March 10, 1942. H. NYQUIST 2,275,459

TELEPHONE SYSTEM

Filed May 31, 1940 13 Sheets-Sheet 1

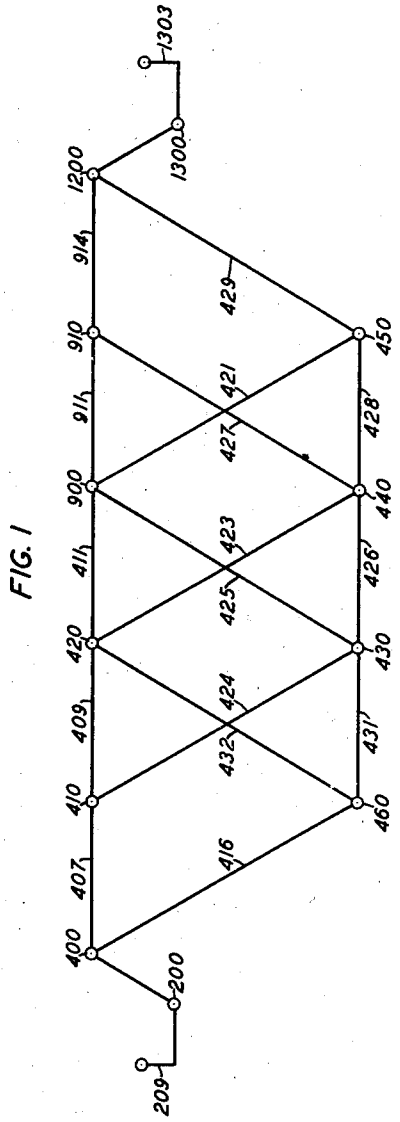

FIG. 1

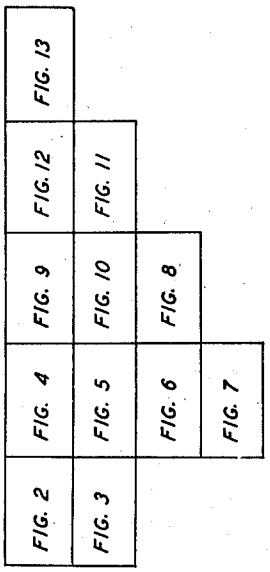

FIG. 14

INVENTOR
H. NYQUIST
BY
ATTORNEY

March 10, 1942. H. NYQUIST 2,275,459

TELEPHONE SYSTEM

Filed May 31, 1940 13 Sheets-Sheet 2

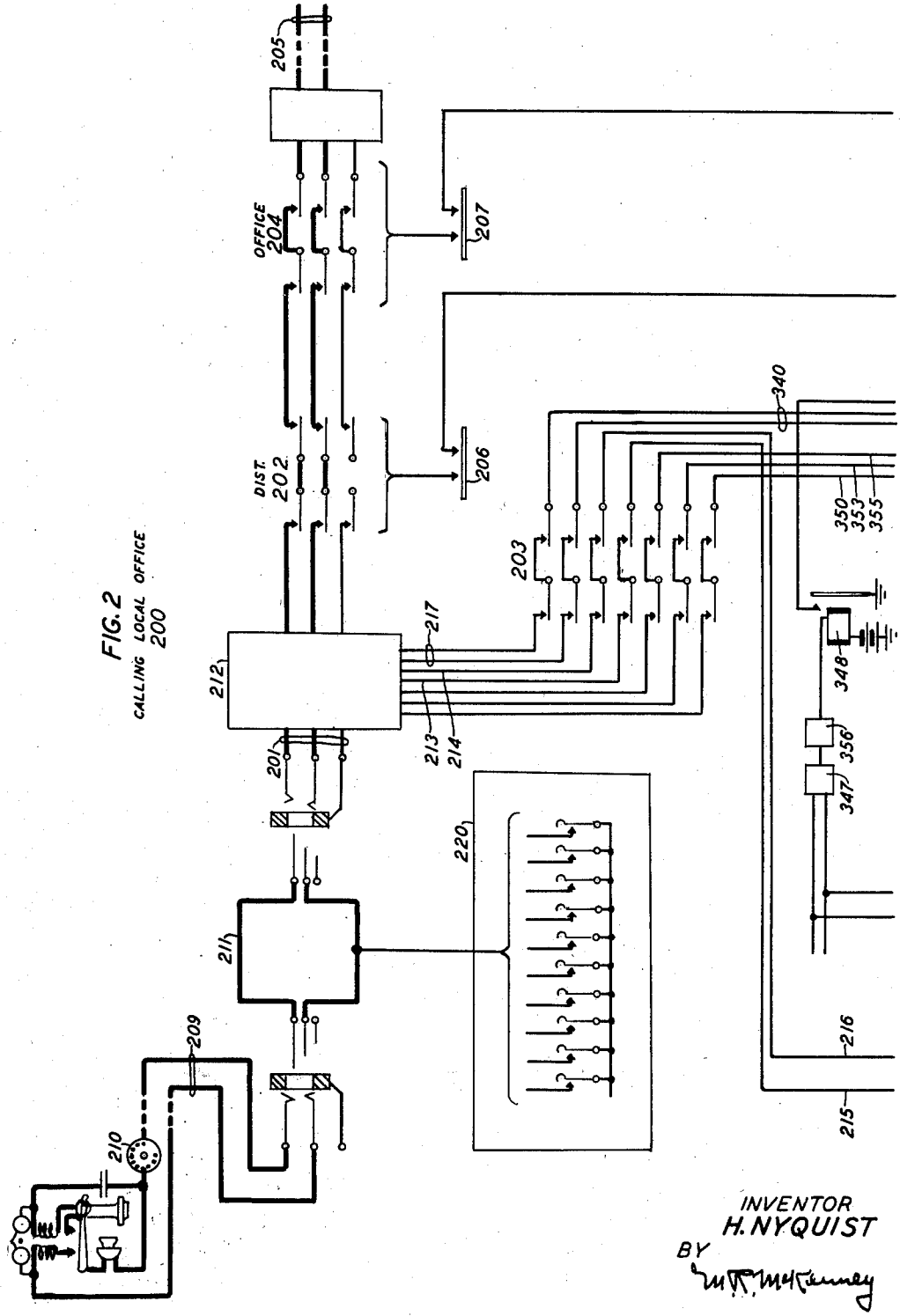

FIG. 2
CALLING LOCAL OFFICE
200

INVENTOR
H. NYQUIST
BY
ATTORNEY

March 10, 1942. H. NYQUIST 2,275,459

TELEPHONE SYSTEM

Filed May 31, 1940 13 Sheets-Sheet 3

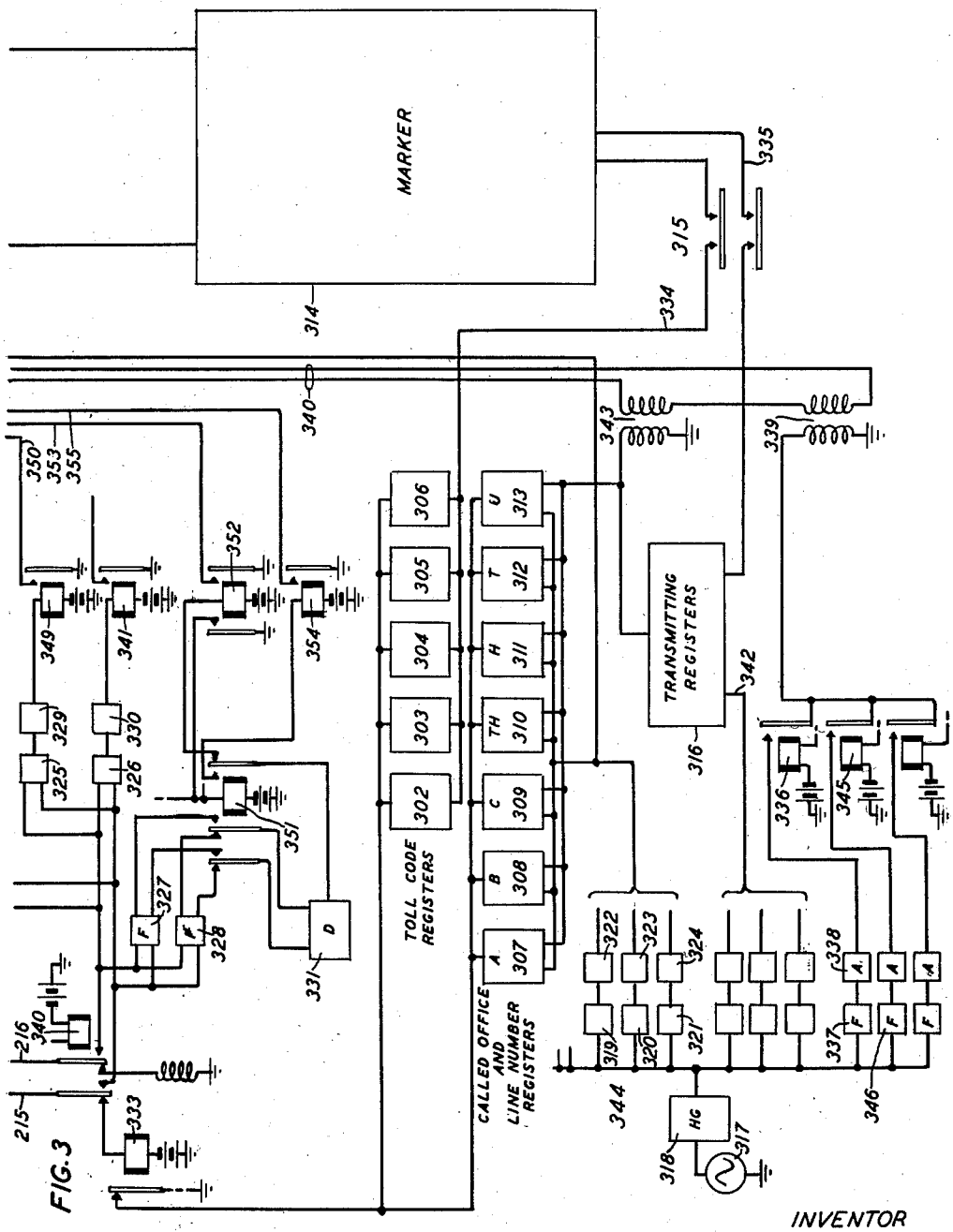

FIG. 3

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March 10, 1942. H. NYQUIST 2,275,459

TELEPHONE SYSTEM

Filed May 31, 1940 13 Sheets-Sheet 4

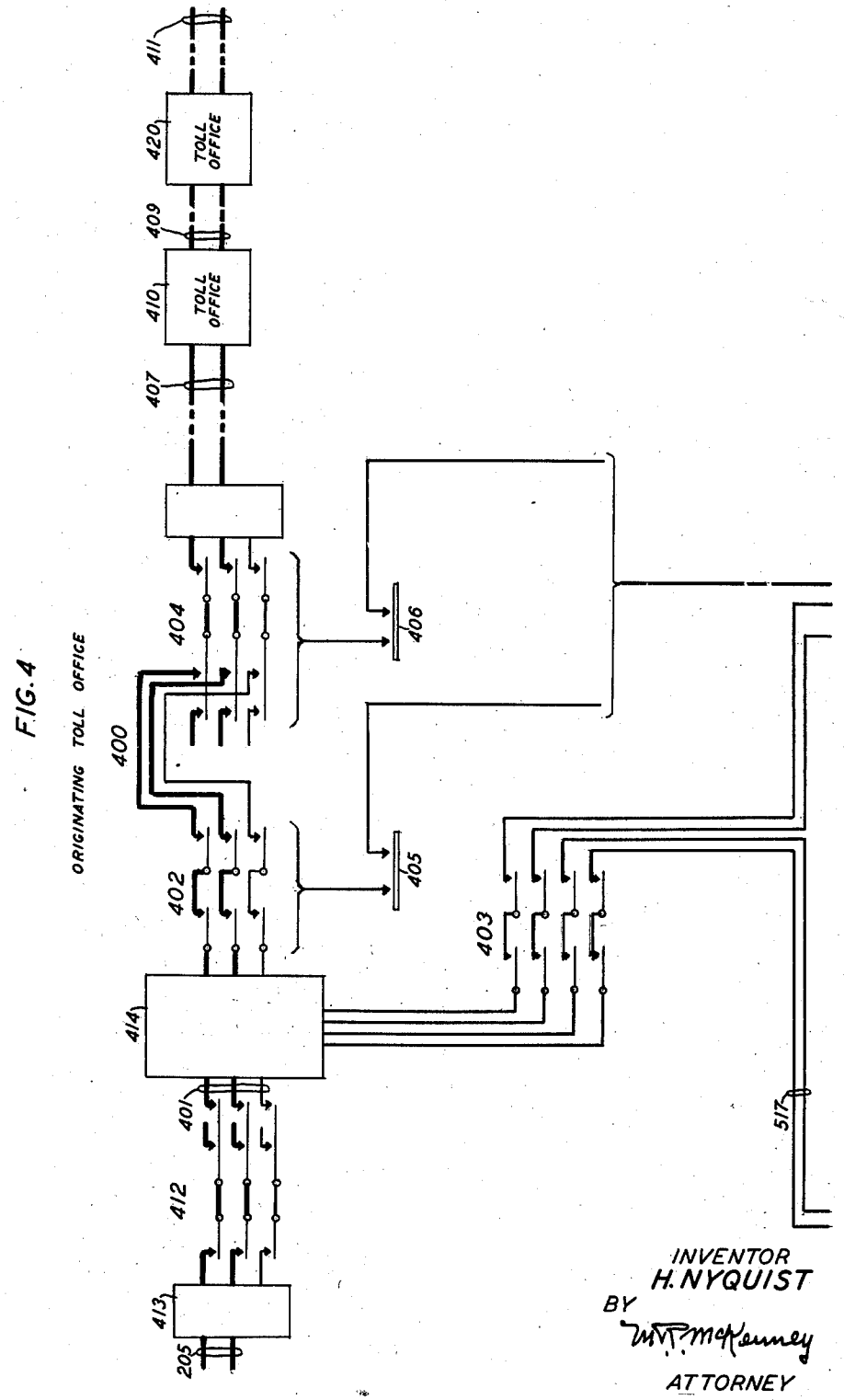

FIG. 4

INVENTOR
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W. P. McKenney
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March 10, 1942. H. NYQUIST 2,275,459

