July 15, 1941. F. A. HUBBARD 2,248,995

TELEPHONE SYSTEM

Filed June 21, 1940 4 Sheets-Sheet 1

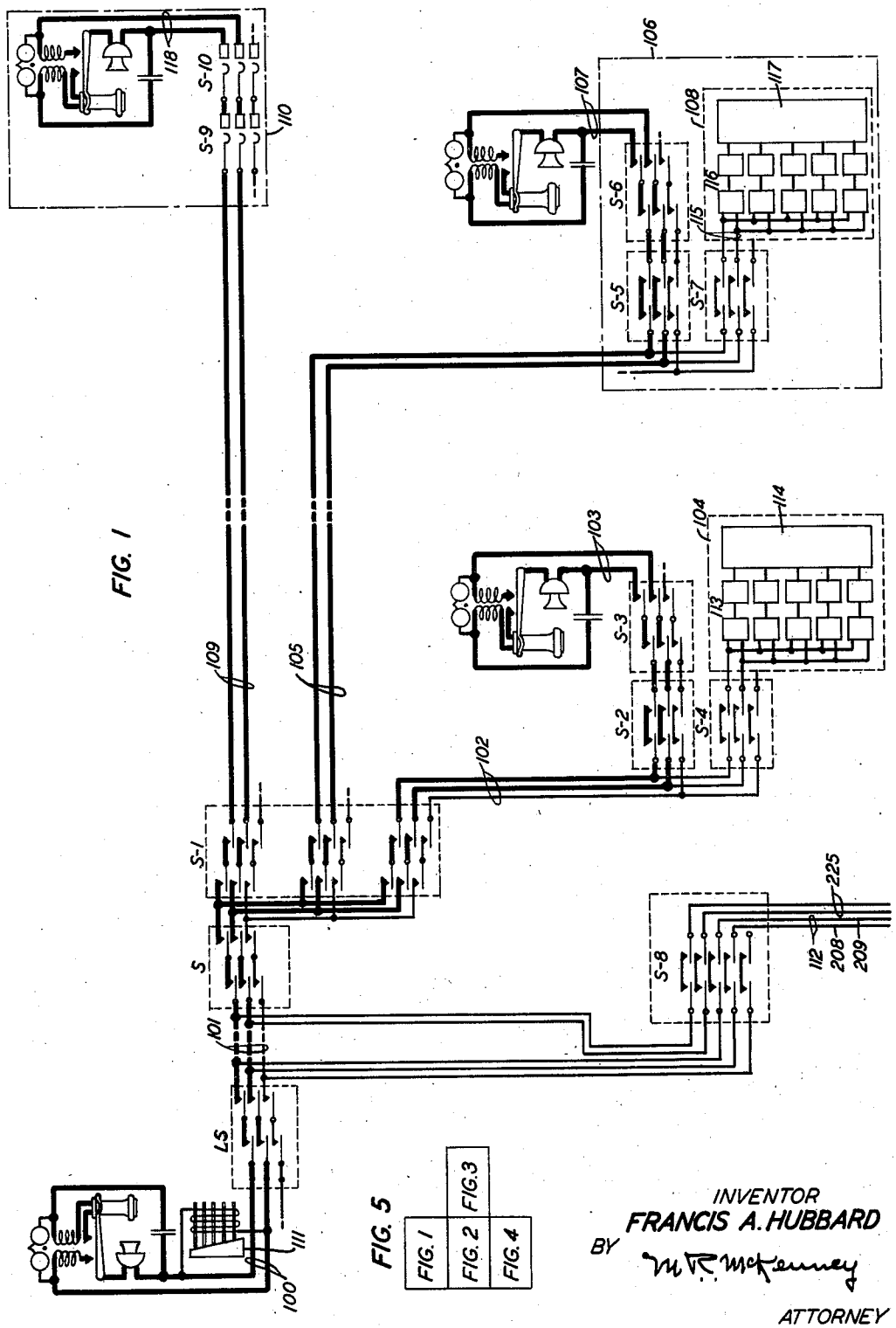


FIG. 1

FIG. 5

FIG. 1	FIG. 3
FIG. 2	FIG. 4

INVENTOR
FRANCIS A. HUBBARD
BY
ATTORNEY

