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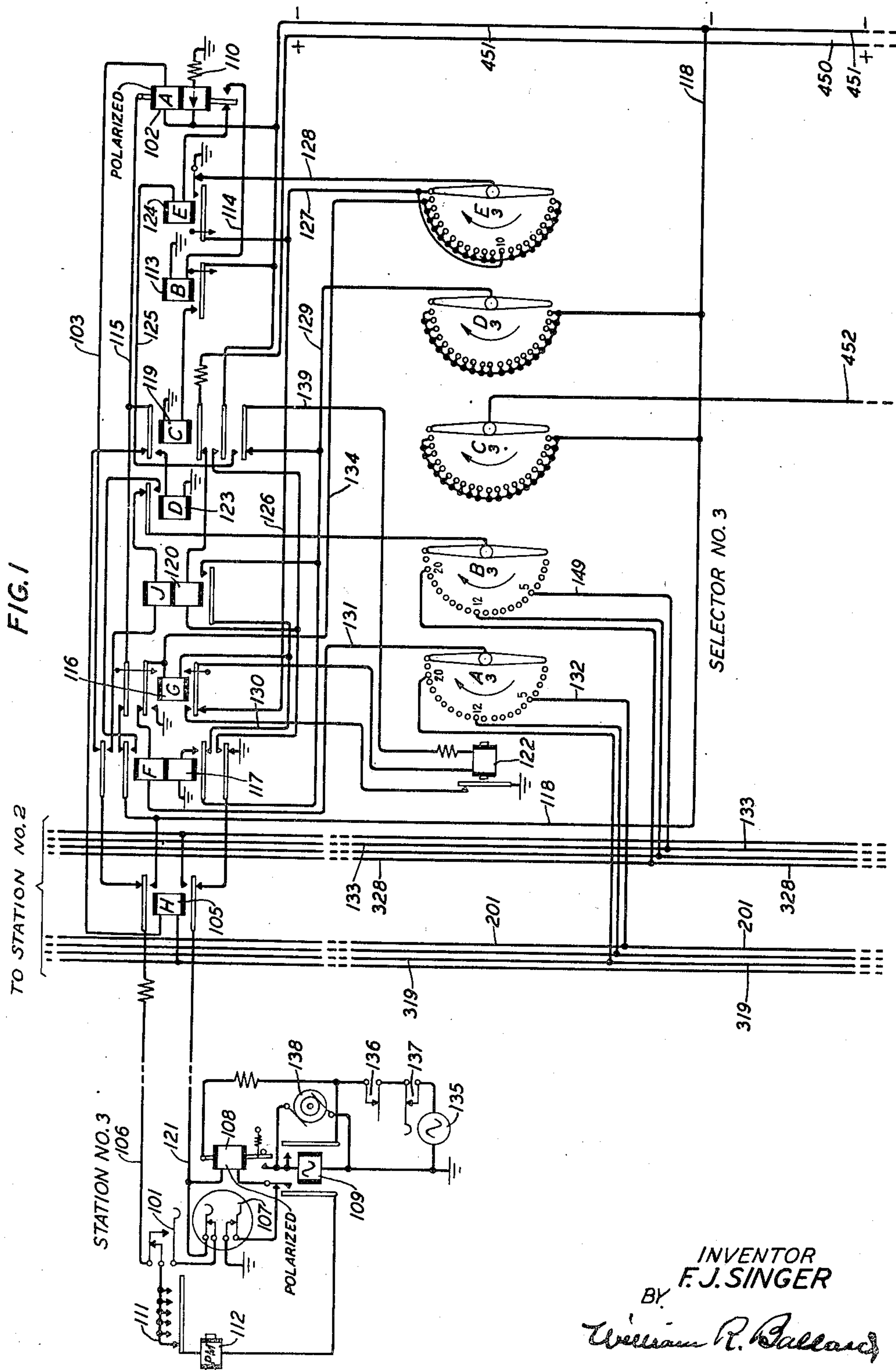
F. J. SINGER

2,198,517

PRINTING TELEGRAPH PRIVATE BRANCH EXCHANGE SYSTEM

Filed Sept. 21, 1937

4 Sheets-Sheet 1



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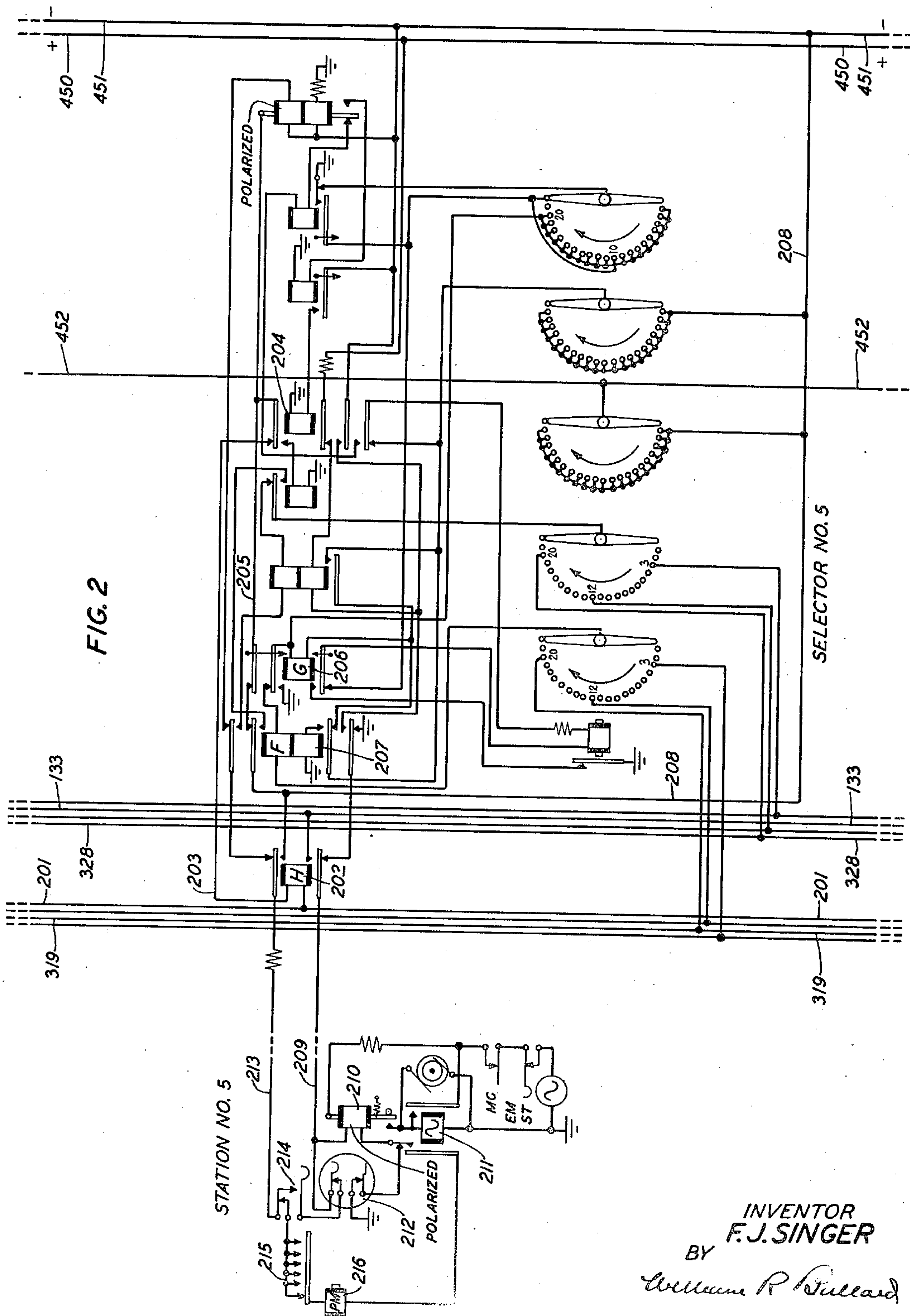
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PRINTING TELEGRAPH PRIVATE BRANCH EXCHANGE SYSTEM