TELEPHONE SYSTEM

Filed May 31, 1940 13 Sheets-Sheet 5

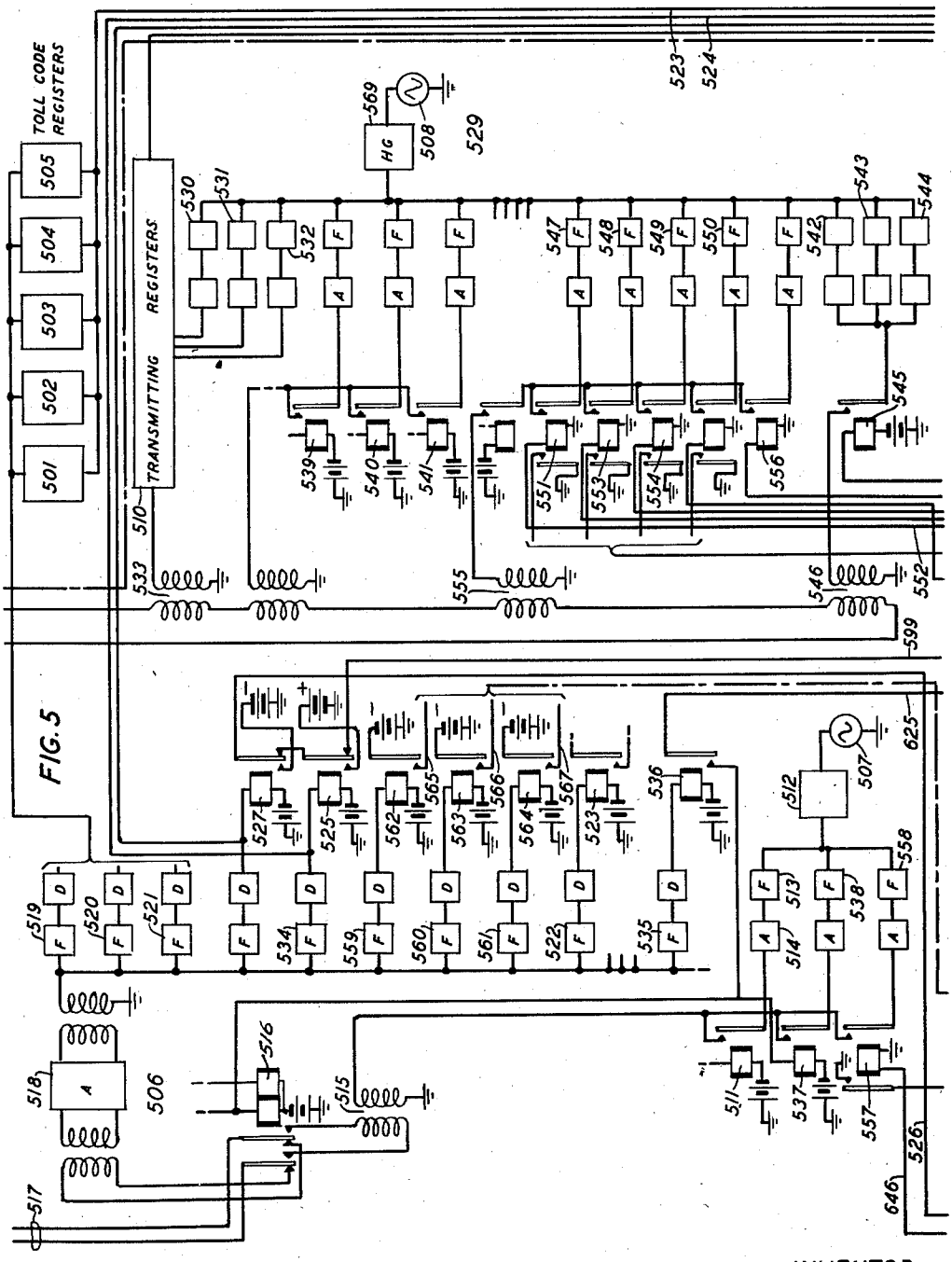

FIG. 5

INVENTOR
H. NYQUIST
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March 10, 1942. H. NYQUIST 2,275,459

TELEPHONE SYSTEM

Filed May 31, 1940 13 Sheets-Sheet 6

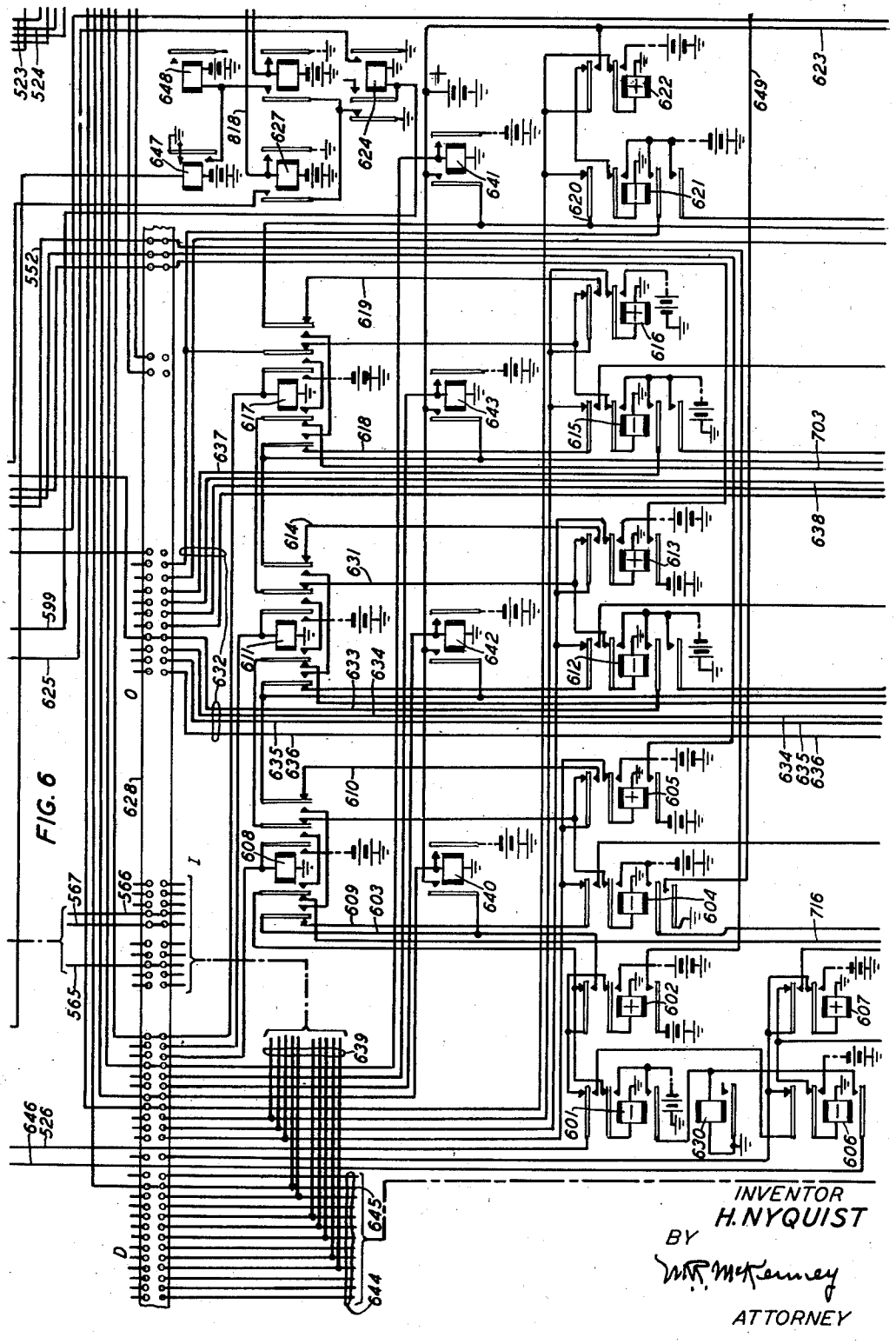

FIG. 6

INVENTOR
H. NYQUIST
BY
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March 10, 1942. H. NYQUIST 2,275,459

TELEPHONE SYSTEM

Filed May 31, 1940 13 Sheets-Sheet 7

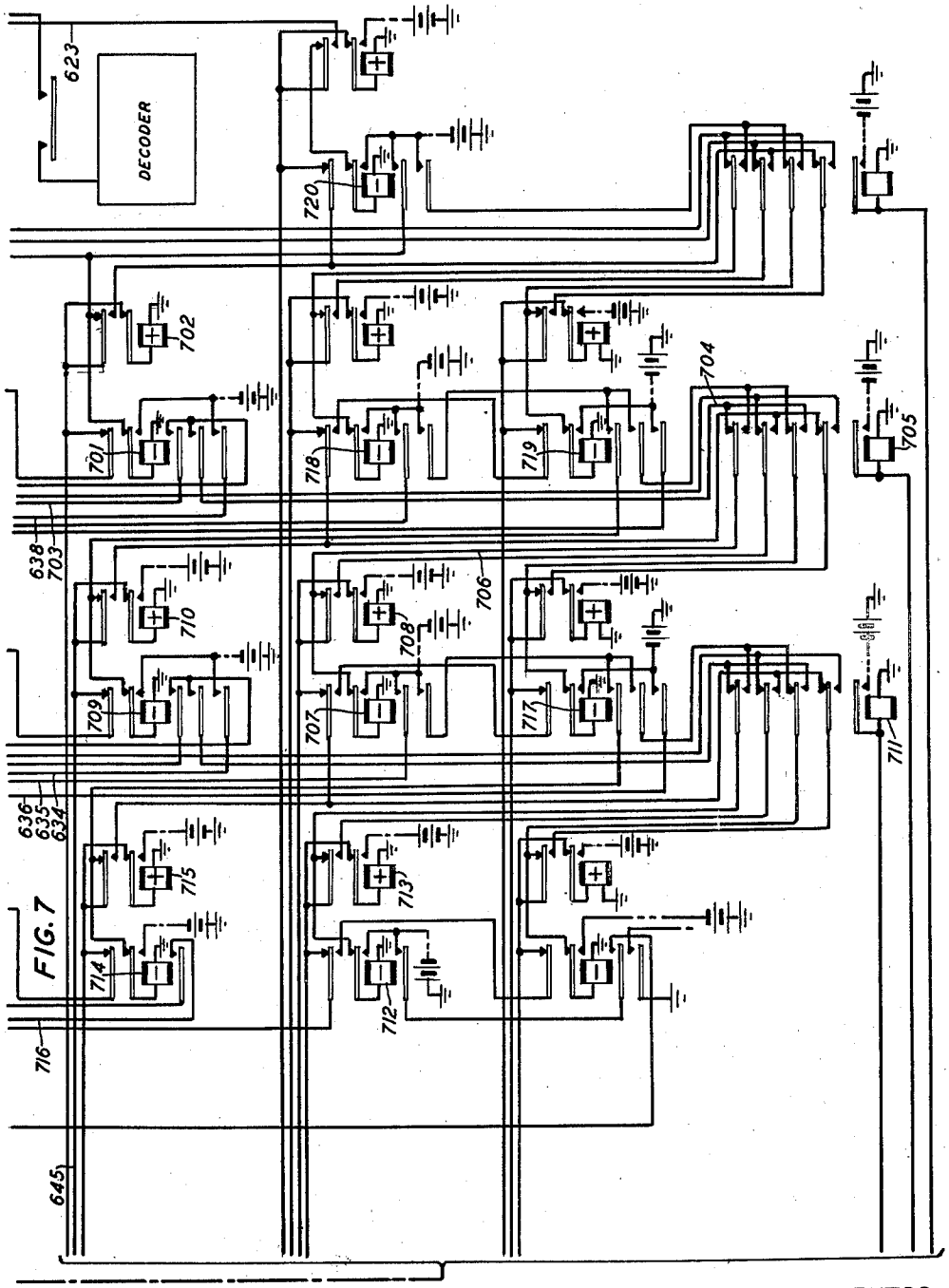

FIG. 7

INVENTOR
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March 10, 1942. H. NYQUIST 2,275,459

TELEPHONE SYSTEM

Filed May 31, 1940 13 Sheets-Sheet 8

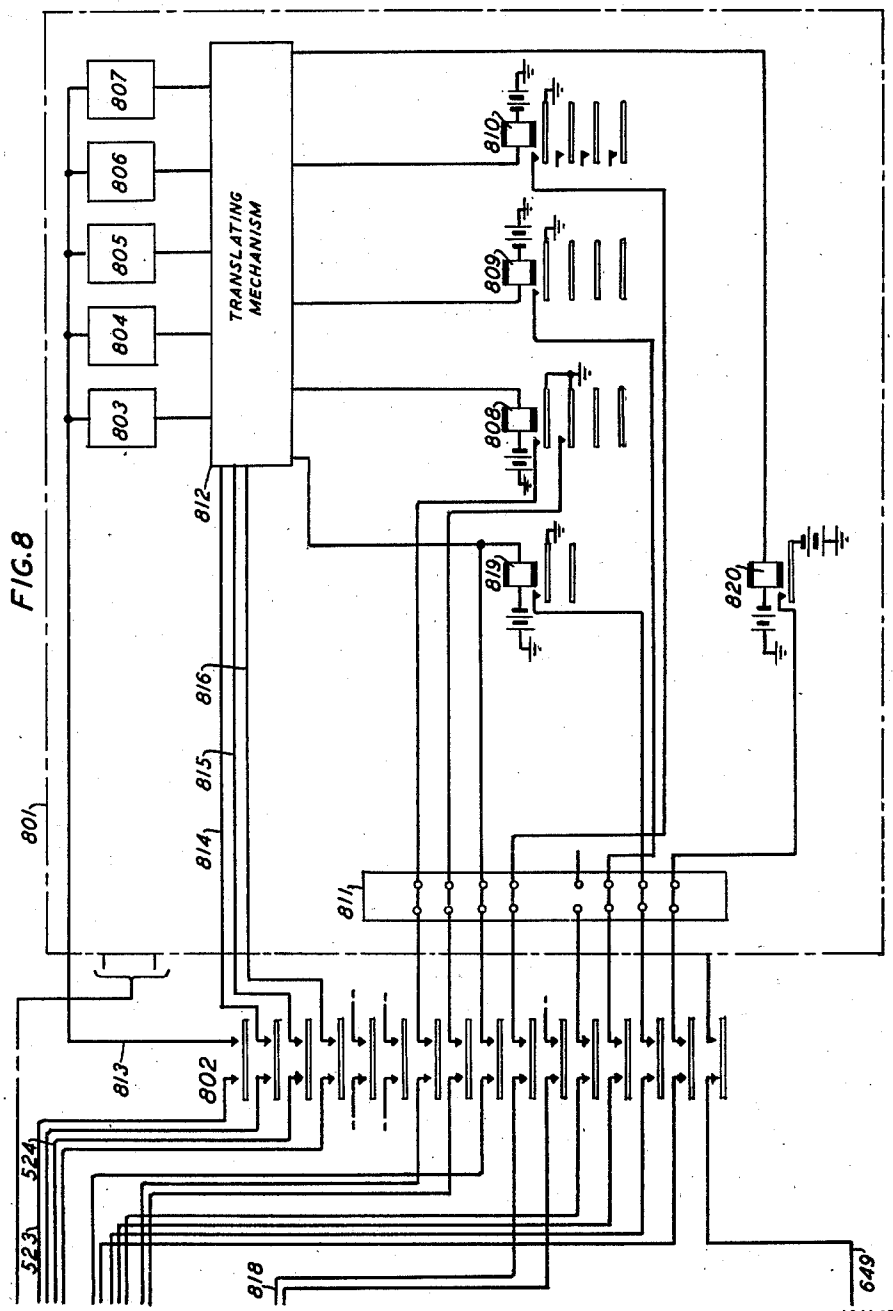

FIG. 8

INVENTOR
H. NYQUIST
BY
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March 10, 1942. H. NYQUIST 2,275,459

