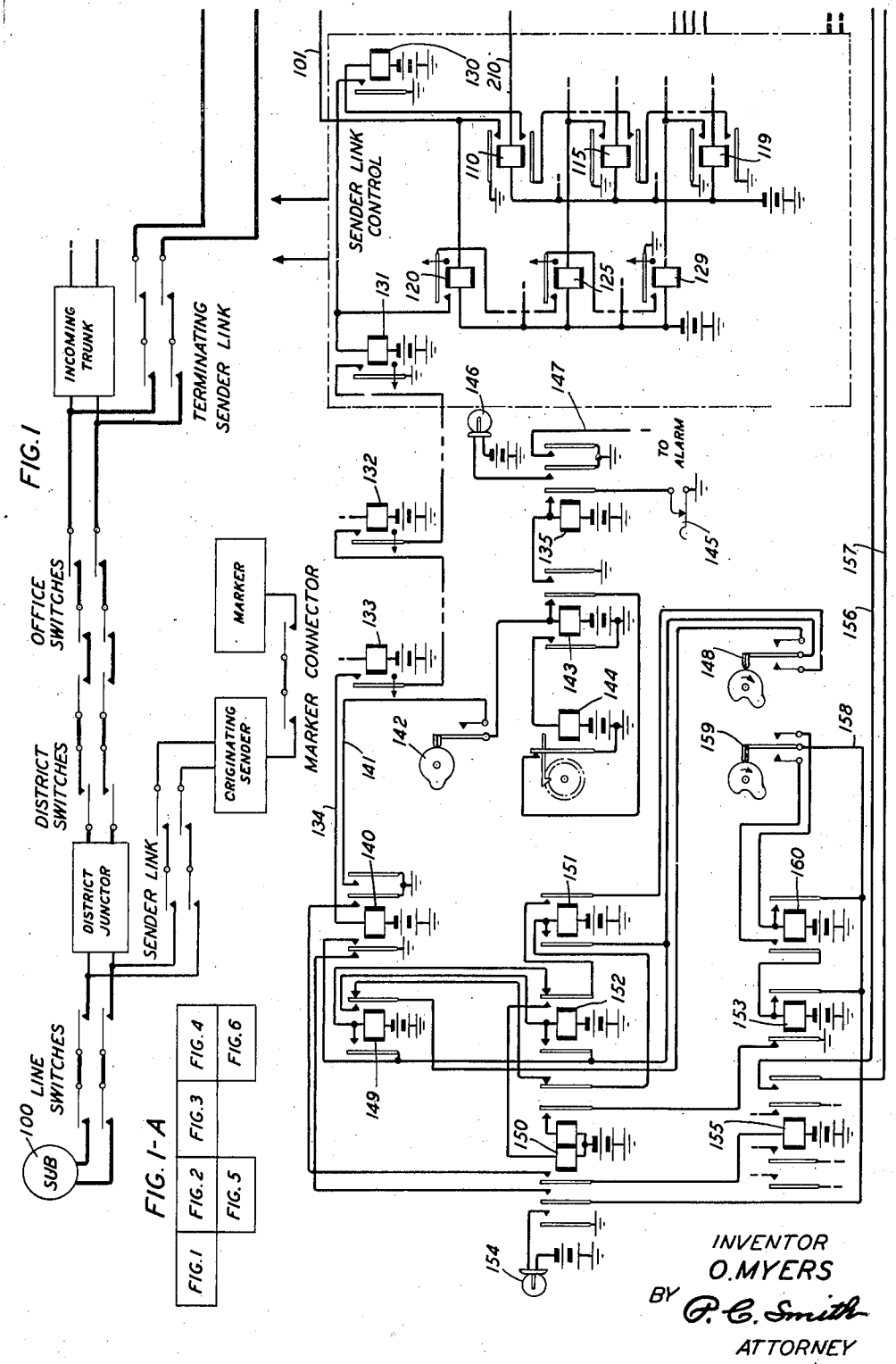
June 13, 1944. O. MYERS 2,351,446

SENDER LOAD CONTROL

Filed Dec. 22, 1942 6 Sheets-Sheet 1



June 13, 1944. O. MYERS 2,351,446

SENDER LOAD CONTROL