Filed Sept. 21, 1937

4 Sheets-Sheet 2



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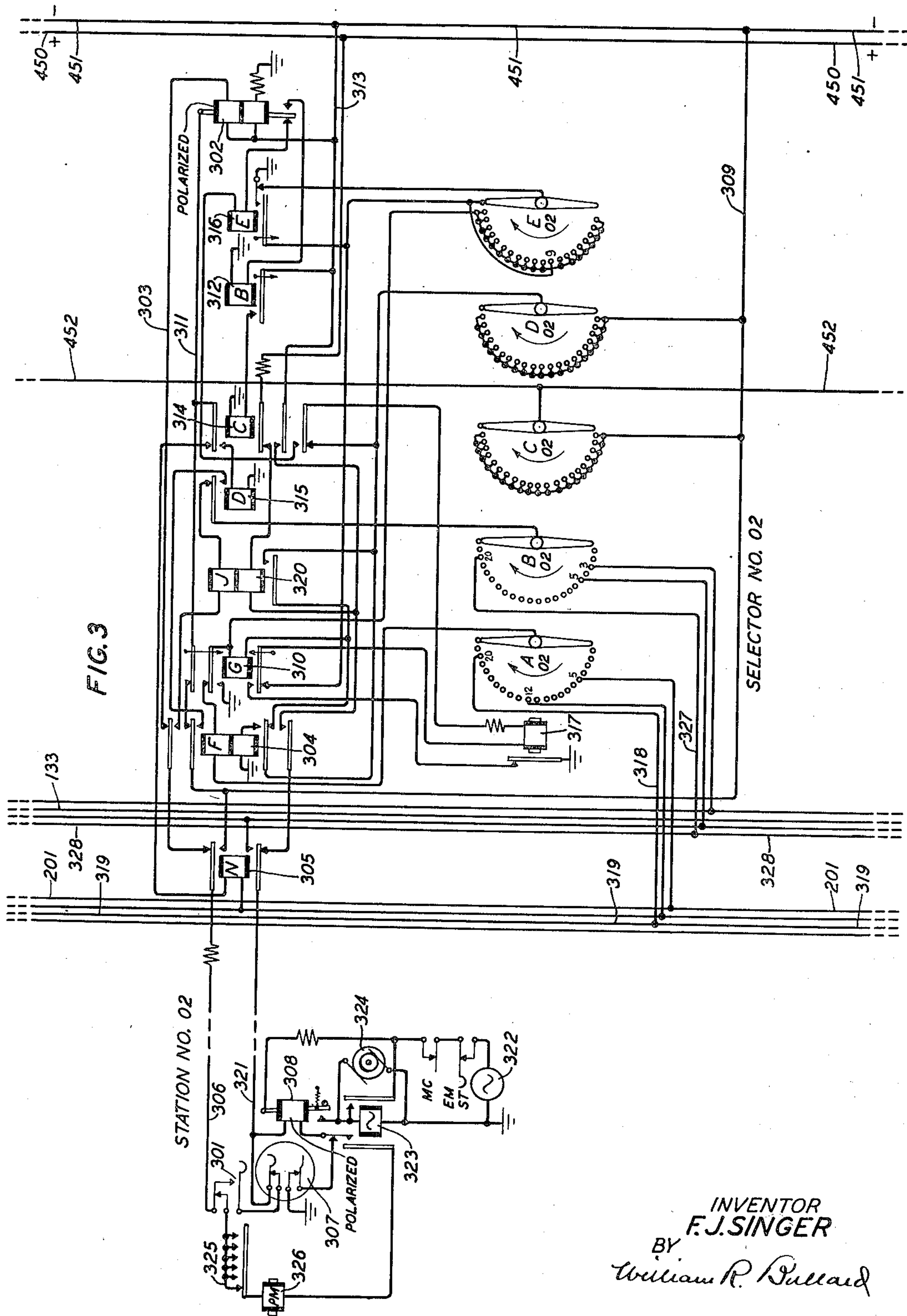
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PRINTING TELEGRAPH PRIVATE BRANCH EXCHANGE SYSTEM

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4 Sheets-Sheet 3



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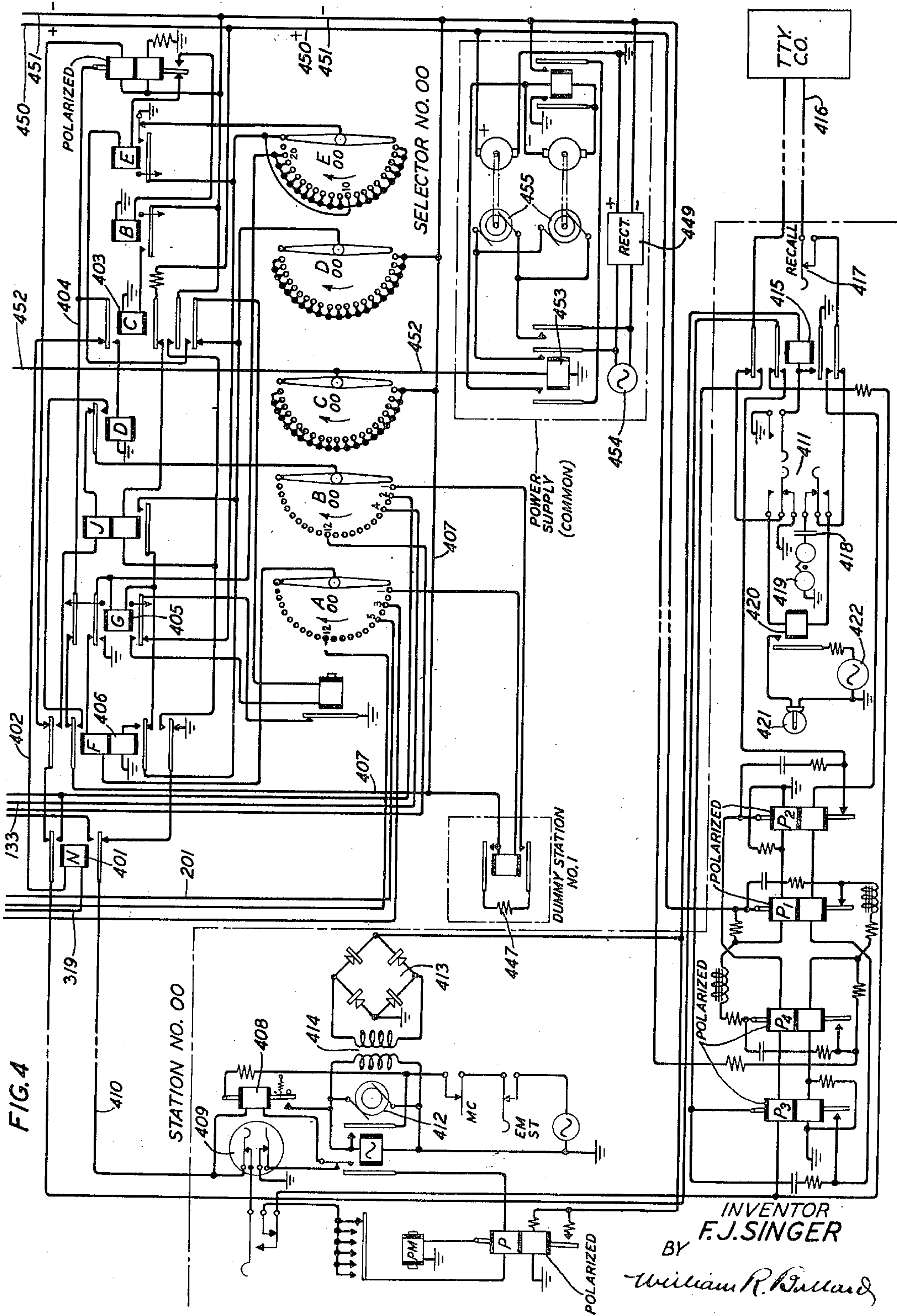
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PRINTING TELEGRAPH PRIVATE BRANCH EXCHANGE SYSTEM