TELEPHONE SYSTEM

Filed May 31, 1940 13 Sheets-Sheet 9

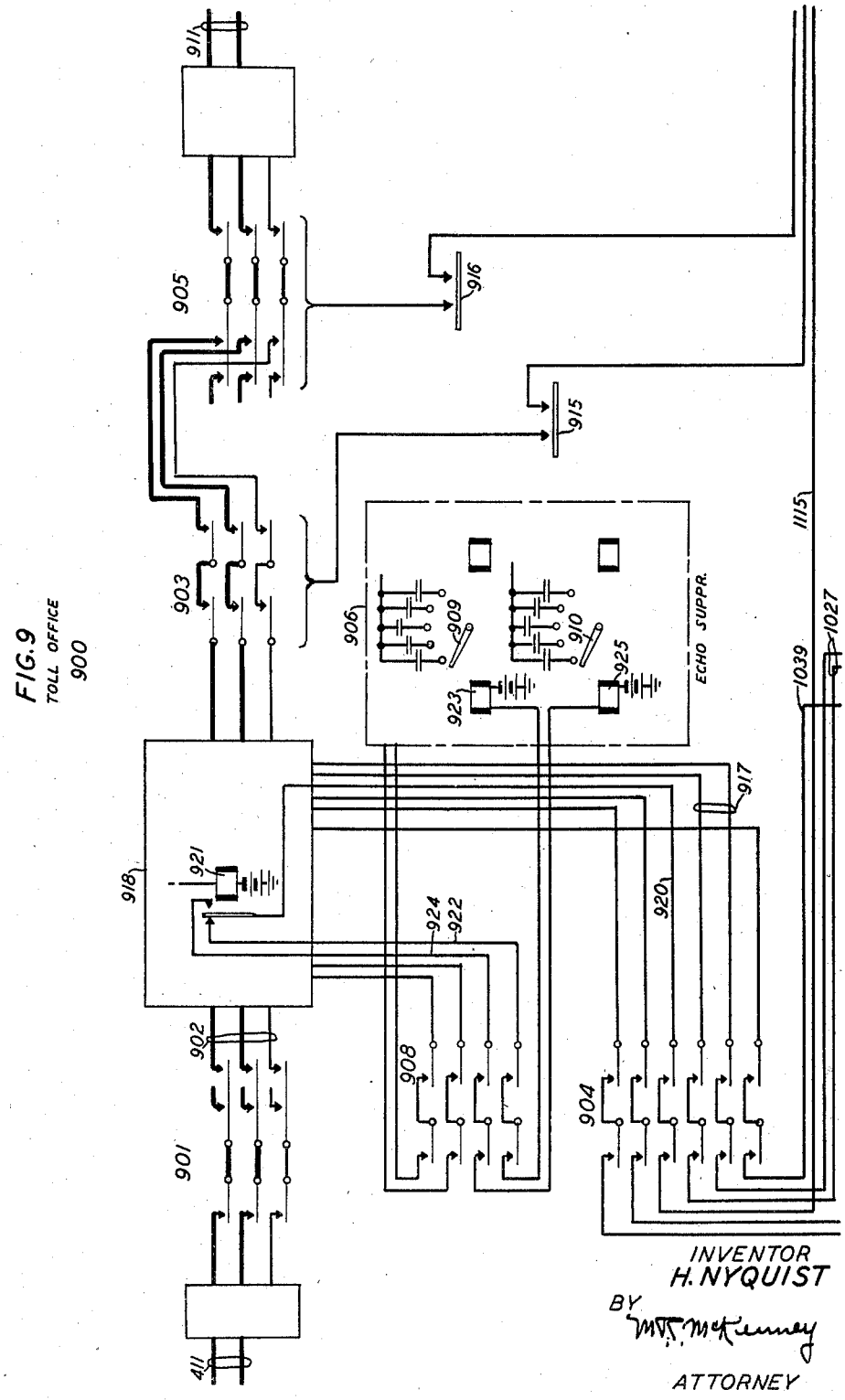

FIG. 9

TOLL OFFICE

900

INVENTOR

H. NYQUIST

BY

ATTORNEY

March 10, 1942. H. NYQUIST 2,275,459

TELEPHONE SYSTEM

Filed May 31, 1940 13 Sheets-Sheet 10

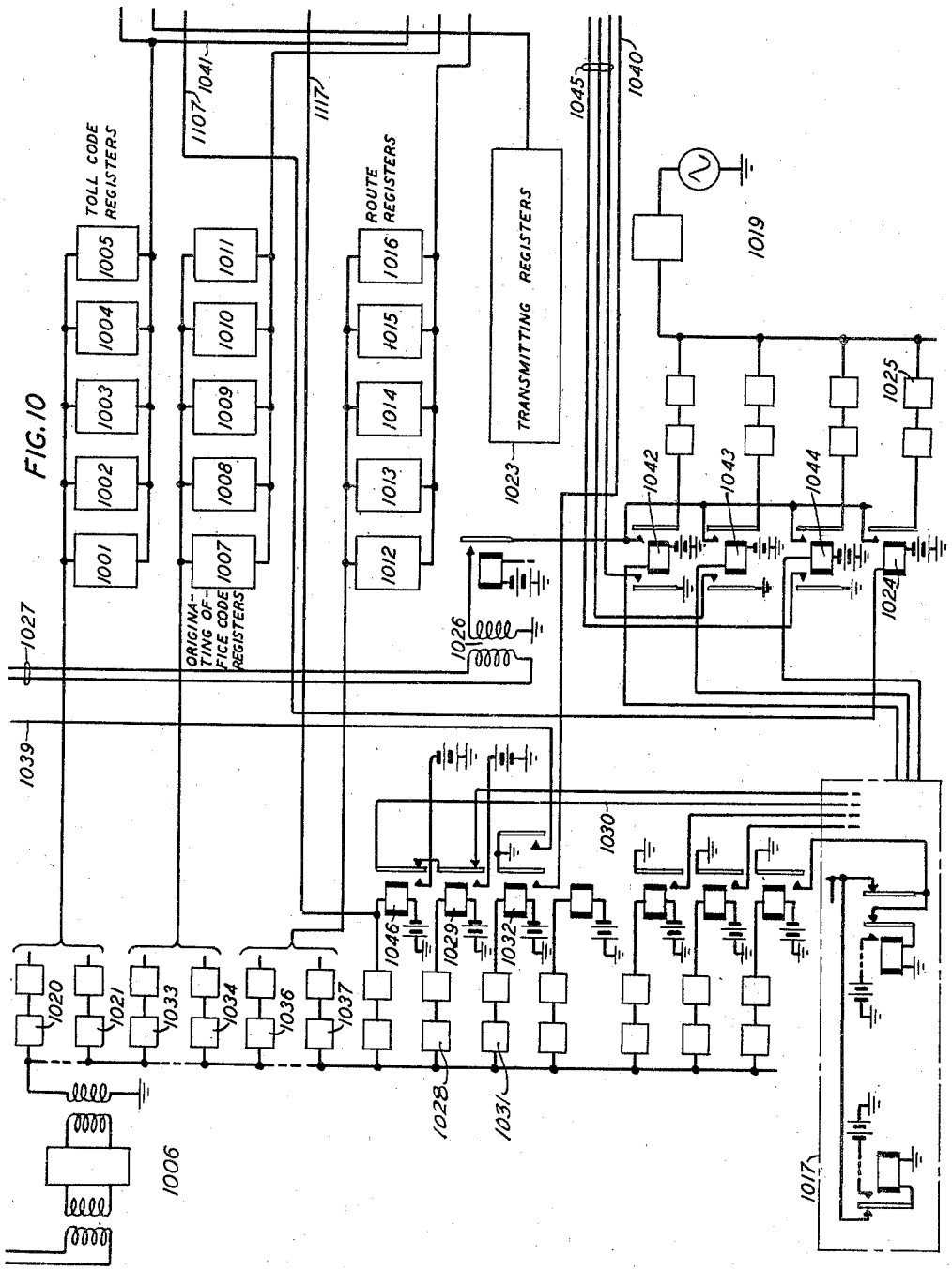

FIG. 10

INVENTOR
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March 10, 1942. H. NYQUIST 2,275,459