Filed Dec. 22, 1942 6 Sheets-Sheet 2

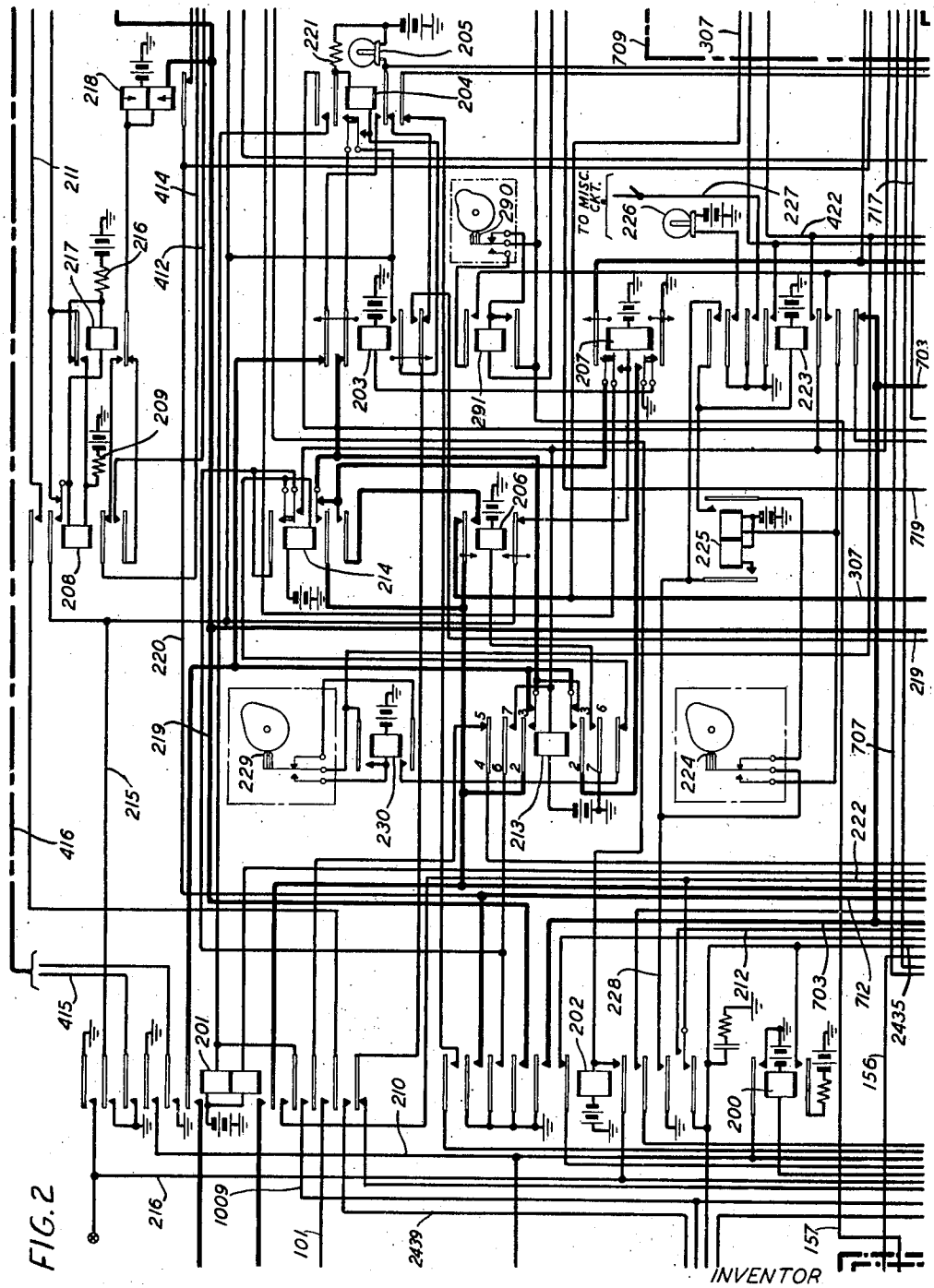


FIG. 2

June 13, 1944. O. MYERS 2,351,446

SENDER LOAD CONTROL

Filed Dec. 22, 1942 6 Sheets-Sheet 3

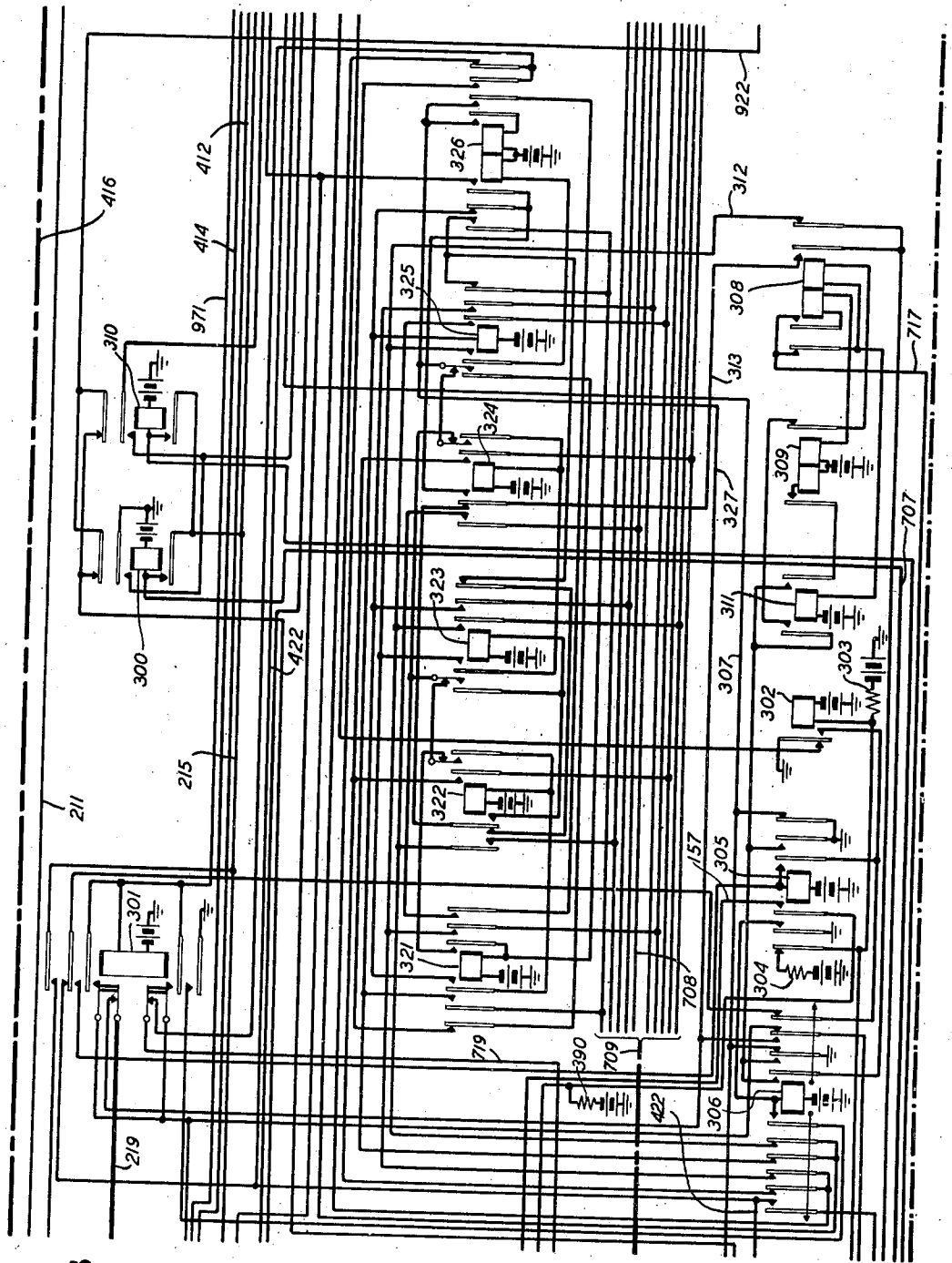


