

June 20, 1944.

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2,351,766

TELEPHONE SYSTEM

Filed July 30, 1943

4 Sheets-Sheet 1

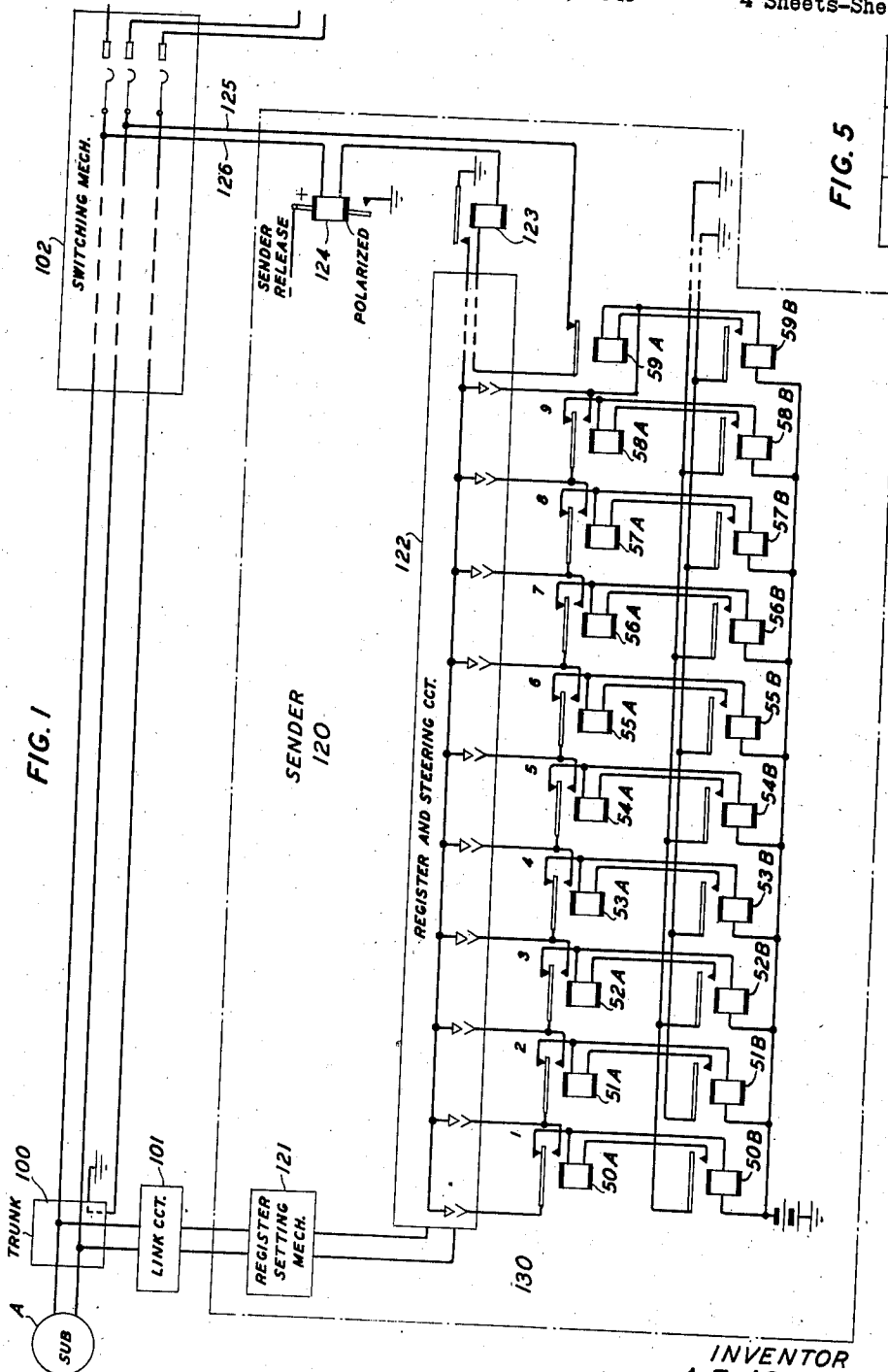


FIG. 1

FIG. 5

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

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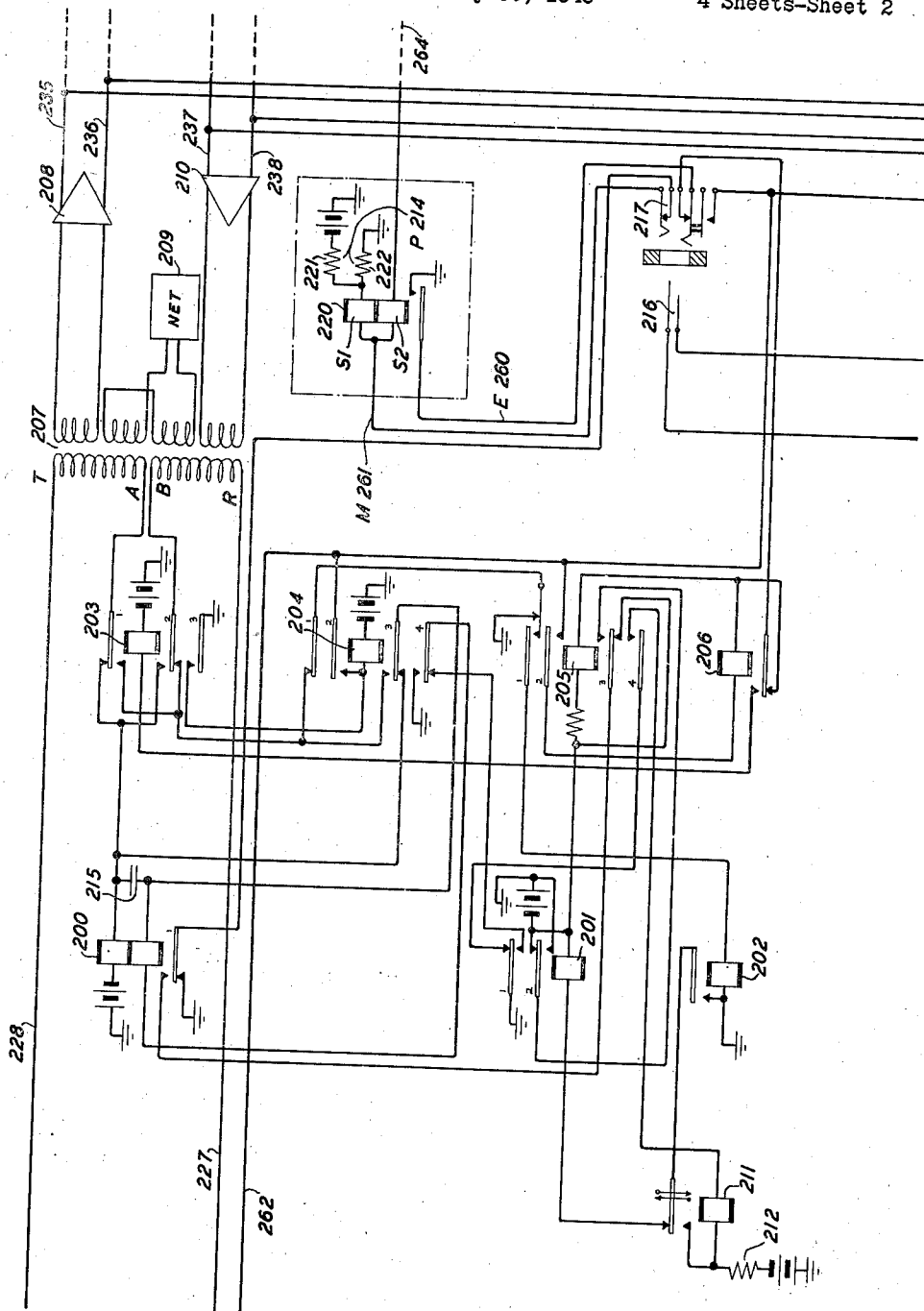
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FIG. 2