July 15, 1941. F. A. HUBBARD 2,248,995

TELEPHONE SYSTEM

Filed June 21, 1940 4 Sheets-Sheet 2

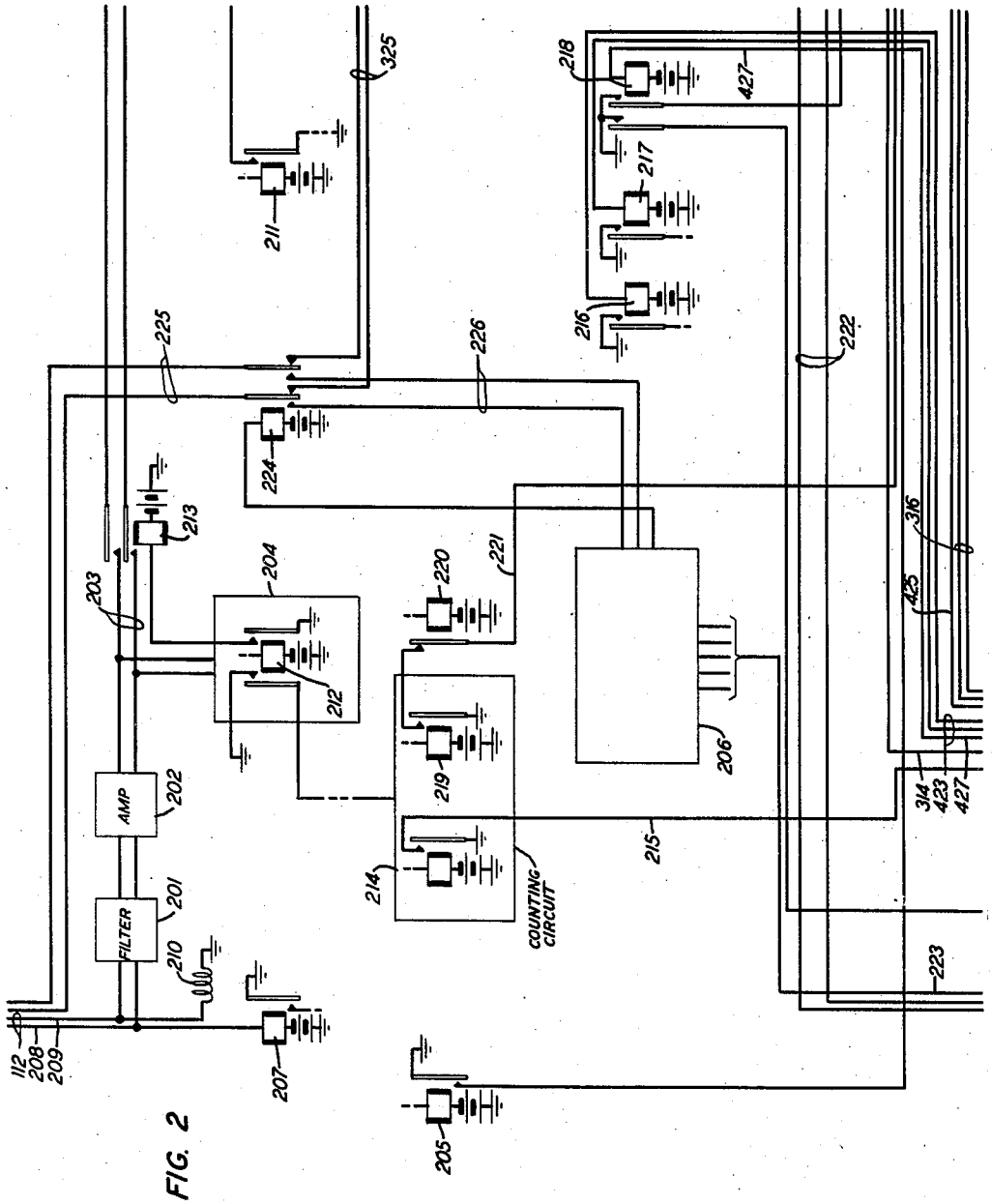


FIG. 2

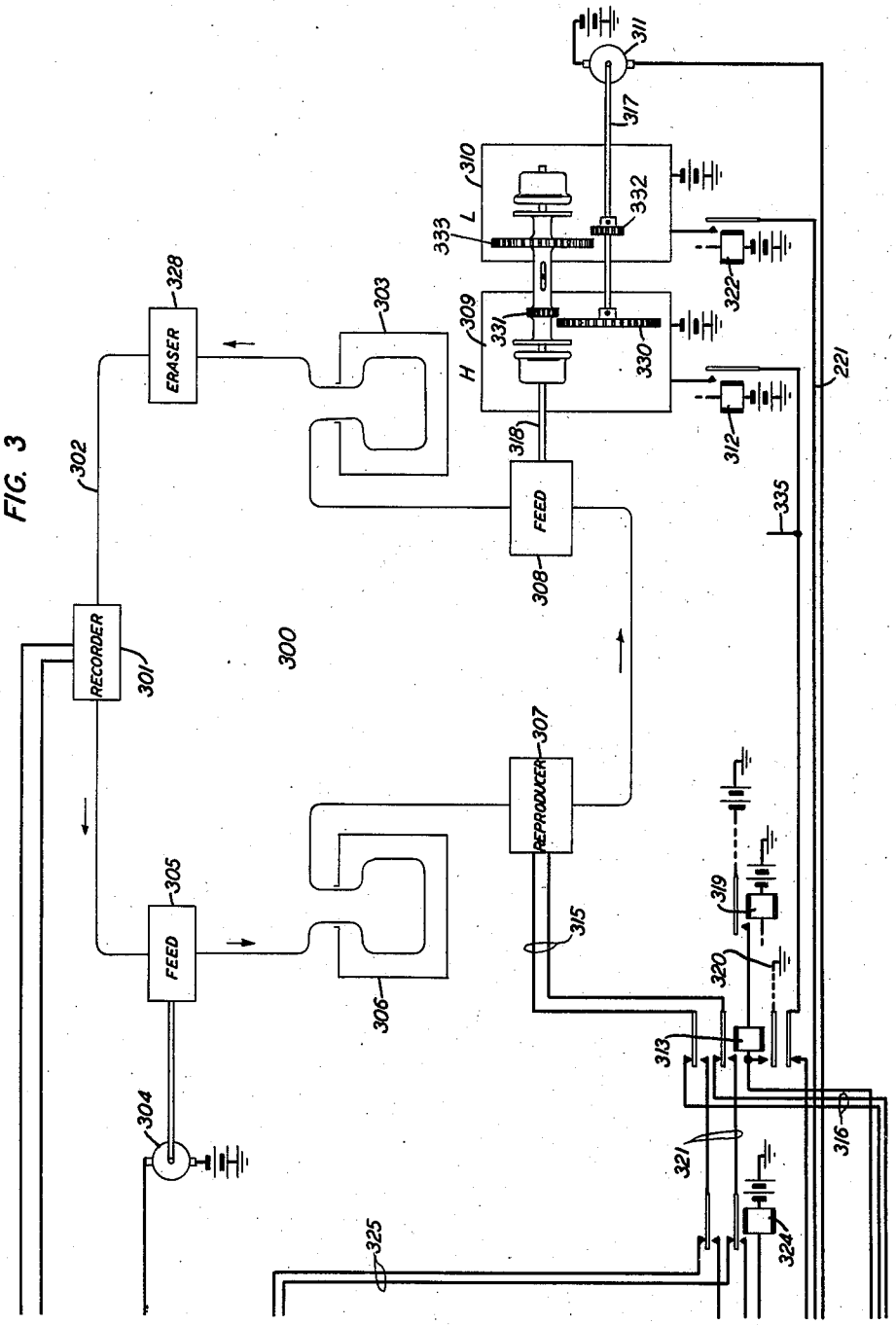
INVENTOR
FRANCIS A. HUBBARD
BY M. T. McKenney
ATTORNEY