TELEPHONE SYSTEM

Filed May 31, 1940 13 Sheets-Sheet 11

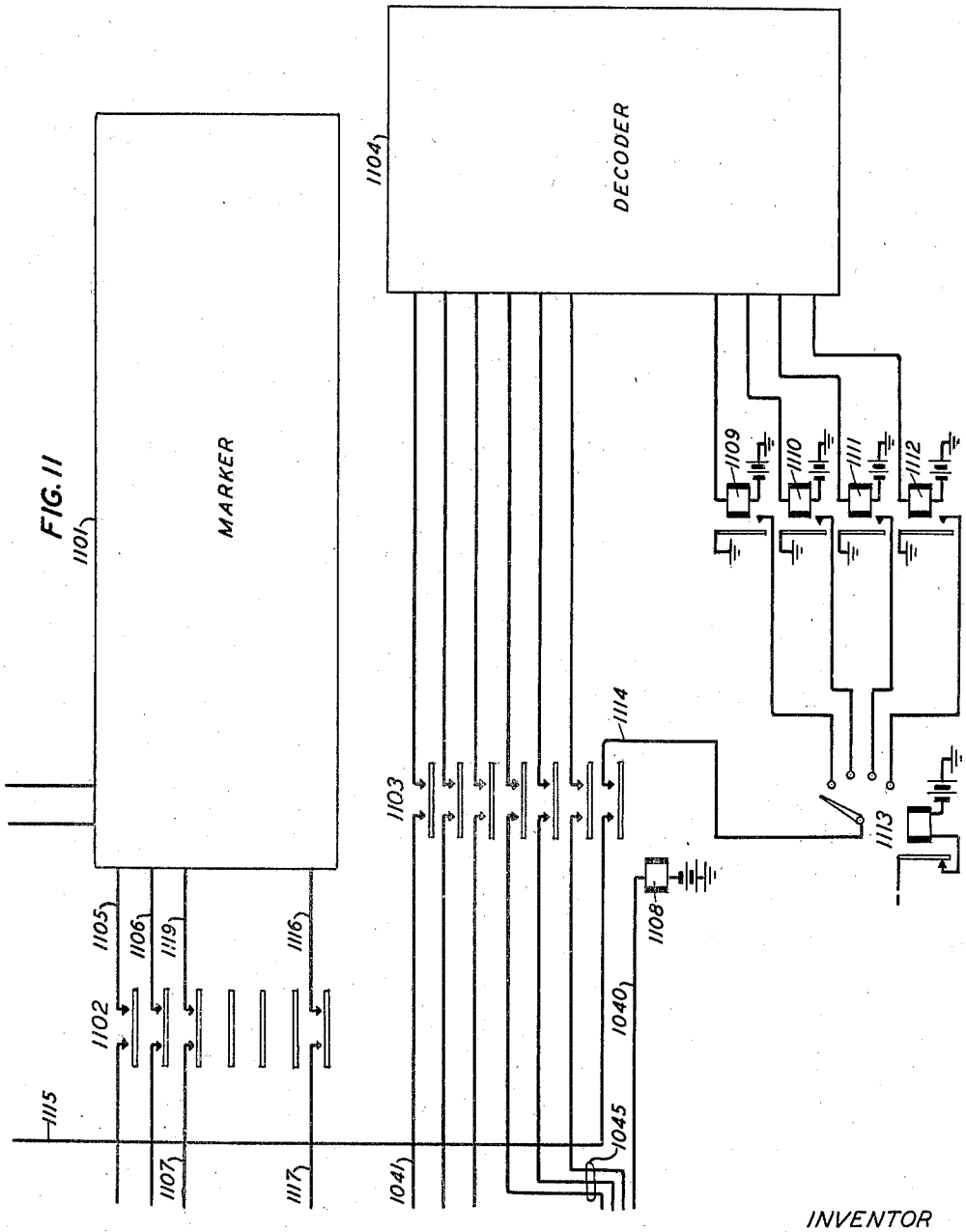

FIG. 11

INVENTOR
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BY
ATTORNEY

March 10, 1942. H. NYQUIST 2,275,459

TELEPHONE SYSTEM

Filed May 31, 1940 13 Sheets-Sheet 12

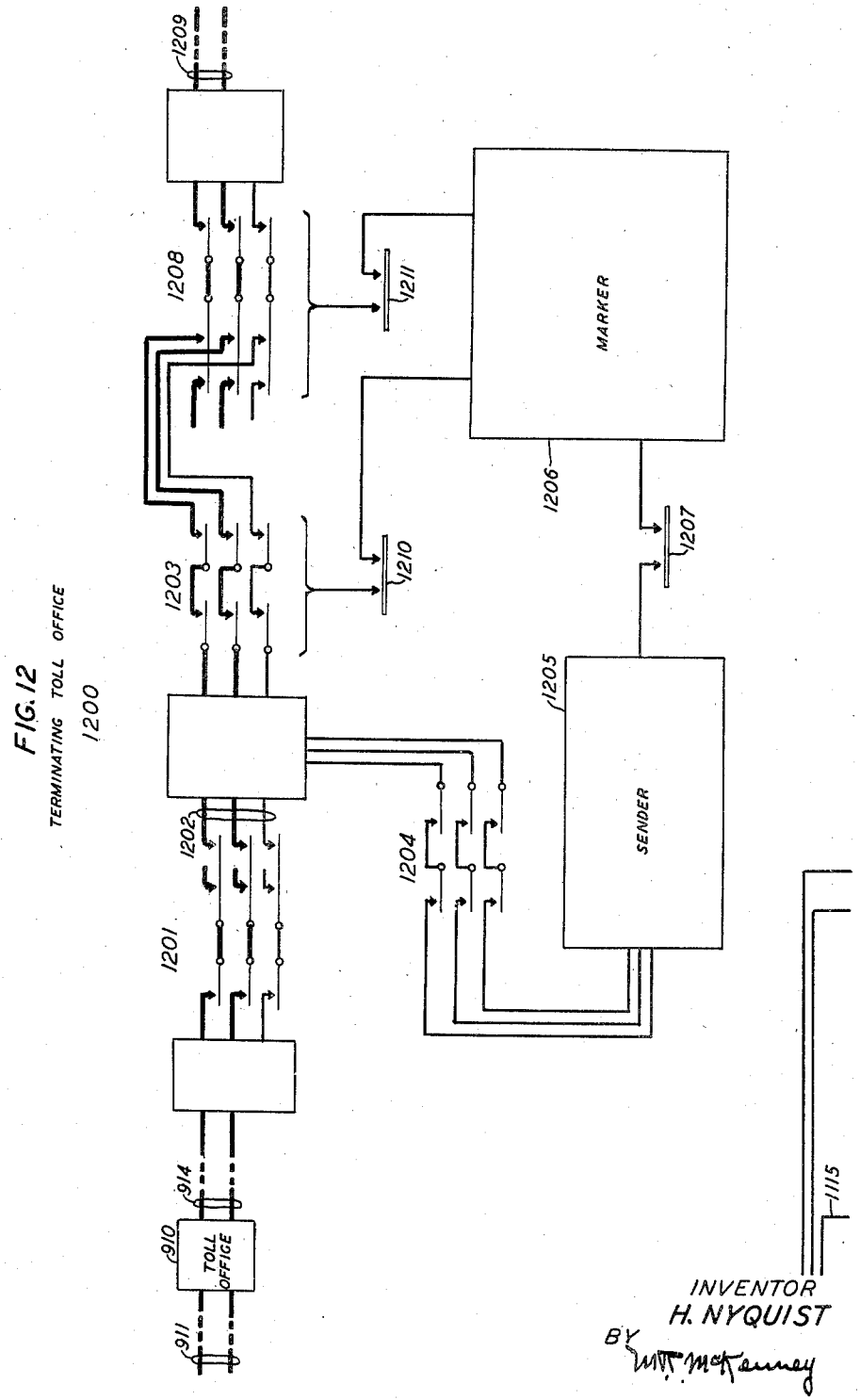

FIG. 12

TERMINATING TOLL OFFICE

1200

INVENTOR

H. NYQUIST

BY Wm. McFarney

ATTORNEY

March 10, 1942. H. NYQUIST 2,275,459

TELEPHONE SYSTEM

Filed May 31, 1940 13 Sheets-Sheet 13

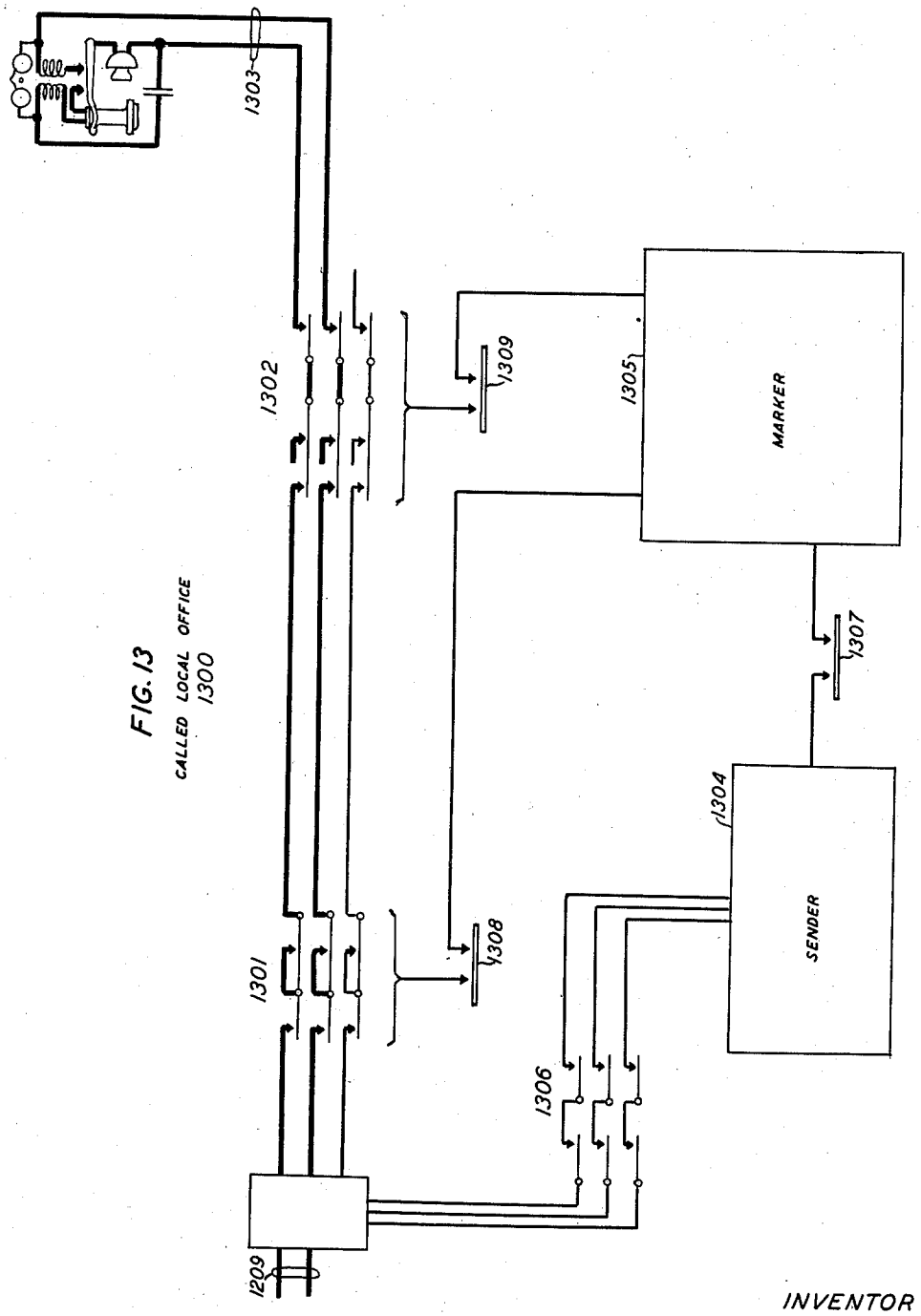

FIG. 13

INVENTOR
H. NYQUIST
BY
M. T. McKenney
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Patented Mar. 10, 1942

2,275,459

UNITED STATES PATENT OFFICE

2,275,459

TELEPHONE SYSTEM

Harry Nyquist, Millburn, N. J., assignor to Bell Telephone Laboratories, Incorporated, New York, N. Y., a corporation of New York

Application May 31, 1940, Serial No. 338,001

22 Claims. (Cl. 179—27)

This invention relates to telephone systems and particularly to systems in which long-distance connections are established automatically.

The objects of the invention are to enable a more efficient use of the direct and alternate routes available in the automatic establishment of connections between remote offices in large toll areas; to increase the flexibility of switching systems in the extension of such connections; to make provision for automatically varying the routes available in accordance with traffic conditions existing in the area involved; to increase the speed and reliability with which call designations are transmitted over long distances to control switching operations; to utilize the call designation signals for controlling the establishment of long-distance connections and also for determining the transmission characteristics of said connections; and in other respects to obtain improvements in systems of this character.

Systems have been proposed heretofore for the establishment of toll connections by automatic switches controlled by subscribers' or operators' dials. Also systems have been devised in which calls are extended from any given point over direct trunks as a preferred choice and over alternate-route trunks as a secondary choice in case the direct trunks are not available. However, none of these prior plans makes it possible to obtain the most efficient use of the many toll trunks that interconnect the numerous toll offices in a country-wide system.

According to a feature of the present invention, advantages are realized over these prior arrangements by means of a system in which long-distance connections are extended automatically over trunk lines interconnecting successive offices; in which each office makes a registration, as the call progresses, of the busy and idle condition of all routes tested; and in which the registration thus established in a given office, which has already extended the call to an office beyond, causes the switching mechanism in said given office to reroute the call over an untried alternate path in the event the office beyond fails because all routes available to it are found busy or out of service. This method of switching makes it possible to use any available route between the originating and terminating toll offices, since each office along the way is capable of making a second trial over a new route after its first and initially successful trial over the preferred route has met with failure at some point beyond.

Another feature is a system in which the routing registration established in any particular office causes the switches in that office to release the connection, originally extended therefrom, when the registration indicates that all available routes are busy, and to reroute the connection over an alternate route from said particular office to another office beyond, and in which the routing registration is then transferred from said particular office to said office beyond. Since this registration shows the condition of the routes tested following the first attempt to complete the connection from said particular office, and since some of these routes are normally available for completing the connection from said office beyond, the transferred registration serves the useful purpose of indicating to the control mechanism in said office beyond which routes are busy, thus obviating a futile attempt to extend the connection over these routes and directing the trials to other routes.

Another feature of the invention is a system in which the toll offices are equipped with senders and markers for controlling the selective switches therein to extend the connection from one office to another, in which the code designation of the called toll office is transferred from one sender to the next as the call progresses, in which the trunk network available to one office may differ from that available to the use of other offices, and in which the marker in any particular office analyzes the code received and determines the trunk pattern available to it for the extension of the call.

Another feature of the invention is a system in which the code designation of the called toll office is utilized in the originating toll office to determine whether certain transmission equipment, such as echo suppressors, shall be included in the connection and to determine the intermediate office at which this equipment is to be connected. When the connection has been extended from the originating office through the intermediate offices to the terminating office, a signal is transmitted over the connection to identify the particular intermediate office at which the echo suppressor is required. Signals are also transmitted giving the identification of the calling office and the route over which the connection was extended therefrom to the intermediate echo suppressor office. This information, together with similar information concerning the called office and the route thereto already recorded in the echo suppressor office makes it possible to adjust the delay values of the suppressor to give the best transmission characteristics.

Another feature of the invention is a system of the kind above described in which the designation of the called office and the supervisory and other signals are transmitted over the extended connection by means of carrier frequency channels.

Another feature of the invention is a system in which the signal receiving mechanism in the originating office is tuned to a narrow band for receiving specific signals during the time the connection is established and is automatically tuned to a wide band for receiving the speech signals of the operator or the called subscriber at the distant end. These speech signals serve as the supervisory signals to notify the originating operator that the call has been answered.

Other features and advantages of the invention will be explained more fully in the following detailed description and will also be set forth in the appended claims.

Referring to the drawings which accompany the detailed specification:

Fig. 1 is a route diagram of a toll exchange area showing the interconnecting trunks between toll offices;

Figs. 2 to 13 when taken in the order illustrated in Fig. 14 disclose, partly in diagrammatic manner and partly in detail, the circuits and apparatus of a toll exchange system embodying the features of this invention;

Fig. 2 shows a calling local office located in the area served by one of the toll offices;

Fig. 3 shows the controlling equipment in the local office, including senders and markers for controlling the operation of the automatic switches illustrated in Fig. 2;

Fig. 4 illustrates the originating toll office serving the local office of Fig. 2 and shows automatic switches over which calls from the local office are extended to distant toll offices. This figure also illustrates two of these distant intermediate toll offices;

Figs. 5, 6 and 7 disclose one of the common register senders in the originating toll office of Fig. 4;

Fig. 8 shows one of the markers in the originating toll office which cooperates with the register sender to control the operation of the automatic switches;

Fig. 9 illustrates a third distant or intermediate toll office and shows the automatic switches therein for extending incoming calls to still more distant toll offices;

Fig. 10 illustrates one of the common register senders in the third intermediate toll office;

Fig. 11 illustrates one of the switch controlling markers and also a timing mechanism located in said third toll office;

Fig. 12 illustrates a fourth intermediate toll office and also shows a fifth toll office, which is here illustrated as a terminating office; and

Fig. 13 illustrates a called local office in the area served by the terminating toll office.

The present invention is particularly applicable to large telephone areas, and it is contemplated that the routing, extension, and completion of long-distance calls may be effectively accomplished by automatic switching and controlling means in a country-wide system. A portion of such a system is illustrated in Fig. 1 of the drawings in which a plurality of toll offices are located in various parts of the area and are interconnected by a network of toll trunks. Some of these offices serve as regional centers, others as primary outlets, and still others as toll centers. Since each office in the system is interconnected with other offices over a plurality of different trunk routes, it is possible, by providing the necessary switching and controlling facilities, to make the most effective and efficient use of the trunking network in the extension of a toll call originating in any one of the toll offices and destined for completion through any other toll office. To this end each toll office will have a particular route over which it prefers to extend its calls to another office in the system, and this preferred routing may be changed from time to time by simple wiring alterations made in the controlling equipment. Likewise, each office in the system will have a number of alternate routes to any other particular office, and these will be tried successively in a certain fixed order until an available one is found or until it is determined that all routes are unavailable.

For example, the toll office 400 may prefer to use trunks 407, 409, 411, 911, and 914 for extending its calls to the office 1200. If trunk 407 is busy, the office 400 may then prefer to extend these calls by way of trunks 416, 432, 411, 911 and 914. But if trunk 432 is busy, it may then prefer to extend the call by way of trunks 416, 431, 425, 911 and 914. And in similar manner other patterns may be used as subsequent choices in the extension of the call from office 400 to office 1200. Similarly, each office in the system has a preferred route over these interconnecting trunks to each other office and a plurality of alternate choices.

A call may progress successfully over several interconnecting trunks and then find itself blocked because all routes ahead are busy or otherwise unavailable. This does not mean, however, that the call must fail, because there still may be several available routes between the originating office and the called office. For instance, a call from office 400 to office 1200 may have progressed successfully over trunks 407, 409 and 411 to the office 900. Office 900, however, finds both trunks 911 and 421 busy, but some or all of the trunks 423, 427, 914, 428 and 429 may be idle at this time; therefore, the call should not be permitted to fail notwithstanding the fact that office 900 is powerless to reach these idle trunks with its own switching equipment. To make use of these idle trunks rather than allowing the call to fail, it is only necessary to provide some means for releasing the partially completed connection back to the preceding office 420 and to provide means in office 420 for rerouting the call over its alternate route 423 to the office 440. Thereupon the office 440 is free to further extend the call over trunks 427 and 914 if both are idle or, alternately, over trunks 428 and 429 to the called office 1200. Should the office 420 on its second attempt find the alternate route trunk 423 busy the connection is released back to the next preceding office 410. In like manner the office 410 reroutes the call over its alternate route trunk 424 to the office 430, assuming this trunk to be idle, and office 430 proceeds to further extend the call over available routes between it and the called office 1200.

This comprehensive method of routing and rerouting a call to obtain the fullest advantage from the trunking system is made possible by providing each toll office with a route registering mechanism. The function of the route registering mechanism in each toll office is to establish and maintain a complete registration of

all trunk routes beyond that office that are tested in the process of projecting a connection toward a terminating office in the area. Since, therefore, each office through which the connection is extended keeps a registration of every trunk route tested beyond, it is possible for any particular office to release the connection forward as soon as it determines that the call has failed to find an idle route and to reroute the call over an alternate trunk route to an untried office beyond. The routing pattern available to a particular office will, of course, vary in accordance with the called office in the system. The route recording mechanism, however, is universal in this respect and is capable of selecting the proper route pattern as soon as the designation of the called office is received. Hence any office in the system, when called upon to extend a connection toward any distant terminating office, is capable of automatically determining a pattern of preferred and alternate routes available for that particular call and to keep a registration of the condition of each trunk tested in the selected pattern. With this information, the controlling mechanism in the office is able to determine what routes are available, to cause second trials as long as there is hope of extending the connection over the chosen route, to recognize the existence of a complete failure over the chosen route, and to release an office from the connection in favor of a preceding office which may ultimately succeed in completing the desired connection.

A general understanding of the equipment used in the system disclosed herein may be had by referring to Figs. 2 to 13, inclusive, of the drawings. These drawings illustrate a calling local office, an originating toll office, several intermediate toll offices, a terminating toll office and a called local office. It will be obvious, however, from the foregoing description of Fig. 1 that any number of intermediate toll offices may be involved.

The calling local office **200**, shown in Figs. 2 and 3, may be of any type. As illustrated, however, it is an office of the automatic type and is provided with the usual operator's position equipment **220** and with operator's cord circuits **211** for extending calling lines to the toll office. For this purpose the operator has access to trunks, such as the trunk **201**, terminating in the district selector switch **202**. The trunk **201** also has access through a sender link connector **203** to idle register senders, one of which is disclosed partly in detail in Fig. 3. The register sender when associated with the trunk **201** seized by the operator responds to the operator's keyboard and registers the code designation of the terminating toll office and also the code designation of the called local office and the number of the wanted line in the called local office. Thus the complete information concerning the call is first stored in the sender of the calling local office. Without limiting the invention in any way it may be assumed that the toll area is of such magnitude that five code digits are required to designate any particular called toll office and to include such other information as may be required in the extension of the connection. These five toll code digits are registered in any conventional manner on registers **302**, **303**, **304**, **305** and **306** in the sender. The called office code, which may comprise three digits, is registered on registers **307**, **308** and **309**, and the number of the called line called is registered on the numerical registers **310**, **311**, **312** and **313**. After the designations have been registered, the sender seizes an idle marker **314** through a marker connector **315**. The toll code digits are then transferred to the marker, and the marker utilizes this information to selectively operate the district and office switches **202** and **204** to seize an idle trunk **205** extending to the originating toll office **400**. The marker controls the district and office switches in the usual manner by connecting itself thereto through the frame connectors **206** and **207**. The marker also translates the toll code and sends the translated registration back to the sender where it is registered on a set of transmitting registers **316**.

The local office sender is provided with carrier frequency signaling equipment having a substantial number of frequency channels by means of which information is transmitted from the sender to senders in the distant toll offices and by means of which supervisory and other information is received from the distant offices. The various designation characters and supervisory signals may each be represented by a single frequency or by a code of frequencies simultaneously sent over the signaling circuit. To this end the transmitting signaling equipment in the local office sender includes a source of alternating current **317**, a harmonic generator **318**, channel filters **319**, **320**, **321**, etc., detector amplifiers **322**, **323**, **324**, etc. For example, these transmitting signal channels are used to transmit the translated toll code from the calling office to the toll office, to transmit supervisory information when the connection has finally been extended to the terminating toll office, and to transmit the called office code and line number to said terminating office. The signal receiving mechanism in the sender comprises a plurality of frequency selecting filters and detector amplifiers, including filters **325**, **326**, **327**, **328**, **347**, and detector amplifiers **329**, **330**, **331**, **356** and associated circuit controlling relays.

