

May 31, 1932.

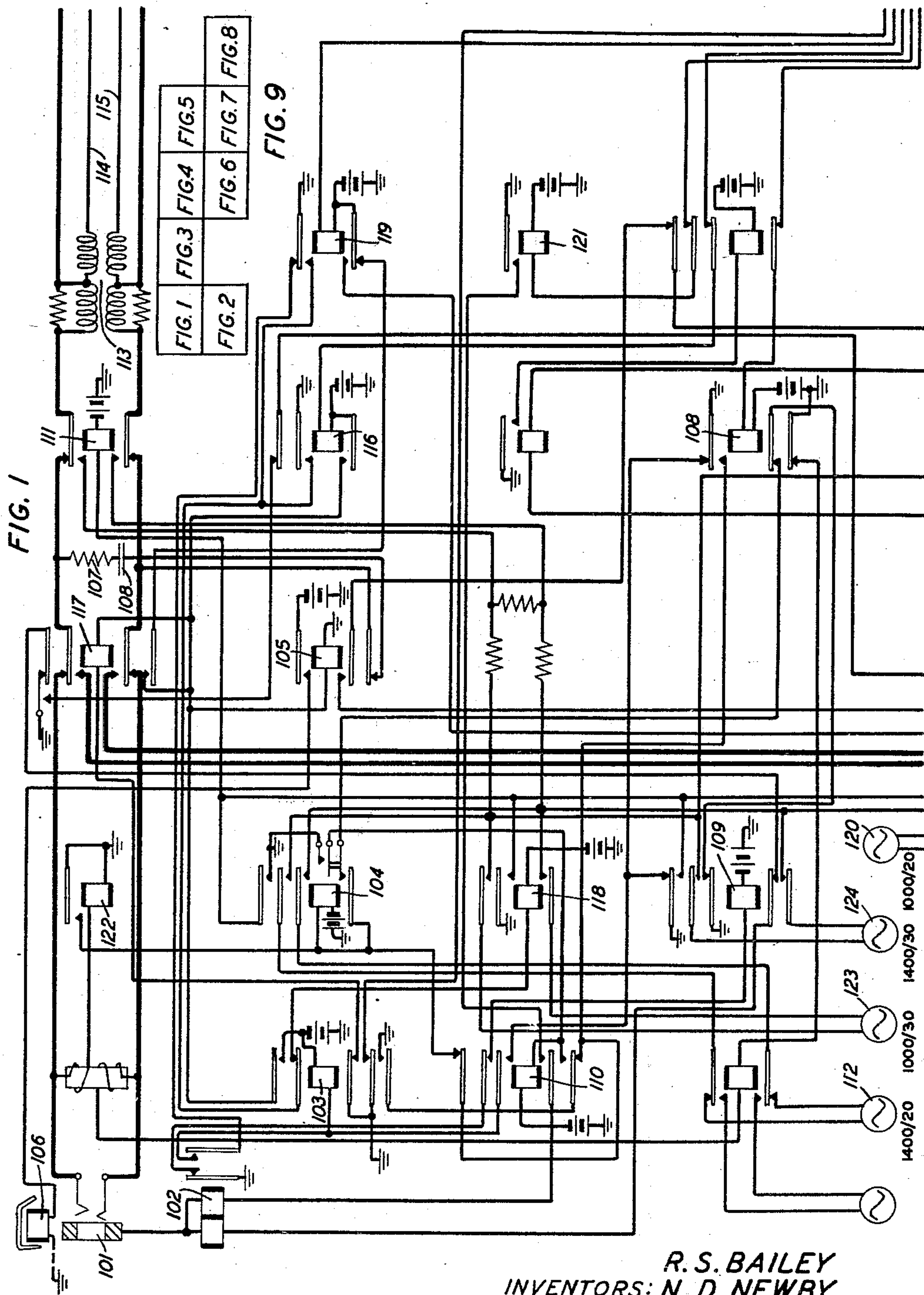
R. S. BAILEY ET AL

1,860,446

SIGNALING SYSTEM

Filed Oct. 11, 1930

8 Sheets-Sheet 1



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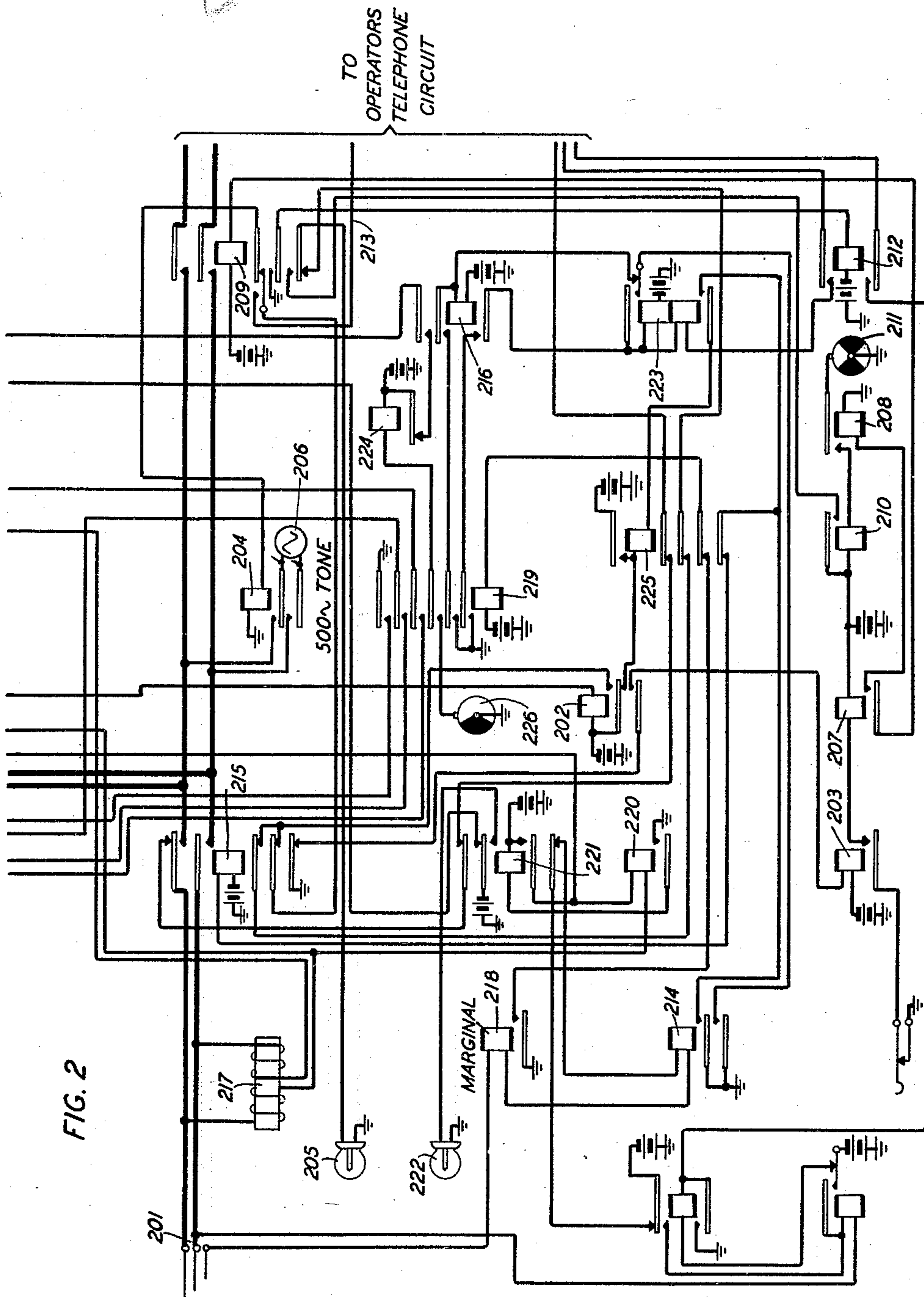
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SIGNALING SYSTEM

