Jan. 21, 1936. F. P. GOHOREL 2,028,656

AUTOMATIC TELEPHONE SYSTEM

Filed May 12, 1933 3 Sheets-Sheet 1

FIG. 1

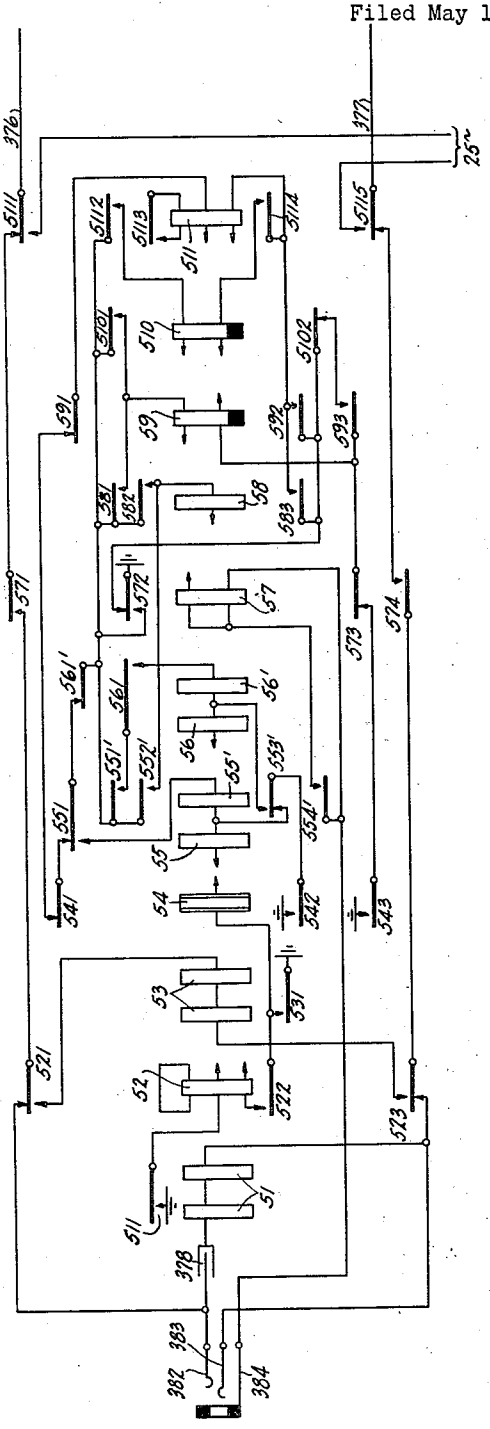


FIG. 5

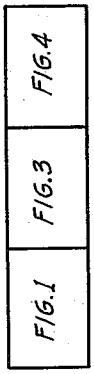
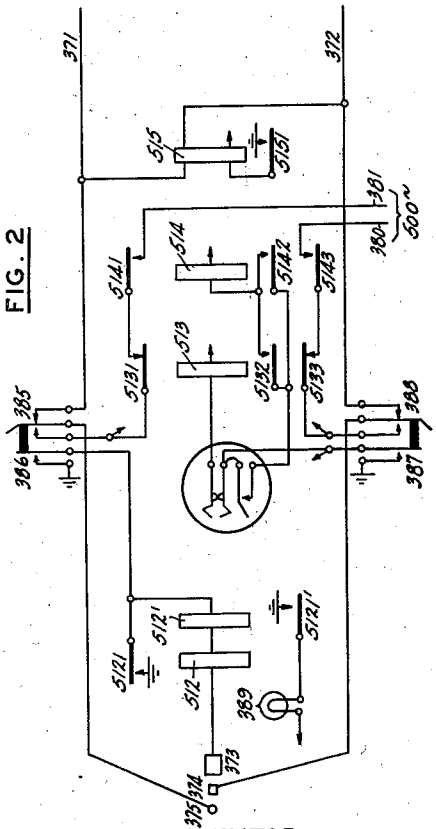


