June 24, 1930. R. J. WENSLEY 1,765,471

TELEVOX CONTROLLER AND SUPERVISOR

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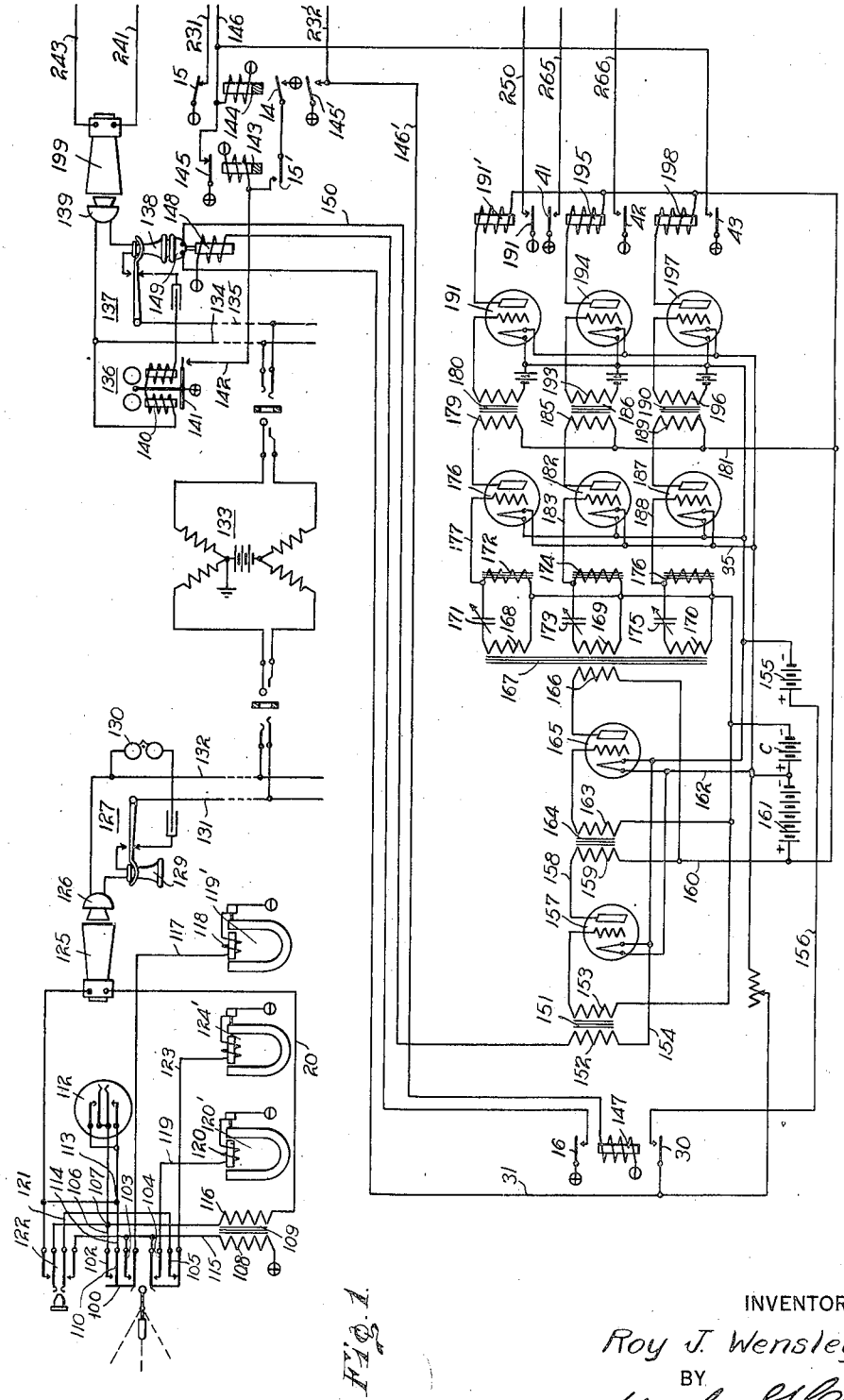

FIG. 1.

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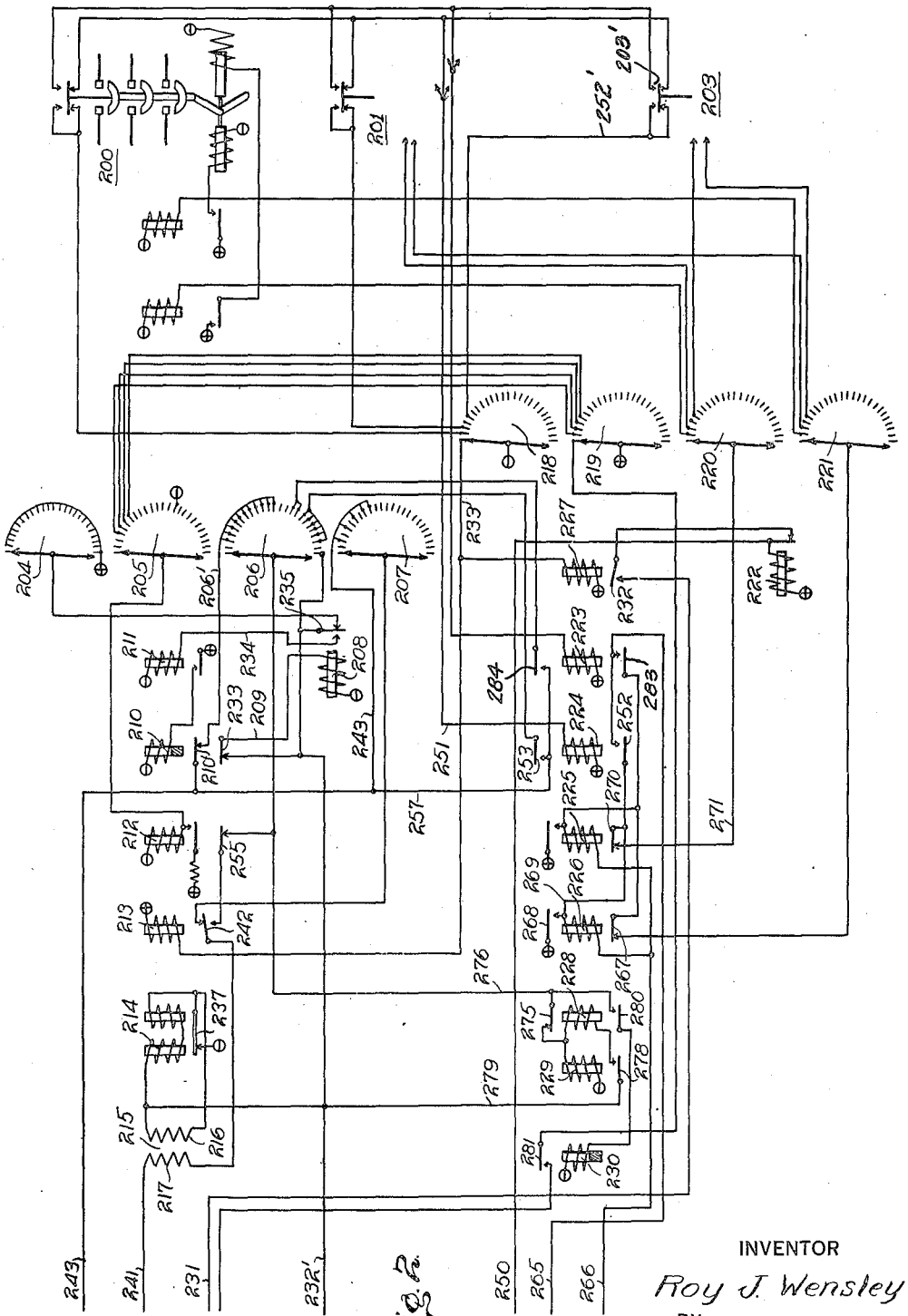

Fig. 2.