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8 Sheets-Sheet 2



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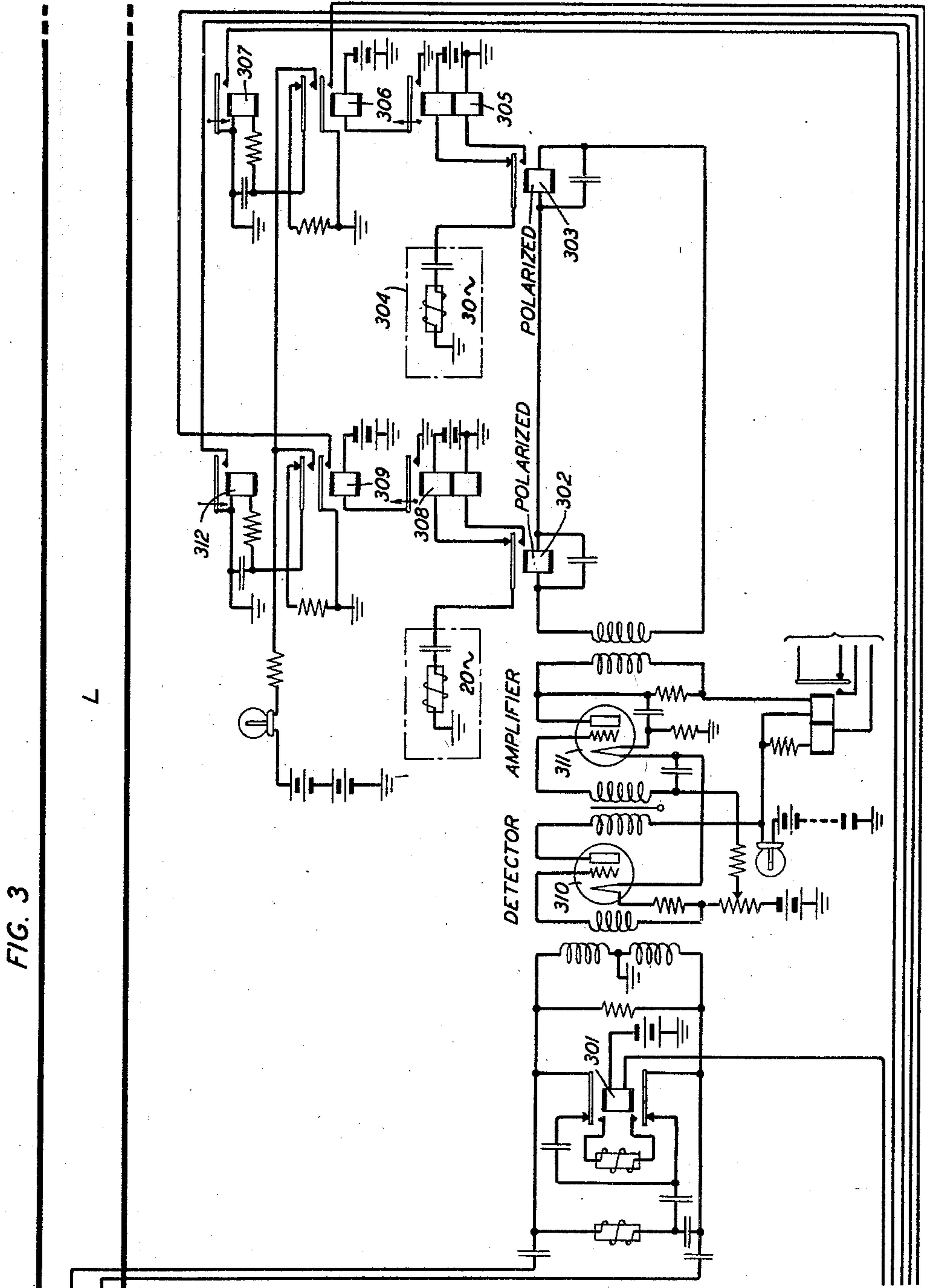
R. S. BAILEY ET AL