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4 Sheets-Sheet 3



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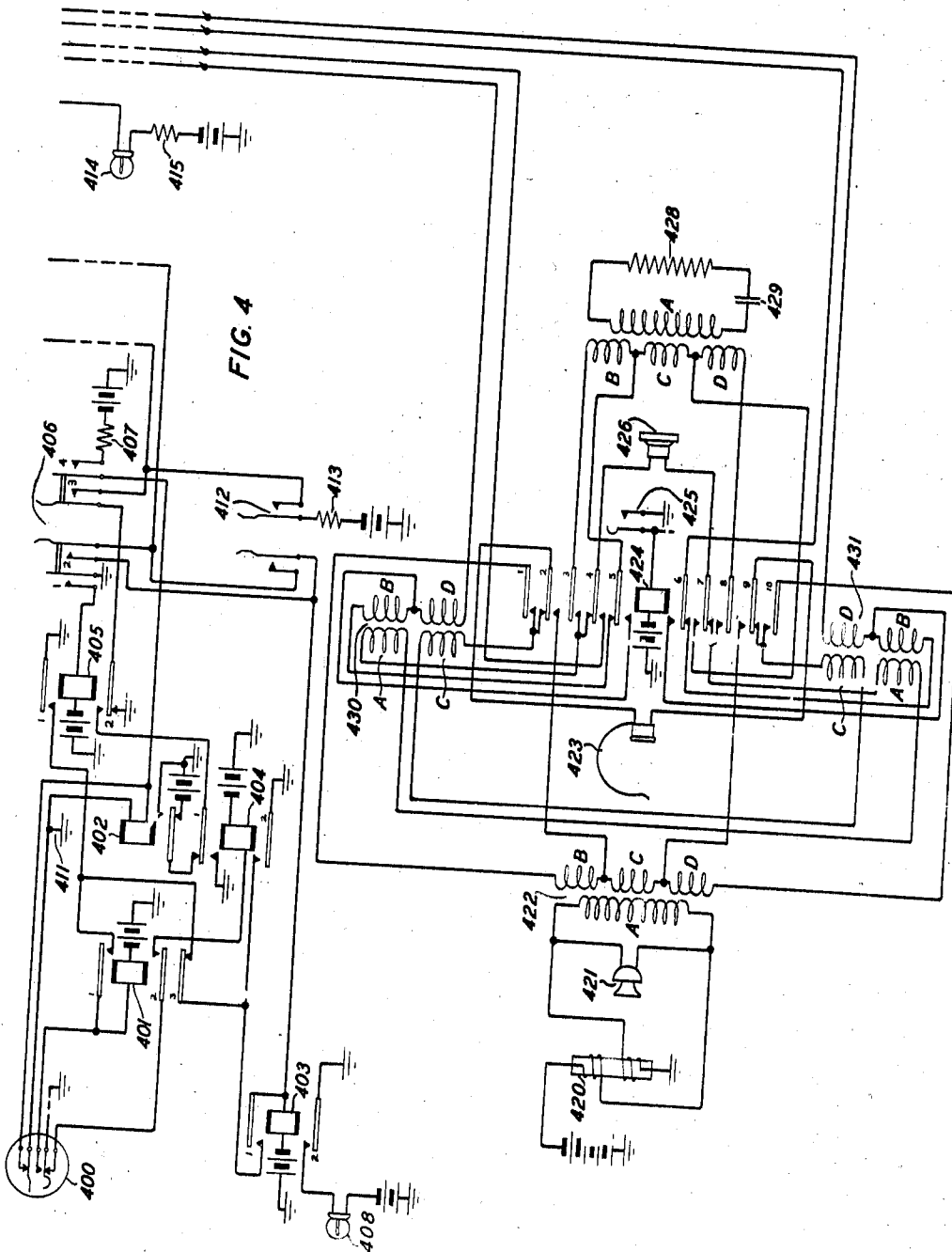
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4 Sheets-Sheet 4



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UNITED STATES PATENT OFFICE

2,351,766

TELEPHONE SYSTEM

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Application July 30, 1943, Serial No. 496,739

5 Claims. (Cl. 179-27)

This invention relates to automatic switching telephone systems and more particularly to the control of pulse responsive devices for such systems.

It is the object of the invention to increase the range of operation of impulse systems for controlling the operation of switches in automatic switching telephone offices.

Revertive impulse systems have been used in both panel and cross bar automatic switching telephone offices in which a fundamental circuit is used for controlling the positioning of switches. In well-known systems of this character a group of counting relays and a stepping relay are used for controlling the number of pulses which comprise a digit, the connection to the counting relay being automatically altered for each digit by a steering device. The fundamental circuit of these systems extends from battery through the winding of a line relay, known as the L relay, thence over one leg of the fundamental circuit loop through the winding of the above-mentioned stepping relay and a contact of the last operated counting relay, over the other leg of the fundamental circuit through the winding of another stepping relay to ground in a nearby switch controlling device. When the fundamental circuit is closed both stepping relays are operated and released by the closed circuit and shunt method a number of times for each digit depending upon the counting relay connection to the originating pulse controlling device. The L relay remains operated during the pulsing of a digit and is released during the interdigital period. This invention contemplates the use of such fundamental circuits in automatic switching offices a considerable distance apart for setting the switches in one office according to the digit pulse controlling devices of the originating office.

A feature of the invention consists in the use of the revertive pulsing fundamental circuits in two automatic switching telephone offices, one originating and the other terminating, interconnected by a composite signaling circuit and associated devices for controlling the setting of switches in the distant terminating office.