FIG. 3

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SENDER LOAD CONTROL

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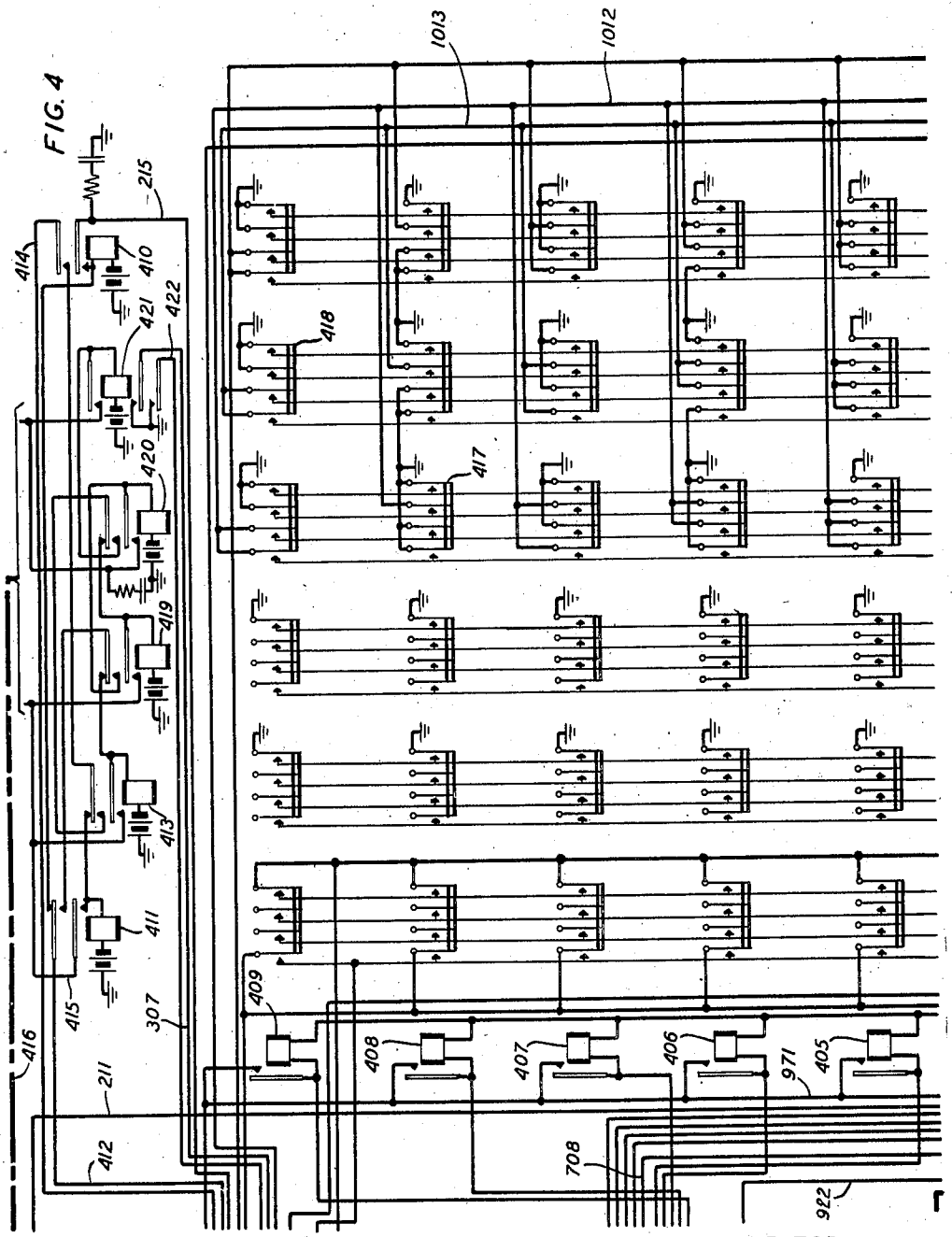
FIG. 4