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SIGNALING SYSTEM

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8 Sheets-Sheet 3



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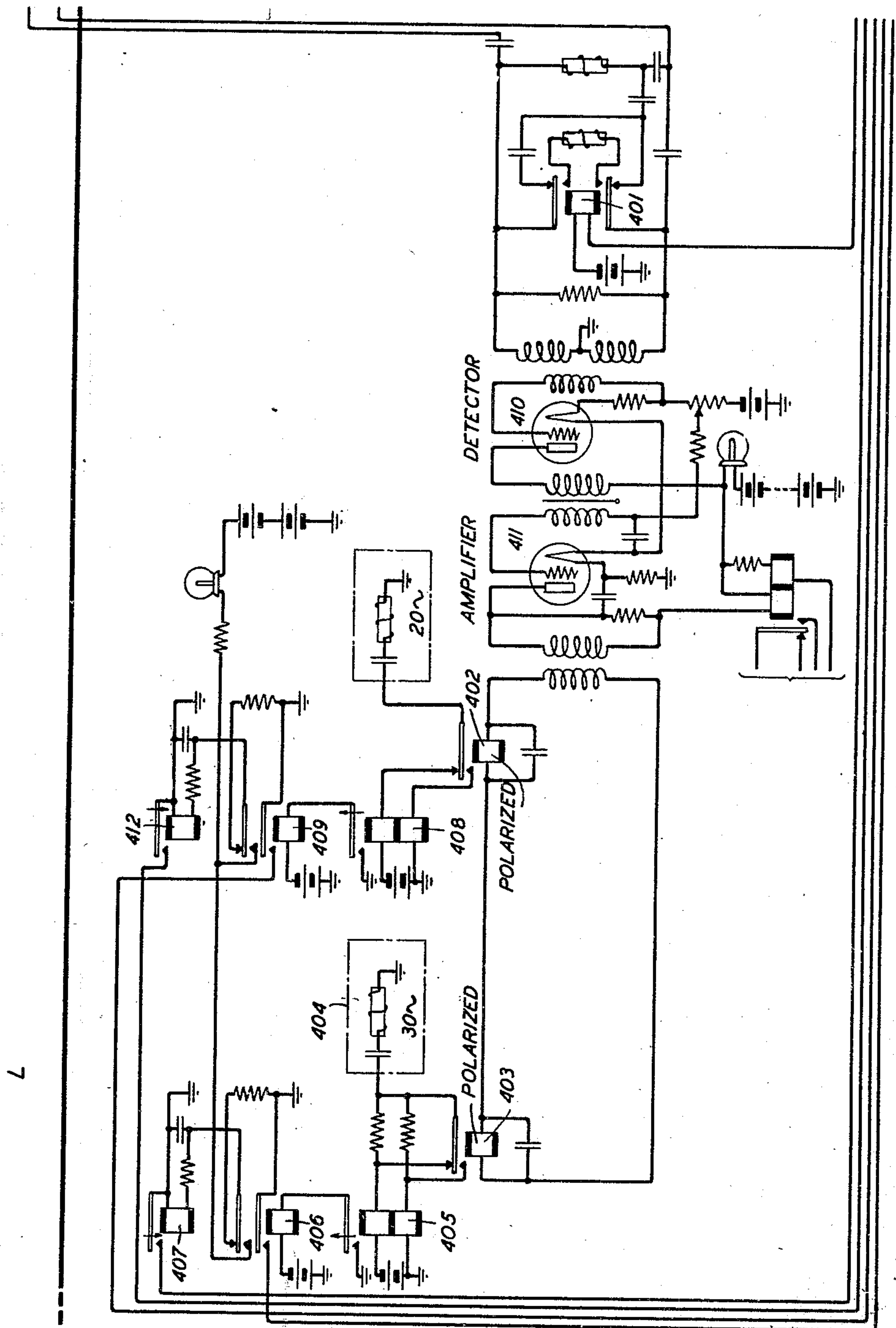
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SIGNALING SYSTEM

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FIG. 4



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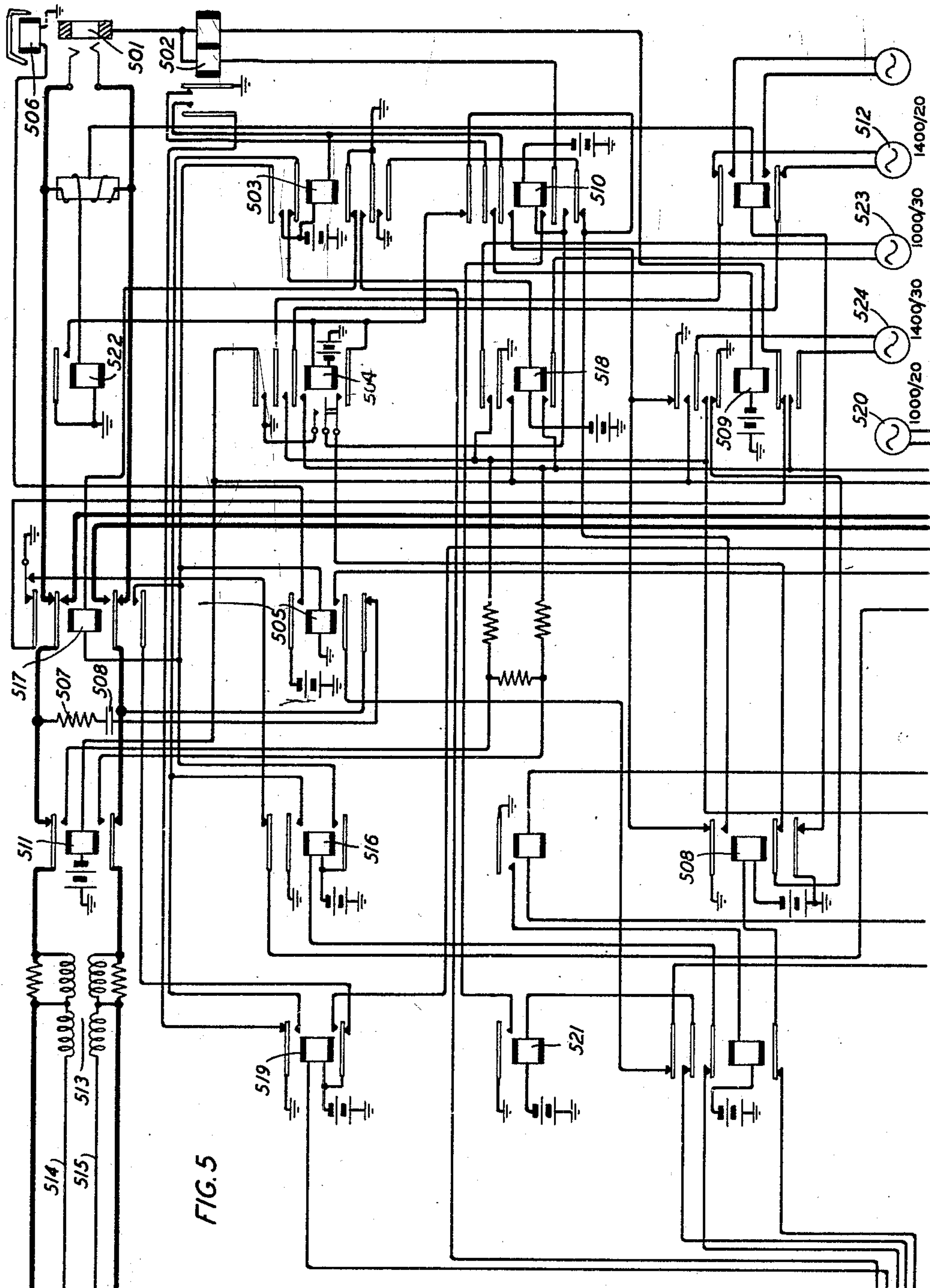
R. S. BAILEY ET AL

