the director, assuming that it is still connected to the trunk line, and also the release of the first selector 1E, the line switch C, and the trunking selector K³, as well as the operated automatic switches in the distant office.

Under certain conditions, it is possible that all the trunk lines in the level to which the wipers 136-138, inclusive, of the trunking selector K³ are raised, is busy. In this case, the rotation of the switch wipers continues until they are rotated into their eleventh rotary position. In this position, the cam springs 135 and 134 are operated by the cam on the switch shaft. By the operation of cam spring 134, the circuit of the switching relay 145 of the secondary switch SS is opened, as is the circuit of the relay 221 in the director. The opening of these circuits bring about the release of the secondary switch SS and also the release of the director in substantially the same manner as before described. The operation of cam springs 133 causes a lead from the busy signalling machine to be connected to the lower talking conductor whereby an audible signal is given to the calling subscriber in order to inform him that he cannot obtain the desired connection at the present time. The release of the trunking selector K³, the first selector 1E, and the line switch C, take place in an ordinary manner responsive to the replacement of the receiver at the calling substation.

It will be noted that in the sender switch S associated with the director that there is a pause between the successive digits of an interval sufficiently long to allow one operation of the operating magnet and also to allow the deenergization of the slow acting relay 417. This is made in order to give ample time for an idle trunk to be selected by the automatic switches which are controlled from the sender.

The construction of the director whereby the register switches are used over and over again saves a number of register switches and, in combination with the manner of switching through by the operation of the switching relay 100 of the trunking selector K³, allows the directors to be uniformly constructed regardless of the number of digits in the called number. However, it is necessary to have enough register switches so that the calling subscriber will not be able to fill all the register switches, by calling a long digit followed by two or three short

ones, before one register switch is freed. To illustrate, if the digit 0 is dialed followed by three digits, each of which is 1, it is calculated that by the time the second 1 is set up the digit 0 will have been sent out by the director.

When the conversation is finally terminated the release of the connection occurs responsive to the replacement of the receiver at the calling substation in a manner similar to that already described.

Call from Center to Wolf.

It will now be assumed that the calling subscriber at substation A desires to communicate with a subscriber in Wolf exchange instead of a party in Wentworth exchange. In this case the calling subscriber will operate his calling device for the digits of the called number. The connection is extended in substantially the same manner as before to the first selector by the operation of the individual line switch C and it will be assumed that this selector is the selector 1E. This selector is operated responsive to the first digit W in the called number to raise its wipers to the eighth level of bank contacts and to then rotate them to seize a trunk line leading to an idle trunking selector such as the trunk line shown in the drawings comprising conductors 80-82, inclusive, and terminating in the bank contacts 69-71, inclusive, extending to the trunking selector K³ Fig. 5. The secondary switch SS is now operated to associate an idle director such as the director D', shown in Figs. 6, 7 and 8, with the trunking selector.

In response to the second digit 0 of the called number the vertical magnet 108 of the trunking selector K³ is operated to raise the wipers 136-138, inclusive, to the tenth level of bank contacts. The trunk selecting operation of the switch now takes place, the wipers being automatically rotated until they are placed in engagement with a set of bank contacts associated with an idle trunk line, which, it will be assumed, are the bank contacts 160-162, inclusive. The switching relay 106 of the trunking selector immediately energizes and closes the circuit of the line relay of the repeater R¹. This relay operates to close the circuit of its associated slow acting release relay and also to complete the circuit of the line relay of the incoming second selector in Wolf exchange. The associated slow acting release relay energizes to complete a holding circuit for the switches K³, 1E, and C. The register switch M² of the director is also operated bringing its wiper 315 into engagement with the tenth set of bank contacts. The sending switch S of the director now functions to send out the digit 0 to the relay 103 of the trunking selector K³ whereby the line relay of the repeater R¹ is deenergized ten times

to open the circuit of the line relay of the incoming second selector in the Wolf exchange the same number of times. The wipers of this incoming second selector are consequently raised to the tenth level of bank contacts and are then rotated to seize an idle trunk line leading to a third selector. The operation of the director in the extension of the connection to the desired line is substantially the same as the control it exercised in the previous connection, with the exception that if the calling subscriber is not calling a party line subscriber in the Wolf exchange there will only be seven digits in the directory number instead of eight as in the previous connection. As a result of this, only the register switches M^1 and M^2 will be reoperated in response to the sixth and seventh digits of the called number.

When the connection is finally terminated, the release takes place upon the replacement of the receiver at the calling substation.

If the calling subscriber desires to communicate with a party in the Wall exchange the operation is the same as before described with the exception that the digit 1 is added to the directory number and the wipers of the trunking selector K^2 are raised to the first level of bank contacts and then rotated to seize a trunk line extending to the Main exchange through a repeater such as R^2 . The incoming second selector in the Main exchange is now operated to the first level under the control of the register switch M^2 and sender switch S of the director. The remaining portion of the connection is completed in the usual manner.

The release of the connection at the end of the conversation takes place in substantially the same manner as has been described before, following the replacement of the receiver at the substation A.

Call from Center to Berkley.

It will now be assumed that the subscriber at substation A desires to call a subscriber in the Berkley exchange. To accomplish this result the subscriber at substation A will remove his receiver and operate his calling device for the desired number. The manner in which the drawings should be laid out in order to follow this description may be seen in Fig. 21.

When the receiver is removed at substation A, the line relay 16 of the individual line switch C is energized in the same manner as before and the trunk selecting operation of the switch is initiated. When an idle trunk is found, which, it will be assumed, is the trunk line shown in the drawings terminating in the bank contacts 28—30, inclusive, the switching relay 15 of the line switch C is energized in series with the motor magnet 17. Upon operating, relay 15,

extends the line conductors of the calling line to the line relay 50 of the first selector 1E.

The line relay 50 and the release relay 51 are energized as before described with the same results. These results include the preparation of the operating circuits of the first selector 1E and the establishment of the holding circuit for the line switch C.

The calling subscriber at substation A may now operate his calling device in accordance with the first digit B of the called number. By this operation, two interruptions are produced in the circuit of the line relay 50, which vibrates twice responsive thereto. By the operation of the line relay 50, the vertical magnet 64 is operated to step the wipers 66—68, inclusive, to the second level of bank contacts. The slow acting relay 52 is energized in series with the vertical magnet and, upon the first vertical step of the switch, when the off normal springs are shifted, completes a circuit at armature 58 and its front contact for the stepping relay 53. Relay 53, upon energizing, establishes a locking circuit for itself at armature 59 and at armature 60 prepares a circuit for the rotary magnet 67. A short interval after the termination of the vertical operation of the switch, the slow acting relay 52 deenergizes and completes a circuit for the rotary magnet 67. Magnet 67 operates to rotate the wipers of the switch into engagement with the first set of bank contacts on the second level, and at its armature 49 opens the circuit of the stepping relay 53, which deenergizes, opening the circuit of the rotary magnet, which deenergizes also. The trunk selecting operation of the selector 1E now continues in the usual manner until the switch wipers are brought into engagement with the bank contact set associated with an idle trunk line, which, it will be assumed, is the trunk line terminating in bank contacts 72—74, inclusive, and comprising conductors 83—85, inclusive. Immediately upon the wipers of the switch being brought into engagement with this set of bank contacts, a circuit is effective for energizing the switching relay 54. This relay operates in the usual manner to disconnect the line relay 50 and to extend the calling line by way of wipers 66 and 68, bank contacts 72 and 74, conductors 83 and 85, normally closed springs controlled by armature 509 and 511 to the upper and lower windings of the line relay 501 of the relay group RG².

The line relay 501, immediately energizes over the calling line loop and, upon operating, completes a circuit at its armature 512 for the slow acting relay 502. The latter relay, upon attracting its armature, places ground upon the release trunk 84 at armature 513, and at armature 515 prepares an

impulsing circuit for a director, which will be associated with the trunk line by the operation of the secondary switch SS^1 . Other results of the energization of the relay 502 are that at armature 517 a circuit for the switching relay 605 is completed in series with the motor magnet 606 and at armature 516 the test wiper 613 is connected to a point in the above circuit midway between the switching relay and the motor magnet. Still another result of the operation of relay 502 is that at armature 514 a circuit is completed for the line relay 504 of the trunking selector K^1 . Relay 504 operates to close a circuit for the slow acting relay 505. The latter relay, upon operating, places an additional ground upon the release trunk conductor 84 at armature 522 and at armature 523 prepares the impulsing circuit of the trunking selector K^1 . As mentioned before, the trunk hunting circuits of the secondary switch SS^1 are closed and a trunk selecting operation of this switch takes place in the usual manner. When an idle trunk is selected, which, it will be assumed, is the trunk line terminating in the bank contacts 620-623, inclusive, the switching relay 605 is energized to associate the director D^3 with the relay group RG^2 . It will be seen that upon the energization of the relay 605 ground is placed upon conductor 615 which extends through the winding of the relay 630 in the group of relays G^3 to battery. Upon operating, relay 630, at armatures 653, 654, 655, 656, and 657 opens the circuits of the release magnets of the switches M^1 , M^2 , M^3 , M^4 , and Z^2 , respectively and at the front contact of armature 657 prepares certain circuits in the relay groups G^3 and G^4 .

The calling subscriber may now call the second digit E of the desired number, whereby three interruptions are produced in the circuit of the line relay 501 of the relay group RG^2 . The line relay 501, in operating in response to the interruptions produced in its circuit deenergizes three times to send out three impulses of current over a circuit which extends from ground by way of armature 512 and its back contact, armature 515 and its front contact, armature 608 and its front contact, wiper 612, bank contact 621, conductor 618, conductor 694, through the winding of the slow acting relay 850, wiper 878 of the sequence switch Z^2 in its first position, conductor 804 and through the winding of the operating magnet 764 to battery. Magnet 764 operates to rotate the wipers 765 and 767 of the first register switch M^5 into engagement with the third set of bank contacts, which, as shown in the drawings are the bank contacts 710 and 711. Upon the first movement of the switch, the spring 761 comes into engagement with its working contact and the relay 730 is ener-

gized. Upon operating, relay 730 at its armature 759 prepares a certain locking circuit for the relays of the relay group G^5 , at armature 760 prepares one point in the circuit of the release magnet 763 and places ground upon the conductor 686 at armature 762. The grounding of the conductor 686 brings about the energization of relay 663. Upon operating, relay 663, closes a circuit for the slow-acting relay 662 at armature 672, prepares a point in the operating circuit of the sender switch S^1 at armature 671, and at armature 670 opens one point in the certain switching circuit as will appear later. The slow-acting relay 850 is, of course, energized in series with the operating magnet 764 of the first register switch M^5 . Upon energizing, relay 850, closes a circuit for the slow-acting relay 851 at armature 855 and at armature 858 closes another circuit for the slow-acting relay 662. Upon operating, relay 851, at its armature 857 prepares a circuit for the operating magnet 852 of the sequence switch Z^2 and at its armature 856 prepares a circuit for placing ground upon conductor 685. Shortly after the termination of the operation of the line relay 501 at the end of the second digit, the slow-acting relay 850 deenergizes. As a result of this operation, an impulse of current is sent to the operating magnet 852 of the sequence switch Z^2 at armature 855 and at armature 858 a circuit is completed, which extends from ground by way of armature 858 and its back contact, front contact and armature 856, conductor 697, armature 648 and its back contact, conductor 685, wiper 765, bank contact 710, and through the left-hand windings of the relays 725, 726, 727, and 728 in multiple to battery. The relays mentioned are of the shunt field type and only attract their armatures when both windings are energized in the same direction for the reason that when only one winding is energized, the magnetic flux is shunted away from the armature by the low reluctance path through the core of the associated coil. Thus, the closure of the above circuit has no particular function at the present time. It was mentioned that the deenergization of the relay 850 closed a circuit for the operating magnet 852 of the sequence switch Z^2 . By the operation of this magnet the sequence switch wiper 878 is advanced one step into its second position.