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SENDER LOAD CONTROL

Filed Dec. 22, 1942 6 Sheets-Sheet 5

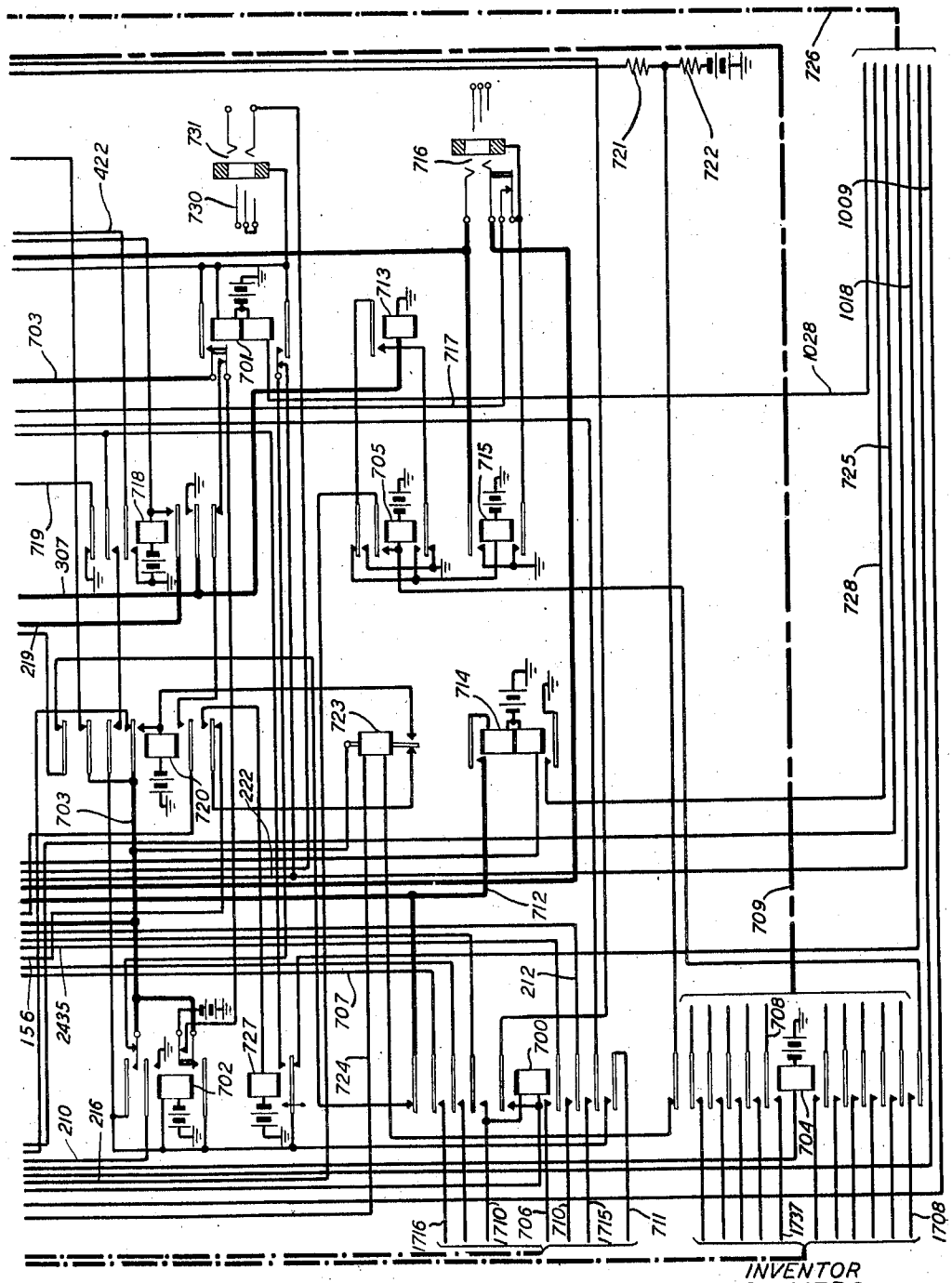

FIG.5

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SENDER LOAD CONTROL

Filed Dec. 22, 1942 6 Sheets-Sheet 6

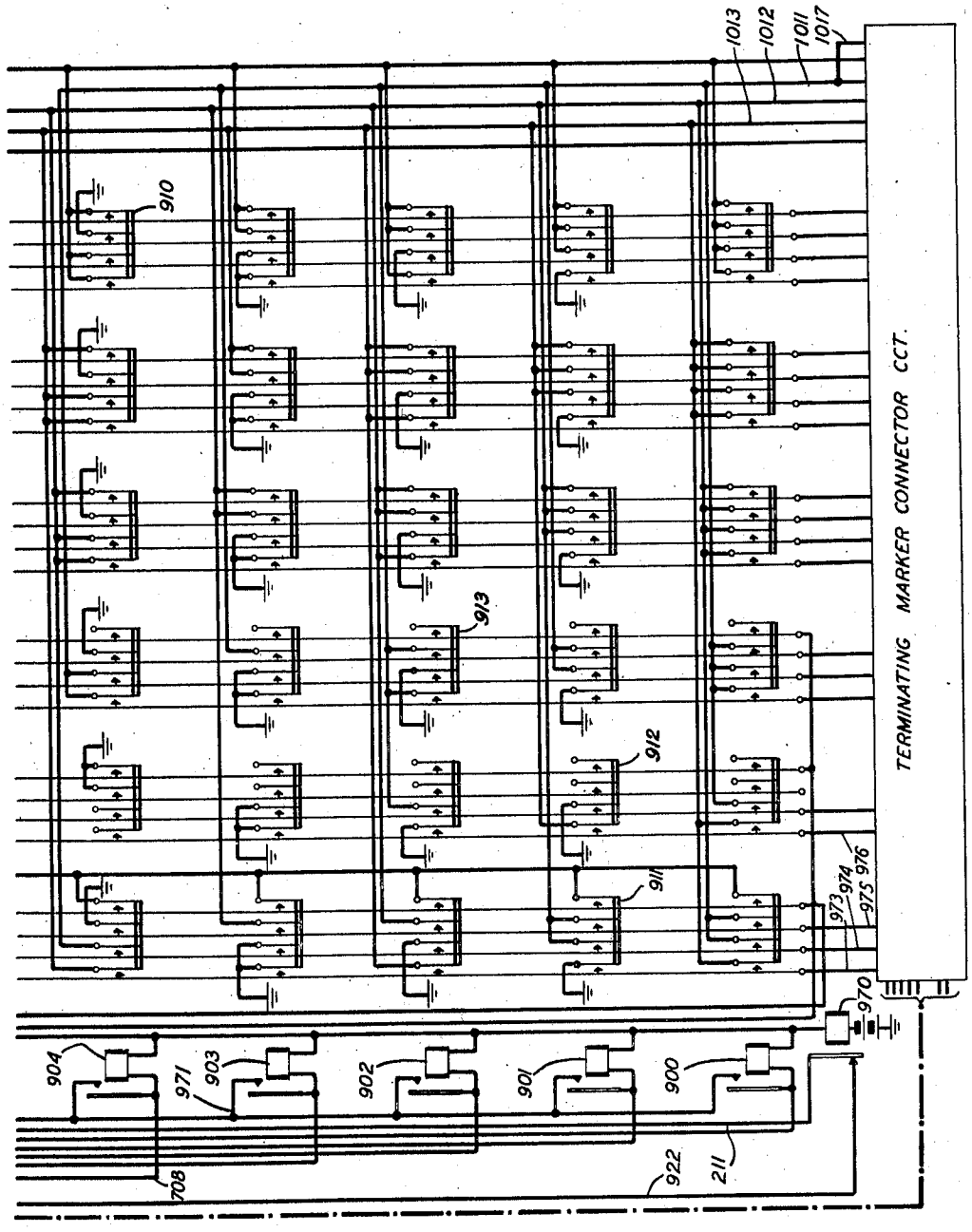

FIG. 6

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Patented June 13, 1944

2,351,446

UNITED STATES PATENT OFFICE

2,351,446

SENDER LOAD CONTROL

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Application December 22, 1942, Serial No. 469,787

8 Claims. (Cl. 179—18)

This invention relates to telephone systems and has for its object to reduce the ill effects of peak load conditions.

In a cross bar system, the switches are directed in their action by control devices, senders and markers. These control devices are of two kinds, originating and terminating, the former receiving the complete designation of the wanted line and connecting the calling line to a trunk incoming to the office at which the wanted line is located. The terminating sender receives the numerical designation from the originating sender and with the help of the terminating marker controls the connection of the incoming trunk to the wanted line, thereby completing the connection between the calling and called lines.

Telephone exchanges are designed to complete all calls during heavy load periods with a certain minimum of delay. Throughout the greater part of the time, therefore, there will be no delay. Occasionally, however, some event of exceptional interest will produce such a congestion of calls that the control equipment will all be busy and calls will experience long delay. When such a condition arises, any action which tends to increase the holding time of the sender adds to the congestion.

In the setting up of a connection in the cross bar system, the subscriber usually dials seven digits all of which are recorded in the originating sender. The first three digits are transmitted to the originating marker which uses them to determine the identity of the wanted office, to operate a plurality of cross bar switches to connect the originating sender with the wanted office and to transmit to the sender an indication of the type of office to which the call is going and with which the connection has been established. The originating sender cannot start to transmit the numerical digits to the distant office until it receives this indication from the marker and it can only transmit the digits as fast as they are recorded in the sender. However, it is apparent that under normal conditions some of the numerical digits will have been recorded during the operation of the marker and the remaining digits will be received promptly. The sender is designed to make a brief pause between successive digits to allow time for the necessary interdigital