Filed Sept. 21, 1937

4 Sheets-Sheet 4



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2,198,517

PRINTING TELEGRAPH PRIVATE BRANCH
EXCHANGE SYSTEMFred John Singer, Rockville Centre, N. Y., as-
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Application September 21, 1937, Serial No. 164,922

13 Claims. (Cl. 178—2)

This invention relates to a printing telegraph system and more particularly to a small local radial telegraph system wherein the automatic switches are employed for the establishment of channels of telegraphic communication.

The invention has for its main object to provide a telegraph private branch exchange system which utilizes automatically and directly operable switches at a switching center for establishing telegraphic connection between separated stations, attended and unattended, in said private branch exchange and between the stations of the private branch exchange and a public teletypewriter exchange office whereby flexibility, economy and efficiency are greatly increased.

Heretofore in private interconnecting systems employing printing telegraph equipment and operating on an automatic basis, complicated switching mechanisms were required to establish connections between switches at separated stations. Considerable time was consumed in establishing the connections particularly in the systems wherein selected rotary step-by-step switches, that is, the two-movement, or up and around, types, were used. Furthermore, the auxiliary apparatus required for testing idle and busy conditions of a called station were equally complicated and expensive.

According to the present invention no complicated apparatus, expensive to install and maintain, is required other than a sending and receiving printer at each station as is required in the older systems over which the present system is an improvement. The present invention provides a system wherein no more than twenty stations are present and any two of which may be interconnected automatically. Each station in the system is provided with a non-locking dial key whereby a call to any station in the system may be initiated. A normally opened line extending to a switching center is immediately closed by the operation of the key to thereby operate a pulsing relay. A series of relays are frequently closed by the operation of the pulsing relay to prepare a circuit for operating a rotary switch magnet whereby the rotary switch is stepped around in response to a series of dialing impulses corresponding to the code of the called station, to a contact to which is connected the line extending to the called station. Each station has associated therewith two types of cut-through relays, one of which, referred to herein-after as an outgoing cut-through relay, is operated when its associated station is calling and the other, referred to herein as the incoming cut-

through relay when its associated station is being called. One of each type at any two stations between which a connection is desired, operates at the completion of dialing to thereby connect the calling station with the called station. Separate busy tests may be made depending on whether the called station is busy because of a call initiated by the station itself or by another station. A disconnect signal may be transmitted from either of two interconnected stations. The power supplies at each of the stations and at the switching center are normally idle. One station is adapted to complete connections to any of the other stations of the system or a public teletypewriter exchange office, and in a connection so established it is possible to obtain all the supervisory features of call, recall and disconnect signaling usually provided at public teletypewriter exchange switchboards.

One of the features of this invention is the use of a normally opened transmission line connecting each of the separated stations with the switching center of the private branch exchange system and with the outside, or public, teletypewriter exchange office.

Another feature is the adaptation of the invention to a demand for low priced teletypewriter dial private branch exchange systems which can be used with or without connections to a public teletypewriter exchange system and which can serve from two to twenty separated stations.

Another feature is to simultaneously establish connections between pairs of separated stations respectively, each pair of separated stations being interconnected, independently of other pairs.

Another feature is to start and stop the printer motors at both of two interconnected separated stations from either of the interconnected stations when both stations are attended.

Another feature is to make it impossible for a calling station to interrupt, or cut-in, on a communication between two interconnected stations.

Another feature is to furnish additional equipment at one of the attended stations whereby any one of the other stations may be connected through to a trunk circuit extending to a public teletypewriter exchange office, the trunk circuit connections so established having all the supervisory features of call, recall and disconnect signaling in so far as the teletypewriter exchange switchboard is concerned as are provided from a regular teletypewriter exchange subscriber's station.

Another feature is that the equipment at an attended station is equipped so that connections

may be established to a printing teletypewriter exchange office, provides automatic means for disconnecting the trunk circuit at the end of a communication.

5 Another feature is that the selecting device is individual to each station in the private branch exchange.

Another feature is that the system is full automatic with automatic control of power supply for the complete system.

10 A preferred embodiment will now be described with respect to the accompanying drawings which illustrate an intercommunication system comprising twenty stations, only four of which are shown. Each station is equipped with type printing telegraph apparatus. The drawings are arranged into four figures:

Figures 1 to 4 respectively show the third, the fifth, the twelfth and the twentieth stations, each represented by a calling dial, a dial key and a sender and receiving telegraph printer set. Each of Figs. 1 to 4 also shows the switching equipment associated with its station and located at a common switching center in the system. The twentieth station, shown in Fig. 4, is further equipped with apparatus for establishing a connection between any of the stations and a switchboard at a public teletypewriter exchange office. Also in Fig. 4 is shown additional apparatus comprising a line relay, a transformer, the primary winding of which is connected in parallel to the printer motor and a rectifier connected to the secondary winding of the transformer. Fig. 4 further shows a trunk circuit arranged for connecting the twentieth station and any one of the other stations to a public teletypewriter exchange switchboard, as desired. The trunk circuit comprises a single line repeater, a control key, an alarm and a signal device, a cut-through relay and a recall key.

40 When the intercommunication system is adapted for connection to a public teletypewriter exchange office, the first station of the intercommunication system serves as a dummy station and is so designated in Fig. 4.

Only so much of the equipment as is necessary to give a clear understanding of the invention is shown.

Referring to Fig. 1, the equipment shown to the left of the broken portion of the line circuit comprises a sending and receiving printer set for the third station and a non-locking dial key for initiating a communication connection, and a calling dial for completing the connection. At the right of the broken portion of the line circuit is shown the switching equipment individual to the third station. The switching equipment comprises a rotary selector switch and a group of relays arranged to be controlled from the third station. An additional cut-through relay, referred to herein as an incoming cut-through relay, is provided in the switching equipment, which is arranged to be controlled from the switching equipment at one of the other stations.

65 Each of Figs. 2 and 3 comprises station and switching equipment for the fifth and the twelfth stations, respectively. The equipment is identical with that shown in Fig. 1 and similarly arranged.

Fig. 4 shows in the upper portion equipment for the twentieth station. The equipment is substantially identical in character and similar in arrangement to that shown in Figs. 1, 2 and 3 except that additional equipment is furnished at the left of the broken portion of the line circuit for establishing connection to a public teletype-

writer exchange office, and the line circuit is arranged to extend through the printer set at the twentieth station to the teletypewriter exchange office. The twentieth station may in this way be used on a monitoring basis at all times while the teletypewriter exchange connection is established. Fig. 4 further comprises a single line repeater, a signal and an alarm device, control key, cut-through relay and recall key together with the teletypewriter exchange office shown in diagrammatic form in the lower portion of the drawing. At the right side of Fig. 4 is the power supply for the entire intercommunication, or private branch exchange system, which comprises a control relay arranged to operate as soon as any one of the rotary selector switches takes its first step, sources of alternating current arranged to be connected to two motor generator sets when the power supply relay operates, and a rectifier for furnishing a source of negative voltage when the dial key at any station is operated to initiate the operation of the rotary selector switch associated with the calling station. Normally the power supply is disconnected from the system except for a slight steady drain to hold the pulsing relays for each station normally biased, as will be hereinafter described.