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SIGNALING SYSTEM

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8 Sheets-Sheet 5



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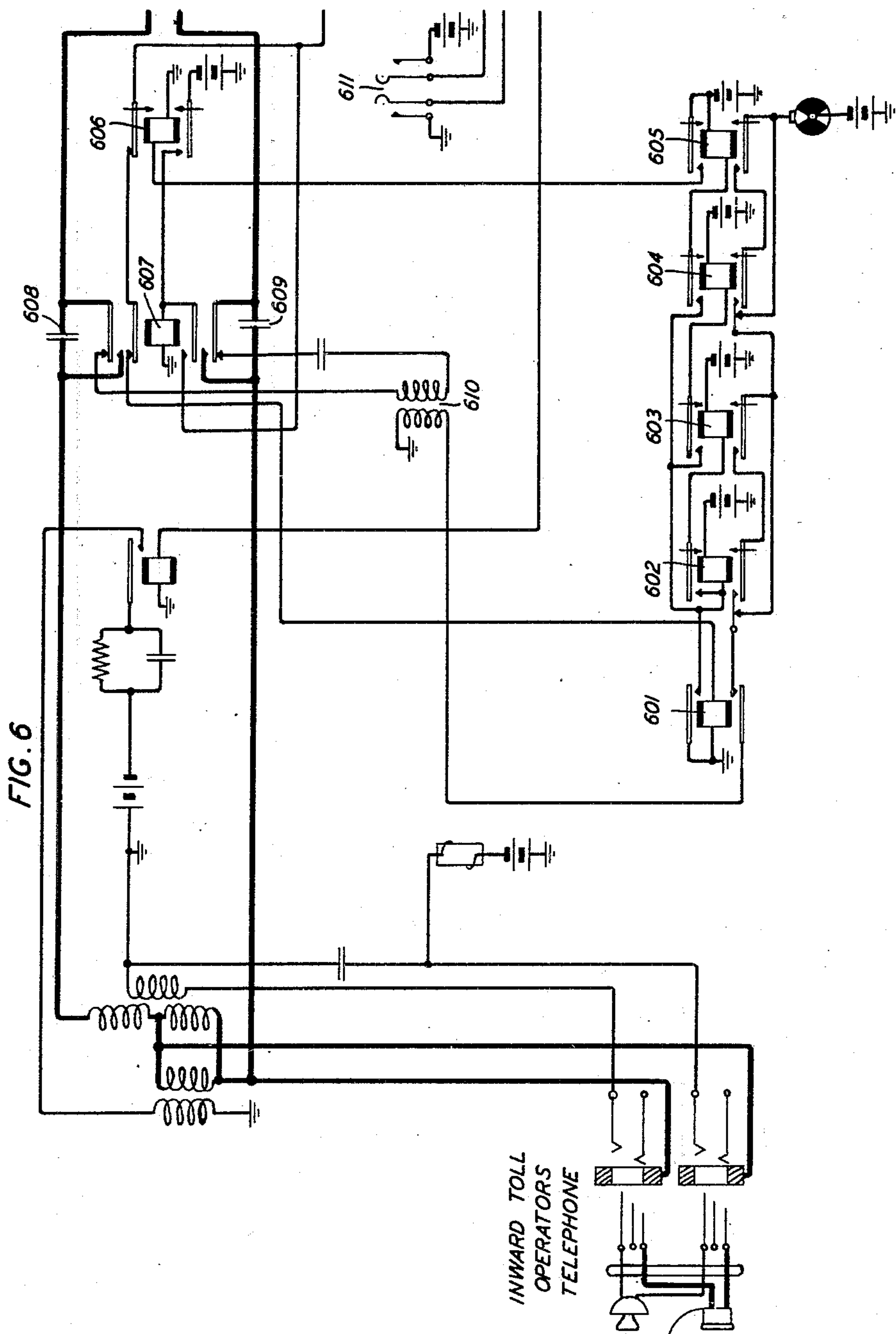
R. S. BAILEY ET AL

1,860,446

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8 Sheets-Sheet 6



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1,860,446

SIGNALING SYSTEM

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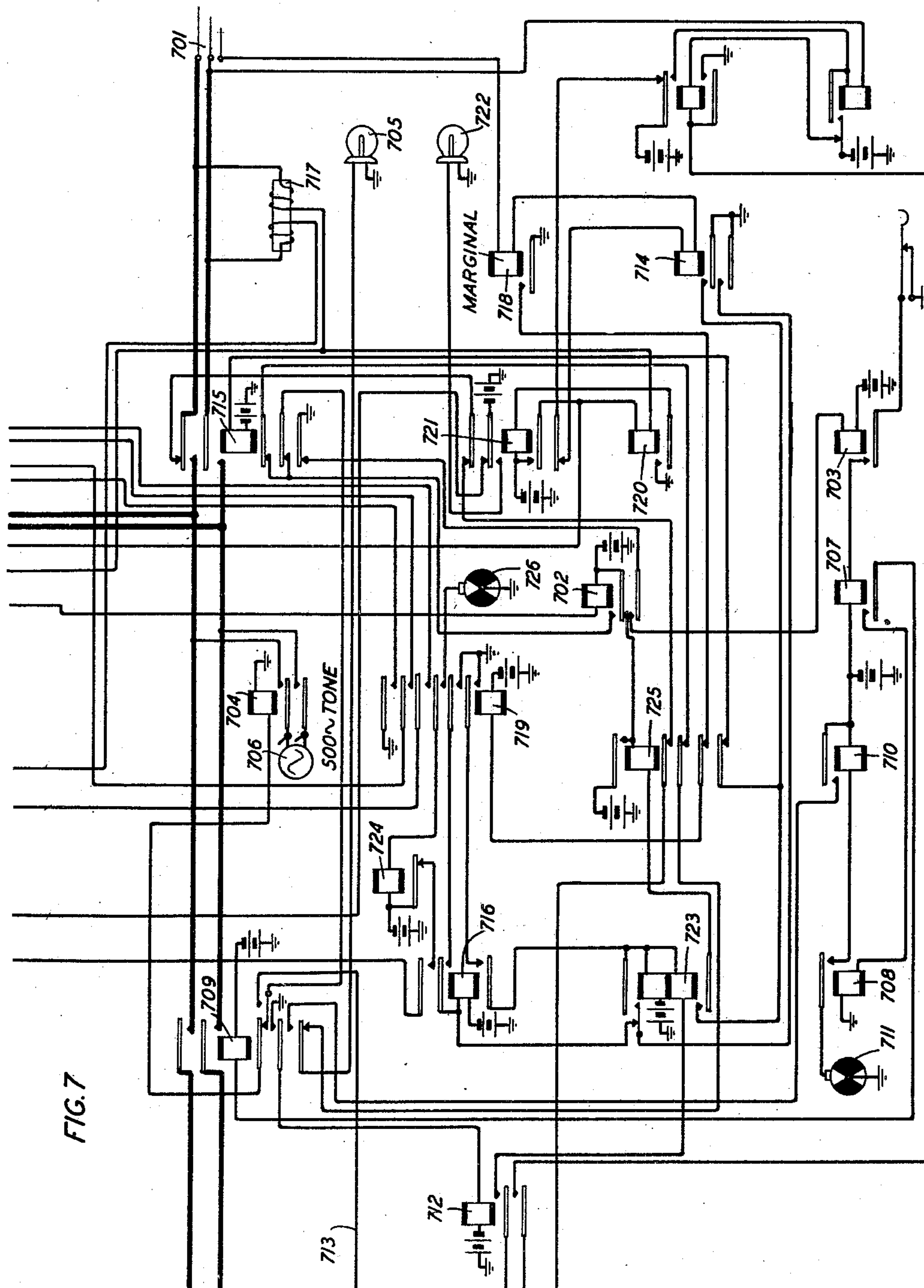