Another and related feature consists in connecting the digit pulse controlling mechanism of the originating office sender fundamental circuit with the mechanism of a composite signaling outgoing trunk circuit, the fundamental circuit thus extending from the originating sender through the mechanism of the composite signaling outgoing trunk circuit and in connecting the switch controlling mechanism of the terminating

office fundamental circuit with the mechanism of a composite signaling incoming trunk circuit in said terminating office, thus extending this second fundamental circuit from the terminating office through the mechanism of the composite signaling incoming trunk circuit for simultaneously actuating the mechanism of both fundamental circuits under the control of the originating office sender.

Another and related feature consists in the use of a telephone operator's position mechanism of the originating office for controlling the mechanism of the fundamental circuit extending between the terminating office and the incoming composite signaling trunk circuit to complete an automatic switching telephone connection between the originating office operator's position and a subscriber or operator in the terminating office.

These and other features will be discussed more fully in the following description when taken in connection with the illustrated embodiment in which:

Figs. 1, 2 and 4 illustrate the originating mechanism of one automatic switching telephone office and Fig. 3 the terminating mechanism of another automatic switching telephone office. The figures taken separately illustrate the following:

Fig. 1, a subscriber's line, a register sender and the switches which are operated under the control of the sender.

Fig. 2, a composite signaling outgoing trunk circuit connected to a four-wire transmission line having speech amplifying repeaters therein.

Fig. 3, an incoming composite signaling circuit connected to the terminating end of the four-wire transmission line and connected to a sender and the switching mechanism of the terminating office.

Fig. 4, a telephone operator's position.

The composite signaling relays are associated with the composite signaling trunk circuit, Fig. 2, in one office and with the composite signaling trunk circuit, Fig. 3, in a distant office for increasing the distance over which pulses may be transmitted for connections between two full mechanical switching offices. As noted in the art of record, the one fundamental circuit is ordinarily used between the signal sending devices and the signal receiving devices. The arrangement shown herein has two fundamental circuits, one between the outgoing composite trunk, Fig. 2, and the sender 120 and another fundamental circuit between the incoming trunk, Fig. 3, and

the sender circuit 330. Between these two trunk circuits the composite signaling circuit is used to develop in one fundamental the pulses which are created in the other fundamental circuit. This composite signaling circuit is also used for transmitting signals from the distant end to the originating end for various purposes. The operation of the composite signaling circuit will first be discussed.

Referring to the composite signaling relays 220 and 320 each has two windings designated S1 and S2. The two signaling windings S1 and S2 of each relay have approximately the same number of ampere turns and are connected differentially. One is connected to the composite signaling channel 264 and the other winding to a biasing potentiometer. The current builds up and decays in the two windings at the same rate. The other terminals of the two windings are connected together and to a lead marked M. In the outgoing trunk Fig. 2, lead M extends to the armature of the L relay 200 which when released is associated with ground and when actuated is connected to battery through the contact of relay 205 for the start signals and through the contact of relays 205 and 201 for the transmission of pulses. The M lead in the incoming trunk, Fig. 3, is connected through contact 5 of relay 308 to ground on contact 4 of relay 309. Battery is connected to the M lead of the composite relay 320 either by the operation of relay 309 or by the operation of relay 307 and the operation of relay 308. The circuit connections to the composite signaling relays 220 and 320 with the other relays normal as shown, causes both composite relays to remain released. The current flows from the biasing potentiometer through windings S1 to ground connected to the M lead of each of the composite signaling relays 220 and 320. This biases the composite relays to their released positions. When the L relay 200 is operated battery is connected through contact 1 of relay 205 to the M lead of relay 220. This causes current to flow in the S1 winding of the composite relay 220 in the opposite direction and tends to operate this relay but current also flows in the S2 winding of relay 220 tending to release the relay and because the voltage at the biasing potentiometer is higher than ground, the current through the S2 winding is enough greater than that through the S1 winding to hold the relay 220 released. The current flowing through the S2 winding of relay 220 flows out over the composite signaling lead 264 and through the S2 winding of the composite relay 320 in the distant office. Here, because of its greater value, the current in the S2 winding overpowers the effect of the current in the S1 winding and operates relay 320. As later will be explained, the operation of relay 320 establishes a circuit for the A relay 306 in the distant incoming trunk and other mechanism as shown. The duplex action of this signaling system may be illustrated by now referring to a signal transmitted from the distance office, Fig. 3, to the originating office, Figs. 1 and 2 after the composite signaling relay 320 has been operated. For this illustration, let it be assumed that the L relay 200 is operated and relay 201 is released. Thus, battery is connected to the M lead 261 through the S2 winding of relays 220 and 320 to ground in the incoming trunk, Fig. 3. In order to transmit a signal from the incoming trunk, Fig. 3, battery may be connected to the M lead of com-

posite signaling relay 320 as described. Battery connected to this M lead and battery connected to the M lead of composite signaling relay 220 places the S2 windings of both relays in series and no current will flow through either one of the S2 windings. Relay 220 now operates from the current through its S1 winding and relay 320 remains operated from the current through its S1 winding. The operating current in the S1 winding of relay 320 takes the place of the previously operated current in the S2 winding. Thus, when signaling current is transmitted from Fig. 3 to Fig. 2 with the current as related in this example, relay 320 remains operated in order to continue the circuit for the A relay 306 and establish a circuit for operating relay 220 to transmit a start pulsing signal, a signal to an operator or for other purposes such as releasing a sender at the termination of the transmission of digits.

A telephone call is initiated over the wires of this system in the usual manner by a subscriber A which under some conditions may be a telephone operator. The removal of the telephone receiver at station A by a subscriber transmits a signal to a telephone office which in this instance is shown diagrammatically as a full mechanical switching office of the type disclosed by R. Raymond in his Patent 2,106,360, January 25, 1938. In response to the removal of the receiver, switches are energized in the full mechanical switching office for connecting the subscriber's line to a link 101 which selects an idle pulse responsive sender 120 and connects it to the calling line. The link 101 used for connecting the calling subscriber with a sender is shown diagrammatically as well as the pulse responsive mechanism, the registers, and sequence circuit of the sender 120. The pulse responsive mechanism energizes the register setting mechanism 121 for setting a number of registers according to the dial pulses transmitted for connecting the calling subscriber with another subscriber. In this case, it may be assumed that the calling subscriber desires a connection with a subscriber connected with another full mechanical switching office a considerable distance away which requires special signaling equipment to obviate the use of an intermediate switching office for completing a connection to this distant subscriber. The code registers which are set by the calling subscriber A indicate the office to which the call shall be extended and the sender 120 thus controls the selection of an outgoing trunk for this connection which outgoing trunk is shown in Fig. 2. The calling subscriber continues to dial the numerical digits which are also set up on the registers 122. These registers are associated with a steering circuit which successively associates the registers with the counting relays shown as the pulses are transmitted over a fundamental circuit extending through the sender mechanism including stepping relay 123, the contact of the last counting relay 159A and the pulsing mechanism of the outgoing trunk circuit Fig. 2.