In a dialing system consisting of eleven to twenty stations, such as described herein, the dial which is equipped to send one to ten current impulses each time it is operated will have to be operated twice successively whenever it is desired to call a station above the first ten and, therefore, the numbering of the stations herein is shown corresponding to the number of current impulses required to call the desired stations, for example, the numbering for the twentieth station is 00, which means that ten must be dialed twice in order to call the twentieth station.

The dial key at each station is of the non-locking type. The sending and receiving printer set may preferably be of the start-stop type such as is disclosed in United States Patent 1,745,633 granted to S. Morton et al. on October 4, 1930.

The system is normally in the position shown. All relays are normally deenergized except the pulsing relays for each station, which relays are normally energized by a biasing current flowing through their lower windings. Assuming that it is desired to connect the printer set at the third station, No. 3, to the printer set at the fifth station, No. 5, and that station No. 5 is not busy, the attendant at station No. 3 operates dial key 101. A circuit is closed from a grounded source of negative potential at rectifier 449, conductor 451, through the upper winding of pulsing relay 102, conductor 103, back contact and outer upper armature of outgoing cut-through relay 117, back contact and upper armature of incoming cut-through relay 105, line conductor 106, make-before-break contact of key 101, upper contact of dial 107, through the winding of polarized relay 108, break contact of relay 109, lower contact of dial 107 to ground. The armature of pulsing relay 102 which is normally held against its left-hand contact by the biasing current flowing from the negative side of rectifier 449, through the lower winding of relay 102 through resistance 119 to ground, moves to its right contact. Closure of dial key 101 disconnects the printer set comprising transmitter 111 and receiver 112 from the line circuit. The current through the polarized relay 108 is in such a direction at this time, that is, with negative potential on the tip side conductor 106, of the line circuit, that the relay

does not operate. The operation of relay 102 to its right-hand position causes slow-release relay 113 to operate in a circuit traceable from ground on the winding of relay 113, conductor 114, right contact and armature of relay 102, conductor 115, outer upper armature and contact of relay 116, back contact and inner upper armature of relay 117, conductor 118 to the grounded negative potential conductor 451. Relay 113, in operating, closes an operating circuit for relay 119 which circuit is traceable from ground, through the winding of relay 119, contact and armature of relay 113, grounded negative potential conductor 451. Relay 119, in operating, opens at its innermost lower armature and contacts a circuit extending through the lower winding of relay 120 and prepares at its middle lower armature and contact a circuit from the grounded negative potential conductor 451 to the ring conductor 121 of the line circuit, which prepared circuit will later be established when the outgoing cut-through relay 117 operates. Relay 119, in operating, also prepares at its outermost lower armature and front contact an operating circuit for the stepping magnet 122 of selector switch No. 3, which circuit is now open at the armature and left-hand contact of relay 102, and closes an operating circuit for relay 123 which operates. Relay 123, in operating, breaks at its armature and back contact, the connection between the wiper of selector bank B₃ and the upper winding of relay 120 and prepares at its armature and front contact a circuit extending over the front contact and inner upper armature of relay 117, conductor 118 to the grounded negative potential conductor 451.

Selector switch No. 3 is now prepared to receive dial pulses from dial 107. The attendant at station 3 dials station No. 5 and pulsing relay 102 will be released five times and then operate at the end of the period. When relay 102 releases the first time, slow-release relay 124 and the stepping magnet 122 will operate in series, the operating circuit being traceable from the grounded negative potential conductor 451, conductor 118, inner upper armature and back contact of relay 117, contact and outer upper armature of relay 116, conductor 115, armature and left-hand contact of relay 102, through the winding of relay 124, conductor 125, front contact and outermost lower armature of relay 119, through the winding of stepper magnet 122, lower armature and back contact of relay 116, conductors 126 and 127, normal contact, that is, contact No. 22, of bank E₃ engaged by its associated wiper, conductor 128 to ground at the break contact of relay 124. When relay 102 operates to its right hand contact in response to the second pulse the current supply will be removed from the windings of relay 124 and stepping magnet 124. Relay 122 being of the slow-release type will remain operated, but the stepping magnet 122 will release thereby causing the wipers of selector switch No. 3 to step from their respective contacts No. 22 to their respective contacts No. 1 on the five banks shown.

When relay 102 releases the second time the stepping magnet 122 will again operate and this time the selector wiper on bank E₃ is on contact No. 1 and relay 124 is operated so that the operating circuit for the stepping magnet is established directly through the armature and front contact of relay 124 and not over the wiper of bank E₃ as previously traced. Relay 102 in operating the second time causes the selector wipers to step to their respective contacts No. 2. This sequence

is repeated during the remaining dial pulses, the selector wipers stepping to their respective contacts No. 5 when relay 102 operates at the end of the series of pulses. It is to be noted that during the time the selector wipers are stepping, the wiper circuit extending through bank B₃ is held open at the front contact and inner upper armature of relay 117 thus preventing interference with other circuits on the multiples of that bank. The wiper on bank A₃ has grounded negative potential applied to it during the second interval from contact bank D₃, but this applied potential meets a similar potential on each point through the multiples to each respective station and no false operation occurs. For example, the circuit may be traced from grounded negative potential conductor 451, conductor 118, any one of contacts Nos. 1 to 5 on contact bank D₃ while engaged by its associated wiper, conductor 129, inner lower armature and back contact of relay 117, conductor 130 through the winding of relay 116, inner upper armature and back contact of relay 116 through the upper winding of relay 117, conductor 131, wiper in engagement with any of contacts Nos. 1 to 5 on contact bank A₃, any one of the conductors connected to contacts Nos. 1 to 5, respectively, for example, conductors 132, 201, through the winding of incoming cut-through relay 202, conductor 203, back contact and upper armature of relay 204, conductor 205, outer upper armature and back contact of relay 206, back contact and inner upper armature of relay 207, conductor 208 to grounded negative potential conductor 451. Therefore, the applied potential on contacts Nos. 1 to 5 on contact bank A₃ meets a similar applied potential on conductor 208 and the incoming cut-through relay 202 does not operate. Similar conditions are met at each of the contacts engaged by the wiper in turn on bank A₃ and the corresponding incoming cut-through relays at each of the stations do not operate.