When the calling device at substation A is operated in accordance with the next digit R of the called number, seven interruptions are produced in the circuit of the line relay 501 of the relay group RG^2 and this relay deenergizes seven times responsive thereto. At each deenergization, an impulse of current is sent to the operating magnet 703 of the second register switch M^6 over a circuit similar to the one above traced except that

as the sequence switch Z^2 is in its second position the circuit extends over conductor 805 to the operating magnet 703. Magnet 703 operates to rotate the wipers 767 and 768 into engagement with the seventh set of bank contacts 708 and 709. The relay 701 is energized upon the first movement of the switch and operates at armature 705 to prepare a circuit for the release magnet 702 and at armature 706 places another ground connection upon the conductor 686. The slow acting relay 850 is energized in series with the operating magnet 703 and, as before, operates to close the circuit of the slow acting relay 851, at armature 855, and at armature 858 operates to close another circuit for the slow acting relay 662. The slow acting relay 851 operates in the usual manner to prepare the circuit of magnet 852 and to prepare the circuit for certain other relays in the relay group G^5 . At the end of the operation of the line relay 501 of the relay group RG^2 , the slow acting relay 850 deenergizes to open the circuit of the relay 851, to send an impulse of current to the operating magnet 852 of the sequence switch Z^2 at armature 855, and to close the following circuit: From ground by way of armature 858 and its back contact, front contact and armature 856, conductor 697, armature 648 and its back contact, conductor 685, wiper 765, and through the left hand windings of the relays 725, 726, 727, and 729. Another circuit in multiple with the above extends from the grounded conductor 685 by way of the wiper 767, bank contact 708, normally closed springs controlled by armature 737, and through the right hand winding of the relay 726 to battery. As both windings of the relay 726 are energized, this relay attracts its armatures. Upon operating, relay 726, establishes a locking circuit for itself at armature 737, at this same armature opens its original energizing circuit, at armature 738 places ground on conductor 675, whereby a circuit is completed for the relay 661 in the relay group G^4 . Another result of the energization of the relay 726, is that at armature 739 a circuit is closed which extends from ground by way of armature 649 and its back contact, conductor 677, armature 739 and its front contact, conductor 810, to bank contact 875 in the bank of the sender switch S^1 . Still other results of the energization of relay 726 are that at armatures 740 and 741 circuits are prepared for the relays 626 and 625 in the relay group G^3 . As the circuit of relay 661 is closed by the operation of relay 726, the former relay operates and closes a locking circuit for itself at armature 688 and opens its energizing circuit at the same armature. The operation of relay 661 also prepares a circuit for the relay 625 at armature 666, and at armature 673 completes a circuit which extends from ground by way of front contact and said armature, front contact and armature 671, conductor 698, back contact and armature 874, through the winding of the relay 865, and thence to battery by way of the constantly operating interrupter I^1 . The relay 865 is now intermittently operated as long as the above circuit remains closed. Upon the first energization of relay 865, a circuit is completed for the magnet 361 of the sender switch S^1 . The operation of the sender switch S^1 is similar to the operation of the sender switch S previously described and consequently it is thought unnecessary to repeat the description. It will suffice to say that the wipers 859 and 860 of the sender switch S are automatically stepped until the wiper 859 engages the bank contact 857, which operation occurs after the conductor 699 had been grounded three times. When this occurs, the relay 867 is energized and the circuit of the impulsing relay 865 is opened. The wipers 859 and 860 are now rotated automatically to their normal position. Each time the conductor 699 is grounded as stated before, a circuit is completed over conductors 617, by way of bank contact 620, wiper 611, front contact and armature 607, and through the winding of the relay 503 to battery. Relay 503 is thus energized three times to interrupt the circuit of the line relay 504 of the trunking selector K^1 . The operation of the line relay 504 controls the vertical magnet 531 of the trunking selector in raising wipers 535-538, inclusive, to the third level of bank contacts. The slow acting relay 506 is energized in series with the vertical magnet and completes a circuit for the stepping relay 507, which energizes and locks. At the end of the vertical movement of the switch, the trunk selecting operation takes place in the usual manner. When an idle trunk is selected, which, it will be assumed, is the trunk line terminating in back contacts 555-558, inclusive, the switching relay 508 is energized to extend the connection to the repeater BLR. The line relay 588 of this switch is immediately energized and operates to close the circuit of the slow acting relay 589. The slow acting relay 589 energizes to complete a holding circuit for the switching relay 508 of the selector K^1 at armature 593 and to close the circuit of the high impedance relay 590. On account of this high impedance, the relay 590 is somewhat slow to energize. During the interval required for the energization of the relays 588, 589, and 590, a circuit is complete which extends from ground by way of armature 529 and its front contact, wiper 537, bank contact 557, back contact and armature 597, trunk conductor 595, armature 906 and its back contact, back contact and armature 910, and through the winding of the relay 900 to

battery. Upon operating, relay 900, at its armature 902 closes a circuit which extends from ground by way of armatures 902 and its front contact, armature 903 and its back contact, and through the winding of the relay 904 to battery. The relay 904 is energized over this circuit and extends the trunk line comprising conductors 595 and 596 to the secondary switch SL. The line relay 916 of the secondary switch SL is immediately energized and brings about its trunk selecting operation. The trunk selecting takes place in substantially the same manner as has been previously described in connection with the primary line switch C, Fig. 4. When the wipers 918-920, inclusive, are brought into engagement with the bank contacts of the idle trunk line which, it will be assumed, is the trunk line terminating in bank contacts 930-932, inclusive, the switching relay 915 is energized to extend the trunk conductors to the line relay 980 of the repeater R'. The relay 980 immediately operates to close a circuit for the slow acting relay 981 at armature 984 and at armature 985 closes a bridge across the trunk conductors 982 and 983. The operation of the slow acting relay 981, following the closure of its circuit, places ground upon the release trunk, whereby a holding circuit is established for the switching relay 915 of the secondary switch SL and for the relay 904. It will be noted that the energization of the relay 904 opens the circuit of the slow acting relay 900. Due to the slow operation of this relay the circuit of the relay 904 is maintained closed until the energization of the line relay 916 of the secondary switch SL. The closure of the bridge across trunk conductors 982 and 983, as before described, brings about the energization of the line relay of the incoming fourth selector in the Berkley office this relay operates to close the circuit of its associated slow acting release relay which operates to prepare the circuits of the selector for use.

Returning now to the operation of the repeater BLR, it will be seen that the energization of the relay 590 closes a bridge across the trunk conductors 595 and 596 through the impulse springs comprising armature 594 and its front contact and the line relay 598. The line relay 980 of the line repeater R' in the Condon exchange is thus under the control of the line relay 588.

Returning now to the operation of the director D³, it will be noted that the slow acting relay 660 is energized in multiple with the impulsing relay 503 of the relay group RG². Relay 660, upon operating, closes a circuit at its armature 665 for the upper winding of the relay 629. The relay 629 is so constructed that with its upper winding energized it only attracts the armature 651. Upon the armature 651 engaging its front

contact a circuit is closed for the lower winding of the relay 629. However, as long as the slow acting relay 660 is energized, the lower winding of the relay 629 is short circuited. At the termination of the series of impulses to the impulsing relay 503 the slow acting relay 660 deenergizes and the short circuit is removed from the lower winding of relay 629. This relay now operates all its armature. As a result of the attraction of armature 649, ground is removed from the conductor 677 and consequently from the bank contact 875 of the sender switch S¹ and ground is placed upon the conductor 680 extending by way of armatures 740 and 741, conductors 678 and 679 to the windings of the relays 626 and 625 in multiple to battery. Another result of the energization of the relay 629, is that the conductor 685 is disconnected from the conductor 697 so that the subsequent operation of the relays 850 and 851 do not ground the wipers 765, 767, 766, or 701. Still other results of the operation of relay 629 are that at armature 650 its original energizing circuit is opened and extends now to the relay 625, and at armature 652 ground is placed on armature 631 of the relay 625. The relays 625 and 626 are energized over the previously traced circuit. Relay 625, upon operating, at its armature 631 connects ground to armature 635 of relay 636, at its armature 633 extends the energizing circuit to the relay 626, at its armature 634 establishes a locking circuit for itself, and at its armature 632 closes a circuit which extends from ground by way of front contact and said armature, conductor 687, armature 870 and its front contact, and through the winding of the release magnet 763 of the first register switch M⁵ to battery. Magnet 763 operates to restore the wipers 765 and 766 to their normal position. When the register switch M⁵ is restored to normal the relay 730 deenergizes. The deenergization of this relay removes one ground connection from the conductor 686, opens the circuit of the release magnet at armature 760 and at armature 759 opens the locking circuit of the relay 726, which, immediately deenergizes. The deenergization of relay 726 restores certain circuits to normal. The relay 626 in the relay group G³, upon energizing, establishes a locking circuit for itself at armature 638, at armature 637 prepares an energizing circuit for the relay 627, at armature 635 places ground upon conductor 684 which extends to the wiper 770 of the third register switch M⁷ and at armature 636 closes a circuit which extends from ground by way of front contact and armature 632, front contact and armature 636, conductor 688, armature 705 and its front contact, and through the winding of the release magnet 702 of the second register switch M⁶ to bat-

tery. Magnet 702 operates to restore the wipers 767 and 768 to their normal position. Upon the switch wipers being restored to normal, the relay 701 is deenergized, which operation brings about the opening of the release magnet circuit at armature 705, and the removing of another ground connection from the conductor 686.

All the above operations occur responsive to the dialing of the third digit R of the called number. If the calling subscriber at substation A should dial the fourth digit of the desired number before these operations occur the third register switch M^7 will be operated, it being understood that the wiper 878 of the sequence switch Z^2 is advanced to its third position at the termination of the impulses constituting the digit R. Assuming this register switch to be operated the disconnection of ground from the conductor 686, at the restoration of the register switch M^6 , has no effect, as ground has been connected to the conductor 686 by the operation of the relay 787. Consequently the relay 663 in the relay group G^4 is maintained energized. The grounding of wiper 770 of register switch M^7 has been described and causes ground to be placed upon a particular bank contact in the sender switch S^1 depending upon the number of impulses that had been sent to the register switch M^7 . The sender switch S^1 now operates in the usual manner to ground the conductor 699 the same number of times as there are impulses in the digit stored on the register switch M^7 . This operation causes the relay 503 to be energized a corresponding number of times to open a circuit of line relay 588 of the bi-level repeater BLR. This relay deenergizes to produce the same number of interruptions in the circuit of the line relay 980 of the repeater R^7 . By the operation of this line relay these interruptions are repeated to the circuit of the line relay of the incoming fourth selector in the Berkley exchange. Responsive to the operation of the line relay of this switch the wipers are raised to the proper level of bank contacts and are then automatically rotated into engagement with the bank contacts associated with an idle trunk line extending to a fifth selector. The slow acting relay 660 is energized in multiple with the relay 503 and maintains its armature attracted throughout the sending of the impulse series. Relay 660, upon energizing, at its armature 665 closes a circuit which extends from ground by way of front contact and armature 665, the armature 650 and its front contact, armature 666 and its front contact, armature 633 and its front contact, armature 637 and its front contact, armature 641 and its back contact, and through the upper winding of relay 627 to battery. The relay 627 only operates the armature 642 with its upper winding ener-

gized. The operation of armature 642 prepares a circuit for the lower winding of relay 627, which is effective upon the deenergization of the slow acting relay 660, which occurs at the end of the impulse series. Relay 627, upon attracting its armatures opens its original energizing circuit, prepares the energizing circuit of the upper winding of the relay 628 at the front contact of armature 641, at armature 639 disconnects ground from the wiper 770, at the front contact of this armature connects ground to the wiper 772 by way of conductor 683, and at armature 640 completes a circuit by way of conductor 690 for the release magnet 794 of the third register switch M^7 . Magnet 794 restores the wipers 769 and 770 of the third register switch to normal, whereupon the relay 787 deenergizes to open the release magnet circuit and to remove another ground connection from the conductor 686. After the sending out of the digit, the wipers of the sender switch S^1 are automatically restored to normal in the usual manner.