The trunk **205** extending from the local office enters the toll office **400** and appears in the automatic switch **412**. Since the trunk **205** may be a two-way circuit, the function of the switch **412** is to extend this trunk to an idle junctor **401** on an inward call and to seize the trunk **205** on an outward call for the purpose of extending the desired connection from the toll office to the local office. The junctor or trunk **401** appears in the district selector switch **402** and also has access, through a sender link connector **403**, to register senders, one of which is shown in Figs. 5, 6 and 7.

The register sender in the toll office **400** includes toll designation registers **501**, **502**, **503**, **504** and **505** for registering the designation of a terminating toll office. These registers are set in response to carrier current signals incoming to the signal receiving mechanism in the sender from a distant local or toll office, depending upon the origin of the call. The signal receiving mechanism **506** includes a plurality of channel filters and detector amplifiers. The sender also includes signal transmitting mechanism comprising generators **507** and **508**, harmonic generators **512** and **509** and associated channel filters and amplifier detectors and switching relays for transmitting designation routing and supervisory signals over the extended connection, both in the direction of the originating office and in the direction of the terminating office.

The toll office sender also includes the routing

mechanism shown in Figs. 6 and 7. This mechanism comprises a plurality of relays which are operated, when the call is first received, in accordance with the designation of the terminating toll office to determine the pattern of the trunk network beyond that will be used in extending the call to the terminating office. This pattern determination is effected by the switch controlling marker 801, which is seized by the register sender through a marker connector 802 and which receives on its registers 803, 804, 805, 806 and 807 the toll designation of the terminating office. This code designation is translated and analyzed by the marker and utilized to operate the necessary relays in the routing mechanism to determine the available route network for the extension of the call.

The marker 801, having received the toll code and having translated it, proceeds to control the operation of the selector switches 402 and 404, through the frame connectors 405 and 406, to extend the connection over the preferred or direct route trunk 407 outgoing to the next toll office 410 beyond. If the trunk 407 is idle and the call is successfully extended over this route, a signal is transmitted to the routing mechanism to register the fact that the first tested link in the network pattern is idle.

Thereafter the toll offices beyond, which will be described presently, further extend the connection over the preferred routes, if idle, toward the terminating office. If the preferred routes are found idle, success signals are transmitted back to the originating office sender, causing the operation of the relays in the routing mechanism. These operated relays register the fact that the preferred links beyond are idle. On the other hand, if any one of the preferred links beyond is busy, an alternate route is attempted, and a failure signal is sent back to the originating toll office where it causes the operation of a relay in the routing mechanism to register the busy condition of the tested link. In this same manner success and failure signals are transmitted back over the connection each time a route is tested during the progress of the connection toward the terminating office, and the routing mechanism registers these signals and thus establishes a complete registration of the condition of the tested links or routes in the routing pattern chosen for the particular call being extended.

To explain more specifically how the marker 801 determines the initial setting of the routing mechanism for the selection of the appropriate patern, it may be noted that the marker is provided with the usual route relays, such as the relays 808, 809, 810, 819, 820. Generally speaking, there is one of these relays in the marker for each toll code designation that may be received on the registers of the marker. However, in some cases remote offices which are not regional centers may be represented by a single route relay. The route relay, therefore, represents the terminating toll office, and its contacts may be wired in such a manner that relays in the routing mechanism are operated to determine the particular trunk routes available for the completion of a call to that terminating office. By extending the circuits from the contacts of the route relays through a wiring rack or terminal strip 811 it is possible, by changing the jumper wires on the terminal strip, to alter at will the pattern of the route network available to this particular toll office for the extension of calls to any terminating office in the area. If desirable, the route relays may be made common to a number of markers which seize them for use when required.

The marker 801, having received and analyzed the toll code, transmits this registration, either in its original form or in translated form according to the location of the terminating office, back into the sender where it is registered on the transmitting registers 510 in the sender. When the proper time arrives, this registration in the sender will be transferred therefrom over the extended connection to the sender in the succeeding toll office. Where translation of the toll code is not required, the sender may be arranged to send this code to the office beyond under control of the registers on which it is received from the preceding office and without the assistance of the marker.

The toll trunks 407, 409, 411 interconnecting the successive toll offices may be of the two-way type for extending calls in both directions. At the intermediate office 900, for example, the automatic switch 901 serves to extend the trunk 411 in either of two directions, depending upon the direction of the particular call involved. On an inward call from office 420, the trunk 411 is extended by the switch 901 to the junctor 902 which appears in the contacts of the district selector switch 903. The junctor 902 has access through the sender link connector 904 to register senders in the office 900, one of which is illustrated in Fig. 10.

It will be understood that the register senders in the several toll offices may be substantially the same, although the sender illustrated in the drawing for the originating toll office 400 shows some parts that are omitted from the sender in the office 900, and the latter sender illustrates some parts that are omitted from the sender of the originating office. Like the sender in the originating toll office, the sender of the intermediate office 900 is provided with registers 1001, 1002, 1003, 1004 and 1005 for registering the code designation of the terminating toll office. This designation is transferred, as above mentioned, from the sender in the originating toll office and is received by the carrier signal receiving mechanism 1006 and registered on the registers 1001 to 1005. The sender in the intermediate office is also equipped with a routing mechanism 1017, similar to the one shown in Figs. 6 and 7.

The intermediate toll office is also provided with a marker 1101 which cooperates with the sender through the marker connector 1102 and serves to control the operation of the automatic switches 903 and 905 to extend the connection over a toll trunk 911 to the next succeeding toll office.

In view of the long distances that may be involved in some toll connections where several trunks are connected in tandem, it is desirable to provide certain of the toll offices in the area with devices, such as echo suppressors, for improving the transmission characteristics of these long connections. It may be assumed that the intermediate toll office 900 is equipped with a number of echo suppressors, such as the suppressor 906. The function of the suppressor is to respond automatically to speech transmission in either direction and after an interval of delay to open or disable the transmission circuit in the opposite direction. The purpose of opening the circuit is to prevent an echo reflected from the called end of the line from passing the suppressor and returning to the talking party. The

amount of delay should be just long enough to intercept the returning echo. In the present system disclosed herein the inclusion of a suppressor in any particular connection or its omission therefrom is determined automatically from the code of the called office, and the inclusion of the suppressor, when required, is effected automatically. Moreover, the delay intervals for transmission in both directions are adjustable automatically in accordance with the transmission distances between the suppressor office and the terminals of the connection. The selection of a suppressor is effected by transmitting a distinctive signal from the originating toll office to the suppressor office. This signal is received like the other signals and causes the operation of a suppressor connector switch **908**, which merely serves to connect the suppressor **906** in the talking conductors of the junctor **902**. The amount of delay for the transmission circuit extending from the originating toll office to the suppressor office is determined by the code designation of the originating office and by the particular route that was used in extending the connection from the originating office to the suppressor office. The code designation of the originating office is transmitted therefrom at the proper time to the suppressor office and is registered on the registers **1007**, **1008**, **1009**, **1010** and **1011** in the sender. The exact route used in extending the connection from the originating office to the suppressor office is known by the routing mechanism in the originating office. Accordingly, this information is transmitted in the form of carrier signals over the extended connection and registered on the calling route registers **1012**, **1013**, **1014**, **1015** and **1016** in the sender. The setting of these registers is transferred through a connector **1103** to a decoder **1104**. The decoder **1104** analyzes the calling office code and the route information and utilizes this information to set the variably operable delay switch **909** in the suppressor **906**. Concerning the delay required for the transmission line between the suppressor office and the terminating office, it will be noted that the sender in the suppressor office already has recorded therein the designation of the called office. Furthermore, when the connection has been fully completed to the called office the routing mechanism **1017** has a full registration of the particular route chosen in extending the call from the suppressor office to the terminating office. Hence the called toll office code and the routing information are similarly transferred to the decoder **1104**, which analyzes this information and proceeds to operate the variably adjustable delay switch **910** in the echo suppressor to determine the amount of delay appropriate for the transmission line between the suppressor office and the terminating toll office.

The toll trunk **911** extends to the next toll office **910**, from whence the connection may be further extended over trunk **914** to the office **1200**, which is assumed to be the terminating toll office. At office **1200** the trunk **914**, which also may be of the two-way type, appears in an automatic switch **1201**. The switch **1201** extends the connection to a junctor **1202** terminating in the district selector switch **1203**. The junctor **1202** also has access through the sender connector **1204** to the sender **1205**, which is similar to the senders in the other toll offices. The sender **1205** has access to the marker **1206** through the marker connector **1207** and the marker, in cooperation with the sender, controls the switches **1203** and **1208** to extend the connection over a trunk **1209** to the called local office **1300**, illustrated in Fig. 13.

The incoming trunk **1209** appears in the incoming selector switch **1301** in the local office, and the selector **1301**, in conjunction with the final switch **1302**, serves to complete the connection to the called subscriber's line **1303**. The switches **1301** and **1302** are controlled by the sender **1304** and marker **1305**.

Since the invention is not particularly concerned with the types of automatic switches that are used in extending the connections, nor with many of the details of the controlling mechanisms which determine the selective operation of the switches, the disclosure has been simplified to a large extent to faciiltate a clearer understanding of the invention by omitting many of the unessential circuit details.

It is assumed, however, that the local and toll offices in the system herein disclosed are equipped with automatic switches of the well-known cross-bar type, although these offices might be provided with other kinds of switches, such as step-by-step switches, panel switches, or relay switches. The register senders and markers provided in each office for controlling the cross-bar switches therein are, in general, similar to those disclosed in numerous prior art patents. Also the several connecting devices, such as the sender connectors, the marker connectors and the frame connectors, may be essentially the same as those already disclosed in the prior art patents. For a more complete disclosure of the cross-bar system, of the manner in which the register senders receive and register the designations, of the manner in which these senders cooperate with the markers, of the manner in which the markers test the trunk groups, select idle trunks, control the selective operation of the switches to extend the desired connections, of the manner in which the marker supplies the sender with information concerning the further extension of the connections, of the manner in which the senders transfer information to distant offices and receive supervisory information therefrom, and of the manner in which the established connections are held during conversation and released thereafter, reference may be had to the following: Carpenter Patent 2,093,117 of September 14, 1937; Carpenter Patent 2,089,921 of August 10, 1937; Williams et al. Patent 1,543,967, June 30, 1925; Moody et al Patent 2,161,376 of June 6, 1939; Carpenter Patent 2,235,803 of March 18, 1941; and King et al. Patent 2,236,246 of March 25, 1941.

For the manner in which the senders and markers cooperate to effect repeated trials and to choose alternate routes when the direct route trunks are busy, reference may be had to the Williams et al. Patent 1,543,967 of June 30, 1925; Kerr Patent 1,577,033 of March 16, 1926; and to the Carpenter Patent 2,093,117, September 14, 1937 and the Carpenter Patent No. 2,235,803, above noted.

Although the signal sending and receiving equipment is illustrated herein as comprising an individual part of each sender, it will be understood that this equipment may be common to the senders in an office and may be seized by any sender whenever it is needed to transmit or receive signals.

The operator's position equipment in the calling local office may be of any suitable type,

equipped with a keyboard or with a dial for setting the register sender.

The trunks interconnecting the several offices in the system, which are preferably of the two-way type, may be provided with the usual signal receiving devices for responding to the seizure signals and to the supervisory signals transmitted from distant offices. These intertoll trunks may be of the two-wire type or of the four-wire type, depending upon the transmission requirements.

The detailed operation of the system will now be described, and for this purpose it will be assumed first that the subscriber of line 209 wishes to converse with the subscriber on line 1303 in a distant office. Referring to Fig. 1, it may also be assumed that the calling line 209 belongs to the local office 200 served by the toll office 400. Also, it may be further assumed that the called line 1303 belongs to a local office 1300 which is served by the terminating toll office 1200. It will be noted further that the originating and terminating toll offices 400 and 1200, respectively, and the four intermediate toll offices 410, 420, 900 and 910, disclosed in the detailed drawings, correspond to the toll offices illustrated in the routing diagram of Fig. 1.

The calling subscriber manipulates his dial 210 and extends his line over automatic switches (not shown) to the service operator's position in the local office. The operator responds with her cord circuit 211, obtains the information concerning the desired subscriber's office name and line number and proceeds to forward the call by connecting her cord circuit 211 to an idle trunk 201 extending to the district selector switch 202. Seizure of the trunk 201 causes the trunk control mechanism 212 to function and initiate the operation of the sender connector 203. The connector 203 connects the trunk 201 to an idle register sender, and a visual signal or a dial tone is sent to the operator. The operator verifies the calling subscriber's number, if necessary, and then manipulates her dial or keyboard associated with the position equipment 220 to transmit designation signals over the trunk 201 through the sender connector 203 to the selected idle register sender. The signal or impulse circuit over which these designation signals are transmitted includes the tip and ring conductors of the trunk 201, conductors 213 and 214, conductors 215 and 216, and a signal receiving relay 333. The first five digits represent the code of the terminating toll office, and the impulses representing these digits are transmitted by the relay 333 in the well-known manner to the five successive toll code registers 302 to 306, inclusive. The next seven digits represent the code of the local called office and the number of the called line, and these digits are successively registered on the registers 307 to 313, inclusive.

At the proper time the register sender causes the operation of the marker connector 315 to connect the numerous control conductors from the sender to the marker. Thereupon the toll code digits are transferred from registers 302 to 306 over a plurality of conductors, represented by the line 334, to the marker 314. The marker transmits the toll code (translated if necessary) to set the transmitting registers 316. The signals for setting the transmitting registers are sent from the marker back to the sender over conductors 335. The marker also tests the group of trunks extending to the originating toll office 400, selects an idle trunk 205 in the group, and operates the switches 202 and 204 through the connectors 206 and 207 to extend the connection from trunk 201 and over the trunk 205 to the toll office. The connection having thus been extended to the toll office, a signaling relay 336 is operated to transmit a seizure signal to the toll office. Relay 336 connects the channel filter 337 and amplifier 338 to the winding of transformer 339. A signal current of the selected frequency is thus transmitted from the harmonic generator 318 through the primary winding of the transformer 339. Current of this frequency is induced in the secondary winding of the transformer and flows over the signal circuit 340, through the connector 208, over signal circuit 217, and thence over the extended connection to the controlling equipment 413 associated with the incoming end of the trunk 205 in the toll office. In any well-known manner the seizure signal causes the automatic switch 412 to extend the trunk 205 to the junctor 401, and the junctor 401 initiates the operation of the sender connector 403 to extend the junctor through to an idle register sender in the toll office.