operations at a mechanical terminating office and, in the case of a properly dialed designation, the last digit will be recorded by the time the sender is ready to send it out. Both the originating sender and the terminating sender are provided with timing means for timing their complete operation but these intervals are made long enough to permit even very slow dialing to be completed. However, in the case of traffic congestion, if the subscriber stops dialing without restoring his receiver, both the originating sender and the terminating sender will be held out of service until the timing means complete their operations.

In accordance with the present invention means is provided by which a predetermined interdigital delay will bring about the release of the terminating sender. Furthermore, this release means is rendered effective only in the case of an overload condition in which all terminating senders of the office are simultaneously busy for more than a predetermined length of time.

The invention will be more clearly understood from a consideration of the following description in connection with the drawings, in which:

Fig. 1 shows in diagrammatic form the connection between an originating subscriber and the terminating sender, as well as the sender link control circuit and the timing equipment;

Figs. 2, 3 and 5 show the control circuits of the terminating sender;

Figs. 4 and 6 show the cross bar register of the terminating sender; and

Fig. 1A shows the manner in which the other figures should be arranged.

A complete disclosure of the originating circuits of a cross bar office may be found in United States Patent 2,235,803 granted March 18, 1941, to W. W. Carpenter, while the terminating circuits are disclosed in United States Patent 2,089,921, granted to W. W. Carpenter on August 10, 1937.

When the subscriber at substation **100** initiates a call, the substation is connected over line switches to an idle district junctor and over the line switches and sender link to an idle originating sender. He then dials the designation of the wanted line. Having received the designation of the wanted office the sender connects by means of a marker-connector with a marker. The marker controls the operation of the district and office switches to extend the calling line to an incoming trunk at the wanted office.

At the wanted office, the sender link control circuit selects an idle terminating sender which may be assumed to be the sender shown. The sender link then operates relay **700** followed in turn by relay **704**. With relay **704** operated, the frame designating leads are connected to the select magnets **900**, etc. and to relays **300** and **310**. Either relay **300** or relay **310** in operating extends its operating ground to conductor **215**, operating

relay 207 which in turn operates relays 203 and 204.