FIG. 2



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AUTOMATIC TELEPHONE SYSTEM

Filed May 12, 1933 3 Sheets-Sheet 2

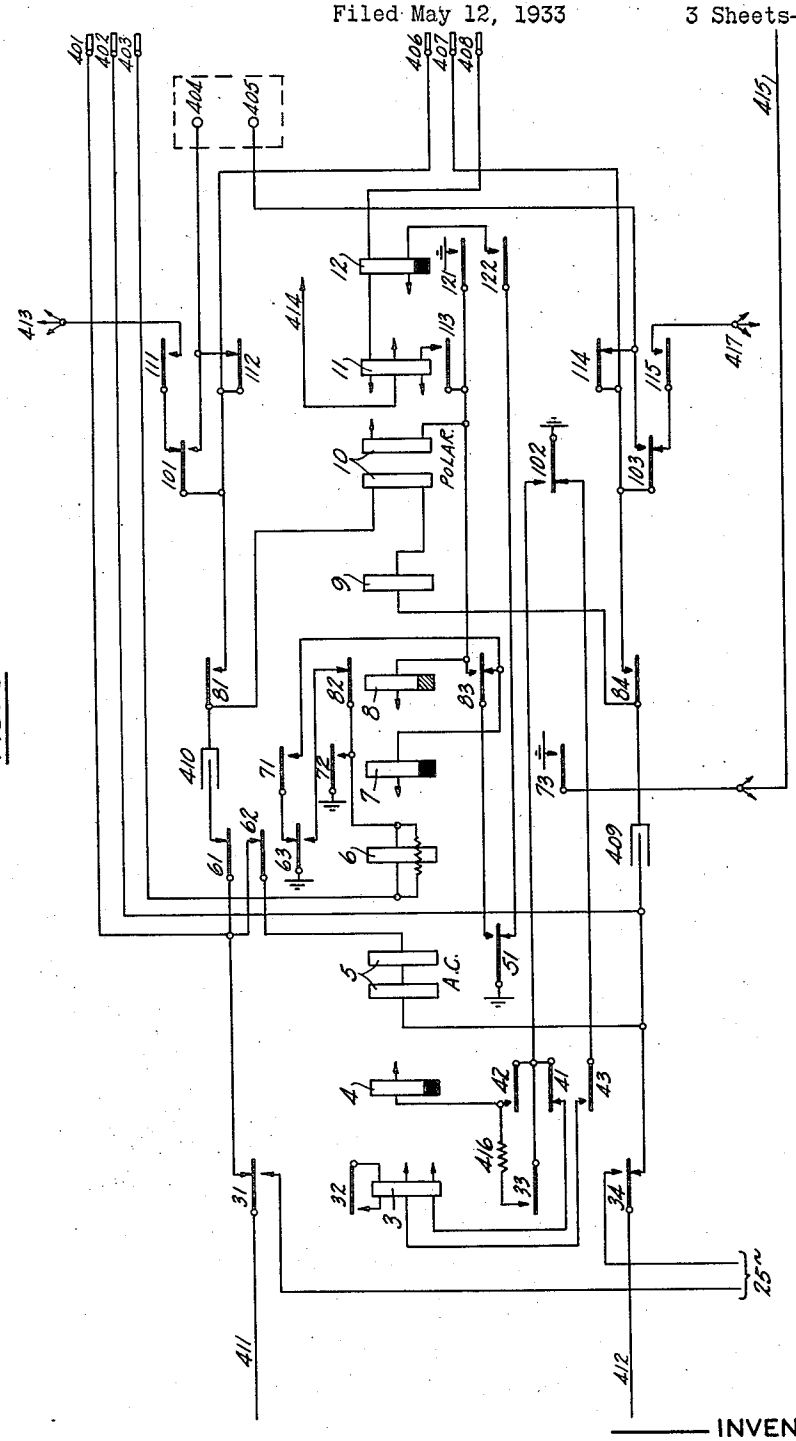

FIG. 3

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AUTOMATIC TELEPHONE SYSTEM

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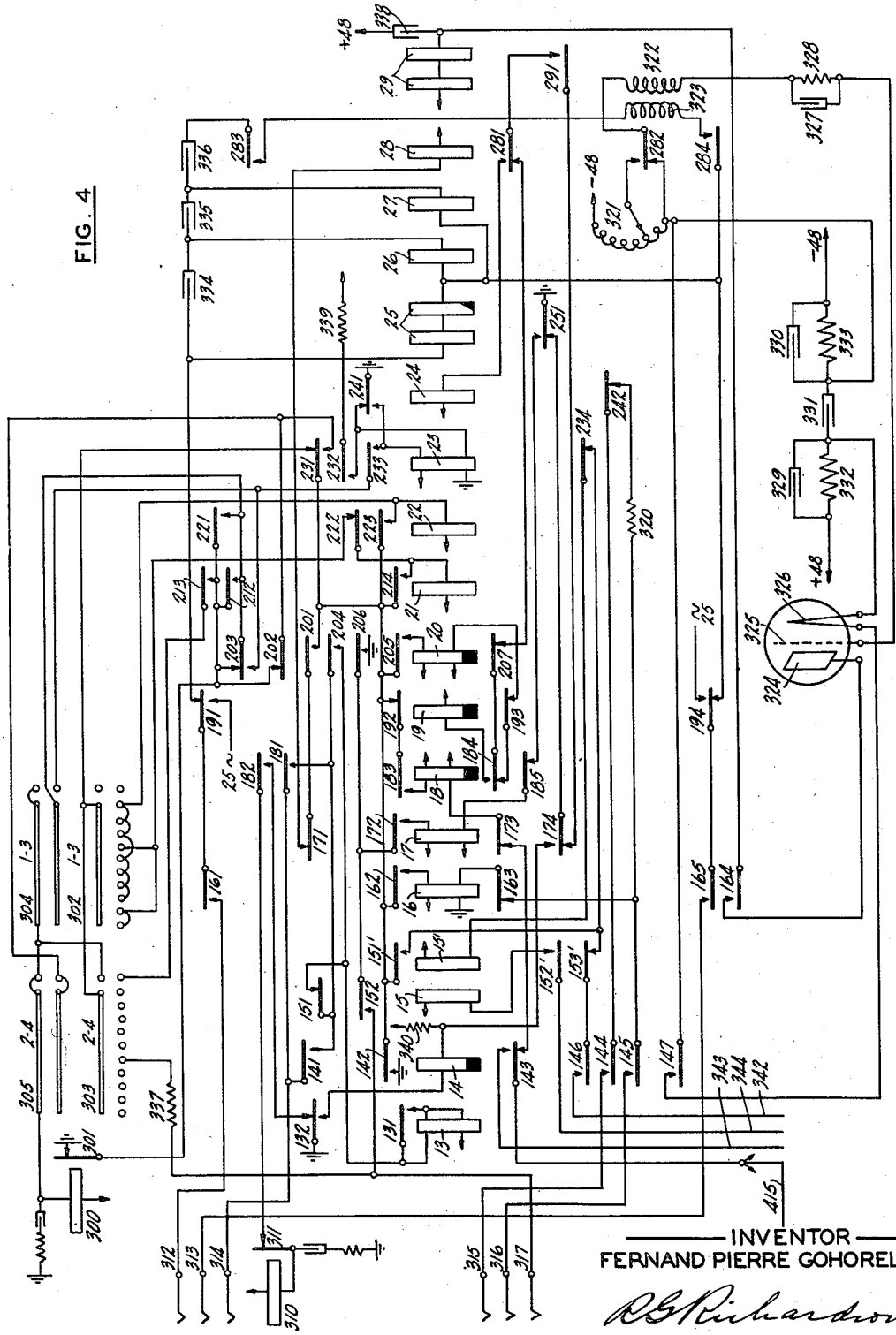
FIG. 4