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UNITED STATES PATENT OFFICE

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TELEVOX CONTROLLER AND SUPERVISOR

Application filed October 14, 1927. Serial No. 226,116.

My invention relates to signalling systems, and, more particularly, to that class of signalling systems known as supervisory-control systems in which remotely disposed circuit breakers or other power-apparatus units are selectively controlled and supervised from a central dispatching point.

The growth of power transmission systems employing large numbers of comparatively small-capacity substations located in proximity to each other has made the attendance of operators at each station costly and, therefore, impracticable.

In order to overcome this difficulty, supervisory control systems have been developed by which power-apparatus units located at a substation may be selectively controlled and supervised over signalling lines from a dispatching office. This manual, selective, remote control and supervision has been found to be an effective substitute for the individual operators at each substation.

In order, however, to selectively control and supervise remotely disposed apparatus units from a dispatching point, it was found necessary to develop signalling systems having characteristics particularly adapted to supervisory control. Thus, for example, infallible accuracy of operation in selecting a unit for operation is necessary as distinguished from the permissible errors in other forms of signalling systems. Furthermore, while the control and supervisory operations must be accurate, comparatively few operations are normally made during any considerable period of time and the apparatus must, therefore, be maintained normally in a non-operating condition and arranged to be started into operation either upon a manual operation at the dispatching office or upon an automatic operation from the substation.

The need for a high degree of accuracy in the control and supervision of circuit breakers has resulted in the development of very complicated systems which are exceedingly costly. Added to this, there is the additional excessive cost of the signalling lines which connect the dispatching office and the substation. This is a particularly heavy burden where, in order to maintain dependable electric service, duplicate circuits are extended to a large number of distributing points scattered throughout the area to be served. Inasmuch as the control and supervisory operations which are performed are comparatively few in number during any reasonable period of time, the signalling lines connecting the stations are normally idle.

It is evident, therefore, that these normally idle signalling lines add considerably to the cost of the system and that this cost is unjustified in view of the long idle periods of the signalling line.

The substation and dispatcher's office, however, are usually provided with standard telephone equipment for telephone intercommunication. These signalling lines provide an excellent medium for transmitting the necessary control and supervisory operations except for the fact that the telephone companies have consistently objected and refused to permit the use of their signalling lines for other purposes than speech transmission because of the fact that such other use, such as the possible transmission of a telegraphic code, interferes with the normal use of the system, the telephone lines being normally designed for characteristics of voice frequencies and not for telegraph service. The objections raised by the telephone companies is due to the characteristics of some forms of signalling which differ from those of telephone communication and there would, therefore, be no objection to the use of the telephone lines for supervisory control if this could be accomplished by currents of characteristics similar to the voice current. I have discovered that currents of voice frequencies transmitted over the telephone lines can be employed for controlling and supervising circuit breakers.

An object of my invention, therefore, is to provide means for employing telephone lines for the transmission of control and supervisory signals in a supervisory control system in such manner as to overcome the objections raised by the telephone companies.

Another object of my invention is to pro-

vide means for transmitting currents of characteristics suitable for telephone transmission, for controlling and supervising remotely disposed apparatus units from a central dispatching point.

Another object of my invention is to provide means for operating a telephone receiver located at a remote substation from a dispatching point.

Still another object of my invention is to provide means for supervising and controlling remotely disposed circuit breakers by the use of standard telephone equipment.

Another object of my invention is to provide means for selectively controlling remotely disposed devices from a central station.

Other objects of my invention are such as may be attained by the utilization of the various combinations and subcombinations of the principles hereinafter set forth and as defined by the terms of the appended claims.

As shown in the drawings, Fig. 1 is a diagram of the circuits and apparatus employed at the dispatching point and the receiving apparatus at the substation with the standard telephone line connection.

Fig. 2 is a diagram of the circuit and apparatus employed at the substation.

Referring now more particularly to the Fig. 1, a key 100 is shown comprising spring contactors 102, 103, 104 and 105, the key being normally in the position shown with the contacts 102 to 104 open and contact 105 closed. The contactor 102 is connected by conductor 106 to the terminal point 107 on the secondary 116 of the transformer 109. The spring 102, when with engagement in contact 110, by-passes a circuit through a dial 112 of the standard telephone type, from contact 113 over the conductor 114 and conductor 106 to contact 107. This operation will be described in more detail in the specific operation hereinafter. The spring 103 is connected over the conductor 115 to the primary winding 108 of transformer 109. When the spring 103 engages its contact, a circuit is also completed over the conductor 117 to the winding 118 of an oscillator 119'. The oscillator 119' comprises a tuning fork which vibrates when the winding 118 is energized, the circuit through the relay being opened and closed by operation of the microphone button as the tuning fork vibrates. The oscillators 120', 124' and 119' are each tuned to vibrate at a particular frequency to generate alternating currents. These frequencies are employed respectively for selecting and operating the selected apparatus units at the remote station and restoring the selecting apparatus to its normal condition.

The spring 104 is connected by conductor 119 through the winding 120 of the oscillator 120' and over conductor 115 to the primary winding 108 of the audio frequency transformer 109. When the circuit is completed for the winding of the oscillator 120', a current impulse is transmitted over the telephone system in a manner to be described in detail hereinafter for selecting one of the remotely disposed apparatus units for operation.

The spring 105 is connected by conductor 121 to a control key 122, and over conductor 123 to the winding of the oscillator 124'. When the circuit for this oscillator is completed through the contacts and spring 105 and the contacts and the control key, as will be described in detail hereinafter, a current of a predetermined frequency is transmitted over the telephone line for operating the selected apparatus unit to the position desired. The dial 112 controls the circuit from the secondary winding 108 of the transformer 109 to the howler 125 which is of the standard well known type and, as illustrated in the drawings, is placed adjacent the mouthpiece 126 of a standard telephone set 127. The telephone set 127 comprises a transmitter 126 and the receiver 129, connected in the usual manner through the alarm bell box 130 over the telephone line 131, 132 to the central exchange 133.

The central exchange, diagrammatically illustrated at 133, is of well known construction and is the terminus of a number of subscribers' lines, adapted to be interconnected to afford communication bewteen calling and called subscribers.