July 15, 1941. F. A. HUBBARD 2,248,995

TELEPHONE SYSTEM

Filed June 21, 1940 4 Sheets-Sheet 3

FIG. 3



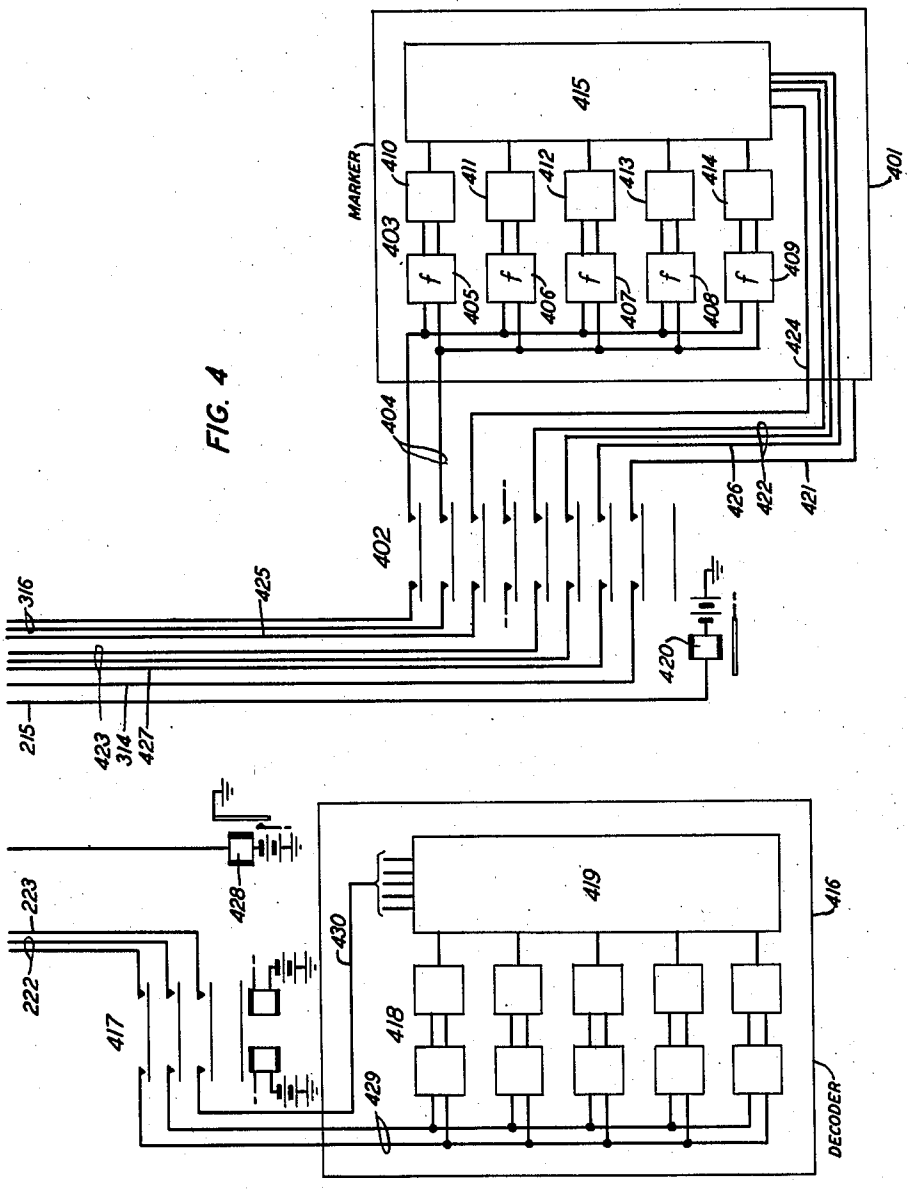
INVENTOR
FRANCIS A. HUBBARD
BY
ATTORNEY

July 15, 1941. F. A. HUBBARD 2,248,995

TELEPHONE SYSTEM

Filed June 21, 1940 4 Sheets-Sheet 4

FIG. 4



INVENTOR
FRANCIS A. HUBBARD
BY W. T. McTierney
ATTORNEY

Patented July 15, 1941

2,248,995

UNITED STATES PATENT OFFICE

2,248,995

TELEPHONE SYSTEM

Francis A. Hubbard, Maplewood, N. J., assignor to Bell Telephone Laboratories, Incorporated, New York, N. Y., a corporation of New York

Application June 21, 1940, Serial No. 341,628

12 Claims. (Cl. 179—18)

This invention relates to telephone systems and particularly to systems in which automatic switches are used for establishing conversational connections.

The object of the invention is to simplify and otherwise to improve the mechanisms which receive and utilize the designations transmitted over telephone lines for the purpose of controlling the operation of the automatic switches.

It has been proposed heretofore to employ alternating currents in combinations of different frequencies for sending called designations over a subscriber's line to the central office and to record these designation signals on a magnetic tape in the central office sender as they are received from the line. The office code portion of the designation is then reproduced from the tape, separated into the component frequencies by a selective signal receiver and utilized to set the code digit registers. In systems employing markers this code registration is then transferred to a selected marker, which controls the operation of the switches of the preliminary switching stages. Thereupon the numerical portion of the designation is reproduced from the tape in the sender and transmitted over the extended connection to a terminating recording sender where it is received and used to complete the connection. A system of this kind is disclosed and claimed in the application of B. F. Lewis and H. A. Lewis, Serial No. 341,631, filed June 21, 1940. In such a system, however, it is necessary to provide each one of the originating senders with a selective signal receiver for setting the office code registers. Moreover, an originating office having senders equipped with these magnetic recorders can extend calls only to other offices having senders also provided with alternating current signal receivers.