As soon as the toll office sender is seized, it transmits a signal back to the sender in the calling local office to notify the latter sender that the toll code may be transferred to the toll office. This signal may be transmitted by operating the relay 511. Relay 511 connects the harmonic generator 512 through the channel filter and amplifier 513 and 514 to the primary winding of the transformer 515. The signal current generated in the secondary winding of the transformer is transmitted over the contacts of relay 516, over signal circuit 517, through the connector 403, through the control mechanism 414 of the junctor 401, thence over the junctor through the contacts of switch 412 and over the extended connection to the calling local office, thence over conductors 213 and 214, conductors 215 and 216, through the contacts of relay 340, through the channel filter and detector 326 and 330 to operate the signal relay 341. The operation of relay 341 is a signal to the sender that the sender in the originating toll office is ready to receive the toll code. Thereupon the signal transmitting channels 342 are rendered effective by the transmitting registers and controlling circuits 316 to energize the primary winding of transformer 343 with currents of frequencies representing the translated digits of the called toll office code. Signal currents of corresponding frequencies are induced in the transmitting circuit 340 and sent over the extended connection to the originating toll office where they are conducted over the circuit 517 through the normal contacts of relay 516 to the signal receiving mechanism 506. After passing the amplifier and after being selected by the corresponding channel filters 519, 520, 521, they are detected and utilized to set the toll office registers 501, 502, 503, 504 and 505 in accordance with the code of the called toll office. At the same time, a signal is sent by the channel transmitting mechanism 344 in the calling local office to notify the toll office 400 that it is to be the originating toll office for this particular call. This signal may be transmitted by the operation of relay 345, which serves to complete the signal channel including the filter 346. At the toll office the signal is received and selected by the channel filter 522 and causes the operation of relay 523. The operation of relay 523 is the signal to the toll office sender that the call is one that originated in this toll office.

Following the receipt of the toll code from the

local office, the marker connector 802 is operated to connect the sender to the marker 801. Thereupon the toll code is transferred from the registers 501 to 505, inclusive, over a group of conductors 523 through the connector 802 and over conductors 813 to set the corresponding registers 803 to 807 in the marker. The code is analyzed by the marker and is sent back over conductors 814 and registered on the transmitting registers 510 in the sender. The marker also utilizes the toll code registration for selecting and operating a route relay 810 representing the preferred route 407 outgoing from the originating toll office 400 in the direction of the terminating office 1200. In the well-known manner the route relay 810 causes the testing of the trunks in the preferred route, the selection of an idle trunk therein and the automatic operation of the switches 402 and 404 to extend the connection from the junctor 401 over the trunk 407 to the first intermediate toll office 410.

It is assumed that the trunk 407 is the preferred route trunk for extending calls from the toll office 400 to the toll office 1200 and that trunks 409, 411, 911 and 914 are the preferred routes, respectively, for toll offices 410, 420, 900 and 910. Therefore, no initial adjustment is needed in the routing circuit (Figs. 6 and 7) of the originating office 400.

Since the preferred route 407 is found idle and chosen as the first link in the desired connection, a success signal is sent to the routing mechanism to register therein the fact that route 407 has been chosen. The success signal is effected by closing a circuit from the marker over conductor 815 through the connector 802, conductor 524, through the winding of relay 525 to battery. Relay 525 operates and closes a circuit from the positive pole of battery through its armature and contact, contact of relay 527, conductor 526, back contact of polarized relay 601, back contact and winding of polarized relay 602 to ground. This circuit is also extended through a back contact of relay 602 and the back contact and winding of relay 601 to ground. The polarity of the relays is such that only relay 602 responds and attracts its armatures. It may be noted at this point that the success and failure signals are recorded in the route recording mechanism by the operation of polarized relays, the positive relays serving to register success signals and the negative relays the failure signals. The polarity of these relays is indicated in the drawings by the positive and negative signs. When relay 602 operates, it extends the circuit over conductor 526 through the front contact of relay 602, conductor 603, contacts of relay 608, conductor 609, and thence to the next pair of polarized relays 604 and 605. This circuit 526, however, is held closed long enough to insure the operation of relay 602 but not sufficiently long to cause the operation of the relay 605 of the next pair. Relay 602, in operating, locks through its front contact over a control conductor to the positive pole of battery. Thus, the operation of relay 602 extends the incoming circuit 526 through to the circuit 603, this being an indication that the toll connection has been extended successfully over the trunk 407 to the toll office 410. Had the preferred route 407 tested busy, the marker 812 would have closed a circuit over conductor 816, causing the operation of relay 527. Relay 527 operating would close a circuit from the negative pole of battery over conductor 526 to the polarized relays 601 and 602. In this case, relay 601 would operate, extending the circuit 526 to the polarized relays 606 and 607 which serve to register the busy or idle condition of the alternate route 416 extending from the toll office 400.

In the manner already described, a seizure signal is transmitted by the signal transmitting mechanism 529 in the originating office sender over the trunk 407 to the toll office 410. The toll office 410 responds to this signal and connects an idle sender to the trunk 407. The sender in the office 410 transmits an acknowledgment signal, as above described, back over the connection to the sender in the office 400. Thereupon the transmitting register 510 sends the toll code by means of signaling frequencies selected by the filters 530, 531 and 532 through the transformer 533 and over the extended connection to the registers of the sender in office 410.

The sender and marker in the office 410 proceed in the manner already described to extend the connection toward a succeeding office. To this end the marker in office 410 first tests the preferred route 409 for an idle trunk. If an idle trunk in this preferred route is found, the connection is extended thereover to the toll office 420. At the same time, the sender in the office 410 transmits a success signal over the trunk 407, to the receiving mechanism 506 in the sender at office 400. This success signal is of a frequency corresponding to the channel filter 534, and relay 525 operates. The positive pole of battery is connected to conductor 526, and the circuit may be traced through the back contact of relay 601, front contact of relay 602, conductor 603, back contact of relay 608, conductor 609, thence through the back contacts and windings of relays 604 and 605 to ground. Relay 605 alone operates and locks in its holding circuit, thus extending the route registering circuit to conductor 610. Thus, the route mechanism in office 410 has a registration that the connection has been extended successfully over routes 407 and 409 to the office 420. At the same time that the office 410 transmits the success signal to office 400, it establishes in its own routing mechanism, in the manner previously described, a registration to the effect that the preferred outgoing route 409 has been tested and selected. This is accomplished by operating a relay in the routing mechanism at office 410, corresponding to the relay 602.

Next, the sender in the office 410 transmits the toll office code over the trunk 409 to the seized sender in the office 420. Thereupon office 420 further extends the connection over the preferred route 411 and transmits a success signal back over the connection to the senders in office 410 and in office 400. It should be noted at this point that the markers in the successive offices release as soon as they have performed their controlling functions, but the senders are held to receive and transmit the necessary signals while the connection is being established. The success signal received in office 400 again operates relay 525 and applies positive potential over conductor 526 to conductor 610. The circuit over conductor 610 may be further traced through the back contacts of relay 608, back contacts of relay 611, thence through the contacts of polarized relays 612 and 613 to ground. Relay 613 alone operates in response to the success signal, locks through its holding circuit, and extends the route registering circuit over conductor 614 to the next pair of registering relays 615 and 616. The success signal, however, is removed before relay 616 has

time to operate. Likewise, the success signal is received in the office 410 and causes the operation of a relay in the recording mechanism.

The connection has now been extended to the toll office 900, and the seizure signal transmitted thereto from the toll office 420 causes the operation of switch 901 to extend the incoming toll trunk 411 to an idle junctor 902 which, in turn, causes the operation of the sender link switch 904 to associate the junctor with an idle register sender. The signal transmitting mechanism 1019 causes an acknowledgment signal to be sent back to the office 420, whereupon the sender in the office 420 transmits the toll office code to the sender in office 900. The signals representing this code are selected by the channel filters 1020, 1021, and the registers 1001 to 1005 are operated to register this code.

The sender next proceeds to select an idle marker 1101 through the marker connector 1102 and to transfer the toll office code over conductors 1105 to registers in the marker. The marker sets the transmitting registers 1023 in the sender over conductors 1106. The marker also tests the preferred outgoing route 911, and, if an idle trunk is found in the group, it controls the selective operation of switches 903 and 905 through the connectors 915 and 916 to extend the connection over the idle trunk 911 to the intermediate toll office 910. The selection having been successful, the marker closes the circuit over conductor 1119, through connector 1102, conductor 1107, through the winding of relay 1024 to battery. Relay 1024 operates and closes the circuit for channel filter 1025 to the winding of transformer 1026. The success signal is, therefore, induced in the circuit 1027 and is transmitted through connector 904 over conductors 917 to the junctor 902 and thence back to the senders in offices 420, 410 and 400. In the office 400 the success signal causes the operation of relay 525, and positive potential is applied over conductor 526 to conductor 614 and thence through the right back contacts of relay 611, back contacts of relay 617, conductor 618, and thence through the contacts of windings of polarized relays 615 and 616 to ground. Relay 616 only operates and extends the registering circuit over conductor 619 through the contacts of relay 617 and conductor 620 to the next and last pair of polarized relays 621 and 622. Relay 622, however, does not have time to operate before the success signal is removed. Similarly, the success signals complete the operation of registering relays in the route registering circuits in offices 410 and 420.

Next, the toll office 910 extends the connection over the preferred route 914 to the terminating toll office, and the success signal is transmitted back and received by the senders in offices 900, 420, 410 and 400. In the office 400 the success signal causes the application of positive potential over conductor 526 to conductor 620, from whence the circuit may be traced through the contacts and windings of relays 621 and 622 to ground. Relay 622 alone operates and locks in its holding circuit and extends the conductor 620 through to conductor 623. Thus, all first choice routes in the network having been chosen and the call having been extended to the terminating office 1200, the routing mechanism in the originating office 400 completes its registration and the conductor 526 is extended to conductors 623. As soon as relay 525 releases a circuit is closed from battery over conductor 623, through the operated registering relays as above traced, over conductor 526, back contacts of relays 527 and 525, conductor 599, winding of relay 624 to ground. Relay 624 attracts its armatures and locks to a holding conductor. The operation of relay 624 is, therefore, an indication to the originating office that the connection has been successfully completed to the terminating toll office. In a similar manner, relays in the registering mechanisms at offices 410 and 420 are operated. Furthermore, the success signal transmitted from office 910 is received by the receiving mechanism 1006 in office 900 and through the channel selecting filter 1028 causes the operation of relay 1029. In the manner already described, relay 1029 applies positive potential to conductor 1030, and the proper registering relay in the route registering mechanism 1017 is operated. Similarly, the route registering mechanism in the last intermediate office 910 is operated to register the successful completion of the call. Each of the registering mechanisms in offices 410, 420, 900 and 910, having completed the registration of a successful call, causes the operation of a relay corresponding to the relay 624 at the originating office.

The seizure of trunk 914 to the terminating toll office causes the operation of switch 1201 to extend the connection to junctor 1202, and connector 1204 operates to associate the idle sender 1205. The sender 1205 transmits the acknowledgment signal back over the extended connection, and this signal is received by the signal receiving mechanisms in each of the preceding office senders. In the sender at the originating office, for example, the acknowledgment signal is selected by the channel filter 535 and causes the operation of relay 536. Since relay 624 is operated at this time, a circuit is completed from ground through the contact of relay 624, conductor 625, through the contact of relay 536, and thence through the windings of relays 516 and 537 to battery. Relay 537 applies the signaling channel including filter 538 to the transformer 515, and a signal is transmitted over circuit 517, back to the calling local office. Here it is received by one of the channel filters 347 and causes the operation of relay 348. The operation of relay 348 is an indication to the calling local office that the connection has reached the terminating toll office.

As soon as the last intermediate office 910 transmits the toll code to the sender 1205 in the terminating toll office, the sender in office 910 releases. Likewise, the senders in the preceding offices 420, 410 and 400, having received the acknowledgment signal from the terminating office sender and having completed the registration indicating that the call has reached the terminating office, proceed to release. The sender in office 900 will release after it has completed connecting and adjusting the echo suppressor or after it has been notified that no echo suppressor is required. When the sender in the terminating toll office receives the toll code, it recognizes this code as its own and prepares itself to receive the called office code and line number. The operated relay 348 in the calling local office renders the transmitting signal channels 319, 320, 321 effective, and the called office code and line number are now transferred from the registers 307 to 313, inclusive, over the established connection to the corresponding registers in the sender 1205 at the terminating toll office. The sender 1205 seizes an idle marker

1206 through the connector 1207, and a test is made of the trunk group 1209 leading to the called local office 1300. If an idle trunk 1209 is found, the marker controls the operation of the selector switches 1203 and 1208 through frame connectors 1210 and 1211 to extend the connection over the idle trunk 1209 to the called office.

In the called office 1300 an idle sender 1304 is seized through the sender connector 1306, and the numerical designation of the line 1303 is transferred to the sender 1304. The sender 1304 seizes an idle marker 1305 through the connector 1307 and transfers the numerical designation to said marker. The marker utilizes the numerical designation to seize and test the subscriber's line 1303. If the line is busy, a busy tone is transmitted back over the incoming connection. If, however, the line is idle, the marker controls the operation of switches 1301 and 1302 through the frame connectors 1308 and 1309 to complete the connection through to the called subscriber's line 1303. Thereupon, ringing current is applied to signal the called line.

If the called line 1303 is found busy when tested by the marker 1309, a busy signal of distinctive frequency is transmitted back over the connection to the calling local office where it is received by the channel filter 325 to operate the signal relay 349. Relay 349 applies ground potential to conductor 350, and a circuit is closed in any well-known manner through the connector 203 and over the trunk 201 to give the operator at position 220 a busy signal.

If, however, as assumed, the called line 313 is idle, ringing current is applied, and a ringing signal is transmitted back over the extended connection to the calling local office 200 where it is received by the channel filter 328. The output energy from the filter 328 is applied over a circuit through the back contacts of relay 351 to the detector circuit 331. The output energy from the detector 331 is applied through the back contacts of relay 351 to operate relay 352. Relay 352 closes a circuit over conductor 353 to signal the operator at position 220 that ringing current is being applied to the called subscriber's line. Relay 352 also operates the relay 351 which locks in a separate circuit in any suitable manner and shifts the detector 331 from filter 328 to channel filter 327 preparatory to the receipt of the signal indicating that the called subscriber has answered. When the party responds to the ringing of his bell and speaks into his transmitter the usual phrase, such as "hello," the speech currents transmitted back over the connection are selected by the filter 327 and applied through the front contacts of relay 351 to the detector 331. The filter 327 is sufficiently broad in its band characteristic to pass all frequencies occurring in the line as a result of the subscriber's response. The detector 331 applies its output energy through the front contact of relay 351 to operate the relay 354. Relay 354 closes a circuit over conductor 355 through the connectors 203 and over the trunk 201 to give the operator a signal indicating that the called party has answered.

Since the sender in the calling local office 200 may contain mechanism for preparing a toll ticket for the call and for recording the duration of the connection and determining the amount of charge to be written on the ticket, it may be held for the duration of the connection to perform the necessary supervisory functions. If desirable, however, the sender in the calling office may release in the usual manner following the completion of the connection, and the ticketing operation may be performed by equipment associated with the junctor 201 or with the outgoing trunk 205.

When the conversation has been completed and the calling party replaces his receiver, a supervisory signal is transmitted over the connection and is received by the sender in the local office, if the same has been retained during the conversation, or by signal receiving mechanism in the trunk circuits. In either case, the operator is apprised that the subscriber has replaced his receiver, and the necessary circuit operations are performed for bringing about the usual release of the automatic switches used in the establishment of the connection.

It will now be assumed that the call above described, which involved the extension of a connection from office 200 through succeeding toll offices 400, 410, 420, 900, 910 and 1200 to the called office 1300, is one that requires the inclusion of an echo suppressor. These echo suppressors are usually provided at the regional centers, such as the offices 420, 900, 430 and 440 (Fig. 1), which are chosen in accordance with geographical locations in the total exchange area. For the purpose of illustration, it is assumed that the echo suppressor is required at the regional center 900 in the connection above mentioned.