A circuit 134, 135 of the usual type employed for telephone subscribers extends to the remote substation at which the power apparatus units to be controlled and supervised are located. The conductors 134 and 135 are connected to the bell-box 136 in the usual manner and to the telephone equipment 137 comprising the receiver 138 and the transmitter 139. The bell box 136 comprising the telephone relays 140 and armature 141 responds to a connection thereto from the central exchange in a manner well known in the telephone art and the armature 141, upon operation, intermittently closes a circuit over conductor 142 to the slow release relay 143. Relay 143 is normally in a non-operating condition and maintains the original energizing circuit for slow release relay 144 which is completed over the back contact of armature 145 of the relay 143. The energizing circuit for the relay 144 is controlled not only by the armature 145 but also by armature 281 over the conductor 146 for restoring the apparatus to normal in a manner to be described in detail hereinafter.

Relay 144, by its armature 145', controls energizing circuit for starting the apparatus normally in a non-operating condition into operation in a manner to be described

in detail hereinafter. The armature 145′ is connected by means of conductor 146′ to a relay 147 which is normally deenergized but energizes following the deenergization of relay 144 when the substation has been connected by a completed circuit through the central exchange in a manner to be described in detail hereinafter.

Upon energization of relay 147, a circuit is completed for the operating magnet 148 which functions to shift the telephone receiver 138 from its resting position to the talking position with the same effect as when similar receiver in an ordinary telephone set is lifted manually by a subscriber. Energization of the relay 147 also closes a plurality of circuits for electron discharge devices as will be described in detail hereinafter. Upon the lifting of the telephone receiver, the telephone circuit is thereupon completed from the dispatching office to the central station in the usual manner to permit the selective control in a manner to be described in detail hereinafter. The telephone receiver 138 operates a carbon microphone 149 in a known manner for varying the current flow in the conductor 150 in accordance with the sounds impinging thereon.

The conductor 150 is connected in series with the primary winding 152 of transformer 151 and by a conductor 154 to the battery 155 and through the battery to conductor 156.

The secondary winding 153 of transformer 151 is connected across the input circuit of the vacuum tube 157. The device 157 comprises the three standard elements of a vacuum tube and is connected in the usual manner for amplifying audio-frequency signals. The output of plate circuits of this device, by means of conductor 158, is passed through the primary winding 159 of the second audio-frequency transformer 164, over conductor 160, battery 161, conductor 162 to the filament of the device 157. The secondary winding 163 of the transformer 164 is connected to the input of a second electron discharge device 165 which is similar to the device 157. The system including the two vacuum tubes and the audio-frequency transformer is standard amplifying equipment and does not form part of this invention.

Connected to the output circuit of the device 165 is the primary winding 166 of the audio transformer 167. The secondary winding of this transformer comprises three portions, 168, 169 and 170, which are connected in tuned circuits including condensers 171, 173 and 175, reactances 172, 174 and 176′ which are resonant, respectively, to the same frequencies as the oscillators 120′, 124′ and 119′ at the dispatcher's office.

The grid of a three-element vacuum tube amplifier 176 is connected by means of conductor 177 to the oscillating circuit including the reactance 172. The output circuit of the vacuum tube 176 is connected over conductor 178 to the primary winding 179 of the audio-frequency transformer 180 and, over conductor 181, to the battery 161 which is connected to the filament of the amplifier. The grids of additional amplifying devices 182 and 187 are similarly connected to the resonant circuits including the reactances 174 and 176 and the output circuits of said devices include the secondary windings 185 and 189 of transformers 186 and 190.

The secondary windings of the transformers 180, 186 and 190 are connected through a second set of amplifying devices 191, 194 and 197, similar to that described above. The grids of the amplifying tubes 176, 182 and 187 have a negative bias to that impressed thereon from battery C, so that no current flows in the plate circuits thereof under normal conditions. When signals are received, however, the potential of the grids is made positive and current passes through the plate circuits of the amplifying tubes to operate the relays 192, 195 and 198.

Referring now more particularly to Fig. 2, a plurality of electromagnetically operated disconnect switches or circuit breakers 200, 201, and 203 are illustrated, although it will be understood that any number of such units can be connected in the system. A plurality of selector switches 204 to 207 each comprising a set of contacts and a wiper moving over the contacts which wipers are operated in a step by step manner by a stepping magnet 208. As these wipers move over the contacts, they control the transmission, from the substation to the office, of signals indicative of the station selected and of the condition of the selected unit, in a manner to be described in detail hereinafter.

The stepping magnet 208 is connected over the conductor 209 to the armature 233 by which it is controlled in a manner to be described in detail hereinafter for stepping the wipers of switches 204 to 207. A slow-to-operate relay 210 is arranged electrically to energize and deenergize as the stepping magnet 208 energizes and deenergizes. By the interaction of these relays, the stepping magnet is intermittently energized and deenergized following a station selection to transmit the supervisory signal. Relay 211 is electrically interposed between relay 210 and stepping magnet 208 for controlling the interaction.

The energizing circuit for the relay 212 is controlled over the contacts of the switch 205 and the selected apparatus unit for controlling the code to be transmitted in a manner to be described hereinafter. The relay 213 is normally maintained energized and

cooperates with the relay 212 to control the codes transmitted over the switch wipers 204 to 207 so that either the selected station code or the selected unit code is transmitted. The buzzer 214 operates through a bell transformer 215 comprising primary windings 216 and secondary winding 217 for generating the frequency to be transmitted which in turn is broken up in accordance with the code set up for the station and the selected unit.

A second set of switches 218 to 221 are selectively operated in accordance with code combinations of impulses from the office for selecting the apparatus units to be operated in a manner which will be described in detail hereinafter. The wipers of switches 218 to 221 are stepped from contact to contact by means of the stepping magnet 222, controlled by the armature 192 of relay 191′ in a manner to be described in detail hereinafter.

Relays 223 and 224 are common to all of the apparatus units and as the wiper of switch 218 is stepped from contact to contact, one or the other of these relays is energized in accordance with the condition of the unit connected to the particular contact with which the wiper is at that time in engagement. Switch relays 225 and 226 are common to all of the power apparatus units and are operated by the final control impulse received from the dispatching point to complete the operating circuit to the selected unit over circuits including the contacts of relays 223 or 224 in accordance with which of these relays is energized.

Relay 227 controls the operating circuit to the stepping magnet 222, normally maintaining the circuit through the stepping magnet open at its armature. Following the selection of the station, a vibrating circuit for the stepping magnet 222 is completed over the armature of relay 227 in a manner to be described in detail hereinafter for restoring the selectors to normal. The relays 228 to 230 are energized in a manner to be described in detail hereinafter, following the selection of a station, and function to restore the apparatus to normal after an interval of time. By this arrangement, should the operator at the central station by mistake make a connection to the substation from some calling subscriber other than the dispatcher, the apparatus will restore itself automatically to normal after an interval of time.