FIG. 7

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1,860,446

SIGNALING SYSTEM

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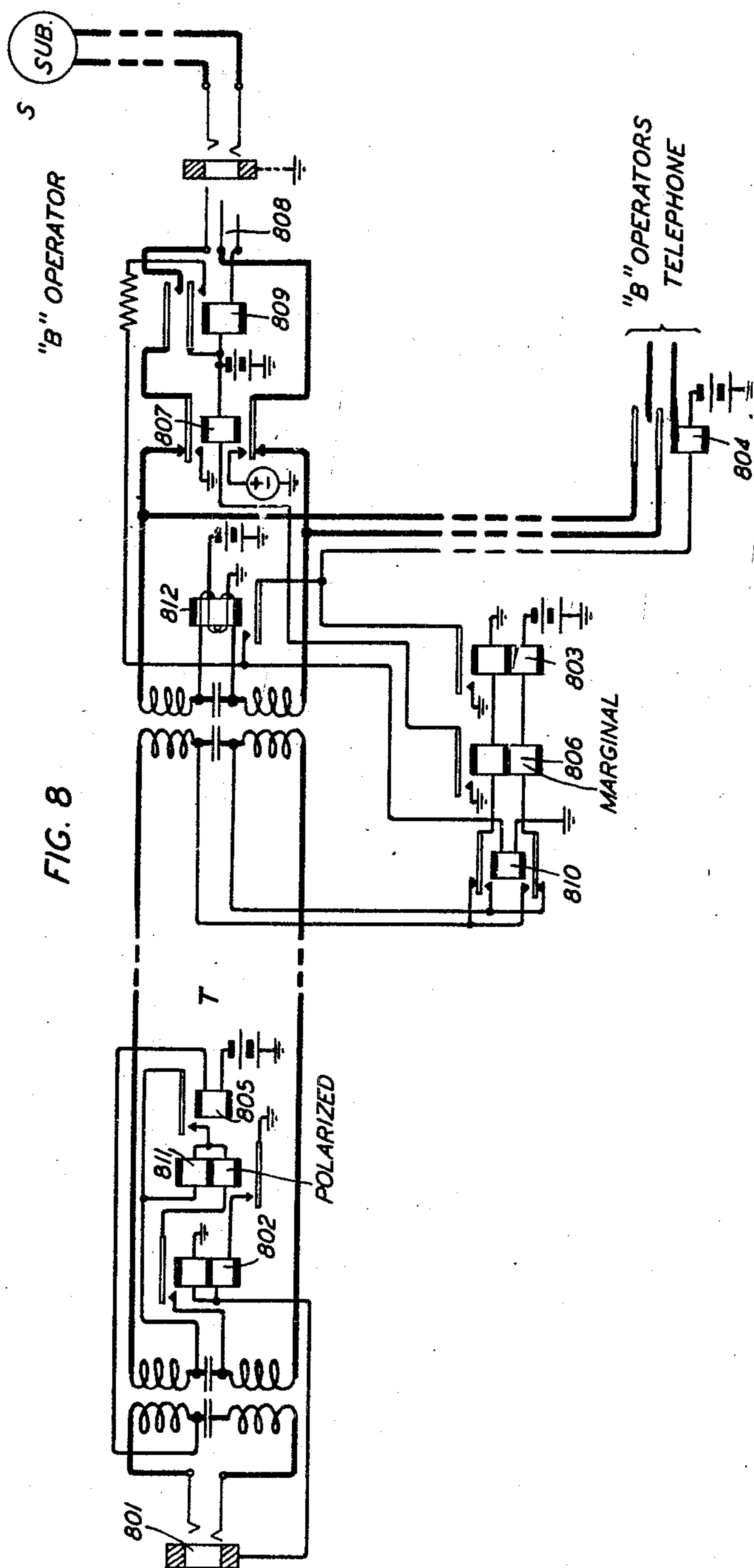


FIG. 8

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UNITED STATES PATENT OFFICE

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SIGNALING SYSTEM

Application filed October 11, 1930. Serial No. 483,110.

This invention relates to signaling systems and more particularly to what are known as two-way straightforward systems employing alternating currents, within the voice frequency range, for operating both the calling and supervisory signal apparatus at both ends of the line.

In many cases involving long toll lines the signaling conditions vary considerably with the character of the circuits and apparatus associated with the line such, for example, as the delay circuits used in conjunction with echo suppressors, etc. Under such conditions it is difficult to determine the proper time interval to hold the signal current on the line to insure satisfactory operation of the receiving circuit at the distant end due to the fact that the same line may present different signaling conditions at various times on account of changes in the associated apparatus, changing weather conditions, etc., which otherwise would have no detrimental effect on the transmission characteristics or operation of the line.

The object of the invention therefore is to conserve the signaling time of lines of this character while at the same time insuring positive operation of the desired signal apparatus before the signal current impulse is terminated.

A feature of the invention, whereby the foregoing object is attained, resides in an arrangement for transmitting current of a predetermined frequency from the inward end back over the line to the calling end as soon as an incoming signal arrives. This current which may be termed a "cutoff" impulse is received at the outward or calling end of the line and immediately cuts off the signaling current. The "cutoff" impulse is in turn cut off when the signal current ceases to flow. When the original signal current ceases to flow the line lamp at the receiving station is lighted.

The invention will be understood from the following description of the initiation and completion of a call over a toll line arranged in accordance therewith and from the accompanying drawings, Figs. 1, 2, 3 representing a portion of the circuit arrangement at one end

of the toll line and Figs. 4, 5, 6 and 7 representing a duplicate arrangement at the other end including an operator's telephone circuit, while Fig. 8 represents a switching trunk extending from an inward toll operator's position to a subscriber's B operator's position and thence to a called subscriber. Fig. 9 represents the arrangement of Figs. 1 to 8 of the drawing.

In the following description the reference characters used have, for convenience, been chosen in groups of 100, those from 101 to 199 referring to Fig. 1, 201 to 299 to Fig. 2, etc.

General description of operation

In general the operation of the present system may be briefly outlined as follows:

When an outward toll operator plugs into the outgoing jack 101 of the toll line extending to a distant toll office, relays function to operate relay 301 to change the tuning of the receiving circuit, Fig. 3, from 1400 to 1000 cycles, to operate busy signals 106 at all outward appearances of the line and to connect voice frequency current of 1400 cycles interrupted at a 20 cycle rate, to the line as a call or connect signal which operates relays at the distant exchange to connect a 1000/30 cycle answer-back signal to the line. The connect signal lights the guard or connect lamp at the inward operator's position, connects the operator's telephone to the line and transmits three "zips" of tone back to the originating operator as a signal to pass the desired destination of the call.

The 1000/30 cycle answer-back signal disconnects the 1400/20 connect signal which in turn disconnects the 1000/30 answer-back signal.