Assuming that the calling subscriber at substation A dials the next digit of the desired number before the release of the register switch M^7 , the register switch M^8 will be operated inasmuch as the deenergizations of the line relay 501 sends impulses of current to the operating magnet 795 of the fourth register switch M^8 , the sequence switch wiper 878 being now in its fourth position. Now as the wiper 772 of the register switch M^8 is grounded by the energization of relay 627 in the relay group G^3 , ground is placed upon a bank contact in the sender switch S^1 corresponding to the number of interruptions in the digit set up on the register switch M^8 . By the operation of the sender switch S^1 , the circuit of the relay 503 is completed a like number of times and the same number of interruptions are produced in the circuit of the line relay 588 of the bi-level repeater BLR. The line relay 588 of this repeater operates to repeat the interruptions to the line relay 980 of the repeater R^7 . This relay, in turn, causes the line relay of the fifth selector in the Berkley exchange to be deenergized a plurality of times to raise the wipers of this selector to the proper level of bank contacts, whereupon they are automatically rotated until they are brought into engagement with the bank contacts of the trunk line leading to an idle connector switch. As before, upon the wiper 859 of the sender switch S^1 engaging a grounded bank contact the relay 867 is energized and the wipers 859 and 860 are automatically rotated to their normal or released position. The slow acting relay 660 is energized in multiple with the relay 503. This time, the operation of the relay 660 causes a circuit to be completed for the upper wind-

ing of the relay 628. The upper winding of the relay 628 only attracts the armature 646 to prepare a locking circuit for the relay. At the termination of the impulse series, the lower winding of relay 628 becomes effective and the relay energizes. Upon operating, relay 628, removes ground from the wiper 772 at armature 643, closes the circuit of the release magnet 796 of the register switch M⁸ at armature 644 and at armature 647 opens the locking circuits of the relays 625, 626, and 627. All these relays deenergize to restore the circuits controlled by them to their original condition. It will be understood, of course, that a wiper of the sequence switch Z² is moved to its fifth position at the termination of the registering of the fifth digit on the register switch M⁸.

Now if the calling subscriber dials the next digit of the called number before the register switch M⁸ is released, this digit will be registered on the first register switch M⁵, the sequence switch wiper 878 being advanced to its sixth position at the termination of this digit. When the relay 625 of the relay group G³ deenergizes, ground is placed upon the wiper 766 on the first register switch M⁵. As there is no ground placed upon the conductor 685 by the operation of the relay 850, associated with the sequence switch Z², the operation of wiper 765 has no function in the present instance. By the operation of the sender switch S¹, the impulses corresponding to the sixth digit are sent to the relay 503, and by the operation of this relay and the relays 588 and 980 of the repeaters BLR and R⁷, respectively, the proper number of interruptions are produced in the circuit of the line relay of the seized connector switch in the Berkley exchange. The line relay of this connector operates to control the operation of the vertical magnet in raising the wipers to the proper level of bank contacts. The energization in the relay 660 during the sending out of the sixth series of impulses cause the operation of the relay 625. The energization of the relay 660 also opens the locking circuit of the relay 628, which deenergizes. Relay 628, upon retracting its armatures, restores certain circuits to normal. The energization of relay 625 closes the circuit of the release magnet of the first register switch M⁵ at armature 632 and at armature 631 disconnects ground from the wiper 766 of the first register switch and connects it to the wiper 768 of the second register switch.

Assuming that this register switch has been operated by the dialing of the seventh and last digit of the called subscriber's number, the grounding of the wiper 768 causes the sender switch S¹ to send out the seventh digit in the usual manner. The relays 503, 588, 980, and the line relay of the connector are operated to control the operation of the

rotary magnet of the connector in rotating the wipers of this switch into engagement with the bank contact set associated with the desired line. The relay 660 is, of course, energized in multiple with the relay 503 and serves to cause the energization of relay 626. The relay 626 operates as before, but, as the last digit has been dialed by the calling subscriber, its energization is without function in the present instance, with the exception that it completes the circuit of the release magnet of the register switch M⁸ at armature 636, whereby the register switch M⁸ is released and ground is removed from the conductor 686. The removal of ground from conductor 686 causes the deenergization of the relay 663. Upon retracting its armature, relay 663 opens the circuit of the sending switch S¹ at armature 671, opens the circuit of the slow acting relay 662 at armature 672, and at armature 670 completes a circuit which extends as follows: From ground by way of armature 855 and its back contact, conductor 695, armature 670 and its back contact, armature 669 and its front contact, conductor 616, bank contact 623, wiper 614, front contact and armature 610, normally closed springs controlled by armature 511, and through the winding of the relay 500 to battery. The relay 500 is energized over this circuit and, upon operating, establishes a locking circuit for itself at armature 511, opens the short circuit of the lower winding of the relay 502 at armature 510, and at armatures 509 and 511' disconnects the relay 501 and extends the trunk conductors 83 and 85 to the line relay 588 of the bi-level repeater BLR. As a circuit of the relay 501 is opened this relay deenergizes to open the circuit of the relay 502, which immediately deenergizes. The deenergization of relay 502 opens a bridge across the trunk conductors at armature 514, removes one ground connection from the release trunk conductor 84 at armature 513 and at armature 577 opens the circuit of the switching relay 605 of the secondary switch SS¹. The latter relay, upon deenergizing, disconnects the director D⁸ from the relay group RG². At the same time that the circuit of the relay 605 is opened, the circuit of the relay 630 in the relay group G³ is also opened and this relay is deenergized to open the locking circuits of the energized relays in the relay groups G³ and G⁴ and to close the release magnet circuit of the sequence switch Z². By the operation of the release magnet 853 of the sequence switch Z², the wiper 878 is restored to its normal position. In this manner the director D⁸ is released and may be used in another connection.

When the connector wipers are brought into engagement with the bank contacts associated with the desired line as before described, ringing current is automatically pro-

jected out on the line to signal the subscriber called. When the called subscriber answers, the ringing current is disconnected and the talking circuits established.

5 When the conversation is terminated, the release of the connection follows the replacement of the receiver at the calling substation A. Immediately upon the occurrence of this last operation the circuit of the line relay 588 of the repeater BLR is opened and this relay deenergizes to open the circuit of the slow acting relay 589 at armature 591, and to open a circuit of the line relay 980 of the repeater R' in the Berkley exchange.

10 The deenergization of relay 589 of the repeater BLR opens a circuit of the relay 590 and also removes ground from the release trunk conductor 84. The removal of ground from the release trunk conductor 84 causes the deenergization of the switching relay 508 of the trunking selector K¹, and the deenergization of the relay 500 of the relay group RG². The deenergization of relay 508 brings about the release of the trunking selector K¹ in the usual manner. The deenergization of relay 500 of the relay group restores the circuits of the relay group to normal. In addition, the removal of ground from the release trunk conductor 84 brings about the deenergization of the switching relay 54 of the first selector 1E and the deenergization of the switching relay 15 of the line switch C. The selector 1E is released responsive to the retraction of the armatures of the relay 54. The circuits of the line switch C are restored to normal by the deenergization of relay 15.

The above is the normal operation of the director D³ when a subscriber in Berkley exchange is called provided the sending out of digits by the director does not catch up with the dialing of the number by the calling subscriber. Assuming that the sending out of the digits does catch up with the dialing of the numbers after the office selecting digits have been sent out, all the register switches such as M⁵, M⁶, M⁷, and M⁸ will be in their normal position and ground will be removed from the conductor 686. This operation brings about the deenergization of the relay 663 and the deenergization of the relay 500 in the relay group RG². By these operations the director D³ is released in a manner similar to that already described. The called subscriber is now enabled to control the line relay 588 of the repeater BLR directly in dialing the subsequent digits of the called number.

Should the calling subscriber replace his receiver upon the switchhook before the connection has been completely set up and the director D³ released the deenergization of the relay 501 opens the circuit of the relay 502. The deenergization of relay 502 brings

about the release of the director D³ and the secondary switch SS¹ in the usual manner.

Call from Center to Condon.

Should the subscriber at substation A have desired to call a subscriber in the Condon exchange in place of the subscriber in the Berkley exchange the operations would be substantially the same as those before described including the seizing of the trunking selector K¹ and the director D³. From this point on the operation would be slightly different and these operations will now be briefly described.

When the second digit 0 is dialed at the calling substation, the line relay 501 of the relay group RG² responds, and ten impulses of current are sent to the operating magnet 764 of the register switch M⁵. The magnet 764 operates to rotate the wipers 765 and 766 into engagement with their tenth set of bank contacts. The slow acting relay 850 is energized in series with the operating magnet of the register switch M⁵ and causes the sequence switch wiper 878 to be advanced to its second position. At the deenergization of the relay 850, at the end of this series of impulses, the relay 729 of the relay group G⁵ is energized. Upon operating, relay 729 establishes a locking circuit for itself at armature 752, closes the circuit of the relay 661 at armature 753, at armature 754 places ground upon the conductor 809 extending to the sender switch S¹, and at armatures 755 and 756 prepares a circuit for the relays 626 and 625 in the relay group G². The relay 661 in the relay group G⁴ operates to initiate the operation of the sender switch S¹. The sender switch S¹ now operates to ground the conductor 699 twice and to then automatically restore to normal. The grounding of conductor 699 brings about the operation of the relay 503, which, in turn, produces two interruptions in the circuit of the line relay 504 of the trunking selector K¹. By the operation of the line relay 504, the wipers 535-538, inclusive, are raised step by step by the vertical magnet 531 to the second level of bank contacts. At the end of the vertical movement of the switch, its trunk hunting operation takes place and continues until an idle trunk is selected, which, it will be assumed, is a trunk line terminating in bank contacts 559-562, inclusive. At this time, the switching relay 508 is energized to extend the connection to the line relay 588 of the repeater BLR. The line relay 588 immediately energizes to close the circuit of the slow acting relay 589. Relay 589, upon energizing, closes the circuit of the relay 590 at armature 592 and at armature 593 completes a holding circuit for the selector K¹. Relay 590 operates at armature 597 to close a bridge

across conductors 595 and 596. By the closure of this bridge, a circuit is completed which extends from ground through the winding of the relay 901 in the traffic separator TS, by way of armature 907 and its back contact, back contact and armature 911, trunk conductor 596, front contact and armature 594, through the right hand windings of the repeating coil of the repeater BLR, front contact and armature 597, trunk conductor 595, armature 906 and its back contact, back contact and armature 910 and through the winding of relay 900 to battery. Relays 900 and 901 are energized over this circuit. Upon the operation of these relays, a circuit is completed which extends from ground by way of armature 902 and its front contact, armature 903 and its front contact, through the winding of the relay 905 and thence to battery. Relay 905, upon energizing, at armatures 910 and 911 opens the circuit of the slow acting relays 900 and 901 and at armatures 908 and 911 extends the trunk conductors 595 and 596 to the line relay 936 of the secondary switch SL¹. Upon operating, relay 936, causes the secondary switch to seize an idle trunk line extending to an incoming fourth selector in the Condon exchange which, it will be assumed, is the trunk line shown in the drawings extending to the fourth selector indicated by the reference character 4E⁵.