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UNITED STATES PATENT OFFICE

2,028,656

AUTOMATIC TELEPHONE SYSTEM

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Application May 12, 1933, Serial No. 670,631
In France October 10, 1932

31 Claims. (Cl. 179—18)

The present invention relates to automatic telephone systems and is more particularly applicable to systems involving the distant control of selector switches over telephone circuits especially cable circuits and those employed for carrier current working. Long distance telephone circuits are generally used for transmitting only voice frequencies (between 400 and 2500 cycles for example); further means are provided for enabling the transmission of low frequency currents (16 to 25 cycles for example) from one end of the circuits to the other for various signalling purposes (ringing and end of conversation).

One of the features of the invention is the provision of a simple arrangement whereby impulses for setting the switches and the necessary signalling currents (seizure, ringing, supervision, release, etc.,) are transmitted over the cable, one by voice frequency and the other by low frequency currents.

A preferred form of the invention consists in employing voice frequency currents for the transmission of setting impulses since their attenuation due to the telephone circuit is less than that for low frequency currents and the latter which are re-transmitted with less accuracy are reserved for signalling impulses such as release impulses in order that the actual voice currents do not affect the holding of the selectors; the selecting impulses being transmitted before conversation, there is no possibility of interference with the voice currents.

In arrangements employing solely voice currents it is necessary to superpose several frequencies to avoid interference with voice currents, the said frequencies being necessarily strictly determined and necessarily acting on relays which are very exactly adjusted; one of the features of the invention is that it allows on the contrary the selecting impulses to be of any frequency as long as they are included in the band of voice frequencies transmitted by the telephone circuit and there is thus no need to adjust the relays which receive the said currents.

Another feature of the invention relates to an impulse receiving arrangement common to several telephone circuits and capable of being connected to any one thereof by means of a finder switch associated with it, and operated by low frequency currents transmitted over the telephone circuit.

A further feature of the invention relates to the use of a three electrode valve for the reception of the voice-frequency selecting impulses and their conversion into direct current, the said valve only being lighted during the reception of the selecting impulses.

A further feature of the invention relates to an arrangement in which a signalling impulse preferably of low frequency is transmitted from the receiving to the sending end of a telephone circuit when the impulse receiving arrangement is in a condition to receive the selecting impulses and particularly when the filament of the three electrode valve is raised to such a temperature that electron emission occurs when such a valve is employed for receiving.

A further feature of the invention relates to the employment of an arrangement for transmitting low frequency impulses in a slow cycle and located at the transmitting end, which impulses cause the seizure of the selecting switches at the receiving end and eventually first the release of the switches and their subsequent seizure if they are accidentally held in an operative position. This arrangement transmits impulses until return impulse is received at the originating end indicating the seizure of the switches at the receiving end.

A further feature of the invention relates to a relay arrangement which prevents the transmission of alternating currents of long duration from one part of a circuit to another while allowing these currents to have a different action according to their origin; the said arrangement comprises a relay connected in parallel with the circuit the operation of which separates the two parts of the circuit and the introduction in one part of the circuit of another relay which is sensitive to the currents which eventually flow in that part and which maintains when energized the separation of the two circuits; the first relay remaining connected to the other part of the circuit.

A further feature of the invention relates to an arrangement serving to separate the circuits traversed by voice currents from the circuit employed for setting up the connection so long as the selecting impulses have not been completely transmitted.