With relay 204 operated a circuit is closed for operating relay 201 through its upper winding from ground supplied over conductor 1715 by the link control circuit. Relay 201 connects ground to conductor 210 operating the sender-busy relay 110 in the link circuit. Relay 110, in operating, connects ground to conductor 101 thereby operating slow-to-release relay 120 and preparing a circuit for relay 202.

When one of the select magnets, for example magnet 904, operates to register the units digit of the frame identification, it extends its operating ground over conductor 971 to the winding of relay 301 and battery. Relay 301 locks under the control of relays 306 and 218 and closes a circuit for operating relay 208 which locks to conductor 215. Relay 208, in operating, closes a circuit from battery through the winding of frame hold magnet 410, back contact of hold magnet 411, conductor 412, front contact of relay 208, back contact of relay 217 to the windings of relay 218. Relay 218 is differentially wound and will not operate on current flowing through both windings even with the hold magnet connected in parallel with its upper winding. When the frame designation has been properly registered the circuit of relay 202 is completed. Relay 202 operates and locks under the control of relay 201 and provides a holding circuit for relay 201 under the control of release relay 702. Relay 202 also connects ground to conductor 2435 to hold the link switches operated.

With relay 201 operated, connecting ground to conductor 219, the circuit for the hold magnet 410 is extended through the lower winding of relay 218 to ground on conductor 219 and magnet 410 operates locking to conductor 215, which is now also grounded by relay 201. Differential relay 218 is energized through its upper winding alone and operates, opening one locking circuit for relay 301.

The sender is now ready to receive the numerical designation of the wanted line. To this end a pulsing circuit is established from battery through the winding of relay 302, upper front contact of relay 207, normal contacts of relays 214 and 213, the inner upper front contact of relay 201, over the tip contacts of the sender link switches and the office and district switches, through the district junctor and the sender link at the originating office to the pulsing relay of the originating sender and back over the ring contacts of the same switches to the inner lower front contact of relay 201, upper back contact of relay 206 to the winding of relay 713 and ground. If the originating sender is ready to transmit the first numerical digit this circuit will be completed and relay 302 operates together with the pulsing relay of the originating sender. Relay 713 cannot operate at once, since its winding is shunted by ground connected to conductor 307 over the inner right back contact of relay 306 and over the right back contact of relay 305. Relay 302 closes a circuit from ground at its front contact over the outer right back contact of relay 306, middle upper front contact of relay 301 to the winding of relay 305 and battery. Relay 305 operates and locks over its inner right contact to ground at the contact of relay 302, disconnects one ground from conductor 307, and closes an obvious circuit for relay 306. Relay 306 operates and opens the second locking circuit for relay 301 causing that relay to release.

Relay 306 opens the second shunt around relay 713, which now operates, closing a circuit from battery through the winding of relay 715, over the upper back contact of relay 705, front contact of relay 713, lower back contact of relay 705 to ground. Relay 715 operates, closing two circuits, one from ground over its upper contact to the winding of relay 302, holding that relay operated and shunting the pulsing relay of the originating sender and the pulsing relay 713 of the terminating sender, thereby sending one revertive pulse to the originating sender. The second circuit controls the counting relays 321 to 326 and may be traced over the lower contact of relay 715, contact of jack 716, conductor 717, over the left back contact of relay 308 to the winding of relay 311 and battery. Relay 311 operates and closes a locking circuit from battery through its winding, right winding of relay 308, back contact of relay 309, front contact of relay 311 to ground at the front contact of relay 305. Relay 308 cannot operate in this circuit being shunted by ground on conductor 717.

When relay 713 releases in response to the closure of the shunt by relay 715, relay 715 is released in turn, permitting relay 713 to reoperate. The reoperation of relay 713 causes the reoperation of relay 715 and these relays continue to operate alternately until the pulsing circuit is opened at the originating sender. When relay 715 releases, relay 308 operates in the locking circuit above traced. At the second operation of relay 715, ground on conductor 717 extends over the left front contact and left winding of relay 308 to the right winding of relay 309 and battery, holding relay 308 operated and operating relay 309. Relay 309 opens the locking circuit for relay 311 and that relay releases. When relay 715 again releases, removing ground from conductor 717, both relays 309 and 308 release so that the cycle of operations by relays 308, 309 and 311 is repeated for each pair of pulses from relay 715.

With relays 305 and 306 operated, ground is connected to the right armatures of relay 308. While relay 308 is released ground is extended to conductor 312 and while relay 308 is operated ground is extended to conductor 313. The counting relays 321 to 326 operate under the control of relay 308 to record the number of revertive pulses transmitted to the originating sender. When the originating sender has been satisfied, the pulsing circuit is opened and relay 302 releases followed by relays 305 and 306. With relay 306 released one of the select magnets of the register of Figs. 4 and 6 is operated under the control of the counting relays, operating relay 301 as before. At this time relay 301 releases relay 208 and the hold magnet 411 of the first digit vertical is operated in the manner described for the frame vertical.

When the originating sender is ready to receive the next digit, the pulsing circuit is reclosed, operating relay 302. With relay 301 operated to indicate that a previous digit has been transferred to a select magnet of the register, relay 305 operates in turn operating relay 306. For the further operation of the sender reference is made to the above-mentioned Carpenter Patent 2,089,921.

However, from the foregoing it will be apparent that the interdigital interval occurring between the completion of the registration of one digit and the start of the next digit may be

measured by the release and reoperation of relay 305.