The line and release relays of this switch are immediately energized and operate to prepare the switch circuits for operation.

In the director D³, the relay 660 is energized in multiple with the relay 503 and operates to cause the energization of relay 629 at the end of the series of impulses constituting this digit. Relay 629, upon energizing, at armature 648 removes ground from conductor 685, at armature 649 removes ground from the bank of the sender switch S¹, and at the front contact of this armature closes a circuit for the relays 625 and 626. The energization of these two relays have the same results as before, among which is the release of the register switch M⁵ and also of the register switch M⁶, if it has been operated. In this case it will be seen that the above operations occur responsive to the dialing of the second digit 0 of the called number and consequently it is quite probable that the register switch M⁶ will only be partially operated when the circuit of its release magnet is closed by the energization of the relay 626. In any event, the energization of relay 626 will release the register switch M⁶ and consequently all register switches will be in their normal position and ground will be removed from the conductor 686, whereby the circuit of the relay 663 is opened and this relay deenergizes. The deenergization of this relay brings about the energization of relay 500

in the relay group RG². The energization of the relay 500 brings about the connection of the trunk line comprising conductors 83-86, inclusive, to the bi-level repeater BLR and the release of the secondary switch SS¹ and the director D³. These last operations all occur in substantially the same manner as has been previously described.

The further extension of the connection responsive to the subsequent digits in the called number takes place in the usual manner.

The release of the connection also occurs responsive to the replacement of the receiver at the substation A in the well known manner.

Call from Center to Cedar.

It will now be assumed, that the subscriber at substation A desires to call the line of a subscriber in Cedar exchange. In this case the extension of the connection to the trunking selector K¹ and the association of a director such as D³ with the trunk occurs in the same manner as described before. In accordance with the second and third digits E and D of the called number the wipers of the register switches M⁵ and M⁶ are rotated into engagement with the third bank contact sets in each instance. At the end of the operation of the register switch M⁵ the sequence switch Z² is placed in its third position and relay 728 is energized. Upon operating, relay 728, establishes a locking circuit for itself at armature 747, closes the circuit of the relay 661 of the relay group D⁴ at armature 748, and at armature 749 places ground upon the conductor 811, extending to the bank of the sender switch S¹. The energization of relay 661 in the relay group G⁴ initiates the operation of the sender switch S¹. The sender switch S¹ now closes the circuit of the relay 503 four times, thus causing this relay to interrupt the circuit of the line relay 504 a corresponding number of times. By the operation of the line relay 504, the switch wipers of the trunking selector are brought opposite the fourth level of bank contacts and are then rotated to seize a trunk line extending to the Wolf exchange, which, it will be assumed, is the trunk line terminating in bank contacts 550-553, inclusive. By the energization of the switching relay 508 the connection is extended to the incoming second selector in Wolf exchange. The line and release relays of the incoming second selector are energized in the usual manner and function to prepare the operating circuits of the selector.

In the director D³, the relays 660 is energized in parallel with the relay 503 of the relay group RG². The operation of the relay 560 brings about the energization of relay 629 at the end of the impulse series. The energization of the relay 629 disconnects

ground from conductor 811 extending to the bank of the sender switch S^1 and the grounding of wipers 766 by way of conductor 681. The grounding of wiper 766 places ground upon the conductor 810 extending to the bank of the sender switch S^1 . By the next operation of the sender switch S^1 three impulses are sent to the relay 503 in the relay group RG^2 and this relay repeats the interruptions to the line relay of the repeater R^{12} , which, in turn, repeats this series of interruptions to the circuit of the line relay of the incoming second selector in Wolf exchange. The line relay of this switch now causes the vertical magnet to raise the wipers to the third level of bank contacts, whereupon the trunk hunting operation occurs and the trunk line extending to the idle third selector in Wolf exchange seized. By the operation of the relay 660, the relay 625 is energized at the end of this impulse series. Upon operating, relay 625 at armature 632 closes the circuit of the release magnet of the first register switch M^5 , removes ground from wiper 766 at armature 631, at the front contact of this armature connects ground to wiper 768 of the second register switch M^6 and prepares an energizing circuit for relay 626 at armature 633. By the grounding of wiper 768 of the conductor 810 is again grounded and the sender switch S^1 operates to send three impulses of current to the line relay 503. By the operation of the relay 503, the line relay of the repeater R^{12} , and the line relay of the third selector in the Wolf exchange, the wipers of this selector are raised to the third level of bank contacts. The wipers of the third selector are now rotated to seize a trunk line extending by way of the repeater to the idle incoming selector in the Cedar exchange. The remaining four digits of the called number are now sent out in the usual manner by the operation of the register switches and the sender switch S^1 , the register switches being operated under the control of the calling dial at substation A. These operations occur in substantially the same manner as has been set forth, and hence it has been thought unnecessary to go into the operation again. The director D^3 is, of course, released when all the digits have been sent out or if it catches up with the dialing of the number by the calling subscriber in the usual manner.

Call from Center to Belden.

Assuming now that the subscriber at substation A desires to connect with a subscriber in Belden exchange, the operations up to the seizure of the trunking selector such as K^1 and the association of an idle director such as D^3 with the trunk line takes place in the same manner as before. In response to the dialing of the second and third

digits E and L the wipers of the register switches M^5 and M^6 are brought into engagement with the third and fifth bank contact sets, respectively. After the termination of the operation of the register switch M^6 the slow acting relay 850 deenergizes to cause the sequence switch wiper 878 to be advanced to its third position. The deenergization of relay 850 also causes the operation of relay 725. Upon operating, relay 726, establishes a locking circuit for itself at armature 731, and at armatures 734, 735, and 736 prepares circuits for the relays 626, 625, and 627, respectively. In response to the fourth digit the register switch M^7 is operated. At the deenergization of the slow acting relay 850 at the end of the fourth series of impulses a circuit is completed for the relay 774. Relay 774, upon operating, closes a locking circuit for itself at armature 776, places ground upon conductor 812 at armature 779, and at armatures 780 and 781 prepares a circuit for the relays 625 and 626. Another result of the energization of relay 774 is that a circuit is completed for the relay 661 at armature 782. Upon operating, relay 661, initiates the operation of the sender switch S^1 . The sender switch S^1 now operates to send five impulses of current to the relay 503, which operates a corresponding number of times to produce five interruptions in the circuit of the line relay 504 of the trunking selector K^1 . By the operation of the relay 504, the vertical magnet 531 is caused to raise the wipers 535-538, inclusive, to the proper level of bank contacts. The trunk hunting operation of the switch is now initiated and continues until the switch wipers are brought into engagement with an idle set of bank contacts, which, it will be assumed, are the bank contacts 545-548, inclusive, whereupon the switching relay 508 is energized. The operation of this relay extends the connection to the repeater R^{11} .

The line and release relays 580 and 581 of the repeater R^{11} are energized in the usual manner and have the same results. The line relay of the incoming fourth selector in Belden exchange is also operated to close a circuit for its slow acting release relay. The latter relay operates to prepare the switch for operation.

In the director D^3 , the energization of the relay 661 responsive to the sending out of this series of impulses bring about the operation of relay 629. Upon operating, relay 629, disconnects ground from the conductor 812 at armature 649, at the front contact of this armature closes a circuit for the relays 625 and 626, and at armature 652 prepares a circuit for grounding the wiper 770. The operation of the relays 625 and 626 have the same results as before, among which is the release of the register switches M^5 and M^6 and the grounding of wiper 770. By the

grounding of wiper 770 ground is placed upon a conductor leading to the bank of the sender switch S^1 , whereby the sender switch is caused to ground the conductor 699 the proper number of times. By the operation of the relays 503, 580, and the line relay of the incoming fourth selector in Belden exchange, the wipers of this switch are brought opposite the proper level of bank contacts and are then rotated to seize a trunk line extending to a fifth selector. The slow acting relay 660 is energized as before, and at the end of this impulse series cause the operation of the relay 627. Relay 627 operates in the usual manner to bring about the release of the register switch M^7 and the grounding of the wiper 772 of the register switch M^8 . The remaining operations of the director D^3 in setting up the desired connection take place in the manner similar to that above described, the director being released either when it catches up with the dialing of the number or when all the digits have been sent out.

It will be noted that in the case above described, the operation of the trunking selector K^1 did not take place until after the setting of the third register switch M^7 . This is due to the fact that when the exchange Belden is called it is impossible to distinguish between it and its branch until the fourth digit is dialed.

Call from Center to 2537 branch of Belden.

In case the 2537 branch of Belden should be called, in place of Belden main exchange the operations up to the operation of the register switch M^7 are the same as before. In this case the register switch M^7 will be operated into engagement with its seventh set of bank contacts and the relay 775 will be energized in place of the relay 774. The operation of the relay 775 places ground upon the conductor 813 extending to the bank of the sender switch S^1 , at armature 786 closes a circuit for the relay 661 and at armatures 778, 784, and 785 prepares a circuit for the relays 627, 625, and 626, respectively. The energization of relay 661 causes the sender switch S^1 to start operating, whereby six impulses of current are sent to the relay 503. The relay 503 interrupts the circuit of the relay 504 a like number of times and the wipers of the trunking selector K^1 are raised to the sixth level of bank contacts and are then rotated until engagement is made with an idle trunk line extending to the 2537 branch of Belden, which, it will be assumed, is a trunk line terminating in bank contacts 540-543, inclusive.

The line release relays of the repeater R^{10} and also of the incoming fifth selector in the branch exchange of Belden are operated in the usual manner and function as before described. The relay 629 is, of course, ener-

gized at the end of this series of impulses. The operation of relay 629 closes a circuit for the relays 625, 626, and 627 and removes ground from the conductors 813 extending to the bank of the sender switch S^1 . The energization of relays 625, 626, and 627, brings about the release of the register switches M^5 , M^6 , and M^7 . Another result of the energization of relay 727 is that the wiper 772 of the register switch M^8 is grounded. By the operation of the sender switch S^1 the digits stored on the register switch M^8 is sent out to operate the fifth selector in the 2537 branch of Belden to the proper level of bank contacts. The selector now rotates to seize an idle switch in the selector group. The subsequent extension of the connection under the control of the director takes place in the usual manner.

It will be noted in the case above described, that the fourth digit is not sent out, as is the case when the Belden main exchange is called, for the reason that the branch exchange of Belden is selected.

Local call in Center.