The outgoing trunk, Fig. 2, is permanently connected with the incoming trunk, Fig. 3, of the distant office and as soon as the sender 120 is ready to complete the telephone connection and the fundamental circuit has been established, the fundamental L relay 200 of Fig. 2 is energized. The circuit for the L relay 200 may be traced from battery through its upper winding, contact 1 of relay 203, left upper winding of hybrid 207,

winding of stepping relay 123, contact of counting relay 159A, left lower winding of hybrid 207, contact 2 of relay 203, contact 1 of relay 204 to ground on contact 3 of relay 205. The L relay 200 and the stepping relay 123 operate in the circuit traced. The operation of the L relay 200 connects battery through contact 1 of relay 205, contact of relay 200, lead 261, lower winding of composite signaling relay 220, composite signaling lead 264, lower winding of composite signaling relay 320, contact 5 of relay 308 to ground on contact 4 of relay 309. For reasons given herein, the composite signaling relay 220 does not operate when the above circuit is established. The composite signaling relay 320 is operated in the circuit traced which connects ground to the winding of the A relay 306 to battery operating this A relay. The operation of relay 306 establishes a circuit for relay 307 from battery through the winding of relay 307, contact 2 of relay 308, contact 3 of relay 309 to ground on contact 4 of relay 306. Relay 306 also establishes connections for the fundamental pulsing circuit between the incoming trunks Fig. 3 and the sender 330 by first connecting a potentiometer, comprising resistance 311 to ground and resistance 310 to battery, through contact 4 of relay 304, winding of polarizing relay 305, contact 5 of relay 304 through a standard incoming trunk of this distant office to an incoming junctor circuit. This causes the energization of link 325 shown diagrammatically, which selects and associates a sender with the tip and ring conductors extending through the regular incoming trunk to the composite signaling trunk. The potentiometer associated with relay 306 is this connected through the link to the stepping relay 333 of a sender such as sender 330. The mechanism of the distant office, including sender 330 in the right portion of Fig. 3, is diagrammatically shown and with the exception of the composite signaling trunk may be substantially the same as shown in Patent 2,089,921, issued to W. W. Carpenter, August 10, 1937.

The fundamental circuit shown for the sender in this distance office and the registering mechanism may be the same as shown in the above-mentioned patent to Carpenter. In place of the more complicated mechanism of this patent, relay 334 has been shown for connecting the registering mechanism with the pulse responsive relay 332 connected with the fundamental circuit.

The stepping relay 333 operates when connected to the potentiometer over the circuit traced and the operation of the stepping relay establishes an obvious circuit for relay 332 and the latter relay establishes an obvious circuit for the L relay 331. The ground connected through the winding of the L relay 331 also extends to the tip conductor 340, contact 1 of relay 304, contact 3 of the A relay 306, contact 2 of relay 307, winding of relay 308 to battery operating relay 308. Relay 308 in operating locks through its contact 3 to ground on contact 4 of relay 304 completing the fundamental circuit between the incoming trunk and the sender 330. The L relay 331 is now held operated over one leg of the fundamental by way of the tip conductor 340, contact 1 of relay 304, contact 3 of the A relay 306 which is slow to release and remains operated during the pulses for each digit, contacts 4 and 3 of relay 308, contact 4 of relay 304 to ground. The stepping relay 333 is held operated over the other leg of the fundamental by way of ring conductor 341, contact 6 of relay 304, winding of polarized relay 305, contact 5 of relay 304, contacts 6 and 5 of relay 305 to

the aforementioned potentiometer. Relay 308 also opens the operating circuit for relay 307; the latter relay is, however, slow in releasing. After relay 308 has operated and before relay 307 has released, a start pulsing signal is established to the distant office which operates the composite signaling relay 220 for automatically starting the generation of pulses over the fundamental circuit between the originating sender 120 and the outgoing trunk circuit, Fig. 2. The circuit operating relay 220 may be traced from battery through contact 1 of relay 307, contact 5 of relay 308, M conductor 351, S2 winding of composite signaling relay 320, S2 winding of composite signaling relay 220, M lead 261, contact 1 of L relay 200 to battery on contact 2 of relay 201. Relay 220 is now operated from current through its S1 winding and relay 320 remains operated from current through its S1 winding since the circuit above traced neutralizes the S2 windings of both composite signaling relays. The operation of the composite signaling relay 220 establishes a circuit for relay 205 from ground through the contact of relay 220, winding of relay 205 to battery, which operates relay 205. The operation of relay 205 now connects the stepping relay 202 in the fundamental circuit previously traced through the winding of stepping relay 123 of the sender and the L relay 200 to battery. It will be remembered that previous to this time this fundamental circuit was established to direct ground on contact 3 of relay 205. The release of relay 307 shortly after the operation of relay 308 opens the battery circuit from the incoming trunk through winding S2 of the composite signaling relay 220 causing the release of the latter relay. The operating circuit for relay 320 now extends from battery through contact 1 of pulsing relay 201, contact 1 of relay 205, contact of L relay 200, M lead 261, S2 windings of relays 220 and 320, contact 5 of relay 308, contact 1 of relay 307, contact 4 of relay 309 to ground.

During the momentary operation of relay 220 which caused the operation of relay 205, a shunt is placed across the winding of relay 206 so that the latter relay does not operate, but upon the release of relay 220 battery flows through the winding of relay 205, winding of relay 206, contact 2 of relay 205 to sleeve ground connected to conductor 262 which locks both relays 205 and 206 to the sleeve ground. Other signals from the distant office which thereafter operate the composite signaling relay 220 will cause the operation of reversing relay 203 for purposes explained later. The start pulsing signal returned to the outgoing trunk circuit, Fig. 2, therefore, establishes the pulse generating circuit in the originating fundamental circuit and arranges a normal composite signaling path between the distant office and the originating office for use after the digits have been transmitted and before if trouble is encountered.