If the called station No. 5 is not busy, the outgoing cut-through relay 117 and the incoming cut-through relay 202 will operate only after the wiper on contact bank A₃ comes to rest and the slow-release relay 124 releases. The operating circuits for relays 117 and 202 may be traced from ground at the break contact of relay 124, conductor 128 in engagement with contact No. 5 on contact bank E₃, conductor 134, inner upper armature and back contact of relay 116 through the upper winding of relay 117, conductor 131, wiper in engagement with contact No. 5 on contact bank A₃, conductors 132 and 201, through the winding of relay 202, conductor 203, back contact and upper armature of relay 204, conductor 205, outer upper armature and contact of relay 206, back contact and inner upper armature of relay 207, conductor 208 to grounded negative potential conductor 451. Busy relay 116 will not operate since it is of the slow-operate type and its circuit will be broken as soon as the inner lower armature of relay 117 has left its back contact. Relay 117, in operating, locks in a circuit traceable from ground through the lower winding of relay 117, front contact and inner lower armature of the relay, conductor 129, wiper in engagement with contact No. 5 on contact bank D₃, conductor 118 to grounded negative potential conductor 451. This locking circuit is required to prevent relay 117 from releasing when subsequent busy tests are made on the line circuit extending from station No. 3. Relay 117, in operating, disconnects at its

outer upper armature and back contact the upper winding of relay 102 from the tip conductor 106 of the line circuit extending to station No. 3 and prepares at its outer upper armature and front contact a circuit extending from the tip conductor 106 through the upper winding of relay 120. The circuit now extended through the upper winding of relay 120 is not established, however, until relay 123 releases. Relay 117, in operating, also connects the ring conductor 121 which is extended over the lower armature and back contact of relay 105, over the outer lower armature of relay 117 and its front contact, front contact and middle lower armature of relay 119 to the grounded negative potential conductor 451. The application of grounded negative potential to the ring conductor at this time now operates polarized relay 108. The operation of polarized relay 108 closes an obvious operating circuit extending from one side of the source of alternating current 135 through the winding of alternating current relay 109, contact and armature of relay 108, motor control contact 136, emergency stop contact 137 to the other side of the alternating current source 135. The alternating current relay 109 operates and closes at its armature and contact a locking circuit for itself. Printer motor 138 which is connected in parallel with the alternating current relay 109 operates at the same time that relay 109 operated. Relay 109 in operating disconnects dial 107 from the line circuit and connects in its place the printer set comprising transmitter 111 and receiver 112. The starting of the teletypewriter motor is an indication to the station attendant that the connection has been established and the station attendant immediately releases dial key 101.

Relay 117, in operating, connects at its inner upper armature and front contact, conductor 118 which receives grounded negative potential from conductor 451 to a circuit extending over the front contact and armature of relay 123, which at this time is still operated, wiper in engagement with contact No. 5 on contact bank B₃, conductors 149 and 133, front contact and lower armature of relay 202, ring conductor 209 of the line circuit extending to station No. 5 through the winding of polarized relay 210, break contact of relay 211 to ground at the lower contact of dial 212. The direction of current flowing through polarized relay 210 in the circuit just traced is such that relay 210 operates to thereby operate the motor for the printer set at station No. 5. Also, relay 117, in operating, disconnects at its inner upper armature and back contact the grounded negative potential on conductor 118 from the winding of relay 113. Relay 113 will therefore release after an interval causing the operating circuit to relay 119 to be opened. Relay 119 will then release, but by this time the printer motors at both stations Nos. 3 and 5 have been started. When relay 119 releases it removes at its front contact and middle lower armature the grounded negative potential supply from the ring conductor 121 and applies at its innermost lower armature grounded positive potential furnished over conductor 450, to the lower winding of relay 120, front contact and outer lower armature of relay 117, back contact and lower armature of relay 105 to the ring conductor. Relay 119, in releasing, disconnects at its front contact and outermost lower armature the operating circuit for stepping magnet 122 and at its back contact and outermost lower armature connects the operating circuit

for the stepping magnet 122 to the wiper of contact bank D₃ for preparation of the subsequent release of the selector when a disconnect signal is transmitted. Also, relay 119 is releasing causes relay 123 to release. Relay 123, in releasing, completes the connection between the line circuits of stations Nos. 3 and 5, which circuits may be traced from negative potential conductor 208, front contact and upper armature of relay 202, tip conductor 213, break contact of dial key 214, printer set comprising transmitter 215 and receiver 216, left-hand armature and front contact of relay 211 through the winding of polarized relay 210, ring conductor 209, lower armature and front contact of relay 202, conductors 133 and 139, contact No. 5 in engagement with the wiper on contact bank B₃, armature and back contact of relay 123, through the upper winding of relay 120, front contact and outer upper armature of relay 117, back contact and upper armature of relay 105, tip conductor 106, break contact of dial key 101, printer set comprising transmitter 111 and receiver 112, left-hand armature and front contact of relay 109, through the winding of polarized relay 108, ring conductor 121, lower armature and back contact of relay 105, outer lower armature and front contact of relay 117, through the lower winding of relay 120, back contact and innermost lower armature of relay 119 to grounded positive potential conductor 450. The attendant at the calling station No. 3 may now call in the attendant at the called station No. 5 by sending "Bell" signals from the teletypewriter keyboard, or send to the called station on an unattended basis.

Disconnect

At the conclusion of the message, either attendant may send the disconnect signal by sending the "Stop" signal code from the teletypewriter keyboard. Upon receipt of this signal the teletypewriter selecting mechanism at each of the interconnected stations causes the motor control contact, such as 136 at station No. 3, to open momentarily. Opening of these contacts will break the locking circuit for the alternating current relays such as relay 109 at station No. 3 and relay 211 at station No. 5. The release of the alternating current relays will cause the power to be removed from the teletypewriter motors so that the motors will stop. It is to be noted that at this time current continues to flow over the ring side of the line circuit of calling station No. 3 through polarized relay 108 to ground at the lower contact of dial 107. However, the direction of the flow of current through the polarized relay is such that the relay will not operate and the printer motor will not start again, the current flow now being due to grounded positive potential being applied to the ring conductor 121 from conductor 450. Alternating current relay 109, in releasing, opens the tip conductor 106 and connects ground to the ring conductor 121 thereby causing differential relay 120 to operate due to current flowing in the lower winding only. The connection to the ring conductor of the called station from positive potential through the calling station loop is cut off when relay 109 releases and relay 210 does not reoperate. Relay 120 in operating closes at its armature and contact an operating circuit for busy relay 116, which circuit may be traced from grounded negative potential conductor 451, conductor 118, wiper in engagement with contact No. 5 on contact bank

D₃, conductor 129, contact and armature of relay 120, through the winding of relay 116, conductor 134, wiper in engagement with contact No. 5 on contact bank E₃, conductor 128 to ground at the break contact of relay 124. Relay 116 operates and locks over its inner upper armature and front contact to ground.

Relay 116, in operating, closes a circuit from grounded negative potential conductor 451, conductor 118, wiper in engagement with contact No. 5 on contact bank D₃, conductor 129, back contact and outermost lower armature of relay 119, conductor 139, through the winding of stepping magnet 122, lower armature and front contact of relay 116, to ground at the armature of stepping magnet 122. Stepping magnet 122 having been operated during the period of the connection releases and then reoperates with a stepping action through its own armature and back contact to restore selector No. 3 to its normal position. As soon as relay 116 operates the connection for relay 202 is broken and relay 202 releases making the called station No. 5 idle and ready to accept new calls. Relay 117 in series with relay 202, however, remains operated through its lower locking winding until the selector switch at station No. 3 has been restored to normal. With relays 116, 117 and 120 operated station No. 3 circuit is held busy until the selector switch is back to normal. This is desirable since it prevents a seizure under improper conditions of the circuit.

Any two of the stations may be connected in accordance with the procedure hereinbefore described.

Power supply

In order to minimize the first cost of power plant for this system and keep the drain small when the system is idle, a grounded negative potential rectifier 449 is furnished as a source of supply to operate a pulsing relay, such as 102 at station 3, at any calling station. Therefore, when the first station in the system calls, the rectifier 449 furnishes power to the loop circuit, for pulsing. After the selector at the calling station has stepped to contact No. 1, the grounded negative potential supplied over contact bank C at the calling station to conductor 452 through the winding of control relay 453 to ground. Relay 453 operates to thereby connect the alternating current source 454 to the motor generator sets 455. The motor generator sets will then start up and thereby furnish the load for the pulses, etc. The motor generator sets will continue to run until the selector has returned to normal on the receipt of a disconnect signal and if other calls have been initiated in the meantime, they will continue to run until the last selector in the system has restored to normal.