The originating operator now passes the designation of the wanted subscriber's exchange, reached over the switching trunk T, and the inward operator plugs into the trunk. This extinguishes the connect lamp 705, disconnects the inward operator from the line and connects the distant B operator to the trunk in the well known straightforward manner. The originating toll operator is now in direct conversational connection with the distant B operator and passes the number

of the desired subscriber after receiving the usual two "zips" of order tone.

When the B operator plugs into the subscriber's line relays 719 and 511 operate to transmit a 1000/20 signal back over the line which lights the cord supervisory lamp before the originating operator. The subscriber is also rung under control of interrupter 726 and relays 724, 805, 806 and 807.

When the called subscriber answers the 1000/20 signal is disconnected which extinguishes the supervisory lamp before the originating operator.

When the called subscriber hangs up a 1000/20 signal is again applied to the line to relight the cord supervisory relay before the originating operator.

In case the originating operator desires to rerung the subscriber she connects battery to the tip of the toll line by means of a ringing key in the cord circuit which causes 1400/20 cycles to be applied to the line. This is received at the inward end and causes relays to function to transmit a 1000/30 cycle answer-back signal to the originating end. This answer-back signal cuts off the 1400/20 cycle signal.

Receipt of the 1400/20 cycle signal and its subsequent disconnection transmits an order tone to the originating operator and reconnects the inward operator's telephone in the usual manner in addition to flashing the connect or guard lamp. If the subscriber is to be rerung the inward operator actuates a position rerung key 712 which causes the subscriber's bell to be rung, the same as on the original call, and the operator's telephone set to be disconnected.

When the originating operator's cord supervisory lamp lights, if the called subscriber is not to be rerung, the operator withdraws her plug from the line whereupon 1400/30 cycles is transmitted to the distant end which causes the disconnect lamp at the inward position to be lighted and a 1000/30 cycle answer-back signal to be transmitted to the originating end which removes the 1400/20 cycle disconnect signal which in turn causes the 1000/30 answer-back signal to be disconnected.

The circuit now restores to normal when the inward operator disconnects from the trunk.

Detailed description

A more detailed description of the circuit operation will now be given.

Call originated

When an outward toll operator inserts a calling plug (not shown) of a cord circuit, which may be of the type disclosed in Patent No. 1,608,524 to L. F. Porter, into the out jack 101 of the toll line L extending to a distant toll office, relay 102 operates in a circuit including its left hand winding and

contacts of relays 109 and 117, which in turn operates relay 103 in a circuit from ground at contact of relay 119. This relay operates relays 104, 105 and 301, this latter relay changing the normal tuning of the voice frequency receiving circuit, Fig. 3, from 1400 cycles per second to 1000 cycles per second. The circuit for operating relay 104 can be traced from battery, winding of 104, upper and lower contacts of relay 110 to ground at the lower contacts of relay 103.

Relay 105 operated, energizes busy signals, such as 106, at all outward appearances of the line at the originating end and opens the line termination, comprising resistance 107 and capacity 108, normally in bridge of the line.

Relay 104, operated, locks at its lowermost contacts, under control of relays 108 and 109 and operates relays 110 and 111. Relay 110 locks up under control of relay 103. With relays 111 and 104 operated voice frequency current of 1400 cps., interrupted at a 20 cycle rate, from the source 112, is connected to and sent out over the toll line L until a 1000 cycle answer-back signal, interrupted at a 30 cycle rate, is received over the line from the distant end.

Interposed in the line L is a directional selection circuit arrangement 113 which is of the nature of a hybrid transformer. Such a directional circuit arrangement is disclosed and claimed in the patent to George Crisson 1,755,243, issued April 22, 1930 and, as it forms no part of the present invention, it is deemed sufficient to state that this arrangement is so constructed and arranged as to prevent any portion of the voice frequency current applied to the line L, by the relay 111, from flowing over leads 114 and 115 into the signal receiving circuit Fig. 3 while at the same time diverting voice frequency signals received over the line from the other end and transmitting them, without attenuation, to the signal receiving circuit. It will, therefore, be understood that the 1400/20 cycle signal, transmitted over the line as a calling or connect signal is not impressed on the signal receiving circuit but that the 1000/30 cycle answer-back signal transmitted from the distant end is shunted into the receiving circuit to cause operation of the polarized relays 302 and 303.

When the 1400/20 cycle connect signal was transmitted over the line it arrived at the distant end and entered the signal receiving circuit Fig. 4, through the directional selection circuit 513 and leads 514 and 515 without attenuation. This signal was detected and amplified by the vacuum tube detector 410 and amplifier 411 and caused relay 402 to vibrate its armature between its back and front contacts which operated relay 408 which in turn operated relay 409. This relay operated

slow relay 412 which operated relay 516. Relay 516 operated relays 517, 518 and 505.

Relay 412 is made slow to operate in order to differentiate between false signals such as static disturbances, and the sustained call signal.

Relay 518 operated relay 511 and applied an answer-back signal of 1000/30 cycles from source 523, to the line. Relay 517 locked up under control of relays 503 and 519 and transferred the line from jack 501 to the inward position at contacts of relay 715. Relay 505 operated the busy signals, as for example 506, at each operator's position at which the line appeared. It also removed the line termination, consisting of resistance 507 and capacity 508, normally in bridge of the line. Relay 517 operated opens the operating circuit of sleeve relay 502 which prevents transmission of a call signal in the opposite direction in case an operator should plug into jack 501.

When the 1000/30 cycle answer-back signal was received at the outgoing or originating end of the line it entered the signal receiving circuit (Fig. 3), thru the directional selection circuit 113 and the leads 114 and 115 without attenuation. This signal was detected by detector 310 and amplified by amplifier 311 and caused relay 303 to vibrate its armature to cause the sequential operation of relays 305 and 306 which latter relay operated relay 108. This released relay 104 by opening its locking path. Release of relay 104 opened the circuit of relay 111 which released and disconnected the 1400/20 cycle calling or connect signal originally applied to the line. Discontinuance of this calling or connect signal, released relays 402, 408, 409, 412, 516 and 518 which in turn released relay 511 and disconnected the 1000/30 cycle answer-back signal. Discontinuance of this answer-back signal released relays 303, 305, 306 and 108 in turn.

Returning now to the inward or called end of the line; when relay 517 operated it completed an energizing circuit for relay 702 which in turn closed energizing circuits to operate relays 703 and 704 and connected battery to steadily light the connect lamp 705. Relay 704 connected the tone source 706 to the line, over contacts of relay 517, while the circuit is waiting to be connected to the operator. When relay 703 operated it closed a circuit to energize relay 707 which in turn completed an energizing circuit to operate relays 708 and 709 in series. Relay 708 closed a circuit to operate relay 710, under control of interrupter 711, and, with relay 709 operated, the lamp 705 was transferred from steady battery to an interrupted source of potential at the contacts of relay 710 thereby causing the lamp 705 to flash as an indication to the inward operator that her telephone set was connected to this particular line.