Pulses are now generated by the operation of the pulsing mechanism in the originating or first fundamental circuit causing responsive action in the terminating or second fundamental circuit. The operation of the stepping relay 220 establishes an obvious circuit for relay 201. Relay 211 is slow to operate and does not operate at this time. Relay 201 in operating opens the composite signaling battery and connects ground through contact 1 of relay 205 and the contact of the L relay 200, S2 winding of relay 220, signaling circuit 264, S2 winding of relay 320 to ground, causing the release of relay 320, which associates a

shunt ground with the ring conductor 341 to cause the release of stepping relay 333 in the distant fundamental circuit. The operation of relay 201 also connects ground through contact 2 of relay 204, lower winding of L relay 200, contact 3 of relay 204, through the winding of the L relay 200 to battery for holding this relay operated and through contact 1 of relay 203, thence over the tip conductor 228 of the fundamental circuit which causes a shunt to be placed on both stepping relay 202 of the trunk circuit and stepping relay 123 in sender 120 causing their release. The contact of the stepping relay 123 is connected through a particular register to one of the counting relays depending upon the original setting of this register by pulses from the calling subscriber. Assuming that this particular register associates the contact of stepping relay 123 with the lead 136, the counting relay 156B is energized by the first operation of relay 123 and relay 156A is operated when the stepping relay 123 releases. The circuit for the counting relays is clear since with relay 123 operated a circuit is established for relay 156B to battery and also relay 156A is shunted, but when relay 123 is released a circuit is established from battery through the winding of relay 156B, winding of relay 156A, contact of relay 156B to ground.

In the distant office the release of composite signaling relay 320 connects ground through contact 6 of relay 306, contact 5 of relay 304, winding of polarizing relay 305, contact 6 of relay 304, thence over the ring conductor 341 to the winding terminal of the stepping relay 333, thus shunting the stepping relay to cause its release. The release of relay 333 releases relay 332 which opens the circuit connection to the registering mechanism in the usual manner and disconnects ground from the L relay and the tip conductor 340 of the trunk. The distant office L relay 331 is however maintained operated from battery through its winding over a circuit to tip conductor 340, contact 1 of relay 304, contact 3 of relay 306, contacts 4 and 3 of relay 308 to ground on contact 4 of relay 304. The L relay 331 is thus held operated during the pulses transmitted for registering a digit.

The release of stepping relay 202 causes the release of relay 201 and thus the stepping relays 202 and 123 again operate. Each operation and release of the stepping relay 202 transmits a signal over the composite signaling circuit to cause the pulsing relays of the fundamental circuit extending between sender 330 and the incoming trunk, Fig. 3, to function and at the same time causes the stepping relay 123 in the originating fundamental to function. Relay 123 successively operates the pairs of counting relays in the manner described until the end counting relay 159A operates to open the fundamental circuit extending between sender 120 and the outgoing trunk circuit, Fig. 2. This terminates the pulses for the first digit and causes the mechanism of sender 120 to function during the interdigital period for connecting the next set of registers to the counting relay circuit for the next digit to be transmitted. Also during this interdigital period the registering mechanism in sender 330 is operated for causing the first digit to be registered. When the fundamental circuit between sender 120 and the outgoing trunk, Fig. 2, is opened, relay 200 is released and relays 201 and 202 are released. With relay 200 released battery is disconnected from and ground is connected to the M lead of the composite signaling relay 220, thus causing the release of the composite signaling relay 320 75

which opens the holding circuit for the A relay 306. Release of relay 306 releases the L relay 331 in the distant sender causing the registering mechanism shown diagrammatically as 335 to function.

When the sender 120 has released the counting relays and the steering circuit 122 has connected the next register with the counting relays and closed the fundamental circuit, stepping relays 202 and 123 are again operated and the L relay 200 is operated as previously described since relay 205 remained locked to the sleeve conductor 262. During the interdigital period a circuit is established for the slow operating relay 211 from battery through resistance 212, winding of relay 211, contact 4 of relay 205, contact 2 of relay 201 to ground which operates relay 211 to open the operating circuit for relay 201. The stepping relay 202 in reoperating places a ground shunt around the winding of relay 211 but this relay is slow to release to permit a signal to be transmitted over the composite signaling circuit. The operation of the L relay 200 connects battery from the back contact of relay 201, contact 1 of relay 205, contact of relay 200 to the M lead of the composite signaling relay 220, thence through the S2 winding of this relay and the S2 winding of composite signaling relay 320, contact 5 of relay 308, contact 1 of relay 307 to ground on contact 4 of relay 309, thus causing the reoperation of the composite signaling relay 320 which reestablishes a circuit for the A relay 306 preparing the fundamental circuit between the incoming trunk circuit, Fig. 3, and the sender 330 as was originally described. The release of relay 211 again establishes the circuit for relay 201 from ground on the stepping relay, back contact of relay 211, winding of relay 201 to battery. Pulses are now generated for the second digit which causes the release and operation of the composite signaling relay 320 for registering the digit in sender 330 and for causing the operation of the counting relays according to the connection of the second register with these counting relays. As previously described, each operation of relay 201 connects a ground shunt to the tip of the line causing the release of stepping relay 123 and stepping relay 202 and also causing the release of the composite signaling relay 320. The release of relay 202 as is apparent causes the release of relay 201 and the stepping relays and composite signaling relays 320 and pulses are transmitted until such time as the incoming relay 159A again opens the fundamental circuit to terminate the pulses for the second digit. This results in an interdigital period, releases L relay 200 and L relay 331 in both fundamental circuits causing the registration of the second digit in the sender 330. The steering circuit of sender 120 now connects the third set of registers with the counting relays and releases the counting relays to again establish the fundamental circuit between the sender 120 and the outgoing trunk circuit. The operation for transmitting the pulses for the third digit and subsequent digits is the same as has already been described.

As shown in the aforementioned Patent 2,106,360 to R. Raymond the fundamental circuit is again closed in the originating sender 120 after the last digit. This signals the terminating sender 330 that the last digit has been sent out. The closure of the fundamental again operates the L relay 200 which connects battery from contact 1 of relay 201, contact 3 of relay 205 through the contact of L relay 200 to the M lead of the com-

posite signaling relay 220. The circuit extends through the S2 windings of relays 220 and 320 to ground on contact 4 of relay 309 energizing the composite signaling relay 320 which again operates the A relay 306. It will be remembered that after each digit has been sent out relays 320 and 306 are released. This procedure is the same after the last digit has been dialed as well as after other digits.