The invention will be better understood by referring to the following description given by way of example only and to the accompanying drawings in which:—

Fig. 1 shows the outgoing equipment terminating in a jack at the trunk table.

Fig. 2 shows a double cord at the trunk table modified to enable the transmission of alternating current impulses.

Fig. 3 shows the equipment on which the junction lines terminate at the exchange at which the call is incoming.

Fig. 4 shows the impulse repeater which receives the alternating current impulses and retransmits them as direct current impulses. This repeater may be common to a number of incoming lines.

Fig. 5 shows the manner in which the various figures should be arranged in order that a complete showing of the system is obtained.

A detailed description of the system will now be given. In the explanation which follows, the numbers of the relay armature are preceded by the letter R or T according as to whether the contact is closed by the said armature in the resting position or the working position; further when the reference of a wiper is followed by two digits this indicates that the wiper is in contact with its bank in the corresponding quarter.

An outgoing operator wishing to set up a connection inserts the plug shown in Fig. 2 into the jack of an outgoing circuit (Fig. 1) and depresses the key.

Relay 57 then energizes over: battery, the two windings of relay 57 in series, sleeve 384 of the jack, sleeve 373 of the plug, windings of relays 512 and 512′ to earth on T386 of the key.

Relay 512′ of the double cord does not energize at this moment since it is in series with the two windings of relay 57 (one of these windings is of high resistance), but 512 does energize and at T5121 provides a holding circuit for the relays. There is therefore no danger that the accidental release of the key will remove earth from the outgoing equipment. The closing of T572 also causes the energization of relay 511 over: earth, T572, R561′, R551, R541, R591, middle winding of relay 511 to battery.

Relay 510 is energized over: battery, upper winding of 510, T5112, T572 to earth. Relay 59 is energized over battery, upper winding of 59, T5101, T572 to earth. At R591 the energizing circuit of relay 511 is opened and this relay releases, opening at T5112 the circuit of relay 510 which in its turn releases and at T5101 causes relay 59 to release. Contact R591 is then closed and the three relays which it controls are again operated.

Briefly, the relays 511, 510, and 59 interact in the order given and this interaction is retarded by the addition of copper slugs on the windings of relays 59 and 510 and by the shunting effect of T5113 on the winding of relay 511.

The object of this interaction is to permit the transmission over the line by the closing of contacts T5111 and T5115 of alternating current impulses by alternating current of a frequency of 25 cycles. The circuit is as follows: T5111, conductors 376 and 411 (Fig. 3), R31, R82, relay 5, R34, conductors 412 and 377 (Fig. 2), T5115.

Relay 5 is a relay responsive to alternating current; it therefore operates intermittently in synchronism with the received impulses, placing earth at T51 on the winding of relay 7 over R83. Relay 7 energizes and holds over T71, R83 to earth. At T73 it extends earth over conductor 415 to control the operation of the repeater by causing the operation of relay 18 (Fig. 4) over the circuit: battery, lower winding of relay 18, R173, R143, conductor 415 (Fig. 3), to earth on T73.

Relay 18 operates and closes the following circuit for the rotary magnet 310; battery, winding of the magnet 310 and its contact, R311, T132, R132 to earth.

The switch advances step-by-step automatically to hunt for the incoming equipment on which the connection from the exchange terminates. When the wipers 312 to 317 are rotated on to the contacts 401 to 403, and 406 to 408 (Fig. 3) of the incoming equipment, earth at T72 through the windings of relay 6 on to bank contact 403 is extended over: wiper 314, T181, R151 to the two windings of relay 13 in series.

Relays 6 and 13 energize in series and the removal of earth from contact R132 terminates the rotation of the switch by the magnet 310.

Relay 6 holds over T63, R82, winding of 6 and the above traced circuit. Relay 7 falls back, earth having been removed at R53; however since this relay is slow-to-release, relay 6 is enabled to close its holding circuit at T63 before its energizing circuit is opened at T72.

Relay 14 (Fig. 4) energizes over: earth, T132, winding of 14, resistance 340 to battery. This relay places earth on T142 thus allowing relay 18 to hold on its upper winding since earth on T73 has been removed on the de-energization of relay 7. Relay 18 is slow-to-release to ensure that it does not de-energize when its circuit is opened at R143 and before its holding circuit is closed at T142.

At T147, relay 14 closes the heating circuit of the three electrode valve over: +48, resistance 332, filament 326, T147, resistance 333 to −48, and at T145 completes a loop over the line conductors as follows: conductor 404, R112, contact 406, wiper 315, T144, R242, resistance 320, T145, wiper 316, contact 407, R114, conductor 405.

The contacts 440 and 405 lead to the line and cut-off relay arrangement of a line switch. While the hunting of the switch for a free connecting circuit is in progress, relay 16 cannot energize, since although it finds battery over the line relay, earth is also extended to relay 16 over a resting contact of the cut-off relay. When the hunting operation is terminated and an idle circuit is found, the cut-off relay is energized and releases the line relay; at this moment only does 16 energize, since the shunting earth is removed and further it finds battery on the free connecting switch.