As previously described, the operation of relay 201 connects ground to conductor 210 operating the sender-busy relay 110 in the sender link control circuit. Relays 115 and 119 are sender-busy relays belonging to other senders of the same sender group and, when operated, in turn operate slow-to-release relays 125 and 129. When all of the senders of a group are busy, a chain circuit is closed from ground over the lower contacts of relays 119, 115, 110 and the intermediate relays of the group through the winding of group relay 130 to battery. Relay 130, in turn, operates relay 131 which is slow to release. When the group of slow relays 120 to 129 are all operated they close a supplementary circuit for relay 131.

Similar groups of busy and slow relays are provided for the other sender groups which, when operated to indicate a group-busy condition, in turn operate relays 132, 133, etc. With all of the sender groups busy, a chain circuit over the contacts of relays 131, 132, 133, etc. is closed, connecting ground to conductor 134. The purpose of the supplemental slow-to-release relays is to prevent the removal of ground from conductor 134 during the brief intervals which occur between the release of the sender by one call and its seizure on the next call when traffic is heavy. The individual slow relays tend to bridge this momentary idle period and the group relay adds an additional bridging interval.

When ground is connected to conductor 134, a circuit is completed for relay 140, which controls the timing circuit. Relay 140 operates and connects ground over its outer right contact to conductor 141 preparing a circuit over interrupter 142 for relay 143. Relay 143 operates at each closure of the interrupter 142, locks to the back contact of meter 144 and operates that meter, thereby obtaining an indication of the duration of the all-senders-busy condition. At its outer right contact relay 143 closes a circuit for relay 135 which operates, locks to ground over key 145, lights lamp 146 and connects ground to conductor 147 to sound an alarm.

At its left front contact relay 140 connects ground to the armature of interrupter 148. When the interrupter closes its right contact it connects this ground over the back contacts of relays 149 and 150 to the winding of relay 151 and battery. Relay 151 locks under the control of relay 140. When interrupter 148 closes its left contact, ground is extended over the right contact of relay 151, back contact of relay 152, to the winding of relay 149 and battery. Relay 149 also locks under the control of relay 140 and connects the right contact of interrupter 148 to the winding of relay 152, which relay operates when that interrupter contact is closed and locks to relay 140. With relay 152 operated, interrupter 148 next closes a circuit from ground over its left contact, right front contacts of relays 151 and 152 to the left winding of relay 150 and battery. Relay 150 operates and locks in a circuit from battery through its right winding and right front contact to ground at the back contact of relay 153. Interrupter 148 has a complete cycle of 7 seconds with a 5-second interval between the closure of its left contact and the closure of its right contact. Therefore the time between the grounding of conductor 134 and the operation of relay 150 will vary between 12 and 19 seconds. If desired, the time may be shortened by omitting relays 149 and 152 thereby omitting one complete cycle of operation by the interrupter.

With relay 150 operated, lamp 154 is lighted and a circuit is closed from ground at the inner right contact of relay 140, inner left contact of relay 150 to the winding of relay 155 and battery. With relay 155 operated, a circuit is closed from ground on conductor 703, left contact of relay 723 which is normally closed, lower back contact of relay 720, conductor 156, front contact of relay 155, conductor 157 to interrupter 290.

From the foregoing it will appear that, when an all-terminating-senders busy condition has existed for a predetermined length of time, interrupter 290 is rendered effective by connection of ground to its contact. Relay 155, and such other relays as are necessary to close the proper number of contacts, closes a similar circuit for each sender of the office. When interrupter 290 closes its right contact it completes a circuit from ground on conductor 157 through the winding of relay 291 to battery through resistance 390. Relay 291 operates and locks over its lower contact to conductor 157. Since the ground for conductor 157 was obtained from conductor 703 of this same sender, interrupter 290 cannot become effective until relay 202 has operated and the sender is ready to receive the first digit. As soon as the pulsing circuit is closed at the originating sender, relay 302 operates as above described in turn operating relay 305. Relay 305 at its inner left contact connects grounded conductor 157 to resistance 390 in shunt of the winding of relay 291, causing that relay to release. At the end of the digit, when the originating sender opens the pulsing circuit, relays 302 and 305 release as above described and relay 291 again operates as soon as the interrupter 290 closes its right contact, only to be released when the pulsing circuit is closed for the next digit.

After the units digit has been recorded the originating sender should reclose the pulsing circuit to receive a reverse battery pulse generated by the terminating sender. Relay 291 would detect a delay in this closure. Relays 302 and 305 are operated during the reverse battery closure, thereby rendering relay 291 ineffective at that time. After the release of the originating sender, relay 720 is operated from the trunk circuit, disconnecting ground from conductor 156 and thereby from conductor 157 so that the sender is permitted to complete its operation in the normal manner.

If, now, there is a considerable delay in the reclosure of the pulsing circuit, relay 291 is permitted to remain operated until interrupter 290 closes its left contact, thereby completing a circuit from ground on conductor 157 over the left contact of interrupter 290, top contact of relay 291, to the winding of trouble-release relay 701 and battery. Relay 701 locks to grounded conductor 703, opens the start circuit for the marker-connector and brings about the release of the terminating sender in the manner described in the above-mentioned Carpenter Patent 2,089,921.