In the terminating sender, the fundamental is again closed by the operation of the A relay 306 the same as previously described. Since the last digit has been registered by sender 330, this sender in recognition of the registration of the last digit now establishes a circuit for a reversing relay in the manner fully described in the aforementioned Patent 2,089,921 to W. W. Carpenter. Relay 336 diagrammatically shows the relay for transmitting the reverse pulse and is operated when the fundamental between the incoming trunk in Fig. 3 and sender 330 is closed after the last digit has been transmitted. A diagrammatic illustration of this arrangement shows the operation of relay 332 and 331 establishing a circuit for relay 334 and a circuit from ground through the contact of relay 334 and through the registering mechanism for operating the relay 336 to transmit the reverse battery pulse. The operation of the latter relay connects battery to ring conductor 341 which extends through contact 6 of relay 304, winding of polarized relay 305, contact 5 of relay 304 to the potentiometer associated with contacts 5 and 6 of relay 306. The current is now in the proper direction for operating polarized relay 305 which establishes a circuit from ground through contact 1 of relay 306, contact of relay 305, winding of relay 309 to battery. Relay 309 in operating locks to ground on contact 1 of relay 308 and immediately transmits the signal to the originating sender 120. For this signal, battery is connected through contact 4 of relay 309, contact 1 of relay 307, contact 5 of relay 308, M lead 351, S2 windings of composite signaling relays 320 and 220, contact 1 of relay 200, contact 3 of relay 205, to battery or ground on contact 1 of relay 201. Under normal circuit conditions the signal is retained before relay 201 is operated.

As previously described, the connection from battery to battery through the S2 windings of the composite signaling relays 320 and 220 neutralizes these windings and the current through the S1 windings is made effective. This current through the S1 winding holds relay 320 operated and operates relay 220. The operation of relay 220 establishing a circuit for the reversing relay 203 from ground through the contact of relay 220, jack 217, contact of relay 206, winding of relay 203 to battery. The operation of relay 203 reverses the current flow in the fundamental circuit and establishes an operating circuit through its contact 3 for relay 204. Relay 204 locks to ground over the sleeve circuit 262 opening the circuit for the stepping relay 202. Battery is thus connected through the winding of L relay 200, contact 2 of relay 203, lower winding of hybrid coil 207, thence over the fundamental circuit through the winding of relay 123, winding of polarized relay 124, upper winding of hybrid coil 207, contact 1 of relay 203, contact 3 of relay 204, lower winding of L relay 200, contact 4 of relay 204 to ground.

The current in the circuit traced through the winding of polarized relay 124 is in the direction to operate this relay and the operation of relay

124 establishes a releasing circuit for sender 120. The sender 120 and link 101 are now disconnected from the line and trunk conductors. The I relay 200 releases causing the release of the distant composite relay 320, the release of the A relay 306. The release of relay 306 establishes a circuit from ground on its contact 4 through contact 1 of relay 309 winding of relay 304 to battery operating the latter relay. The operation of relay 304 connects the tip and ring leads through its contacts 1 and 6 to the distant office, thus closing the transmission circuit. The L relay 200 is connected over the line loop through the subscriber station and reoperates. A circuit is thus established for relay 320 which reoperates relay 306. The operation of relay 306 with relay 304 operated establishes a locking circuit for relay 304 and opens the locking circuit for relay 308 which releases. The release of relay 308 opens the locking circuit for relay 309 which releases. Release of relay 309 removes battery from the M lead of the composite signaling circuit which causes the release of the composite signaling relay 220. Release of relay 220 releases relay 203. Since relay 204 is locked to the sleeve circuit 262, the circuit is now established placing condenser 215 across the transmission coils of the hybrid coil 207. This circuit may be traced from the tip conductor through the upper winding of hybrid coil 207, condenser 215, contact 2 of relay 204, over coil of hybrid 207, ring conductor 227 and through other mechanism of the transmission circuit. Relay 304 when operated also connects the winding of relay 305 to trunk conductors 340 and 341 so that a reverse battery signal may be sent upon the termination of the connection.

The sender 330 having had its registers set in accordance with digit pulses indicating the wanted subscriber, now operates the switching mechanism for connecting the called subscriber A with the calling subscriber B. A four-wire transmission line has been shown, which is well understood in the art, using hybrid coil 207 and 330 having balancing networks 209 and 302 regulated according to the lines with which they are associated. The repeaters in the four-wire line are shown diagrammatically to indicate that the flow of voice currents over conductors 235 and 236 is in the right-hand direction and the flow of voice currents in the lower channel comprising the two wires 237 and 238 is in the left-hand direction through repeaters 303 and 210. Thus the conversation from subscriber A is transmitted over the upper channel of the four-wire circuit comprising repeaters 208 and 301 and the transmission from subscriber B to subscriber A is over the lower channel of the four-wire circuit through repeaters 303 and 210. With relay 305 connected to conductors 340 and 341 as set forth in the foregoing, signals may be transmitted by reversing the battery and ground in this dial out office to operate relay 305 to charge for the office and office calls and for disconnecting purposes. Relay 305 establishes a circuit for relay 309 which operates and connects battery to the M lead 351 which operates the composite signaling relay 220 as herein described. It will be remembered that relay 206 is locked to the sleeve ground over lead 262 and therefore the operation of relay 220 establishes a circuit for the reverse battery relay 203. This reversal of battery and ground over trunk leads 227 and 228 is employed for operating the charging mechanism associated with the calling line in any well-known manner.

An operator's position circuit is shown in Fig. 4 having a telephone set arranged for listening and talking in the manner disclosed in Patent 2,294,237 to J. B. McKim, August 25, 1942. This telephone circuit is normally arranged for monitoring over the four-wire circuit and by the operation of relay 424 is arranged for talking to either subscriber and listening to subscriber's conversation. This telephone circuit is arranged with a combination of hybrid coil windings in such manner that voice transmission will not extend through the telephone circuit from one four-wire channel to the other and thus obviates voice echoes as fully described in the aforementioned patent to McKim. Since this telephone circuit is fully described in the patent, it is believed unnecessary to encumber this description with a description of the direction of transmission current flow through the various windings of the telephone circuit.

The operator's position circuit, Fig. 4, is arranged so that this operator may cause the mechanism of this incoming trunk and sender in the distant office to function by pulsing over the composite signaling circuit by the use of dial 400. This operator selects an idle trunk circuit and inserts plug 216 into jack 217 which disconnects the composite signaling circuit from the trunk of Fig. 2 at the same time it is connected to the operator's position. Key 406 is operated to establish the circuit between the operator's position and the distant office. The operation of key 406 establishes an obvious circuit for operating relay 405. The operation of relay 405 connects battery through the contact of relay 402, contact 1 of relay 404, contact of relay 405, contact 3 of key 406, plug 216 and jack 217 to the M lead 261, thence through the S2 windings of the composite relays 220 and 320, contact 5 of relay 308, to ground on contact 4 of relay 309. This operation was previously described upon the initiation of the call from subscriber A which energized sender 120 to transmit this signal over the composite signaling circuit. Thus the composite signal relay 320 is energized which energizes the A relay 306. The energization of relay 306 associates the potentiometer connected with contacts 5 and 6 through the winding of polarized relay 305 over the ring conductor, winding of stepping relay 333 to ground. As previously described, the operation of the stepping relay establishes the circuit for relay 332 which connects ground through the winding of the L relay to battery and also connects ground over the tip lead to contact 1 of relay 304, contact 3 of relay 306, contact 2 of relay 307, winding of relay 308 to battery. Relay 307, as previously explained, is operated from battery through its winding, contact 2 of relay 303, contact 3 of relay 309 to ground on contact 4 of relay 306. Relay 308 in operating establishes a locking circuit for the L relay 331 from ground on contact 4 of relay 304, contacts 3 and 4 of relay 308, contact 3 of relay 306, thence over tip lead through the winding of the L relay 331 to battery. Relay 308 also opens the circuit for relay 307 but relay 307 is slow to release and before it releases a signal is transmitted to the operator's position. Battery through contact 1 of relay 307 and contact 5 of relay 308 is connected to M lead 351 through the S2 windings of composite signaling relays 320 and 220 to battery on the contact of relay 402 as previously traced. Battery to battery, through the S2 windings of composite signaling relays, neutralizes these windings and relay 320 is held operated