Having now described the apparatus employed in the operation of my system, the details of operation which takes place when a unit is selected for control will now be given in order to explain the invention more fully.

It will be assumed, for purposes of illustration, that the operator at the control station desires to close the circuit breaker 203 which is shown in its tripped position. In order to perform this operation, it is first necessary for the dispatcher to complete a connection through the exchange to the substation. This he will perform in the usual manner by calling central over his telephone line and giving her the number of his substation. Central will complete the connection in the usual manner.

Upon the completion of the connection, at the operation of bell 140 in the manner which is well known in the art, the armature 141 will engage its contact and a circuit will be completed from the positive side of battery over armature 141 and its front contact, conductor 142 to the winding of the slow-to-operate relay 143, and to the negative side of battery.

It will be noted at this point that when the relay 143 is deenergized and the apparatus is in its normal, non-operating condition, a circuit is completed for the relay 144 from the positive side of battery over armature 145 and its back contact and through the winding of the slow-release relay 144 to the negative side of battery. The energization of the relay 144 maintains its armatures 14 and 145′ out of engagement with their back contacts and its armature 15 in engagement with its front contact. As a result, a circuit is prepared for the stepping magnet 222 over the armature 15 and conductor 231, but this circuit is maintained open at armature 232 by reason of the energization of relay 227.

It will also be noted that an energizing circuit is normally completed for both the relays 213 and 227, over the conductor 233, the first contact of switch 218 and its wiper, to the negative side of battery.

Upon energization of relay 143 in the manner described above, the relay 144 is deenergized, its circuit being opened when the armature 145 leaves its back contact. After an interval of time, the armature 14 of relay 144 engages its back contact and a locking circuit is completed for the relay 143 from the positive side of the battery over the back contact and armature 14, the front contact and armature 15′, and through the winding of the relay 143 to negative side of battery. Relay 143 is thereafter maintained energized over this locking circuit until the restoring impulse is received in a manner to be described in detail hereinafter.

Further results of the deenergization of relay 144 are to open the prepared energizing circuit for the stepping magnet 222 at armature 15 which now disengages its front contact and to complete an energizing circuit for the relay 147 from positive side of battery, over armature 145′ and its back contact and through the winding of the relay 147 and to the negative side of battery.

A telephone circuit is simultaneously com-

pleted from the positive side of battery over armature 145′ and its back contact, over the conductor 232′ through the winding of the buzzer 214 and over its armature to the negative side of battery. This circuit, however, will be described in more detail hereinafter.

As a result of the energization of relay 147, an obvious energizing circuit is completed for the operating magnet 148 of the telephone receiver, the circuit including the armature 16 and its front contact.

Telephone transmitter 149 is connected to operate in response to the operations of the telephone receiver 138 and varies the flow of current in the conductor 150 in accordance with the currents received over the telephone line for operating the receiver 138.

A circuit in multiple with the energizing circuit for relay 147 is simultaneously completed for the stepping magnet 208 from the negative side of battery to the winding of the stepping magnet 208 over the conductor 209, armature 233 and its back contact, conductor 232′ and the back contact, armature 145′ to the positive side of the battery. As a result of the energization of the stepping magnet 208 the wipers of the switches 204 to 207 are conditioned to be stepped to their succeeding position and a circuit is simultaneously completed for the relay 211 over the front contact of the armature of the stepping magnet 208, the circuit being completed from the negative side of battery through the winding of the relay 211 over conductor 234 through the front contact of armature 235 and thence over the conductor 232′ to the back contact and armature 145′ and the positive side of battery.

As a result of the energization of relay 211, an obvious energizing circuit is completed for relay 210. The energization of relay 211 opens the original energizing circuit for the stepping magnet 208 at armature 233 and the stepping magnet is deenergized. The wipers are thereupon stepped to their second contacts. Upon deenergization of the stepping magnet 208, the energizing circuit for the slow-to-release relay 210 is opened following deenergization of relay 211 and after an interval of time, this relay deenergizes and permits its armature to drop to its back contact. When the armature 233 engages its back contact, the original energizing circuit for the stepping magnet 208 is again completed and again the wipers are prepared to be stepped from their second to their third contact.

In this manner, by the alternate operation of the stepping magnet 208 and the slow to operate relay 210, the switch wipers are stepped from contact to contact.

After the wiper of switch 204 has moved into engagement with its second contact, it will be noted that a multiple circuit is prepared for the stepping magnet 208 over the contact of the switch 204 and its wiper to ground in multiple with the circuit over armature 145′, so that the magnet will periodically energize irrespective of the condition of the relay 144, after the switch wiper has moved into engagement with its second contact.

In the manner described above, the wipers are now stepped from contact to contact. It will be recalled that, upon the deenergization of relay 144 and the closing of armature 145′ and its back contact, the circuit for the buzzer 214 was completed. As the buzzer vibrates, current impulses traverse the primary winding 216 of the bell transformer 215 at a frequency determined by the adjustment of the buzzer, the circuit being completed from the negative side of battery, through the back contact and armature 237 and then in a multiple circuit to the winding of the buzzer 214 and the primary winding 216 and then to the conductor 232 to the back contact and armature 145′ and positive side of battery.

As the current through the primary winding 216 is thus periodically interrupted by the buzzer operation, an alternating current is generated in the secondary winding 217 of the bell transformer and a circuit is completed from the howler 199 over the conductor 241 through the winding 217 of the bell transformer 215, armature 242 and its front contact over the wiper of switch 207 in engagement with its third contact conductor 243 and back of the howler 199. This circuit, it will be noted, is completed, when the wiper of switch 207 engages the third, fifth, seventh, ninth and tenth contacts, so that five signals of the frequency generated by the buzzer 214 are transmitted through the howler 199 over the telephone transmitter 139 and over the telephone line in the well known manner to operate the receiver 129 at the dispatcher's office. The equivalent switch 207 at any other substation will, of course, be connected to transmit a different code of signals.

The buzzer 214 is designed and adjusted to vibrate at a frequency which is within the telephone range and the currents transmitted over the telephone line thereby, for indicating the station selected, will have the same characteristics as those involved in speech transmission over the telephone line. No objection is made by the telephone companies to the use of the telephone for the transmission of these station-selecting signals. At the dispatching office, the operator having lifted his receiver from the hook, listens to the code received and is able to identify by this code to which of the stations he is connected.

As soon as the code has been received and the dispatcher is aware that the correct sta-

tion selection has been made, the dispatcher will operate his key so as to close the contact of spring 104 and, as a result, a circuit will be completed for the magnet 120 from the negative side of battery through the contact on the oscillator 120', through the winding 120 thereof, the spring 104 and its contact and through the primary winding 108 of the audio-frequency transformer 109 to the positive side of battery.