Relay 16 holds to earth on T142 which is extended over its contact T162. The filament of the three electrode valve being lighted, a filament-plate current flows through the valve and causes the energization of relay 29 which closes the following circuit for relay 19: battery, winding of 19, T184, R207, R281, T291, R174, R251, to earth.

Relay 19 at contacts T191 and T194 closes the circuit of the cycle A. C. generator over: T191, T161, wiper 312, contact 401, R31, conductors 411 and 376, R5111, T571, R521, relay 51, R523, T574, R5115, conductors 377, and 412, R34, contact 402, wiper 313, T165 and T194.

Relay 19 also opens the holding circuit of 13 at R192 which in its turn opens the circuit of 19 at T184. The two relays release but as they are both slow-to-release, during their release period an A. C. impulse is transmitted at T191 and T194 to indicate that the switches at the exchange are in a position to receive number impulses.

After a short period relay 19 releases and completes the following circuit for relay 20: battery, lower winding R193, R184, R207, R281, T291, R174, R251, to earth; relay 20 holding over battery, upper winding of 20, T205, to earth. Relay 20 energizes and causes the energization of relay 28

over: battery, winding of 28, R171, T201, T142, to earth.

At T282, relay 28 varies the polarizing voltage on the grid 325 of the valve thereby causing a diminution in the filament plate current flowing through relay 29 and the consequent release of the said relay.

The A. C. impulse which is transmitted as explained above is received on relay 51 of Figure 1 and causes its energization. This relay in operating at T511 extends earth to the center winding of 52. The latter energizes and at its contacts RT521 and RT523 first opens the energizing circuit of relay 51 and then extends it to relay 53.

Relay 52 is rendered slow-to-release by the shunt around its upper winding and does not release immediately when its energizing circuit is opened at T511. It therefore finds a holding earth over T522 and T531. Relay 53 closes at T531 the circuit of relay 54 which energizes, while relay 55 is energized over: battery, winding of 55, R553', T542 to earth.

Relay 54 releases when relay 53 returns to rest at the termination of the impulse transmitted from the repeater. Relay 55' (Fig. 1) now energizes over: battery, winding 55, winding of 55' in series, T551, R551', T572, to earth; the relay 55' being heretofore short-circuited at armature T542. At T554' relay 55' shunts the high resistance winding of relay 57, thereby allowing relay 512' of the double cord to energize over: earth, contact T386 of the key, windings of 512' and 512, sleeve of the plug, sleeve 384 of the jack, T554', upper winding of the relay 57 to battery.

The lamp 389 is lighted over: battery, lamp 389, T5121' to earth. This signal indicates to the operator that she may commence to dial.

Further, relay 58 is energized over: battery, winding of 58, T552', T572 to earth. This relay holds to its contact T582. The interacting relay 59 remains energized over the circuit: battery, upper winding, T581, T572 to earth. Relay 511 can no longer energize since its circuit is opened at R591 and at T5112 it prevents 510 from operating.

The operator then commences to dial the number of the required subscriber. Relay 513 fulfills the function of the impulse relay, its energizing circuit including the dial springs, and it falls back at each opening thereof, thereby effecting the transmission of 500 cycle alternating current impulses.

Relay 514 energizes on the operation of the dial over: battery, winding of relay 514, T5132, dial switch contact, T367 of the key to earth, and during the vibrations of 513 it is held over an alternative circuit by way of its contact T5142. At its contacts T5141 and T5143 it connects up the 500 cycle alternating current source to the dialling circuit over contacts R5131 and R5133.

Impulses are then transmitted over the following circuit: conductor 381, T5141, R5131, T385, plug conductor 375, jack conductor 382, R521, T571, R5111, conductors 376 and 411, R31, contact 401, wiper 312, T161, R191, condensers 334-5-6, T283, winding 323 of the transformer, T284, R194, T165, wiper 313, bank contact 402, R34, conductors 412 and 377, R5115, T574, R523, jack conductor 383, plug conductor 374, T388 of the key, R5133, T5143 and conductor 380.

A filter circuit is provided in the above impulsing circuit comprising the elements (26, 27, 335, 336) so that only those alternating current impulses having a frequency of 500 cycles may pass.

These impulses are received on the triode over winding 322 of the transformer, thereby causing a filament-plate current to flow through relay 29, which energizes. Each time 29 energizes, it closes at T291 a circuit for relay 24 over: battery, winding of relay 24, T281, T291, R174, R251 to earth. Relay 24 thus operates in synchronism with 29 and repeats the impulses received by relay 29 over the loop circuit given below.

Since relay 16 is energized if a free connecting circuit has been seized, the following loop circuit is closed: conductor 404, R112, bank contact 406, wiper 315, T144, R242, T145, wiper 316, bank contact 407, R114, conductor 405. The conductors 404 and 405 lead to a switch in the seized equipment thereby completing the loop.

Relay 24 at its contact R242 repeats the impulses received by relay 29 and these impulses correspond to the dialled impulses transmitted from the operator's dial switch. These direct current impulses transmitted by relay 24 act on the switch connected to conductors 404 and 405 and cause in any known manner the orientation of the connecting switches in the equipment taken into use.