Called station busy

Assuming that the called station No. 5 is busy at the time the call is initiated at station No. 3, it may be busy under two different conditions, first, station No. 5 having previously called and become connected to another station, and secondly, station No. 5 having been called and connected to another station.

In the first case, the selector for station No. 5 will be in an operated position corresponding to the number which station No. 5 had called and the outgoing cut-through relay 207 will be operated. In the second case, station No. 5 selector will be in its normal position and the incoming

cut-through relay 202 will be operated. There are therefore two types of busy tests which the selector circuit of station No. 3 must be capable of making when the selector wipers come to rest on contact No. 5 of the respective banks of selector No. 3.

Case 1—Called station busy

When the attendant at station No. 3 has finished dialing station No. 5, relay 102 remains operated until the non-locking dial key 101 is released. Relay 124 will release after a short interval, however, and establish ground on contact No. 5 which will be engaged by the wipers of contact bank E₃. This condition closes a circuit from ground at the break contact of relay 124, conductor 128, wiper in engagement with contact No. 5 on contact bank E₃, conductor 134, through the winding of busy relay 116, back contact of inner lower armature of relay 117, conductor 129, wiper in engagement with contact No. 5 on bank D₃, conductor 118, to grounded negative potential conductor 451. A parallel path to the operating circuit for relay 116 may be traced over the inner upper armature and back contact of relay 116, through the upper winding of relay 117, wiper in engagement with contact No. 5 on contact bank A₃, conductor 132, through the winding of incoming cut-through relay 202, conductor 203, back contact and upper armature of relay 204, conductor 205, outer upper armature and back contact of relay 206, to back contact in engageable relation with the inner upper armature of outgoing cut-through relay 207. Inasmuch as the busy condition of station No. 5 is due to station No. 5 initiating the call, outgoing cut-through relay 207 will be operated and therefore the path just described will be opened at the back contact and inner upper armature of relay 207. The outgoing cut-through relay 117 will therefore not operate and relay 116 will operate and lock up to ground at the inner upper armature. Relay 116 will remain operated until selector No. 3 has stepped back to its normal position as hereinbefore described.

Case 2—Called station busy

Assuming that station No. 5 has been called previously by another station and is busy, the busy test is somewhat different. When ground at the break contact of relay 124 is connected to the operating circuit of relay 116 and also to the path extending over the inner upper armature and back contact of relay 116, through the upper winding of outgoing cut-through relay 117, conductor 131, wiper in engagement with contact No. 5 of switch bank A₃, conductor 132, through the winding of incoming cut-through relay 202, conductor 203, back contact and upper armature of relay 204, conductor 205, outer upper armature and back contact of relay 206 to the back contact in engageable relation with the inner upper armature of relay 207, as hereinbefore described, relay 207 is not operated and the path is extended over conductor 208 to grounded negative potential conductor 451. However, since another, or a third station has already called station No. 5 a parallel circuit has previously been established on contact No. 5 of switch bank A of the selector associated with the third station and the outgoing cut-through relay at the third station corresponding to relay 117 at station No. 3 has operated and locked. When relay 117 is therefore connected to this point in parallel with the corresponding relay at the third station,

relay 117 will not operate since it would not receive enough current to permit its operation. Relay 116 will therefore operate and cause the selector for station No. 3 to release as described for the other busy test.

Establishing a trunk circuit to a public teletypewriter exchange office

Assuming that station No. 00 is provided with equipment for establishing a connection between any one of the stations in the private branch exchange office and a multiple switchboard located at the public teletypewriter exchange office, such a connection will now be described between station No. 02 and the multiple switchboard at the public teletypewriter exchange office. It is to be noted that the arrangement shown will permit interconnection to any one of the open line types of teletypewriter exchange switchboard using a standard subscriber's line terminating circuit at the switchboard and a loop circuit to station No. 00 through which such connection will be established. As stated above, the arrangement shown at station No. 00 will permit all the supervisory features of call, recall and disconnect in so far as the teletypewriter exchange switchboard is concerned as are provided from a regular teletypewriter exchange subscriber's station associated with a public teletypewriter exchange office.

Referring to Fig. 3, the attendant at station No. 02 operates dial key 301 and thereby closes a circuit extending from grounded negative side of rectifier 449, conductor 451, through the upper winding of pulsing relay 302, conductor 303, back contact and outer upper armature of outgoing cut-through relay 304, back contact and upper armature of incoming cut-through relay 305, tip conductor 306 of the line circuit, closed contacts of dial key 301, upper contact of dial 307, through the winding of polarized relay 308, lower contact of dial 307 to ground. Pulsing relay 302 operates to move its armature into engagement with its right-hand contact thereby closing a circuit extending from negative ground potential conductor 451, conductor 309, inner upper armature and back contact of relay 304, back contact and outer upper armature of relay 310, conductor 311, armature and right-hand contact of relay 302, through the winding of relay 312 to ground. Relay 312 operates to close a circuit extending from the grounded negative potential conductor 451, conductor 313, armature and contact of relay 312, through the winding of relay 314 to ground. Relay 314 corresponds to relay 119 of the equipment associated with station No. 3 and therefore performs functions similar to those of relay 119 as hereinbefore described. Among these functions is the closing of an operating circuit for relay 315 which extends from the negative grounded potential conductor 451, conductor 309, inner upper armature and back contact of relay 304, back contact and outer upper armature of relay 310, conductor 311, upper armature and front contact of relay 314, through the winding of relay 315 to ground. Relay 315 operates. Relay 315 corresponds to relay 123 of the equipment associated with station No. 3 and performs functions similar to those of relay 123 which were hereinbefore described.

Selector switch No. 02 is now prepared to receive dial pulses. If the attendant at station No. 02 dials station No. 00 which must first be done before a connection can be established to the public teletypewriter exchange switchboard, the

pulsing relay 302 will be released ten times when the first zero is dialed and then operate at the end of the period. When relay 302 releases the first time, relay 316 and the stepping magnet 317 will operate in series. The operating circuit may be traced from grounded negative potential conductor 451, conductor 309, inner upright armature and back contact of relay 304, back contact and outer upper armature of relay 310, conductor 311, armature and left-hand contact of relay 302, through the winding of relay 316, front contact and outermost lower armature of relay 314, through the winding of stepping magnet 317, lower armature and back contact of relay 310, contact No. 22 engaged by the wiper on contact bank E02, break contact of relay 316, to ground. When relay 302 operates again the current supply will be removed from the winding of relay 316 and stepping magnet 317. The selector magnet will therefore step from point 22 to point 1 on the selector switch No. 02, but relay 316 being of the slow-release type will remain operated for the duration of the ten successive impulses transmitted by the dial 307.

When relay 302 releases the second time the selector magnet 317 will again operate, but this time the selector wiper on bank E02 is on contact No. 1 and relay 316 is operated so the grounded operating circuit for the magnet is established directly through the make contact of relay 316 and does not go through the selector bank contacts on contact bank E02. Operation of relay 302 the second time causes the selector switch wipers to step to contact No. 2. This sequence is repeated during the remaining ten dial pulses, the selector wipers stepping to contact No. 10 when relay 302 operates at the end of the series of pulses.