The oscillator 120' now vibrates in a well-known manner and makes and breaks its circuit at a predetermined frequency. As the current through the primary winding 116 is interrupted periodically, an alternating current is generated in the secondary winding 116 of the audio-frequency transformer 109 and a circuit is completed for howler 125 from the secondary winding 116 of the audio-frequency transformer by the conductor 20 to the howler 125, conductor 21, contact 22 of the telephone dial 112 and then back to the other side of the winding 116 of the audio-frequency transformer 109. The dispatcher will now operate his dial to make and break the circuit five times in the manner which is well-known in the telephone art. When current traverses the howler, a signal is produced which operates through the telephone transmitter 126 in a manner which is usual in connection with ordinary conversation and, as this current is periodically interrupted, a series of currents of frequencies in the range of voice currents will be transmitted over the telephone lines 131 and 132.

At the substation, the telephone receiver 138 responds to these received currents and operates the transmitter 149 which, in turn, varies the flow of current through the conductor 150 in accordance with the received signals. A closed circuit now exists, including the transmitter 149, the primary winding 152 of the audio-frequency transformer 151, conductor 154, the battery 155, conductor 156, the front contact and armature 30 of the relay 147 which is energized in the manner described above, and conductor 31. These signals are repeated through the audio-frequency transformer 151 and then through the amplifying tube 157, the audio-frequency transformer 164 and amplifying tube 165 to the winding 166 of the transformer 167. Since these signals are generated by the oscillator 120' at the dispatcher's office, which is tuned to the same frequency as the circuit including the secondary winding 168, and condenser 171, this circuit, therefore, will be set into oscillation by the current flowing through the winding 166. The oscillating circuit is connected across the grid and filament of the tube 176, and the output thereof will be amplified by the amplifier 176 and supplied to the primary winding 179 of the audio-frequency transformer 180. The output of transformer 180 is again amplified and then rectified by the tube 191, the negative bias on the grid thereof being changed to a positive potential. The rectified current then operates the relay 191'.

Upon the first operation of the relay 191', a circuit is completed for the stepping magnet 222 of the switches 218 to 221, the circuit being completed from the negative side of battery over the front contact and armature 192, conductor 250 and through the winding of the stepping magnet 222 to the positive side of battery. As a result of the energization of the stepping magnet 222, the wipers of switches 218 to 221 are conditioned to be stepped from their first to their second contacts. When the dial 112 opens the circuit for the first time, the relay 191 is deenergized and opens the energizing circuit for the stepping magnet 222. The wipers are stepped from their first to their second contacts.

As a result of the wiper of switch 218 stepping from its first to its second contact, the energizing circuit traced above for relays 227 and 213 is opened and these relays are deenergized. As a result of the deenergization of relay 227, an energizing circuit for the stepping magnet is prepared over the armature 232 although this circuit is not completed at this time for the reason that relay 144 is now deenergized.

As a result of the deenergization of relay 213, the energizing circuit through the switch wiper 207 for transmitting code signals indicative of the station selected is opened at armature 242 and a circuit is prepared at its back contact for the wiper of switch 206, for transmitting supervisory signals indicative of the unit selected in a manner to be described in detail hereinafter.

Since the dispatcher operated the dial 112 to transmit five successive impulses in the manner described above, the relay 191' will energize and deenergize successively five different times. As the relay 191' energizes and deenergizes, the stepping magnet 222 energizes and deenergizes to in turn step the wipers of the switches 218 to 221 from contact to contact.

When the switch wipers have reached their fifth contact, an energizing circuit is completed for the relay 224 since the disconnect switch 203 is in its tripped position, this circuit being completed from the positive side of battery, through the winding of relay 224 over the conductor 251 through the pallet contact of the disconnect switch 203, conductor 252', over the fifth contact of switch 218 to negative battery.

As a result of the energization of the relay 224, a circuit is prepared for the relay 226 over armature 252, but this circuit is not completed at this time, because of the

fact that the armature 41 of the relay 195 is in its disengaged position. A circuit is also completed over the armature 253 for the supervisory signal to be transmitted indicative of the condition of the selected unit. This circuit extends from the howler 199 over the conductor 241 through the secondary winding 217 of the bell transformer 215, armature 242 and its back contact, armature 255 and its back contact, over the wiper and contact of switch 206, over conductor 206′, armature 210′ and its back contact, and by conductor 243 to the howler.

As the stepping magnet 208 and slow release relay 210 energize and deenergize in the manner described in the above, this circuit is opened and closed by the stepping of the wiper 206. It will be noted that, when the wiper of switch 205 moves to its seventh contact, a circuit is completed for the relay 212 from the negative side of battery over the winding of the relay 212, through the wiper and seventh contact of switch 205, conductor 260, through the fifth contact of switch 219 and its wiper to positive side of battery. The relay 212 energizes, locks in at armature 212′, and, at armature 255, prevents the transmission of further supervisory signals. The number of signals transmitted up to this time will indicate the unit selected for operation.

When the wiper of switch 205 engages its fifteenth contact, the relay 212 is short-circuited and deenergizes preparatory of the transmission of a supervisory signal indicative of the condition of the unit. This signal is transmitted when the wiper of switch 206 engages its 16th or 18th contacts over armatures 269 or 253 and conductor 257 to conductor 243, according as the circuit breaker 203 is closed or tripped. If the circuit is completed over the 18th contact and armature 253, a long code sound will be transmitted from the buzzer 214 as wiper 206 engages its 18th to 23rd contacts. A long sound of this character indicates that the circuit is in its tripped position whereas a short sound, transmitted as the wiper 206 engages its 16th and 17th contacts, indicates that the circuit breaker is in the closed position. The dispatcher listens to the sound transmitted received and is apprised thereby of the condition of the circuit breaker.

The dispatcher will then operate his control key to close its lower contact 105 for completing a circuit for the second oscillator 124′, from the negative side of battery to the contact and magnet of the oscillator, the contact 105, conductor 121, and over the lower contact of the control key 122 through the primary winding 108 of the audio-frequency transformer 109 to the positive side of battery. An alternating current will be generated by oscillator 124′ and transmitted to the howler 125 and, over the telephone line, to the receiver 138 in the manner described in connection with the transmission of the other signal. A similar current traverses the transmitter 149 and the transformer 151 and, when received at the transformer winding 166, is repeated through the secondary 169 to the second tuned circuit including the condenser 173, this circuit being tuned to the particular frequency generated by the oscillator 124′. The currents received is amplified in the manner explained above and the output of the amplifier operates the relay 195.

Upon the operation of relay 195, a circuit is completed for the relay 226 from the positive side of battery over the front contact and armature 41, conductor 265, through armature 252 and its front contact, the winding of the relay 226, conductor 266, to armature 42 and its front contact and negative side of battery.

As a result of the energization of relay 226, the circuit for tripping the circuit breaker is opened at armature 267 and an operating circuit for closing the circuit breaker is closed at armature 268 from positive side of battery over the front contact and armature 268, conductor 269, armature 270 and its back contact, conductor 271 through the wiper and fifth contact of switch 220 to the closing coil (not shown) of the circuit breaker 203.