It is, therefore, a feature of the present invention to realize economies and other advantages over these prior systems by eliminating the somewhat expensive signal receiver from all of the originating senders. This is accomplished by providing each of the markers, the number of which is small compared with the number of senders required, with a signal receiver, which receives the office code designation directly from the magnetic medium in the sender. More specifically, the office and numerical designations are received from the subscriber's line in the form of alternating current signals and recorded on a magnetic tape or other medium. The sender is connected to a marker, and the office code is transferred as alternating current signals from the tape to the frequency selective receiver in the marker. Thereafter the numerical designation is reproduced from the magnetic tape and is sent as alternating signals over the extended connection to the terminating sender, provided this latter sender is equipped with a frequency selective receiver.

Some offices in the area may have switches which are controlled by revertive pulses, such as panel type switches. Others may be equipped with step-by-step switches which are operated by direct current impulses sent directly thereto. And it is, of course, desirable that calls should be completed to these offices from the originating office as well as to offices equipped to receive the designations in the form of alternating current signals.

Accordingly another feature of the invention is a system in which the originating office, above described, is provided with a number of common decoders, in addition to the recording senders and markers, which are used only on calls that are to be completed to offices having switches requiring direct current impulses either directively or revertively transmitted. When the marker receives the office code from the magnetic tape in the sender, it translates the code and sends class-of-call information back to the sender. If this information indicates the called office is equipped to receive alternating current designation signals, these signals are immediately sent thereto from the magnetic tape in the originating sender. However, if the called office requires direct current impulses, the sender seizes one of the decoders, and the numerical designation on the tape is sent thereto in the form of alternating current signals. A frequency selective receiver in the decoder translates these signals into register operations, and the registration thus established in the decoder is sent back to the sender where it is set up on transmitting registers in form suitable for controlling the switches or other mechanism in the called office.

Another feature of the invention is an arrangement in which the magnetic tape in the sender is driven at a relatively high speed during the process of transferring the office code designation from the tape to the marker and at a relatively low speed during the reproduction and transmission of the numerical designation. By driving the tape at high speed while the office code is being transferred, the holding time of the marker is materially reduced.

Thus the advantages of alternating current signaling are realized in the transmission of telephone designations, while at the same time the

more expensive parts of the equipment necessary for receiving and translating these designations are located in the markers and decoders in order to reduce to a minimum the amount of such equipment required.

These and other features of the invention will be discussed more fully in the following detailed specification.

In the drawings accompanying the specification, Figs. 1 to 4, when arranged in the order illustrated in Fig. 5, disclose an automatic telephone system incorporating the features of this invention.

Fig. 1 shows a calling subscriber's line appearing in a local central office and having access through automatic switches therein to local called subscribers' lines. This figure also shows the switches and equipment in two distant offices of different classes;

Figs. 2 and 3 show a common recording sender in the local office; and

Fig. 4 shows a common switch-controlling marker, and a common decoder together with means for connecting them to the common recording senders.

The subscribers' lines in the local office, including the line 100, appear in line switches LS. These line switches are joined to first or district selector switches S by means of link circuits or junctors 101. The district selectors S have access to office selectors S—1 through interconnecting junctors, and the office selectors have access to trunks extending to the terminating equipment in the same office and to outgoing trunks extending to the distant offices. For example, the local trunk 102 extends from the office selector S—1 to the incoming selector S—2 in the same office, and the incoming selector together with the final selector S—3 serves to complete the connection to a local called line 103. The local incoming trunk 102 also has access through an incoming sender selector switch S—4 to an incoming sender 104. The sender 104 in cooperation with the terminating markers (not shown) controls the operation of the incoming and final switches S—2 and S—3 for completing these connections.

The interoffice trunk 105 appearing in the office selector S—1 extends to the distant office 106 where it appears in an incoming selector S—5 which serves to further extend the connection through the final selector S—6 to a called line 107. The interoffice trunk 105 is also extended through the sender selector switch S—7 to the incoming sender 108.

Although the invention is not so limited, it is assumed for the purpose of the present disclosure that the switches used in the originating office and in the distant office 106 are of the cross-bar type and that these switches are controlled in their selective operations by means of common register senders and common switch-controlling markers.

The interoffice trunk 109, to which the office selector S—1 also has access, extends to a distant office 110 which is assumed to be equipped with switches of a different type, such as panel switches or step-by-step switches.

In the system disclosed it is assumed that the subscribers' lines are arranged for the transmission of telephone designations in the form of alternating currents of different frequencies, each of the several digital characters of a designation being represented by a particular combination or code of frequencies. For example, if five different frequencies are employed, each digital character may be represented by a combination of two of the five frequencies. In order that these designation signals may be transmitted over the subscriber's line to the central office, the substation is equipped with a transmitter of any suitable type which the subscriber may manipulate to send the successive signals, two frequencies at a time, characterizing the wanted designation. A reed type of sender, such as the sender 111 located at the substation of line 100, is suitable for this purpose. A transmitter of this type is disclosed and described in R. F. Mallina Patent 2,147,710 of February 21, 1939.

At the local central office the recording sender, shown in Figs. 2 and 3, is arranged to receive and record the alternating current signals transmitted over the subscriber's line. The sender is automatically associated with the junctor 101 when the subscriber calls by means of the sender selector switch S—8. The alternating current signals incoming from the subscriber's line pass through the sender selector S—8 and over the signaling circuit 112 to the sender where they are selected by a band-pass filter 201. After passing through the filter 201 the signal currents are amplified by an amplifier 202 and delivered to the output circuit 203. Some of the energy from the amplifier 202 is applied to an enabling device 204. The enabler 204 serves to extend the output circuit 203 to the recording unit 301 of a magnetic recording mechanism 300. Generally speaking the function of the enabling device 204 is to respond to the incoming signals and to prepare a circuit at the proper time for delivering these signals to the recorder and to maintain the prepared circuit for the necessary period of time. Since the specific structure of the enabler is not necessary to an understanding of the present invention, it has been shown in diagrammatic form. For a complete description of the manner in which apparatus of this kind functions, reference may be had to the pending application of A. A. Lundstrom, Serial No. 306,466, filed November 28, 1939.