It will now be assumed that the calling subscriber desires to communicate with a subscriber whose line terminates in the same exchange as his own, namely, Center exchange. In this case the operation including the seizing of the trunking selector K^1 and the association of the director D^3 with the trunk takes place in the same manner as before. In response to the second and third digits E and N of the called number, the wipers of the register switches M^5 and M^6 are brought into engagement with the third and sixth sets of bank contacts. At the termination of the third series of impulses the relay 727 is energized. Upon operating, relay 727, completes a locking circuit for itself at armature 742, places ground on conductor 808 extending to the bank of the sender switch S^1 at armature 744, completes a circuit for the relay 661 at armature 743, and at armatures 745 and 746 prepares a circuit for the relays 626 and 625. The operation of relay 661 causes the sender switch S^1 to start operating whereby the conductor 699 is grounded once and the wipers of the trunking selector K^1 brought opposite the first level of bank contacts and then rotated into engagement with the contact set associated with an idle trunk line, which, we will assume, is the trunk line terminating in bank contacts 563-566, inclusive. The switching relay 508 is immediately energized to extend the connection to the fourth selector in Center exchange. The line and release relays of the switch are energized in the usual manner and function as before to prepare the operating circuits of the switch. The relay 629 of the relay group G^8 is energized at the end of this impulse

and operates to disconnect ground from the conductor 808 and to close the circuits of the relays 625 and 626. These relays operate to bring about the release of the register switches M^5 and M^6 and also to ground the wiper 770 of the register switch M^8 , whereby ground is placed upon a conductor leading to a bank contact in the bank of the sender S1. From this point on the director functions in the same manner as before described.

Under certain conditions, it may happen that all the trunk lines in a particular level to which the wipers of the trunking selector K^1 are raised, is busy and under these conditions it becomes desired to give a busy signal to the called subscriber and to bring about the release of the secondary switch SS^1 and the director D^1 . In this case the wipers of the selector K^1 will be rotated until they are in their eleventh position where the cam springs 519 and 520 are operated. The operation of these springs close a busy signalling circuit by connecting a lead from the busy signalling machine to the conductor 85 and also opens the circuit of the switching relay 605 and the relay 630 in the relay group G^8 of the director D^3 . In this manner the busy signal is given to the calling subscriber and the director D^3 is released.

Call from Center to James.

The manner in which the subscriber at substation A is enabled to call a subscriber whose line terminates in the James exchange in district 4 will now be described. To accomplish this result, the calling subscriber will remove his receiver and operate his calling device for the digits of the called number. To follow the description in this instance, the drawings should be arranged in the manner shown in Fig. 22.

Responsive to the removal of the receiver, the individual line switch C is operated to extend the connection to an idle selector switch, which, it will be assumed is the selector 1E.

The line and release relays of this switch are operated in the usual manner and serve to provide a holding circuit for the line switch C and to prepare the operating circuits of the selector 1E.

When the first digit J is dialed, the line relay 50 controls the operation of the vertical magnet 64 in bringing the wipers 66-68, inclusive, to the proper level of bank contacts. The rotary movement of the switch is now initiated and continues until the switch wipers are brought into engagement with the bank contact set associated with an idle trunk line which, it will be assumed, are the bank contacts 72-74, inclusive. The switching relay 54 is now energized and operates to extend the connection

to the relay group RG Fig. 14 over conductors 83-85, inclusive.

The line relay 1001 is immediately energized and operates at its armature 1011 to close the circuit of the slow acting relay 1002 and at its armature 1012 prepares a circuit for the switching relay 1000. The energization of relay 1002 grounds the release trunk conductor 87, thereby establishing a holding circuit for the switches 1E and C, and prepares an impulsing circuit for a director. Another result of the energization of relay 1002 is that the trunk selecting operation of the secondary switch SS^{14} is initiated and continues until a trunk line is seized leading to a director, which, it will be assumed, is a trunk line shown in the drawings leading to the director D^2 from the bank contacts 1101-1106, inclusive. When this trunk is selected, the relay 1087 energizes and operates to associate the director D^2 with the relay group RG. One of the results of this operation is that ground is connected to the conductor 1110 and the relay 1129 in the relay group G^6 is operated. Upon operating, relay 1129, at armatures 1145, 1146, 1147, 1148, and 1149 opens the circuits of the release magnet of the register switches M^{11} , M^{12} , M^{10} , M^9 , and also the circuit of the release magnet of the sequence switch Z^8 .

The calling subscriber may now operate his calling device in accordance with the second digit A of the desired number. By this operation, one interruption is produced in the circuit of the line relay 1001 and, by the deenergization of this relay, an impulse of current is sent over the following circuit: From ground by way of back contact and armature 1012, front contact and armature 1014, front contact and armature 1094, wiper 1100, bank contact 1106, conductor 1111, normally closed springs controlled by armature 1174, armature 1171 and its back contact, conductor 1194, through the winding of the slow acting relay 1200, wiper 1250 of the sequence switch Z^8 in its first position, conductor 1231 and through the winding of the operating magnet 1332 of the first register switch M^9 to battery. The magnet 1332 operates to rotate the wipers 1342 and 1343 into engagement with the first set of bank contacts. Upon the first off normal movement of the register switch M^9 the relay 1330 is energized. One of the results of the energization of this relay is that ground is placed upon the conductor 1187. As a result of this, the relay 1156 is energized. Upon operating, 1156 closes a circuit for the slow acting relay 1155 at armature 1173, and at armature 1174 extends the circuit to the register switches exclusive of armature 1171 on the slow acting relay 1155. The operation of relay 1155 prepares a certain switching

circuit as will appear later. The slow acting relay 1200 is energized in series with the operating magnet 1332 and operates at its armature 1210 to complete a circuit for the slow acting relay 1201 and to prepare a circuit at its armature 1211 for grounding the wipers of the register switches. The slow acting relay 1201 energizes and prepares a circuit for the operating magnet 1208 of the sequence switch Z^3 at armature 1212. Shortly after the end of this impulse the slow acting relay 1200 deenergizes and the operating magnet 1208 is operated and the wipers of the register switches are momentarily grounded. Due to the peculiar construction of the relays 1302, 1303, 1304, and 1305, these relays are not operatively energized, only one of their windings being energized.

In response to the next operation of the calling device at the calling substation for the digit M, five interruptions are produced in the circuit of the line relay 1001 and this deenergizes five times to send five impulses of current to the operating magnet 1334 of the second register switch M^{10} . The circuit over which the impulses are sent is similar to the one above traced for the operating magnet of the first register switch except that as the sequence switch wiper 1250 is in its second position the magnet 1334 is operated. The slow acting relay 1200 is, of course, energized in series with the magnet 1334 and operates to close the circuit of the slow acting relay 1201. By the conjoint operation of the relays 1200 and 1201 an impulse of current is sent to the operating magnet 1208 of the sequence switch Z^3 at the termination of the third series of impulses. The wipers 1342 and 1344 of the register switches M^9 and M^{10} are also grounded and, consequently, the relay 1304 is operated, both its windings being energized at this time. Upon operating, relay 1304, at armature 1318 establishes a locking circuit for itself, at armature 1320 prepares a controlling circuit which will be later described, and at its armature 1319 closes a circuit which extends from ground through the winding of relay 1152 of the relay group G^5 , by way of conductor 1178, armature 1319 and its front contact, conductor 1177, conductor 1114, bank contact 1101, wiper 1095, armature 1089 and its front contact, back contact and armature 1044, and through the winding of the line relay 1041 of the secondary switch SS^3 . The relays 1152 and 1041 are energized over this circuit. Relay 1152, upon energizing, at armature 1163 closes a circuit for the slow-acting relay 1154, closes a circuit for relay 1151 at armature 1162, at armature 1164 prepares one point in the switching circuit, and at armatures 1165 and 1166 opens certain points in the controlling circuit as will appear later. Relay 1154, upon attracting its armature, opens a certain point in a dialing circuit, as will ap-

pear later at armature 1168, and at armatures 1169 and 1170 prepares certain points in the above mentioned controlling circuits. The relay 1151, upon energizing, establishes a locking circuit for itself at armature 1161, at armature 1175 prepares a point in the energizing circuit of relay 1125, at armature 1160 prepares a circuit for the sending switch S^4 , and at armature 1159 places ground on conductor 1183 extending to the wiper 1343 of the register switch M^9 .

Relay 1041, Fig. 14, upon operating, initiates the trunk selecting operation of the secondary switch SS^3 . When an idle trunk is selected, which, it will be assumed, is the trunk line terminating in bank contacts 1052-1054, inclusive, the switching relay 1040 is operated. The operation of relay 1040 extends the connection to the quad-level-repeater QLR at armatures 1043 and 1046 and at armature 1044 opens the circuit of relay 1041 and of the relay 1152, Fig. 15. Relay 1152 immediately deenergizes to open the circuit of the slow-acting relay 1154 at armature 1163 and to close the above mentioned controlling circuit at armature 1166. This circuit may be traced from the ungrounded pole of the high voltage battery B, by way of back contact and armature 1166, front contact and armature 1170, conductor 1182, armature 1320 and its front contact, conductor 1180, conductor 1113, bank contact 1104, wiper 1098, armature 1092 and its front contact, armature 1046 and its front contact, wiper 1051, lower left-hand winding of the repeating coil of the repeater QLR, armature 1078 and its back contact, trunk conductor 1085, armature 1416 and its back contact, armature 1420 and its back contact, armature 1424 and its back contact, armature 1429 and its back contact, through the winding of the polarized relay 1411, and through the winding of the polarized relay 1408 to ground. The polarized relay 1411 is operated by the current flowing over this circuit though the polarized relay 1408 is not operated as it is adapted to respond to current of the opposite polarity to that supplied by the high voltage battery B. Relay 1411, upon energizing, closes a circuit for the slow acting relay 1410. The latter relay, upon energizing, at its armature 1430 closes a circuit for the slow acting relay 1409. This relay operates to disconnect the polarized relays from the trunk line comprising conductors 1084 and 1085 and operates to associate this trunk line with the secondary switch SS^4 . The relay 1072 in the repeater QLR is also energized in multiple with the relay 1411. Upon operating, relay 1072, at armature 1081 closes a circuit for the relay 1070 and at armature 1082 closes a circuit for the relay 1073. Upon operating, relay 1073, places ground upon the release trunk conductor 1086 thereby establishing a hold-

ing circuit for the switching relay 1040 of the secondary switch SS². It will be understood, of course, that this holding circuit is completed before the slow acting relay 1041 has had time to deenergize. The relay 1070, upon operating, opens the circuit of the relay 1072 at armatures 1076 and 1077, at the front contacts of these armatures connects up the line relay 1071, establishes a locking circuit for itself at armature 1075, and at armatures 1074 and 1078 opens the connection between the left hand winding of the repeating coils and the trunk conductors 1084 and 1085.