As a result of the completion of this circuit, the circuit breaker 203 is operated from its tripped to its closed position and, simultaneously, its pallet switch moves from engagement with its lower contact, to engagement with its upper contact. As a result of the operation of the pallet switch 203′, the energizing circuit for the relay 224 is opened at the contact of the pallet switch and a similar energizing circuit is completed for the relay 223, from the positive side of battery to the winding of the relay 223, the upper contact of the pallet switch 203′, the fifth contact of the switch 218 and its wiper to the negative side of battery. As a result of the energization of relay 223, a circuit is prepared at the armature 283 for energizing the relay 225 to trip the circuit breaker and a circuit is prepared at armature 284 for the supervisory signal.

As the wiper of switch 206 now passes over its contacts, the energizing circuit for the howler 199 formerly traced through conductors 257 and 243 and armature 253 is opened and a circuit is now completed over the armature 284. This circuit extends from the howler 199 by conductor 241 to the secondary winding 217 of the bell transformer 215, armature 242 and its back contact, armature 255 and its back contact, the wiper of switch 206, its 16th and 17th contacts, the front contact and armature 284, and thence over conductors 257 and 243 to the

other side of the howler. When the dispatcher receives a short signal of this character, he is apprised that the circuit breaker has been moved to the closed position in accordance with his operation.

After completion of the operation, the dispatcher will close the operate key 100 to cause spring 103 to close its contact and a circuit will be completed for the oscillator 119′ from the negative side of battery through its contact and winding 118 to contact spring 103 and the primary winding 108 of the audio-frequency transformer 109, to the positive side of battery. The oscillator 118 will generate a frequency which it individual to this oscillator and which also is within the telephone range and, as a result, the howler will produce a tone corresponding to the frequency of the oscillator in the manner which has been described in detail above, and the current impulses generated in the transmitter 126 will transmit the tone produced by the howler 125 to the receiver 138.

This tone will be reproduced in the transmitter 149 for transmitting a current of a frequency equivalent to that generated by the oscillator 119′ to the transformer 166. This current will then be amplified in the tubes 187 and 197 since the circuit including the secondary winding 170 and the condenser 175 is tuned to the frequency of the oscillator 119′, and relay 198 will be energized.

As a result of the operation of relay 198, a circuit is completed for the relay 144 from the positive side of battery over the front contact and armature 43, and through the winding of the relay 144 to the negative side of battery. As a result of the energization of relay 144, the locking circuit for the relay 143 including the armatures 15 and 14 is opened at the armature 14. The energizing circuit for the stepping magnet 208 and the relay 147 is opened at armature 145′.

If the wiper of switch 204 is not in engagement with its first contact at the time that the energizing circuit for the stepping magnet 208 is opened by the energization of relay 144 as described above, a circuit is completed for the stepping magnet 208 which is independent of the relay 144. This circuit extends from the positive side of battery to any one of the second to the 25th contacts of wiper 204, the wiper of the switch and the back contact of the stepping magnet 208, the back contact and armature 233, the winding of the stepping magnet 208, to the negative side of battery. No energizing circuit can be completed for the relay 210 at this time inasmuch as the relay 144 has been energized. The stepping magnet, however, opens its own circuit at armature 235, and the wipers of the switches 204 to 207 are stepped from contact to contact until they engage their first contact at which point the energizing circuit for relay 208 is no longer completed. In this manner, the wipers of the switch 204 to 207 are restored to normal.

Upon the deenergization of the relay 147 the energizing circuit for the operating magnet 148 of the telephone receiver 138 is opened and this relay deenergizes to permit the receiver 138 to drop to the position shown, to disconnect the telephones in the usual manner as in the case where the subscriber hangs up the receiver on the hook. Further results of the deenergization of relay 147 are to open the energizing circuit for the filament of all the tubes at the armature 30 and to open the circuit for the telephone transmitter 149 at the same time. A further result of the energization of the relay 144 is to complete a vibrating circuit for the stepping magnet 222 from the positive side of battery through the winding of the stepping magnet 222 and through its own contact, the back contact and armature 232 of the relay 227 which is deenergized at this time conductor 231, and front contact 15 of relay 144, to the negative side of the battery.

Upon the energization of the stepping magnet 222, it opens its own circuit at its own contact and steps the wipers to the succeeding contact. In this manner the wipers are stepped from contact to contact until they are again in engagement with their first contacts, at which point the energizing circuit is completed for the relay 227 from the positive side of battery to the winding of relay 227 over the first contact and wiper of switch 218 to the negative side of battery. A multiple circuit is completed at this time for the relay 213 over the same circuit. Relay 227 energizes and at armature 232 opens the vibrating circuit traced above for the stepping magnet 222, and the stepping magnet thereupon remains deenergized. In this manner the wipers of switch 218 to 221 are restored to normal.

It may happen that the telephone operator at the central station will make an incorrect connection for a calling party by connecting the party to the substation, in which event the apparatus would be started into operation in the manner described above. It is necessary, therefore, to provide means for restoring the apparatus to normal condition, after an interval of time, in the event that no operation is to take place. Provision for such operation is made by the use of the relays 228 to 230. When the wiper of switch 206 reaches its 25th contact after the apparatus has been started into operation following the deenergization of relay 144 in the manner described above, an energizing circuit is completed for the relay 229 from the negative side of the battery through the winding of the relay 229, armature 275

and its back contact, conductor 276 to the wiper and 25th contact of the switch 206 and thence over the conductor 232′ to the back contact and armature 145 and positive side of battery.

The relay 229 energizes and prepares a locking circuit for itself and the relay 228 over the armature 278, but this circuit is not completed at this time because the original energizing circuit traced above short-circuits the winding 228. As soon, however, as the switch wiper leaves its 25th contact and engages its first contact for repeating the operation of transmitting the signals indicative of the station selected, the original energizing circuit for relay 229 is opened and a series of locking circuit for relay 229 and 228 is completed, this circuit being completed from the negative side of battery, to the windings of relays 229, and 228 in series, the front contact and armature 278, conductor 279, over the conductor 232′ to the back contact and armature 145′ and the positive side of battery.

When the wiper of switch 206 now again reaches its 25th contact, for the second time, an energizing circuit is completed for the relay 230 from the negative side of battery, to the winding of relay 230, the front contact and armature 280, and over the conductor 276 to the wiper and the 25th contact of switch 206 to the back contact and armature 145′ to the positive side of battery.

As a result of the energization of relay 230, an energizing circuit is completed for the relay 144 from the negative side of battery to the winding of relay 144, over conductor 146 to the front contact and armature 281 and the first contact and wiper of switch 219 and the positive side of battery. The relay 144 energizes for restoring the apparatus to normal in the manner described above and, at the same time, the relays 229 and 228 deenergize, their locking circuits having been completed over the back contact and armature 145′. Upon the deenergization of relay 228, the original energizing circuit for relay 230 is opened and this relay deenergizes. In this manner the apparatus is restored to normal. It will be noted that the restoring circuit is completed over the contact of switch wiper 219 so that, if the switches have remained in engagement with their first contact, as they would if any person except the dispatcher were connected to the substation, the apparatus is restored to its normal condition.