The magnetic recording mechanism of the sender includes a movable wire or tape 302, a substantial portion of which is normally stored in the container 303. At any suitable time following the seizure of the sender the driving motor 304 is started, and the feed mechanism 305 drives the tape in the direction indicated by the arrows, withdrawing it from the supply container 303 and advancing it through the recording unit 301 to the second container 306. As the tape passes through the recording unit 301 it is magnetized in accordance with the incoming alternating current signals to record both the office and numerical designations, and the magnetized tape is then stored in the container 306.

After all or a substantial part of the designation is recorded on the tape 302, the sender seizes and connects itself to an idle switch-controlling marker 401 through a marker connector 402. As soon thereafter as the marker is ready, that section of the tape 302 on which the office designation is recorded is withdrawn from the container 306 and driven through the reproducing unit 307 and returned to the container 303. For this purpose a second feed mechanism 308 is provided and is driven through the clutch devices 309 and 310 by means of a driving motor 311. The driving motor 311 is started in operation by means of a control relay 205 at any convenient time following the seizure of the sender. The

motor 311 is coupled to the feed mechanism 308 by means of a clutching device 309 constructed in any well-known manner to drive the feed mechanism 308 at a relatively high speed. The clutch 309 is rendered effective by means of a circuit closed through the contacts of an operated control relay 312, normal contacts of relay 313, conductor 314 through the connector 402 to the marker 401. As soon as the marker is ready to receive the office code designation, this circuit is closed, and the motor 311 is connected to the feed mechanism 308 through gears 330 and 331. The tape 302 is driven at high speed through the reproducing unit 307, and alternating current signals, corresponding to those transmitted over the subscriber's line, representing the office code designation are transferred directly to the frequency selective receiving mechanism 403 in the marker. The circuit for this purpose extends from the reproducing unit 307 over conductors 315 through the back contacts of relay 313, conductors 316, through the connector 402 to the common input circuit 404 of the frequency selective filters 405, 406, 407, 408 and 409. These alternating current signals are selected by the filters, detected and amplified by the associated detector amplifiers 410, 411, 412, 413 and 414, and are then utilized to cause the setting of the switch-controlling registers 415. When the office code has been transferred to the marker, the circuit for the clutch device 309 is opened to discontinue the high speed movement of the tape. The reason for driving the tape at high speed is to conserve the holding time of the marker, which is a relatively expensive mechanism.

At the proper time thereafter the low speed clutch device 310 is energized to clutch the motor shaft 317 to the drive shaft 318 through gears 332 and 333. The tape 302 is driven at a relatively low speed to reproduce in the circuit 315 the alternating current signals representing the numerical designation of the called line.

In the meantime the marker 401 has determined the destination of the call and has operated the switches S and S—1 to extend the connection from the subscriber's line over the trunk either to an office arranged to receive alternating current designation signals or to an office equipped with means responsive to direct current impulses. If the called office is one that requires alternating current signals, the signal circuit 315 is extended directly through the switches S and S—1 and over the selected trunk to the sender in the called office, such as the sender 104 in the local office or the sender 108 in the distant office. However, if the call is directed to an office requiring the transmission of direct current signals, the sender seizes an idle decoder 416 through a connector 417 immediately after the marker 401 has received the office code designation. Following the seizure of the decoder 416 the signal circuit 315 is extended through the connector 417 to the frequency selective receiver 418 in the decoder. In this case the alternating current signals reproduced from the tape 302 are transmitted into the decoder where they are selected by the frequency selective receiver 418 and utilized to operate the decoding registers 419. After the signals have been translated by the registers 419, this information is transferred back through the connector 417 to transmitting registers 206 in the sender. Thereafter the sender causes the numerical designation to be transmitted over the extended connection to the distant office in the form of direct current impulses, either forwardly or revertively transmitted, in accordance with the settings of the transmission registers 206.

It was noted above that the switches illustrated in the local office and in the distant office 106 are assumed to be of the cross-bar type. Since these switches are well known in the art it is not considered necessary to disclose them in detail. Likewise the common controlling senders and the common markers are illustrated largely in diagrammatic manner, many of their details being omitted for the sake of clearness. For a better understanding of the principles of the cross-bar system and the details of operation, reference is made to the following: Carpenter Patent No. 2,089,921 of August 10, 1937; Carpenter Patent No. 2,093,117 of September 14, 1937; Carpenter application Serial No. 214,356, filed June 17, 1938.

The detailed operation of the system will now be described. When a call is initiated on one of the subscriber's lines, such as line 100, the line switch LS and the sender selector switch S—8 are operated to extend the calling line over the link or junctor 101 to the district selector S and also to the idle sender disclosed in Figs. 2 and 3. The seizure of the sender results in the establishment of a signaling and controlling circuit which may be traced from battery through the winding of control relay 207, conductor 208 through the sender selector S—8 thence through the line switch LS over the loop of the subscriber's line and returning through the line switch and sender selector over conductor 209 to ground through the reactance coil 210. A tone current is applied to the calling line in any well-known manner to notify the calling subscriber that an idle sender has been seized and that he may proceed to transmit the wanted designation. Also the seizure of the sender results in the operation of relay 211, and the motor 304 operates the tape feed mechanism 305 to start the movement of the tape 302.

The subscriber transmits the wanted designation by manipulating the reed transmitter 111 to send first the office code characters, usually three in number, and then the four successive characters representing the numerical designation of the called line. The alternating current signals representing these designation characters are passed by the filter 201, amplified by the amplifier 202 and delivered to the circuit 203. Each signal passing through the amplifier 202 is applied to the enabling device 204 which serves to introduce a preliminary delay between the arrival of a signal and the operation of the control relay 212. When the relay 212 operates at the end of the delay period, relay 213 is energized, and the circuit 203 is connected to the magnetizing element 301 of the recorder 300. The element 301 responds to each of the successive signals transmitted thereto and records them magnetically on the moving tape 302. As the magnetized section of the tape passes through the recorder 301 it enters the storage container 306. At some convenient time following the seizure of the sender, the relay 205 is operated to close the circuit of motor 311. Motor 311 drives the shaft 317, but the clutches 309 and 310 are ineffective at this time, and the feed mechanism 308 remains at rest.