Referring now to the relay group G⁵ of the director D² it will be noted that the circuit for the high voltage battery above traced, is only completed while the slow acting relay 1154 maintains its armatures attracted after the deenergization of the quick acting relay 1152. Now when the slow acting relay 1154 deenergizes, the circuit for the high voltage battery B is opened at the armature 1170 and at armature 1176 a circuit is closed extending from ground by way of front contact and armature 1149, back contact and armature 1176 front contact and armature 1160, conductor 1195, back contact and armature 1221, through the winding of the relay 1202 and thence to battery by way of the interrupter. The closure of this circuit initiates the operation of the sender switch S⁴ in the manner similar to that already described. Another result of the deenergization of relay 1154 is that at armature 1168 a circuit is completed which extends from ground through the lower winding of the line relay 1071 of the quad-level repeater QLR, front contact and armature 1077, lower left hand winding of the repeating coil, bank contact 1054, wiper 1051, front contact and armature 1046, front contact and armature 1092, wiper 1098, bank contact 1104, conductor 1113, back contact and armature 1168, armature 1167 and its back contact, conductor 1112, bank contact 1103, wiper 1097, armature 1091 and its front contact armature 1043 and its front contact, wiper 1049, bank contact 1052, upper left hand winding of the repeating coil, armature 1076 and front contact, and through the upper winding of the line relay 1071 to battery. The line relay 1071 is energized over this circuit and operates at its armature 1079 to establish another circuit for the relay 1073, before this relay has had time to deenergize, its circuit having been opened by the deenergization of relay 1072. Another result of the energization of relay 1071 is that at armature 1080 a bridge is closed across conductors 1084 and 1085. The closure of this bridge causes the line relay 1447 of the secondary switch SS⁴ to be energized. The energization of relay 1447 ini-

tiates the trunk selecting operation of the secondary switch. When an idle trunk is found, which, it will be assumed is the trunk line shown in the drawings extending by way of the repeater R¹¹ to an incoming second selector in Graceland exchange, the switching relay 1446 is energized. Upon operating, relay 1446 extends the trunk line by way of the repeater R¹¹ to the incoming second selector in Graceland exchange. The line relay 1448 of the repeater R¹¹ immediately operates to close a circuit for the slow acting relay 1449 and to close a bridge across trunk conductors 1452 and 1453. As a result of this last operation the line relay of the incoming second selector in the exchange Graceland is operated to close a circuit for its associated slow acting release relay. The energization of the latter relay prepares the operating circuit of the selector. The slow acting relay 1449 of the repeater R¹¹, upon attracting its armature, establishes a holding circuit for the relays 1446 and 1409, whereby the trunk line comprising conductors 1084 and 1085 is maintained associated with the trunk line comprising conductors 1452 and 1453.

The sender switch S⁴ now operates to send out the digits stored on the first register switch M⁹ by grounding the conductor 1196 the proper number of times. In this case the conductor 1196 is grounded once as the digit A has been registered on the first register switch. The grounding of conductor 1196 causes the relay 1153 to operate thereby opening the circuit of the line relay 1071 of the quad-level repeater QLR. By the operation of the line relay 1071 and the operation of the line relay 1448 of the repeater R¹¹, this digit is repeated to the line relay of the incoming second selector in the Graceland exchange. The line relay of the selector operates to control the vertical magnet in raising the wipers to the first level of bank contacts, whereupon the trunk hunting operation ensues. When an idle trunk is selected, the switching relay of the selector operates to extend the connection to the selected third selector. The slow acting relay 1150 is also energized in multiple with the impulsing relay 1153 and operates to bring about the energization of the relay 1125 at the end of the impulse series. Upon operating, relay 1125, locks itself at armature 1133, prepares an energizing circuit for the relay 1126 at armature 1132, at armature 1130 disconnects ground from the wiper 1343 of the register switch M⁹ and connects ground to the wiper 1345 of the register switch M¹⁰, and at armature 1131 closes a circuit for the release magnet 1331 of the register switch M⁹. By the operation of the release magnet 1331 this register switch is released. As the wiper 1345 is now grounded, the next operation

of the sender switch S^4 grounds the conductor 1196 five times in accordance with the digit stored on the second register switch M^{10} . By the operation of the relays 1153, 1071, and 1448, the line relay of the third selector is caused to vibrate five times. The operation of this relay causes the wipers of the selector to be brought opposite the fifth level of bank contacts. The switch wipers are then rotated until engagement is made with the trunk line extending by way of the repeater to the incoming fourth selector in the James exchange.

In the relay group G^5 the slow acting relay 1150 is energized in parallel with the impulsing relay 1153 and causes the energization, at the end of the series of impulses, of the relay 1126. The operation of relay 1126 brings about the release of the second register switch M^{10} and the grounding of the wiper 1348 of the register switch M^{11} .

In the meantime the calling subscriber at substation A continues to operate his calling device for the digits of the called subscriber's number, and these digits are registered on the register switches M^{11} and M^{12} and thence on the register switches M^9 and M^{10} . These operations are similar to the ones described in the preceding connections and hence need not be entered into at this time.

The operation of the sender switch S^4 in sending out the digits stored on the register switches M^{11} and M^{12} is identical with the operations before described. When the digit stored on the register switch M^{12} is sent out, the relay 1128 is operated to close the release magnet circuit of the register switch M^{12} and to open the locking circuits of the relays 1125, 1126, and 1127 so that these relays may be again operated. Upon the next operation of the relay 1150 when the digit stored on the register switch M^9 is sent out the locking circuit of the relay 1128 is opened and this relay deenergizes. The subsequent operations in establishing the connection take place in substantially the same manner as has been before described, and this description will not be repeated at this point. Assuming that the sending operations of the sender switch S^4 of the director D^2 does not catch up with the operation of the calling device at substation A, when the last digit is sent out by the sender all the register switches will be in their normal position and ground will be removed from the conductor 1187. The removal of ground from this conductor causes the relay 1156 to deenergize thereby opening the circuit of the slow acting relay 1155 at armature 1173 and closing a circuit at the normally closed springs controlled by armature 1174, which extends from ground by way of front contact and armature 1171, by way of said springs, conductor 1111, bank contact 1106, wiper 1100,

armature 1094 and its front contact, armature 1014 and its front contact, armature 1012 and its front contact, normally closed springs controlled by armature 1009 and through the winding of the relay 1000 to battery. Upon energizing, relay 1000, establishes a locking circuit for itself at armature 1009, removes the short circuit from the upper winding of relay 1002 at armature 1008, connects the release trunk conductor 1004 to conductor 87 at armature 1007, and at armatures 1005 and 1010 disconnects the line relay 1001 and connects trunk conductors 86 and 88 to the line relay 1071 of the repeater QLR. The relays 1001 and 1002 now deenergize to bring about the release of the secondary switch SS^{14} and the release of the relay 1129 of the director D^2 . The deenergization of relay 1129 now brings about the release of the director in a well known manner.

Under certain conditions, it may happen that all the trunks extending to the secondary switch SS^3 are busy. Consequently when the line relay 1041 is energized as before described, no idle trunk can be selected, and the relay 1152 in the relay group G^5 will be maintained energized. The register switches M^{11} and M^{12} will now be operated to store the fourth and fifth digits of the called number. If an idle trunk is not selected by the time the register switch M^{11} has finished its operation the relay 1200 will be deenergized and a circuit will be completed extending from ground by way of front contact and armature 1213, armature 1211 and its back contact, conductor 1230, front contact and armature 1327, armature 1328 and its front contact, front contact and armature 1329, armature 1370 and its front contact, conductor 1192, front contact and armature 1164, armature 1174 and its front contact, conductor 1111, bank contact 1106, wiper 1100, armature 1094 and its front contact, armature 1014 and its front contact, armature 1012 and its front contact, normally closed springs controlled by armature 1009 and through the winding of the relay 1000 to battery. The energization of relay 1000 brings about the release of the secondary switch SS^{14} and also the release of the director D^2 . Now as, neither of the switches SS^2 or SS^3 are in an operated position, a circuit is completed extending from ground by way of back contact and armature 1031, back contact and armature 1046, armature 1010 and at its front contact, trunk conductor 88, through the switches 1E and C, and over the calling line loop, conductor 86, front contact and armature 1005, armature 1043 and its back contact, back contact and armature 1033, armature 1006 and its front contact, and through the winding of the relay 1003 to battery. The relay 1003 is energized over this circuit. Upon operating, re-

lay 1003, places ground upon the release trunk conductor 97 at armature 1017 to maintain the switches C, 1E and the relays of the relay group RG operated and at its armature 1018 connects a lead from the busy machine to the conductor 88. By the latter operation, the calling subscriber is given an audible signal in order to inform him that he cannot obtain the desired connection at the present time. The connection is released in the ordinary manner upon the replacement of the receiver at the calling substation, the relay 1003 being deenergized to remove ground from the release trunk conductor 87.

Call from Center to Graceland.

It will now be assumed that in the previous connection the calling subscriber at substation A desires to communicate with a subscriber in Graceland exchange. The operation in this case is substantially the same as in the last connection with the exception that the register switches M⁹ and M¹⁰ of the director D² are operated so that their wipers stand in engagement with the seventh and first bank contact sets, respectively. The relay 1300 is now the one energized to bring about the operation of the secondary switch SS³ and the polarized relay 1411. As a result of the wipers of the register switches M⁹ and M¹⁰ being in engagement with the seventh and first sets of bank contacts, respectively, the first and second digits sent out by the sender switch S¹ consist of seven impulses and one impulse, respectively. The operations of the second and third selectors in the Graceland exchange respond to these two digits cause the connection to be extended to the local fourth selector in Graceland exchange. The remaining extension of the connection takes place in the usual manner.

Call from Center to Holland.

We will now assume that the calling subscriber at substation A desires to call a subscriber in Holland. The operation in this case is very similar to the operation just described. Assuming that the connection has been extended to the relay group RG and that the director D² has been associated with the seized trunk line the operation of the calling device for the second digit brings about the energization of the relay 1306. Relay 1306, upon energizing, locks itself at armature 1324, at armature 1325 closes a circuit for the relays 1152 and 1041, and at armature 1326 closes one point in the controlling circuit, which will be described. The secondary switch SS³ now operates to select an idle trunk line leading to Jasper exchange. It will be assumed that the trunk line shown in the drawings extending through the repeater QLR is the one selected.

When this trunk line is selected, the relay 1040 is energized and the circuit of the relay 1152 is opened. Upon the deenergization of this relay, a circuit is completed extending from the ungrounded pole of the high voltage battery B² by way of back contact and armature 1166, front contact and armature 1170, conductor 1182, armature 1326 and its front contact, conductor 1179, conductor 1112, bank contact 1103, wiper 1097, armature 1091 and its front contact, armature 1043 and its front contact, wiper 1049, bank contact 1052, upper left hand winding of the repeating coil, armature 1074 and its back contact, conductor 1084, armature 1415 and its back contact, armature 1419 and its back contact, armature 1423 and its back contact, armature 1428 and its back contact, through the winding of the polarized relay 1405, and through the winding of the polarized relay 1402 to ground. The relay 1405 is energized over this circuit and causes the operation of the relays 1404 and 1403. The relay 1072 in the repeater QLR operates, as before, to close a circuit for the slow acting relay 1073, which energizes to ground the release trunk conductor 1086. The closure of the circuit of the line relay 1071 occurs upon the deenergization of the slow acting relay 1154. By the energization of the line relay 1071 the trunk selecting operation of the secondary switch SS¹² is started. The secondary switch SS¹² now operates to extend the connection to the idle incoming second selector such as 2E⁴ in Jasper exchange. As the connection is now extended to a second selector in Jasper exchange the connection is completed in the usual manner by the operation of the director D² responsive to the dialing of the called number by the calling subscriber at substation A.

Call from Center to Jasper.

Should the subscriber at substation A in setting up the previous connection, desire to communicate with a subscriber whose line terminates in Jasper exchange, the operation is similar to that above described, though, in this case the relay 1302 is energized to bring about the operation of the polarized relay 1405 and the association of the secondary switch SS¹² with the incoming trunk line comprising conductors 1084 and 1085. The connection is completed under the control of the director D² in the usual manner.

Call from Center to Hazeland.