through its S1 winding, also relay 220 is operated through its S1 winding. The operation of relay 220 connects ground through the contact of jack 217 and plug 216, contact 2 of key 406, winding of relay 403 to battery operating the 403 relay which lights lamp 408. The lighting of lamp 408 is a signal to the operator that a sender, such as sender 330, has been selected in the distant office and is prepared to receive pulses. Relay 403 in operating establishes a locking circuit for itself through contact 3 of relay 401 which holds the lamp lighted until the operator starts to dial. The operator may now dial according to the connection desired.

The movement of the dial from its normal position to the finger stop operates relay 401 by the connection of contacts 2 and 3 associating ground through the winding of relay 401 to battery. The operation of relay 401 opens the locking circuit for relay 403 causing it to release and extinguish the signal lamp 408. Relay 401 in operating also establishes a locking circuit for itself through its contact 1, contact 1 of relay 405 to ground. Upon the return of the dial to its normal position contacts 4 and 5 are intermittently opened and closed. The stepping relay 402 is shunted when contacts 4 and 5 are closed by the ground connection 411 but when the contacts 4 and 5 are open, relay 402 is operated from ground 411 through its winding, resistance 407 to battery. Thus relay 402 is intermittently operated a number of times depending upon the finger grip used by the operator in moving the dial from its normal position. The intermittent operations of relay 402 intermittently associate battery and ground through contact 1 of relay 404, contact 2 of relay 405, contact 3 of key 406, plug 216 and jack 217, thence over the M lead and the S2 windings of composite signaling relays 220 and 320. This intermittently operates and releases the composite signal relay 320 which causes the pulsing mechanism of sender 330 to operate and release responsive to each pulse of the dial as previously explained in connection with the pulsing mechanism of the fundamental circuit of Figs. 1 and 2. When the dial restores to its normal position an interdigital period takes place permitting the registration of the digit by the registers 335 in sender 330. This interdigital period is brought about by the operation of relay 404 from battery through its winding, contact 2 of relay 401, contacts 1 and 2 of the dial 400 to ground. Relay 404 in operating disconnects battery through its contact 1 which extends over the composite signaling circuit and causes the release of composite signaling relay 320 and the A relay 306. The release of the A relay 306 releases the L relay 331 which brings about the interdigital period in the sender 330. The reoperation of the dial causes the release of relay 404 when the dial is moved away from its normal position thus again closing the circuit for the composite signaling relay 320 to reoperate the A relay 306 and upon the return movement of the dial, contacts 4 and 5 are again intermittently opened and closed for causing the stepping relay 402 to intermittently operate and release the composite signaling relay 320 to cause the second digit to be recorded in the sender 330. Upon the return of the dial 400 to its normal position, relay 320 is again released to effect the interdigital period required for the registration of the digit in the sender 330.

It will be recognized that upon the termination of the transmission of digits, relay 404 re-

mains operated and therefore the operator depresses key 412 in order to signal the distant sender that the last digit has been transmitted. This signal again operates the composite signaling relay 320 which again operates the A relay 306. As previously described, sender 330 is adjusted after the last digit has been received so that the transmission of the pulse from the originating end operates a battery reversing relay such as relay 336. The operation of relay 336 returns the reverse battery pulse which operates the polarized relay 305 and relay 305 establishes a circuit for relay 309. The operation of relay 309 now establishes battery circuit between the trunk of Fig. 3 and the operator's position by connecting battery through its contact 4 to the M lead 351 which as previously explained operates the composite signaling relay 220 by neutralizing the S2 windings of both composite signaling relays. The operation of the latter relay connects ground through its contact, jack 217, plug 216, contact 2 of key 406, winding of relay 403 to battery, to reoperate relay 403 and light lamp 403 indicating to the operator that the distant sender 330 has responded to the digit pulses and has completed its registrations. Relay 309 in operating establishes a locking circuit for itself to ground on contact 1 of relay 308. Relay 403 in operating locks to ground on contact 2 of relay 404 since it will be remembered that the latter relay is operated when the dial 400 restores to its normal position after each digit has been dialed. Upon observing the lamp 408, the operator momentarily restores key 412 to normal, disconnecting battery from the composite signaling path. The composite signaling relay 320 and the A relay 306 restore to normal which establish a circuit for relay 304 from ground on contact 4 of relay 308, contact 1 of relay 309, winding of relay 304 to battery. The operator again actuates key 412 to reestablish the circuit for relays 320 and 306. Relay 304 now locks to ground on contact 4 of relay 306. Relay 308 remains locked through contact 4 of relay 304 to ground on contact 1 of relay 306, and thus relay 309 remains locked to ground on contact 1 of relay 308 until after the operation of relay 306 when both relays 308 and 309 release. The operation of relay 304 associates the operator's telephone circuit through the switching mechanism 339 of the distant switching office with a subscriber or a telephone operator B which has been connected thereto by sender 330 in accordance with the settings of registers 335. The operation of relays 304 and 306 connects the polarized relay 305 to the tip and ring conductors 340 and 341 for revision battery supervision. The operator may have other types of mechanism for associating the telephone set with the transmission circuit. The operator may now restore key 406 to normal which restores the relays of the pulsing circuit and keep key 412 operated for supervisory signaling purposes.

The operator's position, as above described, has essentially a fundamental circuit therein comprising the stepping relay and dial contacts along with relays for associating this signal responsive mechanism with the composite signaling circuit for responsive action of the pulsing mechanism in the fundamental of a distant office. A distant subscriber may be reached from a subscriber entering sender 120 in an office using a fundamental circuit between the sender circuit and the trunk circuit of Fig. 2 or from the operator's position using fundamental as described

which materially decreases the mechanism for automatic switching systems in which reverteive pulses are employed and decreases the number of such switching offices required to complete connections which could under other circumstances be considered as toll connections. It is recognized that the sender 120 by selecting an outgoing trunk connected directly to a nearby automatic switching office would operate in the manner disclosed in the aforementioned patent to Raymond. In this type of connection a single fundamental circuit is used which would substantially comprise the connection of the counting relays and stepping relay of sender 120 with the L relay and stepping relay of sender 330.