Relay 709 in operating opened the energiz-

ing circuit of relay 704 thereby disconnecting the tone source 706 from the line. Relay 712 also operated which, however, performed no useful function at this time. Further, relay 709 connected the operator's telephone circuit (Fig. 6) to the line and connected battery over contacts of relays 702 and 715 to conductor 713 to sequentially operate relays 601, 602, 603, 604, 605, 606 and 607. Operation of relays 601 to 605 in sequence caused three short impulses or "spurts" of tone to be applied to the line as the well known order signal which indicates to the distant or originating operator that the operator at the called exchange is connected to the line and ready to receive the call. Relay 607 released relays 601 to 606 and locked itself up to battery on conductor 713. Operation of relay 607 also short-circuited condensers 608 and 609 and removed the secondary of the tone transformer 610 from its normal bridge relation with the line. The inward operator (Fig. 6) is now in conversational connection with the outward toll operator connected to the line at jack 101.

Toll line connected to switching trunk

Let it now be assumed that a subscriber S (Fig. 8) was desired and therefore the inward toll operator inserted the inward plug 701 of the toll line into the trunk jack 801 leading to a B operator's position having access to the line of the desired subscriber.

When plug 701 was inserted in jack 801 relay 714 operated which in turn operated relays 715 and 716. Relay 718 is marginal and does not operate at this time. Relay 715 opens the operating circuit for relay 703 of the sequence circuit which released relays 707, 708 and 709 in turn. Relay 708 permanently releases relay 710 and stops the flashing of lamp 705. Relay 715 also opens the steady battery supply for lamp 705 and also disconnects the battery from the lead 713 thereby releasing relay 607 in the inward toll operator's circuit (Fig. 6) and restores that circuit to normal in readiness for another call. Release of relay 709 disconnects the operator's circuit (Fig. 6) from the line. Relay 715 also connects the line through to the trunk.

When the plug was inserted in the trunk jack 801, relay 802 operated which operated relay 803 and finally caused operation of relay 804 to connect the B operator's telephone set to the trunk and send back the usual two "zips" or impulses of order tone.

Relay 716 in operating connected battery through coil 717 to the tip of the trunk which caused relay 805 in the trunk to operate which operated marginal relay 806, by short-circuiting the upper, high resistance, winding of relay 811, which in turn operated ringing relay 807 to apply ringing current to the trunk conductors in readiness to ring the sub-

scriber when the plug 808 is inserted in the subscriber's jack.

Trunk connected to called subscriber's line

5 Upon receipt of the two "zips" of tone, the outward toll operator passed the number of the desired subscriber and the B operator inserted plug 808 into the jack of the desired subscriber's line thereupon operating sleeve
10 relay 809 and completing the trunk circuit through to the toll line. Operation of relay 809 also operated relay 810 which reversed the current flowing through polarized relay 811 and caused it to operate thereby shunting
15 the upper, and high resistance, winding of relay 802 with its lower, and low resistance, winding. This caused the marginal relay 718 in the toll line to operate which operated relay 719. Relay 719 operated relay 511
20 which connected 1000/20 cycles, from source 520, to the line which was received at the originating end by the receiving circuit (Fig. 3) and caused relays 302, 308 and 309 to operate thereby operating relay 121 which shunted
25 the left hand high resistance winding of relay 102 with its right hand low resistance winding thereby decreasing the sleeve resistance of the associated toll cord and lighting the cord supervisory lamp in the well known
30 manner. This 1000/20 signal persists, thereby maintaining the toll operator supervisory lamp lighted, until the called subscriber (Fig. 8) answers.
35 Operation of relay 719 operates relay 723, over the lower contacts of relay 716, and provides a holding path for relay 716 which otherwise would release when relay 723 operated. Relay 723 locks up under control of relay 714.
40 Relay 719 also closes a circuit from slow-operating interrupter 726 to relay 724 thereby causing that relay to alternately open and close its contacts in step with the interrupter and alternately disconnect and connect the
45 battery supplied to the tip of the line. This alternately releases and operates relays 805, 806 and 807 in sequence to ring the subscriber bell at the usual machine ringing rate of two seconds ring and 4 seconds silent.

50 *Called subscriber answers*

When the called subscriber answers supervisory relay 812 in the trunk circuit operated thereby short-circuiting relay 810 and causing
55 it to release which again reversed the battery flowing through polarized relay 811. This directional change of current flow released relay 811 which again increased the resistance of the sleeve circuit, by removing
60 the low resistance shunt from the upper and high resistance winding of relay 802. This change to a high resistance caused marginal relay 718 to release and in turn release relays 719 and 511 which latter relay in releasing
65 removed the 1000/20 cycle signal and recon-

nected the toll line through to the trunk. Relay 716 was also released by relay 719 which in turn released relay 805 in the trunk. Release of this relay (805) removed the short circuit around the upper, high resistance, 70 winding of relay 811 which released marginal relay 806 which in turn released the ringing relay 807 and disconnected ringing current from the called subscriber's line.

Removal of the 1000/20 cycle signal permitted relays 302, 308 and 309 in the receiving circuit, Fig. 3, at the outgoing end of the toll line to release thereby releasing relay 121 which removed the low resistance shunt from the left hand winding of relay 102 by 80 opening the path to ground through the right hand winding thereby increasing the sleeve circuit resistance of the toll cord to extinguish the outward operator's supervisory lamp as a signal that the called subscriber 85 had answered. The toll line is now connected through to the called subscriber and ready for conversation.

Called subscriber flashes or disconnects 90

Each time the subscriber S restores his switchhook relay 812 releases which permits relay 810 to again operate thereby operating polarized relay 811 which changes the trunk sleeve resistance from high to low 95 thereby operating relay 718 in the toll line circuit. Relay 718 operates relay 719 which in turn operates relay 511 which connects 1000/20 cycles to the line. This signal is received at the originating end and operates relays 302, 308, 309 and 121 which changes the outward toll jack sleeve resistance from high to low and causes the outward toll operator's supervisory lamp to light. If the called subscriber hangs up his receiver the supervisory lamp at the outward toll position will burn steadily, but if he moves the switchhook up and down the supervisory lamp will flash. 105

Originating operator rerings 110

In case the originating operator desires to rerings the subscriber S (Fig. 8) after he has replaced his receiver on the hook, operation of the toll cord ringing key will connect 115 battery to the tip of the line operating relay 122 which in turn operates relay 104, which operates relay 111. Relay 104 locks up under control of relays 109 and 108. Relays 111 and 104 operated connect 1400/20 cycle current from source 112, to the line which persists until an answer-back signal is received from the distant end. 120

When the 1400/20 cycle signal is received at the distant toll office relays 402, 408, 409, 125 412 and 516 operate. Relay 516 operates relay 518 and opens the energizing circuit for relay 702. Relay 518 operates relay 511 which relay combination connects the signaling source 523 to the line which transmits 130

a 1000/30 cycle answer-back signal to the relays 110 and 105, this latter relay opening the busy signal circuit and permitting busy signal 106 to restore. The release of relay 305, 306 and 108. Relay 108 releases relay 104 by opening its path. Relay 104 releases relay 111 thereby disconnecting the 1400/20 cycle signal which permits relays 402, 408, 409, 412 and 516 at the distant end to release. Relay 516 releases relay 518 which in turn releases relay 511 thereby disconnecting the 1000/30 cycle answer-back signal which releases relays 303, 305, 306 and 108 at the originating end.