It will now be assumed that the subscriber at the calling substation A associated to communicate with a party in Hazeland exchange of district 8. The operations when this exchange is called are very similar to the ones above described, the line switch C operating to seize the trunk line extending to an idle first selector such as 1E, and it in

turn being operated to seize a trunk leading to secondary switches such as SS² and SS⁵. By the operation of the secondary switch SS¹⁴, an idle director D² is associated with the trunk line. Responsive to the second operation of the calling device for the digit A the wipers of the register switch M⁹ are brought into engagement with the first set of bank contacts. By the operation of the calling dial for the second digit 0, the wipers of the register switch M¹⁰ are rotated into engagement with their tenth set of bank contacts. Shortly after the operation of the register switch M¹⁰, the slow acting relay 1200 deenergizes and the relay 1305 is operated. Relay 1305 operates to close a locking circuit for itself at armature 1321 and to close a circuit for the relays 1152 and 1041 in series at armature 1322, and to prepare a controlling circuit at armature 1323, which will be traced later. The relay 1041 causes the secondary switch SS³ to select an idle trunk and extend a connection thereover to a repeater, which, it will be assumed, is the repeater QLR. The relay 1040 energizes when an idle trunk is selected and opens the circuit of the relay 1152. After the deenergization of relay 1152 a circuit is completed which extends from the ungrounded pole of the high voltage battery B¹ by way of back contact and armature 1165, front contact and armature 1169, conductor 1181, armature 1323 and its front contact, conductor 1179, conductor 1112, bank contact 1103, wiper 1097, armatures 1091 and its front contact, armature 1043 and its front contact, wiper 1049, bank contact 1052, upper left hand winding of the repeating coil, armature 1074 and its back contact, conductor 1084, armature 1415 and its back contact, armature 1419 and its back contact, armature 1423 and its back contact, armature 1428 and its back contact, and through the winding of the polarized relays 1405 and 1402 to ground. The relay 1402 is energized over this circuit and the relays 1401 and 1400 are operated. In the repeater QLR, the relays 1072 and 1073 are energized to establish a holding circuit for the secondary switch SS⁵. At the deenergization of the relay 1154 in the relay group D⁵, the line relay 1071 of the repeater QLR is energized. The operation of this relay closes a circuit for the line relay 1432 of the secondary switch SS¹⁰. This switch now operates to select a trunk line extending by way of the repeater such as the repeater R¹² to an incoming second selector in Hazeland exchange. The subsequent extension of the connection occurs under the control of the calling dial and the director D² in the usual manner.

Call from Center to Hinsdale.

It will now be assumed that the party at

substation A in setting up the previous connection desires to call a party in the Hinsdale exchange of district 7 instead of the subscriber in Hazeland exchange of district 8. The connection is extended in the same manner as before described except by the operation of the register switches M⁹ and M¹⁰ and the relay 1303 is energized. The operation of this relay causes the selection of the idle trunk by the secondary switch SS³ in the usual manner. It will be assumed that the trunk line selected is the one extending by way of the repeater QLR to Jasper exchange. After this selection takes place, the ungrounded pole of the high voltage battery B¹ is connected to the conductor 1085, whereby the polarized relay 1408 in the traffic separator TS¹ of Jasper exchange is operated to cause the secondary switch SS¹¹ to be associated with the trunk conductors 1084 and 1085. The secondary switch SS¹¹ now operates to select an idle trunk line extending by way of the repeater such as R¹³ to an incoming second selector in Hinsdale exchange. The connection is now completed in the usual manner under the control of the director D².

It will be understood that when a call is extended to either Hazeland exchange district 8, or to Hinsdale exchange of district 7, it does not necessarily have to go to these exchanges, but it may be extended to any exchange in the district selected by means of the regular trunking system. These operations will be apparent from the previous descriptions.

Call from Center to Grove.

It will now be assumed that the subscriber at substation A desires to communicate with a subscriber whose line terminates in Grove exchange. To extend this connection, the subscriber at substation A will remove his receiver and operate his calling device for the directory number of the called subscriber.

By the removal of the receiver and the operation of the calling device, the line switch G and the first selector 1E are operated to extend the connection to secondary switches such as SS² and SS³. Responsive to the seizure of this trunk line, the secondary switch SS¹⁴ operates to associate an idle director D² with the selected trunk line.

In response to the operations of the calling device at the calling substation for the next two digits, the wipers of the register switches M⁹ and M¹⁰ are operated into engagement with the seventh and tenth bank contact sets, respectively. The relay 1301 is now energized and operates to establish a locking circuit for itself at armature 1310, and to close a circuit for the relays 1152 and 1026 in series at armature 1311. The secondary switch SS² is now operated under the control of the line relay 1026 to select an

idle trunk line extending to Grove exchange, which, it will be assumed, is the trunk line terminating in bank contacts 1063-1065, inclusive. Immediately upon the selection of this trunk line the switching relay 1025 is energized to extend a connection by way of the repeater R^3 to an idle incoming second selector in Grove exchange. The energization of the relay 1025 opens the circuit of the relay 1152 in the relay group G^5 , which deenergizes, opening the circuit of the slow acting relay 1154, which deenergizes also. Upon the deenergization of the latter relay, the line relay 1035 of the repeater R^3 is energized to close a circuit for the slow acting relay 1036 at armature 1037 and to complete a bridge across the trunk conductors 1120 and 1121 at armature 1039. The slow acting relay 1036 operates to establish a holding circuit for the secondary switch SS^2 at armature 1038. The closure of the bridge across the trunk conductors 1120 and 1121 brings about the energization of the line relay of the incoming second selector in Grove exchange, which operates to close the circuit of its associated slow acting release relay. The latter relay prepares the operating circuits of the selector. The remaining operations in the establishment of the connection takes place in substantially the same manner as has been previously described under the control of the director D^2 and the calling device at the calling substation.

The features of the invention have been described and ascertained, what is considered to be new and desired to have protected by Letters Patent will be pointed out in the appended claims.

What is claimed is:

1. In a telephone system, a group of trunk lines, a plurality of registering devices common to said group, a plurality of other groups of trunk lines, means for seizing an idle trunk line in the first mentioned group and for associating one of said registering devices therewith, register switches in said registering device for setting up the digits of a called number, means controlled by said register switches for selecting a particular group of trunk lines of said plurality and for selecting an idle trunk in the selected group, a sender switch included in said registering device for sending out over the selected trunk line all the digits set up on said register switches, and means for preventing the initial starting of said sender switch until after said selecting means have operated.

2. In a telephone system, a plurality of exchanges, another exchange, trunk lines extending from said other exchange to certain exchanges in said plurality, another trunk line adapted to be associated with any one of said plurality of trunk lines, a registering device connected to said last men-

tioned trunk line, sending means in said registering device, means for registering the digits of a called number on said registering device, means controlled by said registering device for effecting association between said last trunk line and a trunk line of said plurality independent of said sending device, means for then operating said sending device to send out the digits to control the extension of the connection to the proper office, and means operative responsive to the sending out of the office code for disconnecting said registering device from said other trunk line provided there are no other digits registered thereon.

3. In a telephone system, a trunk line having a plurality of branches individual thereto, each branch terminating in an automatic switch, a plurality of exchanges, a director, means for extending a calling line to said trunk line, means for connecting said director to said trunk upon such connection, means for registering a complete called number on said director, and director controlled means responsive to the registration of a sufficient portion of the number to determine the exchange to which the call is going for operating a particular one of said automatic switches.

4. In a telephone system, a trunk line having a plurality of branches, an automatic switch associated with each branch, a group of trunk lines accessible to each switch, means for extending a calling line to said first trunk line, a registering device and means for associating it with said first trunk line when the same is taken for use, means for setting said device in accordance with digits in a called number, means controlled by said device for operating a particular one of said switches depending on the setting of said device, and means operative responsive to all the trunk lines accessible to said operated switch being busy for disconnecting said registering device from said trunk line.

5. In a telephone system, a trunk line terminating in an automatic switch, groups of trunk lines accessible to said switch, a registering device and means for connecting it to said trunk line when the same is taken for use, a release-control circuit for said director including circuit connections individual to said trunk line, means for setting said device in accordance with digits in a called number, means controlled by said device for operating said switch to select a particular group of said trunk lines, the group selected depending on the setting of said device, and contact springs actuated by said switch if all the trunks in the selected group are busy for disconnecting said device from said first trunk line by opening said circuit connections.

6. In a telephone system, a trunk line, an automatic switch associated therewith, other trunk lines accessible to said automatic switch, a plurality of exchanges, means for
 5 connecting a calling line to said trunk line, a registering device and means for associating it with said first trunk line when the same is taken for use, means for setting up a subscriber's number on said device, means
 10 controlled by said device operative when the portion of the number designating the exchange is set up for causing said switch to seize one of said other trunk lines, means controlled by said device for then sending
 15 impulses over said other trunk line to control the extension of the connection to the desired exchange, means controlled by said device for then sending out the remaining digits of the subscriber's number set up on
 20 said device, and means operative, responsive to the sending out of said impulses catching up with the setting of said device, for always releasing said device immediately.

7. In a telephone system, a trunk line terminating in an automatic switch, groups of
 25 trunk lines accessible to said switch, a director, means for extending a calling line to said trunk line, a switch for associating said director with said trunk line, subscriber
 30 controlled means for setting up a subscriber's number on said device, and means for causing said switch to select one of said groups in accordance with one digit of said number simultaneously with the setting of
 35 said device for the same digit.

8. In a telephone system, a trunk line terminating in an automatic switch, groups of trunk lines accessible to said switch, a
 40 director, means for extending a calling line to said trunk line, a switch for associating said director with said trunk line, subscriber controlled means for setting up a subscriber's number on said device, means for causing
 45 said switch to select one of said groups in accordance with one digit of said number simultaneously with the setting of said device for the same digit, and means for then sending the digits set up on said device over the selected trunk line to complete the
 50 extension of the connection.

9. In a telephone system, a trunk line terminating in a plurality of automatic switches, trunk lines accessible to each of
 55 said switches, a plurality of exchanges, means for extending a calling line to the first mentioned trunk line, a director and means for associating it with said first trunk line when the same is taken for use, means for setting said director in accordance with the
 60 digits in a subscriber's number, means controlled by said director responsive to the setting up of the portion of the number designating the exchange for causing a switch of said plurality to seize a trunk line in its asso-

ciated group, and means controlled by said
 65 director for then controlling the extension of the connection to the desired line in accordance with the set up digits.

10. In a telephone system, a trunk line extending to an automatic switch, groups of
 70 trunk lines accessible to said switch, a director, means for extending a calling line to said trunk line, means for associating said director with said trunk when the same is taken for use, means for setting up on said direc-
 75 tor the number of a called subscriber, means controlled by said director responsive to a setting up of part of said number for causing said switch to select a particular group
 80 of trunk lines, group busy contacts on said switch, and means controlled by an opening of said contacts, if all of the trunk lines in said group are busy for disconnecting
 said director from said trunk.

11. In a telephone system, a trunk line
 85 having a plurality of branches individual thereto each terminating in an automatic switch, a plurality of exchanges, a group of trunk lines accessible to each of said
 90 switches, each group extending to one of said exchanges, a director, means for extending a calling line to said trunk line, means for setting said director in accordance with the digits in a called number, means controlled by said director for operating a par-
 95 ticular one of said switches to select a trunk line in the associated group, automatic switching equipment then operated under control of said director to extend the connection to the desired line, and means operative
 100 if certain of the exchanges are selected for releasing part of the set up number and for sending out the remaining portion.