When the selector wipers reach contact No. 10 at the end of the tenth pulse relay 316 releases. Relays 312, 314 and 315, however, remain operated since the dial key 301 is held operated and relay 302 remains on its right contact between the first and second train of pulses. Relays 304 and 310 remain unoperated since contact No. 10 on E02 is strapped to contact No. 22 only.

If the attendant at station No. 02 dials the second zero the operations described for the first train of pulses will be repeated except the selector will begin stepping from contact No. 10 on the banks to step 11 when the first pulse is received and will step to contact No. 20 when the last pulse is received.

It is to be noted that during the time the selector wipers are stepping, during either train of pulses, the wiper circuit on contact bank B02 is held open at the outer upper armature and front contact of relay 304 thus preventing interference with other circuits on the multiple of that bank. The wiper on contact bank A02 has negative ground potential applied to it during the stepping interval from contact bank D02, but this applied potential meets a similar potential on each point through the multiple for each respective station and no false operation occurs.

Called station No. 00 not busy—connection established

If the called station No. 00 is not busy, relay 304 and incoming cut-through relay 401 will operate as soon as relay 316 has released at the end of the twentieth dialing pulse, the operating circuit being traceable from ground, break contact of relay 316, wiper in engagement with contact No. 20 on contact bank E02, upper armature and

back contact of relay 310 through the upper winding of relay 304, wiper in engagement with contact No. 20 on bank A₀₂, conductors 318 and 319, through the winding of incoming cut-through relay 401, conductor 402, back contact and upper armature of relay 403, conductor 404, outer upper armature and back contact of relay 405, back contact and inner upper armature of relay 406, conductor 407 to grounded negative potential conductor 451. The circuit just traced has a path extending through the winding of relay 310, back contact and inner lower armature of relay 304, wiper in engagement with contact No. 20 on bank D₀₂, conductor 309 to the grounded negative potential conductor 451. Relay 310 will not operate since it is of the slow-operate type and its operating circuit will be broken as soon as the inner lower armature of relay 304 has left its back contact.

When relay 304 operates it locks itself through its lower winding, front contact and inner lower armature, wiper in engagement with contact No. 20 on bank D₀₂ conductor 309 to the grounded negative potential conductor 451. This locking circuit is required to prevent relay 304 from releasing when subsequent busy tests are made on station No. 12. Relay 304 also disconnects the winding of relay 302 from the tip conductor 306 of the line circuit and prepares a circuit from the tip conductor to contact No. 20 on bank B₀₂ through the upper winding of relay 320. The latter circuit is not established, however, until relay 315 releases. Relay 304 also connects the ring conductor 321 of the line circuit to the negative ground potential conductor 451, through the front contact and middle lower armature of relay 314, which relay has not as yet released.

Application of the negative ground potential to the ring conductor 321 causes polar relay 308 at station No. 02 to operate. When relay 308 operates it closes the alternating current source 322 to thereby operate the alternating current relay 323 and start the teletypewriter motor 324. When the alternating current relay 323 operates, it locks up through one of its contacts. It also disconnects dial 307 and connects the teletypewriter comprising transmitter 325 and receiver 326 across the line circuit. The starting of the teletypewriter motor is an indication to the station attendant that the connection has been established. When relay 304 operates it also applies grounded negative potential on conductor 451, through conductor 309, inner upper armature and front contact of relay 304, front contact and armature of relay 315, wiper in engagement with contact No. 20 on contact bank B₀₂, conductors 327 and 328, front contact and lower armature of relay 401, ring conductor 410, through the winding of polarized relay 408, to ground at the lower contact of dial 409. Relay 315 has not as yet released. Since relay 401 is now operated so that the grounded negative potential on conductor 309 is applied to the ring conductor 410, polar relay 408 at station No. 00 operates to cause the teletypewriter motor at station No. 00 to start.

When relay 304 operates, grounded negative potential is disconnected from the winding of relay 312. Relay 312 will therefore release after an interval causing the circuit of relay 314 to be opened. Relay 314 will then release, but by this time the motors at both calling station No. 02 and called station No. 00 have been started. When relay 314 releases, it removes the grounded negative potential from the ring conductor 321

and applies grounded positive potential in its place. The operating circuit for stepping magnet 317 is opened at the front contact and outermost lower armature of relay 314 and another operating circuit for the magnet is prepared at the outermost lower armature and back contact of relay 314 which extends to the wiper on contact bank D₀₂ for subsequent release of the selector switch on the receipt of a disconnect signal. Relay 314 in releasing also causes relay 315 to release. When relay 315 releases, the complete connection between stations Nos. 02 and 20 is established and a loop is provided between the two stations with positive and negative potential applied at opposite ends. The attendant at station 02 may now call the attendant at the called station No. 00 by sending "Bell" signals to the teletypewriter keyboard.

The attendant at station No. 00 upon receiving the information from the attendant at station No. 02, it being assumed that such information is the request to establish a call to the public teletypewriter exchange office, and the attendant at station No. 00, momentarily operates a three-position key 411 to its right-hand position, which position is identified herein as a call-answering position. Since the teletypewriter motor 412 at station No. 00 is operating, rectifier 413 is energized through the transformer 414 and the operating circuit for interconnecting relay 415 is now closed. Relay 415, in operating, closes at its inner lower armature and contact a locking circuit for itself. The attendant at station No. 02 in initiating this call by dialing station No. 00, causes the selector switch No. 02 to operate, and the operation of this switch to effect the engagement of the wiper with contact No. 20 on bank C₀₂ starts the motor generator sets 455 operating. The operation of motor generator sets 455 produces positive and negative voltages over conductors 450 and 451, respectively, to energize the repeater relays P₁, P₂, P₃ and P₄ so that when interconnecting relay 415 is operated and locked, the trunk circuit extending to the public teletypewriter exchange office is connected through the repeater circuit to the loop circuit extending through station No. 00 to station No. 02. A detailed description of the operation of the repeater may be had by referring to U. S. Patent 1,601,799 granted to J. Herman on October 5, 1926. It is to be noted from the above brief description of the operation of this circuit that the teletypewriter at station No. 00 is used on a monitoring basis at all times while the trunk circuit connections to the teletypewriter exchange office are established. It is also to be noted that the teletypewriter mechanism together with the associated alternating current relay rectifier and interconnecting relay 415 provided an automatic means for disconnecting the trunk circuit at the end of a communication.

Call from public teletypewriter exchange office

When a call for one of the stations in the private branch exchange system is completed at the public teletypewriter exchange office switchboard, the operator at the switchboard operates a ringing key which connects battery to the ring conductor 416 which is extended through the normally closed contact of the recall key 417, outer lower armature and back contact of relay 415, normally closed lower left contact of key 411, condenser 418, through the ringer 419 to ground. The ringing current causes the ringer 419 to operate. To answer the call, the station at-

tendant at station No. 00 dials a particular number, such as 1. The dialing of 1 causes the connection to be established between station No. 00 and station No. 1 in the teletypewriter private branch exchange office. Should the teletypewriter private branch exchange be connected to a teletypewriter public exchange office, as shown in the drawings, station No. 1 would be different from the other stations in the teletypewriter private branch exchange system in that there is no teletypewriter dial or associated equipment and no selector switch with its associated relays except in incoming cut-through relay such as relay 105 at station No. 3. In this case station No. 1 might be called a dummy. The line loop extending to station No. 1 includes in addition to the regular resistance, not shown, a second resistance 47 equivalent to that of a teletypewriter and associated polarized relay.