Since the control relay 212 in the enabler operates on each incoming designation signal, it may serve to operate a counting circuit 214 to count the digital characters as they are received. When all characters have been received

from the subscriber's line or when the three office code characters and a portion of the numerical characters have been received, the counting mechanism 214 closes a circuit over conductor 215 to operate the connector start relay 420. Relay 420 operates the connector 402, and the sender is connected to an idle marker 401. As soon as the marker is ready to receive the office code designation, it closes a circuit traceable over conductor 421 through the connector 402, conductor 314, normal contacts of relay 313, contacts of relay 312 to the clutch 309. The clutch 309 connects the shaft 317 to the shaft 318, and the feed mechanism 308 drives the tape at a relatively high speed through the reproducer 307. As the magnetized section of the tape containing the record of the office designation passes through the reproducer 307 the alternating current signals recorded thereon are reproduced in the circuit 315 and transmitted thereover through the contacts of relay 313, circuit 316 through the connector 402 to the input circuit 404. These alternating current signals are selected according to frequency by the filters of the receiver 403 and, after being detected and amplified, are used to set the register mechanism 415. Since the alternating current signals are recorded on the tape 302 at one speed and reproduced therefrom at a higher speed, the frequencies of the reproduced signals are increased by amounts depending upon the speed ratio. In other words the frequencies of the signals applied to the receiver 403 in the marker are greater than the frequencies of the corresponding signals transmitted from the subscriber's station and recorded on the tape 302. Accordingly the filters 405, 406, 407, 408 and 409 in the receiver 403 are designed to accommodate the signals of increased frequency values. In the well-known manner the marker makes use of the record established on the registers 415 to control the selective operation of the district and office switches S and S—1 to extend the connection from the subscriber's line to the terminating equipment of the called office. At the same time the marker decodes the information it has received from the recorder 300 and transmits information back to the sender concerning the class of the call. This class information is transmitted over the conductors 422 through the connector 402 thence over conductors 423 to the class relays 216, 217 and 218. Following the receipt of the office code signals, the marker also closes a circuit over conductor 424 through the connector 402, conductor 425 through the winding of relay 313 and a contact of operated relay 319 to battery. Relay 313 operates and locks over control conductor 320. The function of relay 313 is to disconnect the reproducer 307 from the circuit 316 extending to the marker and to connect the reproducer to the signal transmission circuit 321. Relay 313 in operating also opens the circuit for the high speed clutch 309, and the tape feed mechanism 308 comes to rest.

Assume first that the calling subscriber has transmitted the office name and number of the subscriber's line 103 which appears in the same office with the line 100. Therefore, the marker 401 controls the district and office switches as above explained to seize an idle trunk 102 extending to the incoming selector S—2 in the same office. The extension of the connection to the trunk 102 causes the operation of the sender selector S—4 to seize an idle sender 104. Also the marker sends a class indication back to the sender to inform the sender that the called line is in an office equipped with senders which receive the numerical designation in the form of alternating current signals, the same as those already recorded on the tape 302. This class information is established in the sender by operating a class relay such as the relay 216. As soon as the complete numerical record has been received and recorded on the tape 302 the counting relay 219 is operated, and a circuit is completed from ground over the contact of relay 219 through the normal contact of control relay 220, conductor 221 to the armature of control relay 322. When the sender is in condition to transmit the numerical record from the recorder 300 to the incoming sender 104, relay 322 is operated and the circuit over conductor 221 is completed to the clutch mechanism 310. The feed device 308 is now driven at a relatively low speed, and the tape 302 is drawn through the reproducer 307 to reproduce the signals representing the numerical designation. These alternating current signals are transmitted over the circuit 315 through the front contacts of relay 313, circuit 321, normal contacts of relay 324, circuit 325 through the normal contacts of relay 224, circuit 225, thence through the sender selector S—8 and through the district and office switches S and S—1 over the trunk 102 through sender selector S—4 to the frequency selective receiver 113 in the incoming sender 104. These signals are selected and utilized to operate the registers 114 in the sender 104, and the sender associates itself with an idle marker for the purpose of controlling the selective operation of the incoming and final switches S—2 and S—3 to complete the connection through to the called line 103.

As soon as the marker 401 and the sender of Figs. 2 and 3 have completed their functions they release. Similarly the terminating sender 104 and the terminating marker, not shown, release after they have completed their functions. After the signals have been all reproduced from the tape 302 the feed mechanism 308 may continue to operate the tape until the proper amount is restored to the storage container 303 ready for the next use. The magnetized areas of the tape are restored to their neutral condition by means of a magnetic eraser 328 through which the tape is driven before it reaches the recorder 301.

Assume next that the designation transmitted by the subscriber of line 100 and recorded on the tape recorder 300 pertains to the distant office 106 and to the called line 107. In this case the marker 401 controls the district and office switches S and S—1 to extend the connection from the calling line over the interoffice trunk 105 to the incoming selector S—5. Seizure of the trunk 105 causes the operation of sender selector S—7, and the trunk is extended to an idle sender 108 in the office 106. The class information received in the originating sender from the marker 401 indicates the class of the called office 106, and the sender prepares to reproduce and transmit the alternating current signals representing the number of the called line to the distant office. The transmission path over which these signals are sent extends from the reproducer 307 over circuit 315 through the front contacts of relay 313, circuit 321, back contacts of relay 324, circuit 325, back contacts of relay 224, circuit 225 thence through the

sender selector S—8 and selector switches S and S—1 over trunk 105 through sender selector S—7 to the input circuit 115 of the frequency selective receiver 116 in the sender 108. These signals are decoded and recorded on the registers 117 and the sender 108, in conjunction with a terminating marker (not shown) serves to control the switches S—5 and S—6 to complete the connection to the called line 107. As before, the senders and markers are released as soon as they have completed their function.