When relay 702 released it operated relay 725 which locked under control of relays 723 and 714. Operation of relay 725 released relays 715 and 719. The release of relay 715 disconnected the toll line from the jack.

When relay 516 released, due to the disconnection of the 1400/20 signal, relay 702 reoperated which again completes an energizing circuit for relay 704 which connects a tone to the line. Relay 702 also operates relay 703 of the sequence circuit which operates relays 707, 708 and 709 which causes the connect lamp 705 to flash under control of interrupter 711 and relay 710. Relay 709 releases relay 704 and disconnects the tone from the line. When relay 709 operated it also connected the operator's telephone circuit to the toll line and caused the operation of relays 601 to 607 to again transmit three "zips" of order tone in the manner previously described. When the inward operator is brought in, as indicated by the lamp 705 flashing, she acts as instructed by the originating operator. If the called subscriber is to be rerung the inward operator operates position rering key 611 which deenergizes relay 723, due to its differential connection, which in turn releases relay 725 and reoperates relay 716.

From this point the circuit functions the same as previously described when the operator first plugged into the switching trunk.

Originating operator disconnects

When the originating toll operator removes the plug from jack 101, relay 102 releases. Relay 103 holds operated under control of relays 109 and 108. When relay 102 releases it operates relay 109 which in turn operates relay 111 to connect the signal source 124 to the line which transmits 1400/30 cycles to the distant toll office where it operates relays 403, 405, 406, 407, 508 and 519. Relay 519 releases relays 517 and 505 which latter relay opens the busy signal circuit and permits busy signal 506 to restore. Relay 519 also operates relay 518 which in turn operates relay 511 which connects signal source 523 to the line which transmits a 1000/30 cycle answer-back signal to the originating end to operate relays 303, 305, 306, 307, 108 and 119. Operation of relay 108 releases relay 103 which in turn releases

relays 110 and 105, this latter relay opening the busy signal circuit and permitting busy signal 106 to restore. The release of relay 103 also releases the change tuning relay 301 which restores the tuning of the receiving circuit to 1400 cycles in readiness to receive incoming calls or connect signals of that frequency transmitted from the distant end. Relay 110 released, releases relay 109 which in turn releases relay 111 which removes the 1400/30 cycle signal from the line which releases relays 403, 405, 406, 407, 508 and 519. Relay 519 released, releases relay 518 which in turn releases relay 511 and removes the 1000/30 cycle answer-back signal.

When the 1000/30 cycle answer-back signal ceases relays 303, 305, 306, 307, 108 and 119 release and the circuit at the outward end of the toll line is in its normal condition.

When the release relay 519 at the distant end of the line operated it also operated relay 720 which in turn operated relay 721. Relay 721 closed a holding path for relay 720 from battery on the tip conductor of the trunk. Relay 721 also lighted the connect lamp 722 and opened the sleeve conductor thereby releasing relays 714, 802 and 803.

When the inward toll operator removed the plug 701 from the jack 801 relay 720 released which in turn released relay 721. The inward end of the toll line is now in normal condition.

Operation of the circuit in the opposite direction is identically the same as the operation just described and consequently will not be repeated.

What is claimed is:

1. In a signaling system, a transmitting station, a receiving station, a line interconnecting said stations, a source of alternating signal current of predetermined characteristic at said transmitting station adapted to be applied to said line, signal receiving means at the receiving station adapted to be controlled by said signal current, a second source of alternating current of different characteristic at the receiving station, means responsive to the control of said signal receiving means to apply said second source of current to the line, and means at the transmitting station responsive solely to said second current to disconnect said first current from the line.

2. In a signaling system, a transmitting station, a receiving station, a line interconnecting said stations, a source of alternating signal current of predetermined characteristic at said transmitting station adapted to be applied to said line, signal receiving means at the receiving station adapted to be controlled by said signal current, a second source of alternating current of different characteristic at the receiving station, means responsive to the control of said signal receiving

means to apply said second source of current to the line, means at the transmitting station responsive to said second current to disconnect said first current, and means at the receiving station responsive to disconnection of said first current to disconnect said second current from the line.

3. In a signaling system, a transmitting station, a receiving station, a line interconnecting said stations, a source of alternating signal current of predetermined characteristic at said transmitting station adapted to be applied to said line, signal receiving means at the receiving station adapted to be controlled by said signal current, a signal device at said receiving station controlled by said receiving means, a second source of alternating current of different characteristic at the receiving station, means responsive to the control of said signal receiving means to apply said second source of current to the line and to actuate said signal device, means at the transmitting station responsive to said second current to disconnect said first current and means at the receiving station responsive to disconnection of said first current to disconnect said second current.

4. In a signaling system, a line, two stations interconnected thereby, means at each station for transmitting alternating signal current of a predetermined frequency to the line, means at each station for receiving said line signal currents transmitted from the other station and for registering a signal, means, actuated when an originating signal is received at a station, to transmit back over the line "cutoff" signal current of a frequency different from the frequency received and means at the transmitting station responsive solely to said "cutoff" current to discontinue the transmission of the current which caused registration of the signal.

5. In a signaling system, a line, a calling station and a called station interconnected by said line, a source of alternating current associated with each station for signaling over said line, means at each station for connecting its associated signal source to the line, means at each station for receiving and translating signal current transmitted over said line from the other station, means at the called station responsive to the receipt and translation of signal current from the calling station to connect the signal source at that station to the line to transmit an answer signal to the calling station and means at the calling station responsive solely to the reception of said answer signal to disconnect said current source thereat from the line.

6. In a signaling system, a line, calling and called terminals, a call signal device and an operator's telephone circuit at the called terminal of said line, means for transmitting an alternating current signal over said line from the calling end thereof, means responsive to

the reception of said signal at the called end of said line to actuate said signal device, connect said operator's telephone circuit to the line, transmit an order tone current to the calling end of the line, and connect an alternating current source to the line as an answer-back signal.

7. In a signaling system, a line, stations at each end thereof, a source of alternating signal current at each station, means at each station for connecting its associated source of current to the line, means at each station for receiving and translating signal current transmitted over the line from the other station, and means automatically responsive to the reception and translation of signal current at one station to connect its associated signal source to the line to transmit an answer-back signal.

In testimony whereof, we have signed our names to this specification this 9th day of October, 1930.

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DWIGHT L. MOODY.