The dialing of 1 will operate selector switch No. 00 whereby the motor generator sets 455 will start operating to energize the biasing windings of the repeater relays P₁, P₂, P₃ and P₄ and the operating of the teletypewriter motor at station No. 00 will energize through transformer 414, the rectifier 413 to prepare the operating circuit for interconnecting relay 415. The attendant at station No. 00 then operates the key 411 to its call-answering position momentarily. This causes the interconnecting relay 415 to operate and lock through the front contact and inner lower armature. The operator at the public teletypewriter exchange switchboard and the attendant at station No. 00 may then communicate since positive and negative voltage supplies from generator sets 455 are connected over conductors 450 and 451, respectively, to the repeater and the teletypewriter at station No. 00 is connected in series between the repeater and the line circuit extending to dummy station No. 1. The trunk circuit extending from the switchboard at the public teletypewriter exchange office is connected to the other side of the repeater to the cord circuit at the public teletypewriter exchange office.

After obtaining the number of the called station desired the attendant at station No. 00 operates key 411 to the left, or its "Hold," position and then sends an "H" signal to cause the motor of the teletypewriter at station No. 00 to stop and the interconnecting relay 415 to release. The connection to dummy station No. 1 is also released. With key 411 in the "Hold" position, relay 420 is connected in series with the trunk circuit and this relay therefore operates causing lamp 421 to light from source 422. The lamp remains lighted as long as key 411 is in its "Hold" position and there is no typing on the trunk circuit. Typing at the public teletypewriter exchange office will cause the lamp to flash giving the attendant at station No. 00 a signal that the switchboard operator at the public teletypewriter exchange office wishes to recall the attendant at station No. 00 when the key is in the "Hold" position.

Following the stopping of the motor of the teletypewriter at station No. 00 the attendant at that station dials the number of the called station. This operation causes the teletypewriters at the called station and station No. 00 to start, that is, the motors for the teletypewriters to start. The attendants at the called station and station No. 00 may now communicate and following this the attendant at station No. 00 connects the line circuit to the trunk circuit by releasing key 411

from its "Hold" position and momentarily operating it to the call-answering position. Interconnecting relay 415 then operates and locks and the through connection is established between the public teletypewriter exchange switchboard and the teletypewriter at the called station.

If after the communication is established the attendant at the called station wishes to recall the operator at the public teletypewriter exchange switchboard, he may do so by sending S (bell) signals. These signals will recall the attendant at station No. 00 who in turn may recall the switchboard operator at the public teletypewriter exchange office by operating the recall key 417.

When the called station has completed the communication, he will disconnect by sending an H signal which will cause the teletypewriter motors at the called station and at station No. 00 to stop. The rectifier 413 will deenergize and the interconnecting relay 415 will release. This release will automatically cause a disconnect signal to be transmitted to the public teletypewriter exchange office because the loop to that office will become open and one side will be grounded through the normally closed upper left-hand contacts of key 411 while the other will be connected to the ringer 419.

What is claimed is:

1. A signaling system comprising a switching center, outlying stations, normally open circuits for respectively connecting said outlying stations to said switching center, means at each of said outlying stations for closing its associated circuit, impulse transmitting means and a code combination signal transmitting and receiving device at each of said outlying stations, a rotary selector switch and equipment associated therewith individual to each of said stations and responsive to said impulse transmitting means at its associated station whereby any station, when said impulse transmitting means thereat are operated, may be connected with any other idle station.

2. A signaling system according to claim 1 wherein the equipment at one of said outlying stations includes a trunk circuit for extending an outgoing call from any one of said outlying stations to points outside the system and an incoming call to any one of said outlying stations from points outside the system.

3. A communication system comprising a switching center, outlying stations, normally open circuits for respectively connecting said outlying stations to said switching center, a central office, a main circuit interconnecting one of said outlying stations and said central office, impulse transmitting means and a teletypewriter signal transmitting and receiving device at each of said outlying stations, a selector switch and equipment associated therewith individual to each of said stations and responsive to said impulse transmitting means at its associated station and a common power supply for said impulse transmitting means, said selector switches and their respectively associated equipment comprising means responsive whereby any one of said outlying stations may be connected to any other idle outlying station or to said central office as desired.

4. A communication system in accordance with claim 3, wherein the equipment associated with each of said selector switches includes relays for holding their associated said outlying station busy to calls originating at other of said outlying sta-

tions, when said associated outlying station is engaged in an established connection, means for operating one of said relays when said associated outlying station originates the call for the established connection other means for operating the other when said associated outlying station answers the call.

5. A communication system according to claim 3 wherein the selector switches and the equipment respectively associated therewith comprise means for simultaneously establishing connections between two or more pairs of outlying stations individually, the connection between the stations of any one pair being established independently of a connection simultaneously established between stations of any other of said pairs of stations.

6. A communication system in accordance with claim 3 wherein the transmitting and receiving devices at each of said outlying stations are teletypewriters having driving motors individual thereto and means arranged, when any two of said teletypewriters are interconnected for communication, to be controlled from either of the two interconnected teletypewriters.

7. A communication system in accordance with claim 3, wherein one of said outlying stations comprises signaling equipment for supervising a connection between any one of said outlying stations and said central office, said connection including said main circuit.

8. A communication system in accordance with claim 3 wherein said common power supply comprises means for normally maintaining it in an idle condition and in response to the operation of said selector switch to be automatically controlled to establish a connection between any two of said outlying stations or between one of said outlying stations and said central office for the duration of such a connection and to complete a disconnection of such connection at the conclusion of a communication.

9. A communication system in accordance with claim 3 wherein said main circuit comprises means at said one of said outlying stations for connecting any one of the other of said outlying stations through said one outlying station, and said signal transmitting and receiving device at said one of said outlying stations comprises means for monitoring the communication between any one of said other outlying stations and said central office.

10. A teletypewriter system comprising outlying stations, a selector switch and equipment associated therewith individual to each of said stations, a switching center whereat said selector switches and said equipment are located, nor-

mally open circuits for respectively connecting each of said stations with said switching center, a call initiating device at each of said outlying stations for conditioning for operation its associated selector switch, a pulse transmitting dial at each of said outlying stations for operating its associated conditioned selector switch, a signal transmitting and receiving device and driving means therefor at each of said outlying stations, a common source of power supply at said switching center for furnishing power to initiate a communication connection between said outlying stations in response to the operation of a call initiating device, an amplifying device controlled by said pulse transmitting dial and said common source of supply for completing said connection, starting said driving means at the signal transmitting and receiving devices at interconnected stations, for transmitting signals between the transmitting and receiving devices at interconnected stations, for transmitting supervisory signals and for restoring said driving means and said operated selector switches to normal at the conclusion of a communication.

11. A teletypewriter system in accordance with claim 10, wherein said amplifying device is common to said outlying stations and said switching center for providing grounded positive potentials and grounded negative potentials to opposite ends, respectively, of said normally open circuits interconnected in an established connection.

12. A teletypewriter switching system comprising a plurality of lines, a central switching point including stepping devices for connecting any two of said lines together for intercommunication, a source of power for causing any one of said devices to step, a normally idle auxiliary source of power for devices controlled by any step from normal of any of said stepping devices to render operative said auxiliary source of power, and connections whereby said auxiliary source of power furnishes energy for controlling further stepping of said devices.

13. A teletypewriter switching system comprising a plurality of lines, a central switching point including stepping devices for connecting any two of said lines together for intercommunication, a source of power for causing any one of said devices to step, a normally idle auxiliary source of power for devices controlled by any step from normal of any of said stepping devices to render operative said auxiliary source of power, and connections whereby said auxiliary source of power furnishes energy for telegraphic impulse transmission between any two of said lines connected by said stepping devices.

FRED JOHN SINGER.