Assume finally that the designation transmitted from the calling line 100 and recorded on the tape recorder 300 pertains to the distant office 110 and to the called line 118 therein. The marker 401, having received the office code designation identifying the office 110, controls the district and office switches S and S—1 to extend the calling line 100 over the interoffice trunk 109 to the incoming selector switch S—9 in the called office. In this case the class of the called office 110 is identified in the sender in the originating office by operating the class relay 218. The circuit for operating this relay extends from the marker 401 over conductor 426 through the connector 402, conductor 427 through the winding of relay 218 to battery. The operation of relay 218 is a signal to the sender that the called office is one that requires direct current impulses and is not equipped to receive the alternating current signals recorded on the tape 302. Therefore, the sender seizes an idle decoder 416. The seizure of the decoder 416 is effected by a circuit closed from ground through the contact of relay 218 through the winding of relay 428 to battery. Relay 428 causes the operation of connector 417 to associate the sender with an idle decoder 416. Relay 218 also closes an obvious circuit for operating the switching relay 324. The numerical designation of the called line, which is recorded on the tape 302 in the form of alternating current signals, is now transferred to the decoder 416. The path over which the alternating current signals are transmitted extends from the reproducer 307 over circuit 315, front contacts of relay 313, circuit 321, front contacts of relay 324, circuit 222 through the connector 417 to the input circuit 429 of the frequency selective receiver 418 in the decoder. The alternating current signals are selected by the receiver 418 and utilized to operate the decoding registers 419, and the registers 419 in turn cause the operation of transmission registers 206 in the sender. The decoded information is transferred from the registers 419 to the registers 206 over a group of conductors 430 through the connector 417 and over conductors 223.

In order to save holding time for the decoder 416 while the numerical designation signals are being transferred from the tape to said decoder, the tape feed mechanism 308 may be driven at high speed by energizing the high speed clutch 309 over a circuit to ground in any suitable manner by way of conductor 335.

As soon as the sender is ready to control the switches in the distant office 110 the relay 224 is operated under control of the transmission register circuit 206, and the called line designation is transmitted by impulse series in accordance with the setting of the registers 206. The transmission path extends over circuit 226 through the front contacts of relay 224, circuit 225, through the sender selector S—8 and switches S and S—1 over trunk 109 to the incoming selector S—9. If the selectors S—9 and S—10 are switches of the step-by-step type, the designation impulses are transmitted directly from the register mechanism 206. If, however, the selectors S—9 and S—10 are of the panel type, these impulses are transmitted revertively. In any event the selector S—9 is first operated under the control of these designation impulses, and thereafter the final selector S—10 is operated to complete the connection to the called subscriber's line 118. As in the previous discussion, the marker 401 is released as soon as it completes its functions. Also the decoder 416 is released as soon as it has decoded the numerical designation and transferred the necessary information back to the sender. Similarly the sender in the originating office is restored to its normal condition as soon as the switches in the distant office have been operated and the connection completed.

In some cases it may be desirable to equip the terminating office with a sender and a decoder for converting the called line designation from alternating current signal codes to direct current signals. This would make it unnecessary to provide decoders 416 at the originating office, and in such a case the originating office sender would transfer the called line designation to the called office in alternating current signals for all types of calls.

What is claimed is:

1. In a telephone system, a central office, a line terminating in said central office, means for transmitting over said line signal currents representing a telephone designation, automatic switches in said office, a recording sender in said office including a magnetizable medium, means responsive to said signal currents for magnetizing said medium to record the telephone designation thereon, a switch-controlling marker, means for connecting said sender to said marker, means for reproducing the designation signal currents from said medium and transferring them directly into said marker, registers in said marker, and a signal receiving mechanism in said marker responsive to the signals transferred from said medium for variably operating said registers to register said telephone designation in said marker, said marker serving to control the selective operation of said automatic switches in accordance with the registered designation.

2. In a telephone system, a central office, a line terminating in said office, means for transmitting over said line alternating current signals of different frequencies representing a telephone designation, automatic switches in said office, a recording sender in said office including a movable magnetic medium, means responsive to said signals for magnetizing said medium to record the telephone designation thereon, a switch-controlling marker, means for connecting said marker to said sender, means for reproducing the alternating current signals recorded on said medium and for transferring them directly into said marker, a frequency selective receiving mechanism in said marker responsive to said signals, and registers in said marker controlled by said receiving mechanism for registering said telephone designation in the marker, said marker serving to control the selective operation of said automatic switches in accordance with the registered designation.

3. In a telephone system, a central office, a subscriber's line terminating in said office, means at the substation of said line for transmitting alternating signal currents in codes of different

frequencies to represent a telephone designation, automatic switches in said office, a plurality of recording senders each including a movable magnetic tape, means responsive to a call on said line for seizing an idle one of said senders, means responsive to said signal currents for magnetizing the tape of the seized sender to record said signal currents thereon, a plurality of switch-controlling markers, means controlled by the sender associated with said line for seizing and making connection with an idle one of said markers, means for transferring the recorded signals from said movable tape directly into the seized marker, and means in the marker responsive to said signals for registering the telephone designation represented by said signals, said marker serving to control the selective operation of said switches.

4. In a telephone system, a central office, a line terminating therein, a trunk, automatic switches in said office having access to said trunk, a recording sender in said office including a magnetizable medium, means for transmitting over said line signals in codes of different frequencies representing a telephone designation, means responsive to said signals for magnetizing said medium to record said designation signals thereon, a switch-controlling marker, means for connecting said sender to said marker, means for reproducing from said medium the code signals representing a portion of said telephone designation and for transferring said code signals directly to said marker, means in the marker for decoding said signals and for registering therein the designation represented by said signals, said marker serving to control said automatic switches to extend the connection over said trunk, and means for reproducing from said medium code signals representing the remainder of said telephone designation and for transmitting said signals over said trunk.