If, however, the dispatcher has made a selection this restoring circuit is not completed and the dispatcher can maintain control of the selected unit for as long a period of time as he desires.

It will be evident, from the above description of applicant's system that standard telephone electrical circuits may be employed, operating through a central exchange, for operating remotely disposed circuit breakers and for supervisory control systems. No alteration of the telephone circuit is necessary and the signals transmitted over the telephone lines are, as a matter of fact, of exactly the same characteristics as speech signals inasmuch as frequencies are transmitted within the voice range, so that, on listening in, tones that are very similar to speech signals will be heard.

Although I have disclosed a specific form of my invention, I do not intend to limit myself to this particular form, but only in so far as set forth in the appended claims.

I claim as my invention:

1. In combination, a telephone system, the first subscriber comprising a dispatching office, a second subscriber comprising a substation, said substation comprising a plurality of power operated apparatus units, a telephone system for connecting said subscribing dispatching office to said substation, means at said dispatching office for transmitting telephone signal currents of predetermined frequency over said telephone line, means at said substation responsive to the frequency of said telephone currents for selecting one of said apparatus units for operation, means at said dispatching office for transmitting other telephone currents of a different frequency, and means at said substation responsive to the frequency of said second telephone current for operating said selected apparatus unit.

2. In combination, a telephone system, a first subscriber comprising a dispatching office, a second subscriber comprising a substation, said substation comprising a plurality of power operated apparatus units and selecting apparatus, said selecting apparatus being normally in a non-operating condition, means including a telephone system for connecting said dispatching office with said substation, means responsive to said connection for automatically conditioning said selecting apparatus at said substation for operation, means for transmitting telephone currents of different predetermined frequencies over said telephone line, and means for operating said selecting apparatus in accordance with the different frequencies of telephone currents transmitted over said telephone line for selecting and effecting the operation of any of said units for operation.

3. In combination, a telephone system, a first subscriber comprising a dispatching office, a second subscriber comprising a substation, said substation including a plurality of apparatus units, a telephone exchange for connecting said first and second subscribers for communication, means at said dispatching office for transmitting telephone currents over said telephone system to said second subscriber's office, means at said substation re-

sponsive to said connection to said dispatching office for automatically conditioning one of said apparatus units for operation, means responsive to said telephone currents for selectively operating said selected apparatus units, and means at said substation for transmitting telephone currents over said telephone line to said first station individual to said substation selected.

4. In combination, a first station, a second station, a first and second switch at said second station, a telephone circuit, a telephone exchange for completing a connection from said first to said second station, means responsive to said circuit for starting said first switch into operation, means including said first switch for transmitting a code of a predetermined combination of impulses, a plurality of apparatus units at said second station and means at said first station for selecting one of said apparatus units for operation and means responsive to this selection for rendering said first mentioned switch non-operative and for starting said second mentioned switch into operation to transmit a code combination of impulses to said first station individual to the condition of said selected unit.

5. A remote control system comprising a control station and a remote station, telephone instruments at said stations and connections therebetween, a solenoid at the remote station for lifting the telephone receiver at said station, an initiating relay responsive to the ringing of the remote station telephone bell for energizing the solenoid, a code transmitter and a sound producing device at the remote station, means controlled by said relay for initiating the operation of said code transmitter to cause the sound producing device to produce a series of tones audible in the telephone receiver at the control station for identifying the remote station, a relay operable to restore the system to normal, and means responsive to the first complete operation of the code transmitter to render the restoring relay operable, said restoring relay being responsive to the second complete operation of the code transmitter to effect the deenergization of the initiating relay and the solenoid and to effect the stopping of the code transmitter in its normal position.

6. A remote-control system comprising a control station and a control station and a distant station, telephone instruments at said stations and connections therebetween, a plurality of high-frequency oscillators and a sound-emitting device controlled thereby at said control station, a solenoid at said distant station for lifting the telephone receiver thereat and a relay responsive to the ringing of the substation telephone bell for energizing said solenoid, a microphone at the distant station responsive to the sounds emitted by the substation telephone receiver, resonant devices, tuned to the frequencies of said oscillators, connected to said microphone, a plurality of circuit breakers at said distant station, a selector, a code transmitter and a sound-producing device at the distant station, means controlled by said relay for rendering said code transmitter effective to operate said sound-producing device to produce a series of tones audible in the telephone receiver at the control station for identifying the distant station, and a relay controlled by one of said resonant devices for operating said selector to select one of said circuit breakers and for causing said code transmitter to operate the sound-producing device to indicate the position of the selected circuit breaker.

7. A remote control system comprising a control station and a distant station, telephone instruments at said stations and connections therebetween, a plurality of high-frequency oscillators and a sound-emitting device controlled thereby at said control station, a solenoid at said distant station for lifting the telephone receiver thereat and a relay responsive to the ringing of the substation telephone bell for energizing said solenoid, a microphone at the distant station responsive to the sounds emitted by the substation telephone receiver, resonant devices tuned to the frequencies of said oscillators connected to said microphone, a plurality of circuit breakers at said distant station, a selector, a code transmitter and a sound-producing device at the distant station, means controlled by said relay for rendering said code transmitter effective to operate said sound-producing device to produce a series of tones audible in the telephone receiver at the control station for identifying the distant station, a relay controlled by one of said resonant devices for operating said selector to select one of said circuit breakers and for causing said code transmitter to operate the sound-producing device to indicate the position of the selected circuit breaker, and a relay controlled by another of said resonant devices for causing the operation of said selected circuit breaker, said code transmitter being immediately effective to indicate the changed condition of said circuit breaker.

8. A remote control system comprising a control station and a distant station, telephone instruments at said stations and connections therebetween, a plurality of high-frequency oscillators and a sound-emitting device controlled thereby at said control station, a solenoid at said distant station for lifting the telephone receiver thereat and a relay responsive to the ringing of the sub-

station telephone bell for energizing said solenoid, a microphone at the distant station responsive to the sounds emitted by the substation telephone receiver, resonant devices tuned to the frequencies of said oscillators connected to said microphone, a plurality of circuit breakers at said distant station, a selector, a code transmitter and a sound-producing device at the distant station, means controlled by said relay for rendering said code transmitter effective to operate said sound-producing device to produce a series of tones audible in the telephone receiver at the control station for identifying the distant station, a relay controlled by one of said resonant devices for operating said selector to select one of said circuit breakers and for causing said code transmitter to operate the sound-producing device to indicate the position of the selected circuit breaker, a relay controlled by another of said resonant devices for causing the operation of said selected circuit breaker, said code transmitter being immediately effective to indicate the changed condition of said circuit breaker, and a relay controlled by another of said resonant devices for restoring said first-mentioned relay, said solenoid, selector and code transmitter to their normal positions.