On the reception of the first impulse relay 23 energizes over the circuit: battery, upper winding, T241 to earth. The brief shunts resulting from the vibration of relay 24 are not sufficient to cause 23 to fall back which is maintained held over its lower winding by battery through resistance 339 and its contact T232. The prolonged shunt which occurs at the termination of each impulse series however which is applied over: earth, lower winding of 23, R241 to earth, is sufficient to cause relay 23 to release.

The use and operation of the switch controlled by magnet 300 will now be explained. This switch is provided for causing the release of the receiver after a predetermined number of impulse series have been received. The arrangement shown in Fig. 4 is such that the repeater is released after 5 or 6 trains of impulses, the number being automatically determined by the first digit transmitted.

When relay 23 operates as described above, a circuit is closed for the magnet 300: battery, winding of magnet 306, upper plate of sectors 305 and 304, wiper of sector 304 in the resting position, T233 to earth on T241. Since relay 24 follows the impulses, the intermittent earth at T241 advances the switch step-by-step and the wipers associated with the segments 302 and 304 rotate over the contacts of the corresponding segments.

At the termination of the first train of impulses relay 23 falls back thereby opening the directive circuit of the magnet, but the switch continues to rotate, disengaging wipers 1—3 and engaging wipers 2—4, as will be explained.

It will be notel that in bank 302 the contacts are grouped in two series and at the termination of the first impulse before the magnet advances the switch, the wiper is in contact with one of the series. One series corresponding to the release of the repeater after 6 trains of impulses and the other after 5.

First case.—Release of the repeater after 6 trains of impulses

Suppose that the wiper comes to rest in the second position (or the third) corresponding to

two received impulses or to the digit 2 transmitted by the calling operator.

In this case, when relay 23 deenergizes, relay 22 energizes over the circuit: battery, winding of relay 22, position 2 of the wiper 302, R231, T142 to earth. The magnet 300, therefore, continues to operate over: battery, winding of magnet 300, plate 305 and 304, T221, L212, L202, R301 to earth. The magnet thus rotates the switch step-by-step over this self-interrupting circuit.

At the moment when the wipers 304 (1—3) leave the banks (1—3) and the wiper 305 engages with the banks (2—4) the switch stops since the circuit of the magnet 300 is finally opened on the bank associated with 304.

Magnet 300 is therefore stopped at a position corresponding to the resting position of wiper 305 on (2—4).

The remainder of the operation being identical in the two cases, a complete explanation will now be given for the second case.

Second case.—Release of the repeater after 5 trains of impulses

Suppose the wipers come to rest in position 4. In this case relay 21 energizes over: battery, winding of 21, R222, position 4 on segment 302, R231, L205, T142 to earth. As in the preceding case the switch continues to rotate, the magnet 300 being energized over the circuit: battery, winding of magnet 300, upper segments 305 and 304, T212, R301, to earth. In this case the switch is not stopped in the normal position of wiper 303 (2—4) but continues to rotate and comes to rest on the second contact.

For this extra step the magnet is energized over the circuit: battery, winding of magnet 300, plate 305, resting position of segment 303, T213, T301, to earth. This circuit is automatically opened at the normal position of segment 303 as soon as this position is passed.

In both cases the switch can only advance automatically at the end of the first train of impulses (23 releases and opens the circuit at T231).

The difference between the two cases is in the final position of the wipers 303: but since release takes place when they are in the 6th position, it is obvious that if they advance one step at the end of a train of impulses, they will have 6 or 5 steps to make to reach the 6th position.

During the reception of each succeeding train of impulses, the magnet 300 attracts its armature since it is energized over: battery, winding of magnet 300, plate 305, T231, L205, T142 to earth. At the termination of a train of impulses, 23 releases and opens 231, the magnet releases its armature and the wipers are automatically advanced one step.

This process is repeated for all the trains of impulses received thereby finally setting the switch to the sixth position where the following circuit is closed: earth, T142, R231, plate and bank contact 6 of the segment 303, resistance 337, wiper 317, bank contact 408, relays 12 and 11 in series to battery (Fig. 3).

Relay 12 only energizes and holds over: battery lower winding of 12, T122, R51 to earth, while earth at T121 causes the energization of relay 8 which at R82 opens the holding circuit of the relays 6 and 13 which are in series.

Relay 14 releases, since its circuit is opened at R132, and it removes earth at T142 thereby causing the release of relays 16 and 20. The switch is returned to its normal position over the circuit: battery, magnet 300, plate 305, R202, R301 to earth. The repeater is then completely released and may be employed for another call.

It will be noted that the switch associated with magnet 310 remains in the position to which it has been set, but this is of no importance since it is dissociated from the seized incoming circuit on the release of relay 14. The start conductor is opened at T73 (Fig. 3).

Similarly the wipers 312, 313, 314 and 317, although still set on the corresponding bank contacts of the incoming equipment, are dissociated therefrom by the opening of the contacts of the various relays.

No connection therefore exists and on a succeeding call the start conductor will find earth on other incoming equipment and the hunting operation will take place as described above.