5. In a telephone system, a calling office, a subscriber's line terminating therein, a called office, automatic switches in said calling office, a trunk interconnecting said offices, means for transmitting over said line signals in codes of different frequencies representing the office code and numerical portions of a telephone designation, a recording sender in said calling office including a movable magnetic tape, means responsive to said signals for magnetizing said tape to record them thereon, a switch-controlling marker, means for connecting said sender to said marker, means for reproducing the code signals representing the office code portion of said designation and for transmitting said signals directly to said marker, means in the marker for decoding said signals and for registering the office code designation therein, said marker serving to control the automatic switches in said calling office to extend a connection over said trunk to said called office, a recording sender in said called office, means for reproducing from said magnetic tape the code signals representing the numerical portion of said telephone designation and for transmitting said signals over said trunk to said called office, frequency selective means in the sender at said called office for decoding said signals and for registering the numerical designation therein, and automatic switches in said called office controlled by said last-mentioned sender for further extending said connection.

6. In a telephone system, an originating office having automatic switches therein, a calling telephone line terminating in said office, called offices, called lines therein, trunks extending from said originating office to said called offices, a recording sender in said originating office having a magnetizable medium, means for sending over said calling line alternating current signals representing the office and numerical designations of a called line, means responsive to said signals for magnetizing said medium to record said designations on said medium, a plurality of common markers and a plurality of common decoders in said originating office, means for connecting said sender to one of said markers, means for transferring to the marker the office designation signals recorded on said medium, means in the marker for utilizing said signals to operate said switches to seize a trunk to the called office, means for connecting said sender to one of said decoders and for transferring to the decoder the signals on said medium representing the numerical designation, means in the decoder for decoding said signals and for sending the decoded information back to the sender, registers in the sender for receiving and registering said decoded information, switching means in the called office, and means for sending direct current signals over the trunk between the originating and called offices to control the operation of said switching means in accordance with the setting of the registers in said sender.

7. In a telephone system, a calling office having automatic switches therein, a calling telephone line terminating in said office, other offices having called lines terminating therein, trunks extending from said calling office to said other offices, a recording sender in said calling office having a magnetizable medium therein, means for sending over said calling line alternating current signals representing the office and numerical designations of a called line, means responsive to said signals for magnetizing said medium, a switch-controlling marker and a decoder in said calling office, means for connecting said sender to said marker, means for transferring to the marker the office designation signals recorded on said medium, means in the marker for utilizing said signals to operate said switches to seize a trunk to the called office, means for sending from the marker to the sender information concerning the class of the called office, means depending on the class of the called office for connecting said sender to said decoder and for transferring to the decoder the signals on said medium representing the numerical designation, means in the decoder for decoding said signals and for sending the decoded information to said sender, registers in said sender for receiving and registering said decoded information, switching means in the called office, and means for sending direct current signals over the trunk between the calling and called offices to control the operation of said switching means in accordance with the setting of the registers of said sender.

8. In a telephone system, a calling office having automatic switches therein, two other offices of different classes, a telephone line terminating in said calling office, trunks interconnecting said calling office and said other offices, a recording sender in said calling office having a magnetic tape therein, means for sending over said line alternating current signals in codes of different frequencies representing the office and numerical designations of a called line, means responsive to said signals for magnetizing said tape, a plurality of common markers and a plurality of common decoders in said calling office, means for

connecting said sender to one of said markers, means for transferring to the marker the office designation signals recorded on said tape, means in the marker for utilizing said signals to operate said switches to seize a trunk to either of said other offices as a called office, means for sending from the marker to the sender information concerning the class of the called office, means effective if the class information transmitted to the sender indicates the call is for a particular one of said other offices for reproducing from said magnetic tape and sending over the trunk to said called office the alternating current signals representing the numerical designation, frequency selective means in said particular called office responsive to said alternating current signals, automatic switches in said particular called office controlled by said frequency selective means for further extending the connection, means effective if the class information indicates the call is for the other one of said called offices for connecting the sender to an idle decoder and for transferring to said decoder the alternating current signals on said magnetic tape representing said numerical designation, means in the decoder responsive to said signals for decoding them and transferring the decoded information back to said sender, means in the sender for registering the decoded information received from said decoder, automatic switches in said other called office, and means for sending direct current signals over said trunk to said other called office to control the automatic switches therein in accordance with the information registered in said sender.

9. In a telephone system, a telephone line, a recording device including a movable magnetizable medium, means for transmitting over said line signal currents representing a telephone designation, means responsive to said signal currents for magnetizing said medium to record the designation thereon, means for reproducing from said medium a portion of the recorded designation, means for driving said medium at a given speed during the reproduction of said portion of the designation, means for reproducing the remainder of the designation recorded on said medium, and means for driving the medium at a different speed during the reproduction of said remainder of the designation.

10. In a telephone system, a telephone line, a recording mechanism including a movable magnetic medium, means for transmitting over said line signal currents representing the office code and numerical designations of a called line, means responsive to said signal currents for magnetizing said medium to record said designations thereon, means for driving said medium at high speed, means effective while said medium is moving at high speed for reproducing the signal currents representing said office code designation, means for subsequently driving said medium at low speed, and means effective while said medium is moving at low speed for reproducing the signal currents representing said numerical designation.

11. In a telephone system, a telephone line, a recording mechanism including a movable magnetic tape, means for sending over said line currents representing the office code and numerical designations of a called line, means responsive to said currents for magnetizing said tape to record said designations thereon, means for driving said tape at a uniform speed during the recording of said office and numerical designations, means for driving at high speed the section of said tape on which said office code designation is recorded, means responsive to the movement of said section of the tape for reproducing said office code designation, means for driving at low speed the section of the tape on which said numerical designation is recorded, and means responsive to the movement of said last-mentioned section of said tape for reproducing said numerical designation.

12. In a telephone system, a subscriber's line, a recording mechanism including a movable magnetic tape, means at the subscriber's station for transmitting over said line current signals representing the office code and numerical designation of a called subscriber's line, means for driving an unmagnetized section of said tape at a uniform speed, means responsive to said signals for magnetizing the moving section of said tape to record thereon said office and numerical designations, means for driving said tape at high speed to reproduce the signals representing the office code designation, means for registering the reproduced office code designation, means for driving said tape at relatively low speed for reproducing the signals representing the numerical designation, and automatic switches controlled in accordance with the registered office designation for extending a telephone connection.

FRANCIS A. HUBBARD.