9. A remote-control system comprising a control station and a remote station, telephone instruments at said stations and connections therebetween, means at the control station for producing sounds of predetermined frequencies, means at the remote station responsive to the operation of the telephone bell-ringer thereat for lifting the receiver, a microphone actuated by the sounds emitted from said receiver, resonant devices tuned to said predetermined frequencies controlled by said microphone, a sound-reproducer and a plurality of apparatus units at said remote station, a selector for selecting any one of said units, a code transmitter operative before any selection has been made to cause said sound-reproducer to emit a series of sounds to identify the station, and, after a selection has been made, to cause said sound-reproducer to indicate the unit selected and the condition thereof, means controlled by one of said resonant devices for actuating said selector, means controlled by another of said devices for operating the unit selected by said selector, and means controlled by another of said devices for restoring said receiver-lifting means, said selector and said code transmitter to their normal non-operative positions.

10. A remote-control system comprising a control station and a remote station, telephone instruments at said stations and connections therebetween, means at the control station for producing sounds of predetermined frequencies, means at the remote station responsive to the operation of the telephone bell-ringer thereat for lifting the receiver, a microphone actuated by the sounds emitted from said receiver, resonant devices tuned to said predetermined frequencies controlled by said microphone, a sound-reproducer and a plurality of apparatus units at said remote station, a selector for selecting any one of said units, a code transmitter operative before any selection has been made to cause said sound-reproducer to emit a series of sounds to identify the station, and, after a selection has been made, to cause said sound-reproducer to indicate the unit selected and the condition thereof, means controlled by one of said resonant devices for actuating said selector, and means controlled by another of said devices for operating the unit selected by said selector.

11. A remote-control system comprising a control station and a remote station, telephone instruments at said stations and connections therebetween, means at the control station for producing sounds of predetermined frequencies, means at the remote station responsive to the operation of the telephone bell-ringer thereat for lifting the receiver, a microphone actuated by the sounds emitted from said receiver, resonant devices tuned to said predetermined frequencies controlled by said microphone, a sound-reproducer and a plurality of apparatus units at said remote station, a selector for selecting any one of said units, a code transmitter operative before any selection has been made to cause said sound-reproducer to emit a series of sounds to identify the station, and, after a selection has been made, to cause said sound-reproducer to indicate the unit selected and the condition thereof, means controlled by one of said resonant devices for actuating said selector, and means controlled by another of said devices for restoring said receiver-lifting means, said selector and said code transmitter to their normal non-operative positions.

12. A remote-control system comprising a dispatcher's office and a substation, telephones at said office and station, means responsive to the ringing current for lifting the receiver of the substation telephone, a plurality of devices at the substation each adapted to be operated to a plurality of positions, a selector for selecting any one of said devices, a code sender effective while said selector is in its non-operative position for causing a series of sounds to be produced near the substation transmitter to identify the substation at the office, and, after a selection has been made, to identify the device selected and its position, and means responsive to sounds of predetermined frequencies in the substation receiver for actu-

ating said selector, for operating the selected device, and for restoring said receiver-lifting means, said selector and said code sender to their non-operative positions.

13. A remote-control system comprising a dispatcher's office and a substation, telephones at said office and station, means responsive to the ringing current for the substation telephone for lifting the receiver, a plurality of devices at the substation each adapted to be operated to a plurality of positions, a selector for selecting any one of said devices, a code sender effective while said selector is in its non-operative position for causing a series of sounds to be produced near the substation transmitter to identify the substation at the office, and, after a selection has been made, to identify the device selected and its position, and means responsive to sounds of predetermined frequencies in the substation receiver for actuating said selector, and for operating the selected device.

14. A remote-control system comprising a dispatcher's office and a substation, telephones at said office and station, means responsive to the ringing current for the substation telephone for lifting the receiver, a plurality of devices at the substation each adapted to be operated to a plurality of positions, a selector for selecting any one of said devices, a code sender effective while said selector is in its non-operative position for causing a series of sounds to be produced near the substation transmitter to identify the substation at the office, and, after a selection has been made, to identify the device selected and its position, and means responsive to sounds of predetermined frequencies in the substation receiver for actuating said selector.

15. A long-distance control and supervisory system comprising a control telephone and an operating telephone adapted to be connected through the usual communication system, means responsive to the ringing current of the operating telephone for lifting the receiver thereof and producing predetermined sounds near the transmitter to identify it at the control telephone, a plurality of devices adapted to be operated to a plurality of positions, means for selecting any one of said devices and indicating by appropriate sounds the device selected and the position thereof, and means responsive to sounds of predetermined frequencies for actuating said selecting means, for operating one of said devices after it has been selected and for restoring said receiver-lifting means, said selecting means and said sound-producing means to their normal conditions.

16. A long-distance control and supervisory system comprising a control telephone and an operating telephone adapted to be connected through the usual communication system, means responsive to the ringing current for the operating telephone for lifting the receiver thereof and producing predetermined sounds near the transmitter to identify it at the control telephone, a plurality of devices adapted to be operated to a plurality of positions, means for selecting any one of said devices and indicating by appropriate sounds the device selected and the position thereof, and means responsive to sounds of predetermined frequencies for actuating said selecting means, and for operating one of said devices after it has been selected.

17. A long-distance control and supervisory system comprising a control telephone and an operating telephone adapted to be connected through the usual communication system, means responsive to the ringing of the operating telephone for lifting the receiver thereof and producing predetermined sounds near the transmitter to identify it at the control telephone, a plurality of devices adapted to be operated to a plurality of positions, means for selecting any one of said devices and indicating by appropriate sounds the device selected and the position thereof, and means responsive to sounds of predetermined frequencies for actuating said selecting means.

18. A long-distance control and supervisory system comprising normally non-operative, sound-transmitting means including transmitters and receivers at a plurality of different locations, means at one of said locations for establishing connections with another of said locations for sound transmission, a plurality of devices at one location operable to a plurality of positions, means controlled by said first-mentioned means for producing sounds to identify said location, means responsive to predetermined sounds for selecting and operating one of said devices and for identifying the selected device and its position by other sounds, and means responsive to other predetermined sounds for restoring said first-mentioned means to normal.

19. A control and supervisory system comprising a control station, a remote station, a plurality of devices operable to a plurality of positions in the remote station, means at the control station for transmitting sound waves of different predetermined frequencies, means responsive to sound waves of one predetermined frequency for selecting a device for operation, means responsive to the selection of said device for indicating at the control station the device selected and its position, and means responsive to sound waves of another predetermined frequency for effecting the operation of the selected device.

20. In a telephonic control system, a tele-

phone, means responsive to the telephone ringing current for lifting the receiver and producing characteristic sounds to identify the telephone, means for restoring the receiver to its normal position after a predetermined time, means responsive only to sounds of a predetermined frequency to prevent operation of said restoring means and means responsive to sounds of another predetermined frequency to causing the operation of said restoring means.

21. In a telephone control system, a telephone, means responsive to the telephone ringing current for lifting the receiver and producing characteristic sounds to identify the telephone, means for restoring the receiver to its normal position after a predetermined time, and means responsive only to sounds of a predetermined frequency to prevent operation of said restoring means.

In testimony whereof, I have hereunto subscribed my name this thirteenth day of October, 1927.

ROY J. WENSLEY.