On the reply of the called party the reversal of current over the line conductors causes the energization of the polarized relay 10 (Fig. 3). Earth is extended from T102 over R41 to the lower winding of relay 3 which energizes and closes the following energizing circuit for relay 4: battery, winding of relay 4, resistance 416, T33, T102, to earth. This relay holds over the same circuit to earth on T42. The operation of R41 opens the circuit of relay 3, but this relay does not release immediately since it is rendered slow-to-release by the shunt around its upper winding, and it is thereby enabled to transmit a long A. C. impulse at T31 and T34 over the circuit: T31, conductors 411 and 376, R5111, T571, R521, relay 51, R523, T574, R5115, conductors 377 and 412, T34.

Relay 51 energizes and at T511 extends earth to relay 52 which energizes and cuts off the incoming A. C. from relay 51 and applies the A. C. current to relay 53, which energizes. Relay 54 energizes from earth on T531 and relay 56 energizes over: earth, T542, T553', winding of relay 56 to battery. The operation of T561 closes a holding circuit for relay 56 as well as preparing an energizing circuit for relay 56' over: battery, winding 56, winding 56', T561, T551', T572 to earth. When the A. C. impulse generated by relay 3 (Fig. 3) terminates, relay 53 (Fig. 1) releases and opens the circuit of relay 54, which de-energizes. At T542 the short circuit around relay 56' is removed with the result that relay 56' energizes over the above traced circuit. At R561' the circuit of relay 55' is opened and this relay releases, and at T554' removes the shunt from around the high resistance winding of 57. Relay 512' of the double cord releases and the supervisory lamp is extinguished by removal of earth from T5121', indicating to the operator that the called subscriber has removed his receiver. Relay 56' releases when its circuit is opened at T551'. Neither relay 55' nor relay 56' can energize again at this time and cause a false signal since earth is removed from T542, relay 54 having released when its circuit was opened at T531 on the deenergization of relay 53 at the end of the A. C. impulse.

At the end of the conversation the called subscriber on replacing his receiver causes a current reversal over the line and consequently relay 10 (Fig. 3) releases and completes the following circuit for relay 3 over: battery, center winding of 3, T43, R102 to earth. Relay 4 is slow-to-release so that it holds for a period after 10 opens its circuit, thereby ensuring the operation of 3.

Relay 4, in releasing, opens at T33 the circuit of relay 3, but this relay is rendered slow-to-release by its upper short-circuited winding, there-

by allowing the transmission of a long A. C. impulse which is received as before by relay 51 (Fig. 1) which energizes.

The same operations take place as indicated above and relay 55' which energizes, short-circuits at T554' the high resistance winding of 57 and the supervisory lamp is lighted. The operator is thus informed when the conversation is finished and may withdraw the plug.

On the withdrawal of the plug, relay 57 releases since earth is removed from its winding. Relay 58 releases due to the removal of earth from T572, and the circuit of relay 59 is also opened but the latter does not release since it is slow and is held over: battery, lower winding, T593, R5102, R572 to earth. Relay 511 energizes over: battery, lower winding, T592, R572 to earth, and 510 energizes over: battery, lower winding, T5114, T592, R572 to earth. The latter at R5102 opens the circuit of 59 which in its turn at R592 opens that of 511 and the three relays release, but not without contacts T5111 and T5115 being closed for a period sufficient to allow the transmission of an A. C. impulse over: T5111, conductors 376 and 411, R31, R62, relay 5, R34, conductors 412 and 377, T5115.

Relay 5 energizes momentarily and removes earth at R51 from the lower winding of relay 12 which releases and at T121 opens the energizing circuit of relay 8. When relay 5 deenergizes after the A. C. impulse relay 8 also releases. All the apparatus is now in its normal position.

Premature release.—It may happen that the operator accidentally removes the plug as soon as it has been inserted. In this case the incoming equipment is seized and an A. C. impulse transmitted as in the normal case and this impulse is received on the outgoing equipment (Fig. 1), and relays 51, 52, 53 and 54 are energized successively. Earth on T543 over R573 energizes relay 59 over its lower winding and 59 holds over: earth, R572, R5102, T593, winding of 59 to battery. Relay 511 is energized over: battery, lower winding, T592, R572 to earth. Relay 510 energizes over: battery, lower winding, T5114, T592, R572, to earth.

The releasing impulse is transmitted over T5111 and T5115 and causes normal release. Relay 510 opens the circuit of relay 59 at R5102, relay 59 at T592 that of 511 and relay 511 at T5114 that of 510. The three relays release.

It may happen that the operator removes the plug when the repeater is already taken into use and the circuit ready to receive impulses.

In this case, the releasing impulse transmitted by relay 511 (Fig. 1) is not received by relay 5 (Fig. 3), since the circuit is opened at R62 (relay 6 is energized by the hunting movement of magnet 310) but instead energizes relay 25 (Fig. 4).

At T251 earth is extended over R135 to the lower winding of T17. At R173 the start conductor is opened and at T172 a holding circuit is provided for the relay to earth on T206.