What is claimed is:

1. In a telephone switching system, a first automatic switching office having register senders arranged for reverteive pulsing over a fundamental circuit, a second automatic switching office having register senders arranged for reverteive pulsing over a fundamental circuit, outgoing trunk circuits in said first office, incoming trunk circuits in said second office, a speech transmission circuit and a composite signaling circuit extending between said outgoing and said incoming trunk circuits, means for connecting one of said outgoing trunks with a sender in said first office and the associated incoming trunk with a sender in said second office, means in said trunk circuits for forming reverteive pulse fundamental circuits with the senders associated therewith thus forming separate reverteive pulse fundamental circuits in each office, means for closing the fundamental circuits of both offices by the transmission of signals over said composite signaling circuit, and means including said composite signaling circuit for operating the mechanism of both fundamental circuits simultaneously according to digit registrations in the sender of said first office for completing an automatic switching telephone connection in said second office.

2. In a telephone switching system, a first automatic switching office having register senders arranged for reverteive pulsing over a fundamental circuit, a second automatic switching office having register senders arranged for reverteive pulsing over a fundamental circuit, outgoing trunk circuits in said first office, incoming trunk circuits in said second office, a speech transmission circuit and a composite signaling circuit extending between said outgoing and said incoming trunk circuits, means for connecting one of said outgoing trunks with a sender in said first office and the associated incoming trunk with a sender in said second office, means in said trunk circuits for forming reverteive pulse fundamental circuits with the senders associated therewith thus forming separate reverteive pulse fundamental circuits in each office, means for closing the fundamental circuits of both offices by the transmission of signals over said composite signaling circuit, means including said composite signaling circuit for operating the mechanism of both fundamental circuits simultaneously for registering digits in the sender of said second office for completing a telephone connection according to the called subscribers number registered in said first office, and means in said second sender for causing a signal to be transmitted over said composite signaling circuit upon the completion of registrations for dismissing the sender in the first office and for establishing said speech transmission circuit.

3. In a telephone switching system, a first automatic switching office having register senders arranged for reverte pulse control over a fundamental circuit, a second automatic switching office having register senders arranged for reverte pulse control over a fundamental circuit, outgoing trunk circuits in said first office, incoming trunk circuits in said second office, each outgoing trunk circuit being connected to an incoming trunk by a speech transmission circuit and a composite signaling circuit, lines, means responsive to a call over a line incoming to said first office for selecting a sender, means in said sender responsive to dial pulses over said line for registering a call for said second office and for selecting an outgoing trunk, means in said sender and the outgoing trunk responsive to its selection for transmitting a signal pulse over the composite signaling circuit from said first office to the incoming trunk in said second office causing the selection of a sender in said second office, means in said second office for establishing a reverte pulse fundamental circuit between the selected sender of said second office and said incoming trunk circuit which, in being established transmits a signal pulse over said composite signaling circuit to said first office, means in said first office responsive to said latter signal pulse for closing a reverte pulse fundamental circuit between the sender of said first office and said outgoing trunk circuit, and means responsive to the establishing of both said fundamental circuits for registering digit pulses in said second office sender under the control of the mechanism of said first office sender reverte pulse fundamental circuit, the responsive action of said composite signaling circuit and the mechanism of said second office sender reverte pulse fundamental circuit for completing the automatic switching telephone connection registered in said first office sender.

4. In a telephone switching system, a first automatic switching office having register senders arranged for reverte pulse control over a fundamental circuit, a second automatic switching office having register senders arranged for reverte pulse control over a fundamental circuit, outgoing trunk circuits in said first office, incoming trunk circuits in said second office, each outgoing trunk circuit being connected to an incoming trunk by a speech transmission circuit and a composite signaling circuit, lines, means responsive to a call over a line incoming to said first office for selecting a sender, means in said sender responsive to dial pulses over said line for registering a call for said second office and for selecting an outgoing trunk, means in said sender and the outgoing trunk responsive to its selection, for transmitting a signal pulse over the composite signaling circuit from said first office to the incoming trunk in said second office causing the selection of a sender in said second office, means in said second office for establishing a reverte pulse fundamental circuit between the selected sender of said second office and said incoming trunk circuit which in being established transmits a signal pulse over said composite signaling circuit to said first office, means in said first office responsive to said lat-

ter signal pulse for closing a reverte pulse fundamental circuit between the sender of said first office and said outgoing trunk circuit, means responsive to the establishing of both said fundamental circuits for registering digit pulses in said second office sender under the control of the mechanism of said first office sender reverte pulse fundamental circuit, the responsive action of said composite signaling circuit and the mechanism of said second office sender reverte pulse fundamental circuit for completing the automatic switching telephone connection registered in said first office sender, and means in said second office for transmitting a signal to said first office over said composite signaling circuit for dismissing the sender of the first office and for establishing said telephone transmission circuit after the last digit has been registered by said second office sender.

5. In a telephone switching system, a first automatic switching office arranged for reverte pulsing over a fundamental circuit, a second automatic switching office having register senders arranged for reverte pulse control over a fundamental circuit, outgoing trunk circuits in said first office, incoming trunk circuits in said second office, a speech transmission circuit and a composite signaling circuit extending between said outgoing and said incoming trunk circuits, an operator's position in said first office, means for connecting the mechanism of said position with said speech transmission circuit and the signaling circuit in an idle outgoing trunk circuit, means in said position circuit responsive to its connection with said outgoing trunk circuit signaling means for sending a signal pulse to said second office incoming trunk circuit, means in said incoming trunk actuated by said signal pulse for causing the selection of a sender in said second office and the establishing of a reverte pulse fundamental circuit between said sender and said incoming trunk circuit, means responsive to the establishing of said fundamental circuit for causing a signal pulse to be transmitted from said incoming trunk over said composite signal circuit to said operator's position, a signal in said operator's position actuated by said signal pulse to indicate that the sender in said second office is ready to respond to the reverte pulsing mechanism in said fundamental circuit, pulse controlling mechanism in said operator's position including a dial and a stepping relay for operating the mechanism of said composite signal circuit and the mechanism in the fundamental circuit of said second office, each operation of said dial controlling the pulses of a digit by simultaneously operating and releasing the stepping relay in the operator's position and the stepping relay in said fundamental circuit the number of timing required for each digit to set the registers of the sender in said second office, an operator's telephone set in said position, and means responsive to the setting of said registers for completing a telephone connection from said operator's telephone set over said speech transmission circuit according to the settings of said register.

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