When the busy condition is relieved for long enough to permit one of the slow group busy relays 131, 132 or 133 to release, relay 140 releases, permitting relays 149, 152, 151 and 155 to release also. Since relay 150 is locked under the control of relay 153, that relay remains operated and the release of relay 140 closes a circuit from

ground at the back contact of relay 140, middle left contact of relay 150, conductor 158 to the armature of interrupter 159. Interrupter 159 in closing its right contact operates relay 160 which locks to conductor 158. With relay 160 operated, the next closure of the left contact of interrupter 159 operates relay 153 which also locks to conductor 158. Relay 153, in operating, opens the locking circuit of relay 150 which releases, restoring the timing circuit to normal. Interrupter 159 has a 30-second cycle so that the restoration of the load control circuit will be delayed from 30 to 60 seconds in order to hold relay 155 ready for immediate reoperation should the relief of the congestion be only temporary. After relay 150 releases, an all-senders-busy condition must continue long enough to reoperate relays 151, 149, 152 and 150 in order to operate relay 155 and render the interdigital timing interrupter effective. While relay 150 is held operated, temporary relief of the load will permit relay 155 to release but the recurrence of the overload will immediately reoperate relay 155. The reoperation of relay 140 in response to the renewal of the all-senders-busy condition removes ground from conductor 158 so that a complete release timing cycle will occur after each cessation of the overload.

From the foregoing description it will be apparent that under normal operating conditions neither the timing arrangement of Fig. 1 nor the interdigital release means will function. However, in the case of traffic congestion such that all of the terminating senders become busy and the all-senders-busy condition continues for as much as 12 to 19 seconds, it renders the interdigital timing feature effective and a delay of 3 to 6 seconds in the receipt of any digit, which is indicative that the number has been only partially dialed, will bring about the release of the terminating sender. If the call is abandoned, relay 720, which operates to prevent the seizure of the marker, also disables the interdigital timing interrupter.

When no congestion exists, a sender which encounters trouble is released under the control of interrupter 229 and relays 230 and 214, but the cycle of interrupter 229 requires 30 seconds to complete. It is therefore apparent that the interdigital timing arrangement of the present invention shortens the sender holding time in the case of partial dialing.

If the long interdigital time interval is due to an interruption of the dialing, the originating sender holds the pulsing circuit open until the next digit comes in. It then recloses the pulsing circuit causing the incoming trunk circuit to seize another sender. Since part of the digits stored on the originating sender have already been transmitted, the sender cannot transmit a complete number to the second sender and the interdigital time out will release the second sender, if the all-senders-busy condition continues.

What is claimed is:

1. In a telephone system, a register sender, means to seize said sender, register control means in said sender, means for repeatedly operating and releasing said register control means during the registration of each of a plurality of digits, timing means, means to start the operation of said timing means at each release of said register control means and to release said timing means at each operation of said register control means, and means under the control of said timing means effective to release said sender if more than a predetermined time elapses between successive digit registrations.

2. In a telephone system, a register sender, means to seize said sender, means in said sender for registering a plurality of digits comprising a pulsing circuit, means to close said pulsing circuit to start the transmission of each digit, means to open said pulsing circuit in response to the complete transmission of each digit, a relay included in said pulsing circuit, timing means, means under control of said relay to start the operation of said timing means at each opening of said pulsing circuit and to release said timing means at each closure of said pulsing circuit, and means under the control of said timing means to release said sender if said pulsing circuit remains open more than a predetermined length of time.

3. In a telephone system, a plurality of senders, means to seize one of said senders, means in said sender for registering a plurality of digits comprising a pulsing circuit, means to close said pulsing circuit to start the transmission of each digit, means to open said pulsing circuit in response to the complete transmission of each digit, a relay included in said pulsing circuit, means under the control of said relay to release said sender if said pulsing circuit remains open more than a predetermined length of time, and means to render said releasing means effective only when a predetermined number of said senders are busy.

4. In a telephone system, a plurality of senders, means to seize one of said senders, means in said sender for registering a plurality of digits comprising a pulsing circuit, means to close said pulsing circuit to start the transmission of each digit, means to open said pulsing circuit in response to the complete transmission of each digit, a relay included in said pulsing circuit, means under the control of said relay to release said sender if said pulsing circuit remains open more than a predetermined length of time, and means to render said releasing means effective only when an all-senders-busy condition continues for a predetermined length of time.

5. In a telephone system, a plurality of senders, means to seize one of said senders, means in said sender for registering a plurality of digits comprising a pulsing circuit, means to close said pulsing circuit to start the transmission of each digit, means to open said pulsing circuit in response to the complete transmission of each digit, a relay included in said pulsing circuit, timing means under the control of said relay, means under the control of said timing means to release said sender, and means to render said releasing means effective only when a predetermined number of said senders are busy.

6. In a telephone system, a plurality of senders, means to seize each of said senders, means to mark each sender busy in response to said seizure, register control means in each sender, means for repeatedly operating said register control means during the registration of each of a plurality of digits, timing means effective to release a sender if more than a predetermined time elapses between successive operations of said register control means, means responsive to the joint operation of the busy marking means of all of said senders to render said timing means effective, and other means to render said timing means ineffective after said plurality of digits has been registered.

7. In a telephone system, a plurality of senders,

means to seize each of said senders, means to mark each sender busy in response to said seizure, register control means in each sender, means for repeatedly operating said register control means during the registration of each of a plurality of digits, timing means effective to release a sender if more than a predetermined time elapses between successive operations of said register control means, means responsive to the joint operation of the busy marking means of all of said senders to render the timing means in each sender effective, and means individual to each sender to render said timing means ineffective after said plurality of digits have been registered in each of said senders.

8. In a telephone system, a register sender, means to seize said sender, means in said sender for registering a plurality of digits comprising a pulsing circuit, means to close said pulsing circuit to start the transmission of each digit, means to open said pulsing circuit in response to the complete transmission of each digit, a relay included in said pulsing circuit, timing means, means under control of said relay to start the operation of said timing means at each opening of said pulsing circuit and to release said timing means at each closure of said pulsing circuit, said relay also rendering said timing means inoperative during closures of said pulsing circuit, and means under the control of said timing means to release said sender if said pulsing circuit remains open more than a predetermined length of time.

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