At the time the marker 801 in the originating toll office 400 decodes the toll office code, it determines therefrom that the call is one requiring the insertion of an echo suppressor at either the office 430 or the office 900, depending upon which one of these regional centers is ultimately involved in the established connection. The marker transfers this information back to the sender where it is recorded by the operation of relays 539 and 540. One of these relays selects a signal channel characterizing the office 430 and the other selects a signal channel characterizing the office 900. If no echo suppressor is required, relay 541 may be operated from the marker to select a channel for transmitting a signal indicating this fact. Later, when the connection has been completed to the terminating toll office, either the relay 541 becomes effective to transmit a signal indicating that no suppressor is needed or relays 539 and 540 become effective to transmit their characteristic signals. If no suppressor is required, the sender in the regional center 430 or 900, as the case may be, responds to the signal transmitted by the relay 541 and proceeds to release. On the other hand, as here assumed, if a suppressor is required, the sender in the regional center actually involved in the connection responds to its characteristic signal, transmitted either by relay 539 or 540, and prepares to insert the suppressor.

At the same time, the sender at the originating toll office transmits by carrier frequency signals its own toll code designation to the echo suppressor office 900 and transmits to the suppressor office a registration of the route over which the connection was extended from the originating office to said suppressor office. The signal channels 542, 543, 544 for sending the toll code of the originating office are selected by the relay 545. Relay 545 is operated in a circuit from battery, through its winding, through the contacts of relay 627 to ground at the contacts of relay 624, the latter relay having operated when

the routing circuit determined that the call had been successfully completed. Relay 627 is operated at this time over a circuit traceable from battery through its winding, conductor 818, through contacts of the connector 802 to ground at the contacts of the route relay 810 in the marker which characterizes the route designation of the called office. Relay 545, therefore, connects the signaling channels 542, 543, 544 through to the transformer 546, and the necessary signals characterizing the code of the originating toll office 400 are transmitted to the echo suppressor office. The route registration is transferred to the suppressor office by selecting the proper signal channels, such as the channels 547, 548, 549, 550. The necessary information for selecting these channels is derived from the route registering circuit. Since the call was extended over trunks 407, 409 and 411 to the office 900, the relays 602, 605 and 613 in the registering mechanism were operated in the order named. Accordingly, these relays may be utilized to select the signaling channels. Channel 547, for example, is chosen by the operation of relay 551, this relay in turn being operated over a circuit extending from ground, through its winding, over conductor 552, to the connecting rack 628, thence to battery, through the contacts of operating relay 602. In like manner, relays 553 and 554 are operated over circuits extending to the front contacts of registering relays 605 and 613, respectively. Relays 551, 553 and 554 connect their respective signaling channels through the transformer 555 and these signals are transmitted to the echo suppressor office identifying the route between the originating toll office and said suppressor office.

At the echo suppressor office 900 the signal transmitted by the relay 540 is received by the signal receiving mechanism 1006 and is selected by the corresponding channel filter 1031 to operate the relay 1032. Relay 1032 notifies the sender that a suppressor is required. The signals identifying the code of the originating office are received by the mechanism 1006 and are selected by the channel filters 1033, 1034, and cause the registration of this code on the registers 1007, 1008, 1009, 1010, 1011. The signals representing the route are received at the echo suppressor office and are passed by the channel filters 1036, 1037, and are registered on registers 1012, 1013, 1014, 1015 and 1016 in the sender.

When the signal relay 1032 operates in the sender at the suppressor office, it closes a start circuit in the well-known manner from ground, over its front contacts, over conductor 1039, through the connector 904 to the control circuits 918 of the junctor 902. Thereupon the junctor 902 initiates the operation of the echo suppressor connector 908, which may be similar to the usual sender connector 904, and the connector 908 connects an idle echo suppressor 906 in the transmission circuit of the junctor 902. At the same time the signal relay 1032 closes a start circuit over conductor 1040 for the start relay 1108 of the decoder connector 1103. The decoder connector 1103 operates and associates the sender with an idle decoder 1104. The decoder 1104 is similar to the well-known marker decoder used in the cross-bar system, and its purpose is to analyze the registration of the originating and terminating toll office codes and the route registration and to utilize this information to determine the amount of delay for which the suppressor 906 should be adjusted with respect to the incoming and outgoing sections of the connection.

To this end the originating toll registration is transferred from registers 1007 to 1011 through connector 1103 to registers in the decoder 1104. Similarly, the calling route registration is transferred from the registers 1012 to 1016 through the connector 1103 to the decoder 1104. After analyzing these registrations the decoder 1104 determines that the connection from the originating toll office 400 to the suppressor office 900 calls for a certain amount of transmission delay. It expresses this amount by the operation of one or more of the relays 1109, 1110, 1111, 1112. Thereupon a stepping switch 1113 or other suitable transmitting device is set in operation to transmit impulses for stepping the delay adjusting switch 909 of the suppressor. This impulse circuit may be traced from the closed contacts of relays 1109, 1110, 1111, 1112, through the moving brush of the switch 1113, over conductor 1114, through the connector 1103, conductor 1115, through the connector 904, conductor 920, through the normal contacts of a control relay 921, conductor 922, thence through the connector 908, through the winding of the stepping magnet 923 to battery. Magnet 923 steps the brush 909 in accordance with the setting of the relays 1109 to 1112 and the proper amount of capacitance or other impedance is included in the circuit of the suppressor.

As soon as the decoder 1104 completes the adjustment of the suppressor for the calling end of the connection it proceeds to make a similar adjustment for the called or outgoing end of the connection. Accordingly the toll code designation of the called office, which is registered on registers 1001 to 1005, is transferred from these registers over conductors 1041 through the connector 1103 to the decoder 1104. Also the registration of the route used in extending the call from the echo suppressor office to the terminating office 1200 is established in the decoder 1104. As has already been explained, the route chosen is registered in the route registering mechanism 1017, and the operated relays in the registering mechanism cause the operation of relays 1042, 1043 and 1044 in the proper combination. These relays in turn apply ground potential to the conductors 1045, and the registration is thus transferred through the connector 1103 to the decoder 1104. The decoder 1104 utilizes the toll code and routing information to operate again the relays 1109, 1110, 1111 and 1112 to represent the amounts of delay needed for the echo suppressor 906 with respect to the called end of the connection. As above described, the stepping switch 1113 transmits impulses over conductor 1114 through the connector 904, conductor 920 over the closed contact of relay 921, conductor 924 through the connector 908 to operate the stepping magnet 925 to adjust selector switch 910, thus selecting the proper amount of capacitance for the desired delay.

In the extension of the connection above described from toll office 400 to toll office 1200 all preferred trunks 407, 409, 411, 911 and 914 were found idle when tested. Hence the call progressed to the terminating office without failure. It will now be assumed, however, that the connection encounters busy trunks and that alternate routes are tried, some of which in turn encounter busy trunks. Assume, for example, that the connection progresses from office 400 over trunks 407, 409 and 411, successively, with-

out failure but that the next route 911 is found busy when tested. Since routes 407, 409 and 411 are found idle, the success signals resulting therefrom cause the operation of registering relays 602, 605 and 613 at the originating office 400. Likewise, the success signals cause the operation at office 410 of relays for registering the successful selection of trunks 409 and 411; and at office 420 the successful selection of trunk 411 is registered by the operation of a relay corresponding to relay 602. Thereafter, when the route 911 is tested and found busy, the failure signal transmitted back over the extended connection causes the operation of relay 615 at the office 400 and the operation of corresponding relays in each of the intermediate offices 410, 420 and 900.

Since the route 911 is the first or direct outlet from the office 900 the condition of this route is registered by the relays in the registering mechanism 1017 which correspond to relays 601 and 602 of the registering mechanism at the originating office 400 (Figs. 6 and 7). Since this first group 911 is busy a failure signal is transmitted to operate the relay in the registering mechanism 1017 corresponding to relay 601. This relay closes a circuit for operating a relay corresponding to relay 630, and relay 630 causes the sender in the office 900 to call in the marker 1101 for the purpose of making a second trial to determine whether a trunk in the alternate route 421 is available. If the marker finds an idle trunk in this group, it selects it and extends the connection over this trunk to the office 450. Assume, however that route 421 is busy whereupon the marker 1101 applies ground to conductor 1116 and a circuit is extended through the connector 1102, conductor 1117 for operating the relay 1046. Relay 1046 applies negative potential to conductor 1030, and a circuit is extended over the front contact of a relay in the registering mechanism 1017 corresponding to relay 601 and through the contacts and windings of relays corresponding to relays 606 and 607. The relay corresponding to relay 606 operates, in the manner to be described more fully hereinafter in connection with the operation of the routing mechanism at the originating office, and causes the release of the sender in the office 900.

Before the sender in office 900 releases it transmits the failure signal over the extended connection to offices 420, 410 and 400. At office 400 this signal causes the application of negative potential to conductor 526 which extends through the front contacts of relays 602, 605 and 613 over conductor 618 through the front contact of relay 615 and thence through the windings of relays 701 and 702. Relay 701 alone operates to register the fact that route 421 is busy. When relay 701 operates, a circuit is closed from the negative pole of battery through the front contact of relay 615, front contact of relay 701, conductor 703, back contact of relays 617 and 611, conductor 631, back contact and winding of relay 612 to ground. Relay 612 operates in this circuit and locks through its front contact and winding. Another circuit is closed from negative pole of battery through the front contact of relay 615, front contact of relay 701, conductor 704, back contact of relay 705, conductor 706 through the contacts and windings of relays 707 and 708 in parallel to ground. Relay 707 alone operates and locks through its front contact. Likewise a registration is made in offices 410 and 420 of the busy condition of route 421.

Thus the call is blocked at office 900 since all routes therefrom are busy, and the registering mechanism in the preceding office 420, recognizing this fact, proceeds to cause the release of the trunk 411 from the office 420 to the office 900 and to cause the sender in office 420 to try the alternate route 423 extending from office 420 to office 440. Assuming the alternate route 423 out of office 420 to be busy, a failure signal is transmitted back to offices 410 and 400, and the sender in office 420 releases. At the office 400 the failure signal causes negative potential to be applied to conductor 526 and thence through the front contact of relay 602, conductor 603, back contact of relay 608, conductor 609, front contact of relay 605, conductor 610, back contacts of relays 608 and 611, front contact of relay 612, through the contacts and windings of relays 709 and 710 in parallel to ground. Relay 709 alone operates and locks, registering the fact that route 423 is busy. When relay 709 operates, a circuit is closed from negative pole of battery through the front contacts of relay 612, front contacts of relay 709, back contacts of relays 611 and 608 through the contact and winding of relay 604 to ground. Relay 604 operates and locks. Another circuit is closed from the negative pole of battery through the front contacts of relays 612 and 709, through the back contacts of relay 711, through the contacts and windings of relays 712 and 713 to ground. Relay 712 alone operates and locks in this circuit.

The same information is registered in office 410 and the registering mechanism thereat, recognizing that the call has again been blocked, releases the trunk 409 and tries the alternate route 424 extending to the office 430. Assuming the route 424 to be busy, another failure signal is registered in office 410 and is also transmitted back to the originating office 400. In office 400 this signal causes the application of negative potential to conductor 526 and a circuit is extended through the front contact of relay 602, conductor 603, back contact of relay 608, front contact of relay 604 and thence through the contacts and windings of relays 714 and 715. Relay 714 operates and locks, and a circuit is completed from the negative pole of battery through the contacts of relays 604 and 714, conductor 716, back contacts of relay 608 through the contacts and winding of relay 601 to ground. Relay 601 operates in this circuit and locks. The operation of relay 601 is an indication that all routes beyond available by way of the direct route 407 out of office 400 are busy and that the office 400 should now try the alternate route 416. When relay 601 operates it closes a circuit from the negative pole of battery through its contacts and armature through the winding of relay 630. The operation of relay 630 causes the sender to effect the release of trunk 407 by releasing switches 402 and 404. Also this relay causes the sender to reseize the marker 801 for the purpose of making a trial by way of alternate route 416. In the meantime the sender in the office 410 has released. Thus the original attempt over route 407, which succeeded in progressing for several successive links, has been progressively released as each office exhausted all possibilities of completing the connection, and the originating office 400 is now about to make its final attempt to extend the connection toward the desired toll office 1200. Assuming the route 416 contains an idle trunk, the sender and marker in the office 400 proceed to operate the switches 402 and 404 to

extend the connection over an idle trunk in the route 416 to the office 460 beyond.

Each time one of the toll offices found all routes available over this direct route busy and rerouted the connection over its alternate route to an office beyond it also transferred to the office beyond the registration which it had established concerning the busy or idle condition of all trunk groups that are available to said office beyond in its attempt to further the connection. The manner in which this transfer is accomplished will now be explained in detail in connection with the final attempt on the part of office 400 to complete the connection by way of its alternate route 416. Following the extension of the connection from office 400 over an idle trunk in the route 416 to the office 460 a registration is transferred from the registering mechanism in office 400 to the similar registering mechanism in office 460 indicating the condition of all trunks previously tested and found busy in the network available to the office 460. The purpose of sending this information to the office 460 is to enable it to avoid routes containing busy groups of trunks and to try only those routes which promise success. The signals representing the route registration are transmitted to the office 460 by selecting a combination of the transmitting channels in the mechanism 529 corresponding to the condition of the various links in the network. The channels are selected by relays, one of which, relay 556, is illustrated. These relays are operated in the proper combination by the presence of potential on various leads of the group 632 appearing on the connecting rack 628. The leads of the group 632 extend to the front contacts of the different registering relays in the registering mechanism. By inspecting the registering circuit it will be found that relay 612 is operated to close the lead 633 when the trunk 421 is found busy, that relay 709 is operated to close the lead 634 when trunk 423 is unavailable, that relay 707 is operated to close lead 635 when trunk 421 is unavailable, and similarly that the operated condition of relays 615, 701, 718, 719, 621 and 720 indicates respectively that trunk 911 is busy, that trunks 911 and 421 are busy, that trunk 427 is busy, that trunks 427 and 428 are busy, that trunk 914 is busy and that trunk 429 is busy.

Considering specifically the example assumed, in which trunks 424, 423, 421 and 911 have been found busy, the result is that relays 612, 709, 707, 615 and 701 are operated in the registering mechanism at office 400. Thus conductors 633, 634, 635, 637 and 638 are closed to operate corresponding relays, including relay 556 in the channel transmitting mechanism. The signals are transmitted to the office 460 where they are received and operate relays for causing the operation of the proper busy registering relays in the route registering circuit. Assuming that the registering circuit of Figs. 6 and 7 is located at the office 460, it will be noted that the group of leads 639 extend to the armatures and windings of the respective pairs of registering polarized relays. By connecting potential to the leads 639 in combinations represented by the incoming registering signals the registering relays are operated in corresponding combinations to register the condition of the trunk pattern in the office 460. For the particular combination here being considered the proper registering relays are operated and locked to indicate that trunks 411, 423, 425, 911 and 421 are unavailable. It will be noted that of this group of trunks only trunks 424, 423, 421 and 911 were actually tested and found busy. However, it would be useless for the office 460 to extend the connection by way of trunk 411 since the connection would then be blocked at office 900 due to the busy condition of both outgoing routes. Likewise it would be useless to extend the call over trunk 425 to the office 900 for the same reason. Accordingly the registration of the busy routes when received in the sender of office 460 may be transferred to the marker together with the registration of the called toll designation, which is also transferred to office 460 from office 400, and the marker may make use of this information to determine the selection of a route relay for controlling the operation of the switches to route the call over trunks in groups which are not known to be busy. For example, the route relay selected may prefer the route from office 460 including trunks 431, 426, 427 and 914 as a first choice and trunks 421, 426, 428 and 429 as a second choice. Having thus received full information concerning the designation of the called toll office 1200 and the routes available between office 460 and office 1200, the switching equipment in the office proceeds to extend the call over these available routes. For each success or failure a signal is transmitted back to the originating office 400 where it is registered in the manner already explained.