12. In a telephone system, a first, a second,
 105 and a third exchange, a trunk line extending from the first to the second exchange and terminating at the latter point in an automatic switch, another trunk line extending from the second to the third exchanges
 110 and terminating in the third exchange in an automatic switch, a third trunk line in said first exchange, means for extending a calling line to said third trunk line, a director, means for associating said director
 115 with said third trunk when the same is taken for use, means for setting up a subscriber's number on said director, means controlled by said director for associating the first mentioned trunk with said third
 120 trunk and means controlled by said association for operating a switch in the such second office or a switch in the third office.

13. In a call director, including registering, translating, and sending equipment,
 125 register switches for registering a portion of a called number, means for releasing said switches successively responsive to the send-

ing out of the stored digits by said sending equipment, and means for re-operating the register switches to register the remainder of the called number.

5 14. In a telephone system, a first exchange, a plurality of other exchanges, a trunk line extending from said first exchange through all said other exchanges, a branch for said trunk line in each exchange, 10 each branch terminating in an automatic switch, a second trunk line in said first exchange, a director, means for extending a calling line to said second trunk line, means for associating said director with 15 the second trunk line when the same is taken for use, means for setting up a called subscriber's number on said director, another automatic switch controlled from said director for seizing the first mentioned trunk 20 line, and director controlled means for operating a switch in any exchange of said plurality independent of the switches in all other exchanges.

15. In a call director, including registering, translating, and sending equipment, a set of register switches, a sender switch. multiple connections from the banks of said register switches to the banks of said sender switch, a wiper for each register switch, 30 means for setting up a called subscriber's number on said register switches by operating said wipers into engagement with particular bank contacts, a group of two-step counting relays, and means controlled by the 35 relays of said group for successively grounding the wipers of said register switches to control said sender switch.

16. In a telephone system, a call director including register switches, a group of relays, and a sender switch, two wipers for 40 each of said register switches, means for operating said register switches to register a subscriber's number, means controlled by one of the wipers of one of said register switches 45 for energizing a certain relay of said relay group, means controlled by said relay for causing the energized sender switch to send out a series of code impulses, and means then operative controlled by the other 50 wipers of said register switches for controlling said sender switch to send out all the digits registered.

17. In a call director, register switches, lesser in number than the number of digits 55 in called numbers, translating equipment, and a sender switch, subscriber's numbers varying in the number of digits, and means for operating and reoperating said register switches to register all the digits in called 60 numbers regardless of the varying number of digits therein.

18. In a telephone system, a trunk line having a plurality of branches, an automatic switch associated with each branch, a direc-

tor, means for extending a calling line to 65 said trunk line, means for associating the director with said trunk line when the same is taken for use, means for setting up a called subscriber's number on said director, and means controlled by the registration of 70 one, two or three digits of said number for operating a particular one of said switches, the operation occurring at the registration of the first, second, or third digit registered depending upon their character. 75

19. In a call director, a plurality of single motion switches for registering digits in a called number, an impulse sending device directly controlled by each of said single motion switches, and a translating device comprising a relay controlled jointly by a plurality of said switches, by means of which 80 said sending device is also controlled.

20. In a telephone system, a trunk line divided into two sections, means for extending 85 a calling line to said trunk line, a director, means for associating said director with said trunk line, means for setting up a called subscriber's number on said director, director controlled means for sending out the reg- 90 istered digits, and means for connecting said two sections and for releasing said director responsive to the sending out of any digit, provided none of the following digits are 95 registered.

21. In a call director, register switches, and sending equipment, means for setting up a called subscriber's number on said register switches, circuit connections between said 100 registering and sending equipment whereby the latter is controlled to send out impulses, and means operative after each digit is sent out for releasing the register switch upon which the digit was stored.

22. In a call director, register switches for 105 registering digits in a called number, each switch having a set of banks and a wiper, a sending switch having bank contacts, the banks of said register switches and sending switch being permanently connected to- 110 gether, and a group of two-step counting relays for rendering said wipers effective to control said sending switch one after another in definite order.

23. In a call director, register switches, 115 means for registering the digits of a called number on said register switches, means for successively releasing said register switches one after the other in the same order in which they are operated, and means respon- 120 sive to the condition of all said registers being in an operated condition simultaneously for releasing all said switches.

24. In a telephone system, a first selector operated by a calling subscriber in accord- 125 ance with the first digit of a called telephone number, a trunk line selected by said first selector, said trunk line terminating in a sec-

ond selector, a director and means for connecting the same to said trunk line, registers in said director set in accordance with the remaining digits of said number, a sender in
 5 said director including a contact device for generating series of impulses under the control of said registers in turn, said second selector responding to the first series generated, and other switches responsive to the
 10 other series generated to complete a connection to the called line.

25. In a director, a plurality of registers, a sender, means for placing said sender under the joint control of all said registers, and means for then placing said sender under
 15 the sole control of each register in turn.

26. In a director, a plurality of registers, a sender, means for operating and re-operating said sender under register control, and
 20 circuit connections such that two registers control said sender a plurality of times, one time in accordance with the setting of both registers, and the other times in accordance with the individual settings of said two registers, while another register controls said
 25 sender only once.

27. In a director, a plurality of registers, a sender controlled by each register in turn to transmit a series of impulses, and a sequence switching device consisting solely of
 30 two-step counting relays for placing said sender under the control of said registers as set forth.

28. In a director, registers less in number
 35 than the digits in a telephone number, means for registering certain digits of a number on said registers, a sender controlled by said registers in turn, means for releasing each register after it has effected control of the
 40 sender, and means responsive to the registration of a digit on the last register for rendering the first register responsive to register the next digit.

29. In a director, registers less in number
 45 than the digits in a telephone number, means for operating, releasing, and re-operating said registers successively to register all the digits in a telephone number, and means for transmitting a series of impulses in accordance with each setting of each register.
 50

30. In a telephone system, a trunk line terminating in a plurality of switches, other trunk lines accessible to said switches, means controlled over said first trunk line for
 55 registering digits in a telephone number, means responsive to the registration of a particular series of digits for operating a particular switch to select an idle trunk line, the switch operated depending on the series
 60 of digits registered, and means controlled by the said registering means for transmitting the registered digits over the trunk line selected by the operated switch.

31. In a telephone system, a trunk line, a

plurality of branches individual thereto over
 65 which said trunk line may be extended, a plurality of registers controlled over said trunk line and adjusted in accordance with digits in a telephone number, means for selecting a branch in accordance with the
 70 setting of one of said registers, and means for then transmitting impulses over the selected branch in accordance with the settings of all said registers.

32. In a telephone system, a trunk line, a
 75 plurality of branches over which said trunk line may be extended, a plurality of registers controlled over said trunk line and adjusted in accordance with digits in a telephone number, means for selecting a branch under
 80 the joint control of a plurality of said registers, and means for then transmitting an individual series of impulses over the selected branch in accordance with the setting of each register.
 85

33. In a telephone system, a trunk line having a plurality of branches individual thereto, registers controlled over said trunk line, branch selecting mechanism controlled in accordance with the setting of one of said
 90 registers, and means for transmitting impulses over a selected branch in accordance with the setting of the same register.

34. In a telephone system, a trunk line having two branches individual thereto, one
 95 of said branches also having two branches, a register controlled over said trunk line, two branch selecting devices successively controlled in accordance with the setting of said register, and means also controlled
 100 by said register for transmitting impulses over the selected branches.

35. In a telephone system, a trunk line having two branches individual thereto, one
 105 of said branches also having two branches, a register controlled over said trunk line, means responsive only to a certain setting of said register for connecting the trunk line to its divided branch, a branch selecting device controlled by said register over said divided
 110 branch to connect the said divided branch with one of its branches, and an impulse sender controlled by said register to transmit impulses over the connected branches.

36. In a telephone system, a trunk line
 115 having two branches at the remote end thereof, a register associated with said trunk line at the near end, means for seizing said trunk line and for then setting said register in accordance with a digit in a telephone
 120 number, means for placing either one of two different potentials on a conductor of said trunk line depending on the setting of said register, and a branch selecting device responsive to such potentials for connecting
 125 the trunk line to one or the other of its branches.

37. In a telephone system, a trunk line

having two branches at the remote end thereof, a register associated with said trunk line at the near end, means for seizing said trunk line and for then setting said register in accordance with a digit in a telephone number, means for placing a potential on either one of the two conductors of said trunk line depending on the setting of said register, and a branch selecting device responsive to such potential for connecting the trunk line to one or the other of its branches depending upon which conductor has the potential placed on it.

38. In a telephone system, a trunk line having two branches at the remote end thereof, a register associated with said trunk line at the near end, means for seizing said trunk line and for then setting said register in accordance with a digit in a telephone number, a branch selector controlled by said register by a current impulse of a particular character transmitted over said trunk line, said selector operating to connect the trunk line with a particular branch, and a sender also controlled by said register to transmit a series of impulses of a different character over the trunk line and its connected branch.

39. In a telephone system, a trunk line terminating in two automatic switches, a register controlled over said trunk line, means for operating one or the other of said switches depending on the setting of said register, a trunk line selected by the operated switch having two branches at the distant end, and branch connecting relays controlled over the selected trunk in accordance with the setting of said register.

40. In a telephone system, a trunk line terminating in two automatic switches, a register controlled over said trunk line, means for operating one or the other of said switches depending on the setting of said register, a trunk line selected by the operated switch having two branches at the distant end, means for selecting a branch in accordance with the setting of said register, and means for sending impulses over the selected trunk and branch in accordance with the setting of said register.

41. In a telephone system, a trunk line terminating in an automatic switch, a director associated with said trunk line, registers in said director set in accordance with digits in a telephone number, a sender in said director, means for operating said sender under the joint control of a plurality of said registers to transmit a series of impulses to said switch to operate the same to select another trunk line, and means for then operating said sender under the control of each of said registers independently to transmit series of impulses over the selected trunk line.

42. In a telephone system, a trunk line terminating in an automatic switch, a director associated with said trunk line, registers in said director set in accordance with digits in a telephone number, a sender in said director, means for operating said sender under the joint control of a plurality of said registers to transmit a series of impulses to said switch to operate the same to select another trunk line, means for then operating said sender under the control of each of said registers independently to transmit series of impulses over the selected trunk line, and means for skipping the other one of the said two registers when the generation of independent series of impulses is started to prevent such register from controlling the generation of an independent series.

44. In a telephone system, a trunk line terminating in an automatic switch, a director associated with said trunk line, registers in said director set in accordance with digits in a telephone number, a sender in said director, means for operating said sender under the joint control of a plurality of said registers to transmit a series of impulses to said switch to operate the same to select another trunk line, means for then operating said sender under the control of only one register of said plurality to transmit a series of impulses over the selected trunk line, the remainder of said plurality of registers being prevented from further controlling said sender, and means for then operating said sender under the control of the registers not included in said plurality to transmit other series of impulses over the selected trunk line.

45. In a telephone system, a trunk line terminating in an automatic switch, groups of trunk lines accessible to said switch, a registering device and means for connecting it to said trunk line when the same is taken for use, a tone machine, means for setting said device in accordance with digits in a

called number, means controlled by said device for operating said switch to select a particular group of said trunk lines, the group selected depending on the setting of said device, and means operative responsive to all the trunks in the selected group being busy for connecting said machine to said trunk line and for disconnecting said device from the said trunk line.

In witness whereof, I hereunto subscribe my name this 18th day of December, A. D. 1922.

JOHN E. GARDNER.