To further illustrate the manner in which the relays in the registering mechanism of the office beyond are energized in response to the incoming signals, assume that the registering mechanism shown in Figs. 6 and 7 at office 460 is receiving such a registration from a preceding toll office. The incoming carrier frequency signals are first received by the receiving mechanism 506 and are passed by selective channel filters 559, 560, 561, etc., causing the operation of relays 562, 563, 564, etc. These relays apply negative potential to conductors 565, 566, 567, etc., of the group 639, resulting in the operation of the proper registering relays, such as relays 604, 707 and 718. Relay 604 indicates that the route 409 in the network is busy, relay 707 indicates that the route 425 is busy, and relay 718 indicates that route 427 is busy. By extending circuits from the operated registering relays into the marker 801, the information thus obtained by the marker enables it to determine which route to choose in its attempt to extend the call. For example, relay 604, when thus operated to register a busy link in the pattern, closes a circuit over conductor 649 to the marker, and each of the other registering relays is arranged to close similar circuits (not shown) to transfer this information to the marker.

If the terminating toll office on any particular call is some office other than office 1200 previously assumed, the registering mechanisms in each of the preceding offices are automatically adjusted to take this fact into account. For example, if the call originates in office 400 and is destined to terminate in office 410 the registering mechanism in office 400 must be adjusted to complete its record upon the testing of a single route 407. This is accomplished by the route relays in the marker which determine the called office and therefore the number of links to be tested in reaching that office. When the code is received in the marker 801 indicating that the office 410 is being called, the corresponding route relay 819 operates and closes a circuit through the connector 802 for operating relay

640 in the registering circuit. When therefore the route 407 is tested and found idle a circuit is closed from conductor 526 through the back contact of relay 601 and the front contact of relay 602 through the front contact of relay 640 directly to conductor 623 to operate relay 624 indicating that the call has been successful. Similarly, if the call is intended for terminating toll office 910 the route relay, such as relay 809, operates relay 641 in the registering circuit. If thereafter trunk routes 407, 409, 411 and 911 are successfully tested, the registering circuit is extended over conductor 619 through the back contact of relay 617 through the front contact of operated relay 641 to conductor 623 indicating that the call has been successfully completed to the terminating office. In like manner other relays, such as relays 642 and 643, may be operated by the route relays in the marker to determine the routing for different terminating offices.

It may also be desirable to eliminate automatically certain links in the route network available to any particular office regardless of their busy or idle condition. For instance, the link 423 may be omitted from the patterns available to the office 400 in extending calls to offices beyond, and this is accomplished automatically by the route relays in the marker at office 400. To this end it will be noted that the group of leads 644 appearing on the connecting rack 628 is connected to the different pairs of registering relays in the recording mechanism. By closing circuits over these leads from the contacts of the route relays of the marker it is possible to eliminate any one or more of the links in the network. To eliminate the link 423, as suggested, the lead 645 in the group 644 may be connected through the front contact of the route relay 820 to the negative pole of battery, causing the operation of relay 709. An inspection of the registering mechanism will show that the operation of relay 709 serves to eliminate the trunk route 423 so that the registering process skips this route and proceeds with the next link in the pattern. Hence if trunk 411 is found busy when tested, no attempt will be made to seize route 423, and the offices 410 and 400 will be apprised that office 420 was unsuccessful in its effort to forward the call. Therefore, office 410 will proceed at once to try its alternate route.

It was explained how the relays of the registering mechanism in each succeeding toll office are operated to register successes or failures as the call progresses and how the relay 601 at any particular office is ultimately operated when all possibilities of completing the call out of said office are exhausted. The operation of relay 601 results in the operation of relay 630 which is the signal to the sender to release the connection over the preferred route and to try the alternate route. If the alternate route extending from the office is found busy, meaning that the call cannot be completed, the failure signal is applied to conductor 526, and the circuit extends through the front contacts of relay 601 and the contacts and windings of relays 606 and 607 to ground. Relay 606 alone operates and a circuit is now completed from the negative pole of battery through the contacts of relay 601, contacts of relay 606, conductor 646 through the winding of relay 557 to ground. Relay 557 closes an obvious circuit for the slow-operate relay 647. Relay 647 operates and closes an energizing circuit for the sender release relay 648. Before the sender releases, however, relay 557 renders the signal channel 558 effective and the necessary supervisory signal is transmitted to the preceding office indicating that the call has failed.

What is claimed is:

1. In a telephone system, a plurality of offices, trunks interconnecting said offices, certain offices having a plurality of different routes over said trunks to other offices, automatic switching means in said offices for progressively extending a connection in the direction of a called office, means effective if the preferred route trunks outgoing from any particular office test busy for causing the selection of an alternate route trunk, and means in one of said offices for registering the condition of the trunk routes tested in other offices during the establishment of a connection to a called office.

2. In a telephone system, a plurality of offices, trunks interconnecting said offices to form a network of variable routes between calling and called offices, each office having a plurality of different routes over said trunks to other offices, automatic switches in each of said offices for testing the outgoing routes in the desired directions and for extending a connection progressively from one office to another over available routes toward the called office, and means in one of said offices for establishing a temporary registration of the condition of all trunk routes tested during the process of extending the connection toward the called office.

3. In a telephone system, a plurality of offices, trunks interconnecting said offices, certain offices having a plurality of different routes over said trunks to other offices, automatic switching means in said offices for progressively extending a connection in the direction of a called office, means effective if the preferred route trunks outgoing from any particular office test busy for causing the selection of an alternate route trunk, and means in each office for registering the condition of all trunk routes tested during the progress of the connection from said office toward the called office.

4. In a telephone system, a plurality of offices, trunks interconnecting said offices, certain offices having a plurality of different routes over said trunks to other offices, automatic switching means in said offices for progressively extending a connection in the direction of a called office, means effective if the preferred route trunks outgoing from any particular office test busy for causing the selection of an alternate route trunk, means in one of said offices for registering the condition of the trunk routes tested in all offices during the establishment of a connection to a called office, and means for utilizing said registration to control the routing of the connection.

5. In a telephone system, a plurality of offices, trunks interconnecting said offices to form a network of variable routes between calling and called offices, each office having a plurality of different routes over said trunks to other offices, automatic switches in each of said offices for testing the outgoing routes in the desired directions and for extending a connection progressively from one office to another over available routes toward the called office, means effective each time a trunk route is tested for sending a signal to the preceding offices indicating the busy or idle condition of said route, and means in each office responsive to said signals for registering the condition of the routes tested.

6. In a telephone system, a plurality of offices,

trunks interconnecting said offices, certain offices having a plurality of different routes over said trunks to other offices, automatic switching means in said offices for progressively extending a connection in the direction of a called office, means effective if the preferred route trunks outgoing from any particular office test busy for causing the selection of an alternate route trunk, means effective each time a trunk route is tested for sending back to the preceding offices a success signal if a trunk is idle and a failure signal if no trunk is idle, and means in each office responsive to said signals for registering the condition of the trunk routes tested.

7. In a telephone system, a plurality of offices, trunks interconnecting said offices, certain offices having a plurality of different routes over said trunks to other offices, automatic switching means in said offices for progressively extending a connection in the direction of a called office, means effective if the preferred route trunks outgoing from any particular office test busy for causing the selection of an alternate route trunk, means in each office for registering the condition of all trunk routes tested during the progress of the connection from said office toward the called office, and means effective when any particular office finds busy all routes outgoing therefrom for utilizing the registration established in the preceding office to cause the connection to be rerouted over an alternate route outgoing from said preceding office.

8. In a telephone system, a plurality of offices, trunks interconnecting said offices, automatic switches for extending a connection from an originating office through intermediate offices to a terminating office, each office having a direct route trunk and an alternate route trunk outgoing therefrom toward the terminating office, and means effective when any office finds busy all routes extending therefrom toward the terminating office for causing the preceding office to reroute the connection over the alternate route outgoing therefrom toward the terminating office.

9. In a telephone system, a plurality of offices, trunks interconnecting said offices, a particular one of said offices having a plurality of different routes over said trunks toward a called office, automatic switches in said offices for testing the available routes and for progressively extending a connection toward the called office, means in said particular office for establishing a registration of the condition of the routes tested beyond after the connection has been extended from said particular office over one of the outgoing routes available thereto, means effective when said registering means indicates the busy condition of all available routes beyond for causing the release of the connection at said particular office and the extension of the connection over another of the available routes outgoing from said particular office.

10. In a telephone system, a plurality of offices, trunks interconnecting said offices, each office having a plurality of different routes over said trunks toward a called office, automatic switching means in each office for testing the available outgoing routes and for progressively extending a connection toward the called office, means in a particular one of said offices for establishing a registration of the busy or idle condition of all routes tested during the extension of said connection from said particular office toward the called office, means effective when said registration indicates the busy condition of all available routes for causing the switching mechanism in said particular office to reroute the connection over an alternate route to another office beyond, and means for transferring the registration established in said particular office to said office beyond.

11. In a telephone system, a plurality of offices, trunks interconnecting said offices, each office having a plurality of different routes over said trunks toward a called office, automatic switching means in each office for testing the available outgoing routes and for progressively extending a connection toward the called office, means in a particular one of said offices for establishing a registration of the busy or idle condition of all routes tested during the extension of said connection from said particular office toward the called office, means effective when said registration indicates the busy condition of all available routes for causing the switching mechanism in said particular office to reroute the connection over an alternate route to another office beyond, means for transferring from said particular office to said office beyond the registration of the busy condition of all routes tested during the original extension of the connection from said particular office, and means responsive to the registration transferred to said office beyond for determining the selection of the routes outgoing from said office beyond toward the called office.

12. In a telephone system, a plurality of offices, trunks interconnecting said offices to form a routing network, each office having a plurality of trunk routes over said network toward the called office, automatic switches in said offices for extending a connection progressively from an originating office through intermediate offices toward said called office, means for transmitting a code designation over the extended connection to control the selective operation of said switches, and means in any particular office controlled by said code designation for determining the pattern of the routing network available to the switches in said particular office for the further extension of said connection toward the called office.

13. In a telephone system, a plurality of offices, trunks interconnecting said offices to form a routing network, each office having a plurality of trunk routes over said network toward the called office, automatic switches in said offices for extending a connection progressively from an originating office through intermediate offices toward said called office, a register sender in each of said offices, means for transmitting the code designation of the called office over the extended connection to said register senders, means controlled by the sender in each office for causing the selective operation of the switches therein in accordance with said code designation, and means in each office controlled by said code designation for determining the pattern of the routing network available to the switches in said office for further extending the connection to the called office.

14. In a telephone system, a plurality of offices, trunks interconnecting said offices to form a routing network, each office having a plurality of trunk routes over said network toward the called office, automatic switches in said offices for extending a connection progressively from an originating office through intermediate offices toward said called office, means for transmitting a code designation over the extended connection to a particular office, means responsive to said

code designation for controlling the selective operation of the switches in said particular office, a route pattern mechanism in said particular office responsive to said code designation for determining the pattern of the routing network available to said particular office for the further extension of the connection toward the called office, means for testing the routes forming the determined pattern during the extension of the connection from said particular office, and means for operating the pattern mechanism to indicate the condition of the routes tested in said determined pattern.

15. In a telephone system, a plurality of offices, trunks interconnecting said offices, automatic switches in said offices for extending a connection from an originating office through intermediate offices in the direction of a terminating office, means for transmitting the designation of the terminating office over said connection to control the selective operation of said switches, an echo suppressor in a particular one of said intermediate offices, and means controlled by said designation for automatically including said echo suppressor in the extended connection.

16. In a telephone system, a plurality of offices, trunk lines interconnecting said offices, automatic switches for extending a connection over said trunk lines from an originating office through an intermediate office to a terminating office, means for transmitting the designation of the terminating office to said intermediate office to control the selective operation of the switches therein, an echo suppressor in said intermediate office, means controlled in accordance with said designation for transmitting signals from said originating office to said intermediate office, and means in said intermediate office responsive to said signals for including said echo suppressor in the established connection.

17. In a telephone system, a plurality of offices, trunks interconnecting said offices to form a plurality of routes between an originating office and a terminating office, automatic switches in said offices for testing the available outgoing routes and for extending a connection from the originating office through intermediate offices to the terminating office, means for controlling the selective operation of said switches in accordance with the designation of said terminating office, an echo suppressor in one of said intermediate offices, means dependent upon the designation of said terminating office for transmitting a signal over the extended connection to said echo suppressor office, means responsive to said signal for automatically including said suppressor in the established connection, means for transmitting to said suppressor office information concerning the route over which the connection was extended to said office, and means controlled in accordance with said information for determining the transmission characteristics of said echo suppressor.

18. In a telephone system, a plurality of offices, trunks interconnecting said offices forming a network including a plurality of routes from each office toward a called office, automatic switches controlled in accordance with the designation of the called office for extending a connection progressively from a calling office through intermediate offices toward the called office, means in a particular intermediate office for registering the busy or idle condition of all routes tested in the extension of the connection from said particular office toward the called office, an echo suppressor in said particular office, means depending upon the designation of the called office for transmitting a signal to said particular office, means responsive to said signal for causing the automatic insertion of said echo suppressor in the established connection, means for transmitting from the originating office to said suppressor office the identity of the originating office and information concerning the route over which the connection was extended to said suppressor office, and means in said suppressor office controlled in accordance with the designations of the originating and called offices and in accordance with said route information for adjusting the transmission characteristics of said echo suppressor.

19. In a telephone system, central offices, trunks interconnecting said offices, automatic switches in said offices for progressively extending a connection over said trunks from one office to another in the direction of a called office, a plurality of sources of current of different frequencies in each of said offices, means including said current sources for transmitting from each office to the next code signals representing the designation of the called office, and means in each office responsive to said code signals for causing the selective operation of the switches therein.

20. In a telephone system, central offices, trunks interconnecting said offices, automatic switches in said offices for extending a connection progressively over said trunks toward a called office, a register sender in each of said offices, a plurality of sources of current of different frequencies in each office, means controlled by the sender in each office for transmitting over the extended connection to the office beyond code signals from said sources representing the called designation, and means controlled by each successive sender in response to the code signals received for causing the selective operation of the switches in the corresponding office.

21. In a telephone system, a calling office, a called office, interconnecting trunks, automatic switching means for extending a connection over one of said trunks from the calling office to the called office, means for transmitting supervisory signals from the called office to the calling office by applying to the extended connection alternating currents having frequencies lying within a relatively narrow band, signal receiving means at the calling office including a narrow band-pass filter tuned to the frequencies of said supervisory signals and a broad band-pass filter tuned to the frequencies of the voice range, means responsive to the signal frequencies passing said narrow band filter for effecting supervisory signals in the calling office, means for automatically substituting said broad band filter for said narrow band filter, and means responsive to the currents transmitted over the extended connection and through said broad band filter when the called party speaks into his telephone for effecting an answering supervisory signal in the calling office.

22. In a telephone system, a calling office, a called office, a telephone line accessible to said called office, interconnecting trunks, automatic switching means for extending a connection over one of said trunks from the calling office to the called office, means for transmitting supervisory signals from the called office to the calling office, means for effecting a signal indicating that ringing current is being applied to the called line,

said signals being effected by applying to the extended connection alternating currents having frequencies lying within a relatively narrow band, signal receiving means at the calling office including a narrow band-pass filter tuned to the frequencies of said supervisory signals and a broad band-pass filter tuned to the frequencies of the voice range, means effective in response to the signal currents passing said narrow band filter when ringing current is being applied to the called line for producing a ringing supervisory signal in the originating office, means also responsive to the signals passing said narrow band filter for disabling said narrow band filter and substituting therefor said broad band filter, and means responsive to the voice currents passing said broad band filter when the called party answers by speaking into his telephone for effecting an answering supervisory signal in the calling office.

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