Relay 14 releases since it is short-circuited over: earth, T132, relay 14, T174, R251 to earth. In releasing it removes the holding earth at T142 from 20 which releases and causes the release of 17 by removal of earth from T206.

The magnet 300 returns the switch to normal over the usual circuit.

If the operator for any reason delays to dial, a relay operated by cams causes the release of the repeater so that it is not held inoperative for a prolonged period. This operation takes place in the following manner:

At the end of a predetermined period, an earth cam is connected to conductor 342 and energizes relay 15' over: T146, R153', R234, relay 15' to battery. At T152' relay 15' extends earth from the cam connected to conductor 344 to relay 15 which energizes.

Earth from T206 is extended over T152 on to wiper 317 and passes over bank contact 408 to energize the two relays 12 and 11 in series. Relay 11 is held over: earth, T121, T113 to battery over the lower winding.

At R112 and R114 the loop to the equipment is interrupted and at T111 a busy signal is transmitted to the operator who notified of the condition withdraws the plug to begin the operation again. On withdrawing the plug an impulse is transmitted as before to relay 511.

In the case when the operator performs the various operations normally, the cam on conductor 342 is without effect since the circuit of relay 15' is opened at R234 (relay 23 is operated during impulsing).

What is claimed is:

1. In a telephone system, a plurality of trunk circuits and a plurality of automatic switches for establishing telephone connections, an impulse repeater common to all said trunk circuits for operating said automatic switches, means including a vacuum tube in said repeater operated by series of high frequency alternating current impulses transmitted thereto during the dialling period in establishing a telphone connection for converting said series of impulse into corresponding series of direct current impulses for operating said switches, and means for associating said repeater with any of said trunk circuits only during the dialling period in establishing a telephone connection.

2. In a telephone system, a plurality of trunk circuits and a plurality of automatic switches for establishing telephone connections, an impulse repeater common to all said trunk circuits for controlling said automatic switches, means for associating said repeater with any one of said trunk circuits only during the dialling period in establishing a telephone connection, means including a vacuum tube in said repeater operated in response to the said association for transmitting an indicating impulse back over said associated trunk circuit to the originating end, and means including said vacuum tube operated by series of high frequency alternating current impulses transmitted over said trunk circuit to said repeater during the dialling period in establishing a telephone connection for converting said series of impulses into corresponding series of direct current impulses for operating said switches.

3. In a telephone system, a trunk circuit having an originating end and a receiving end, automatic switches accessible to the receiving end of said trunk circuit, means for seizing said trunk at the originating end, transmitting means in the originating end for automatically transmitting an impulse of current over said trunk circuit to the receiving end, response means in said receiving end operated by said impulse for connecting an idle one of said switches to said receiving end, transmitting means associated with said receiving end for automatically transmitting an impulse back over said trunk circuit to the originating end in response to said connection, receiving means in said originating end op-

erated by said last impulse for indicating said connection, means controlled over said trunk circuit for operating said switches to establish a talking connection over said trunk circuit to a called party, transmitting means in said receiving end operated in response to the called party answering for transmitting an impulse of current back over said trunk circuit to the originating end, said receiving means operated in response to said last impulse for indicating that the called party has answered, said last transmitting means again operative when the called party hangs up to transmit another impulse of current to said receiving means, said receiving means operated responsive to said last impulse for indicating that the called party has hung up, said first transmitting means again operated to transmit another impulse of current to the receiving end to initiate the release of said connection, said response means again operated by said last impulse to release the established connection and automatic switches.

4. In a telephone system, a plurality of automatic switches, a trunk circuit having access to said switches at the receiving end thereof, means for seizing said trunk circuit at the originating end, means in said trunk circuit at the originating end for transmitting low frequency impulses of alternating current in a slow cycle to the receiving end of said trunk circuit in response to said seizure, means associated with the receiving end of said trunk circuit responsive to said transmission for first releasing the automatic switches if accidently held in operated position and then seizing an idle one of said switches, means associated with the receiving end of said trunk circuit for transmitting an impulse of current over said trunk circuit to the originating end in response to the seizure of an idle switch at the receiving end, said first transmitting means continuing to transmit impulses from the originating end to the receiving end of the trunk circuit until the originating end receives the transmitted impulse indicating the seizure of an idle switch.

5. In a telephone system, a plurality of automatic switches, a trunk circuit having access to said switches, means for seizing said trunk circuit at the originating end, an impulse repeater automatically connected to the receiving end of said trunk circuit responsive to said seizure, a vacuum tube included in said repeater, means in said repeater responsive to said connection for closing a circuit to light the filament of said tube and for closing a circuit over the receiving end of said trunk circuit to cause an idle one of said switches to be connected to the receiving end of said trunk circuit, a plate relay in said repeater, means in said repeater responsive to the connection of the idle switch to said trunk circuit for connecting said plate relay to the plate of said tube to energize said relay, and means operated responsive to the operation of said relay for transmitting an impulse of current over said trunk circuit to the originating end to indicate that the repeater is ready to receive selecting impulses.

6. In a telephone system, a plurality of trunk circuits, an impulse repeater common to all said trunk circuits, means for seizing one of said trunk circuits, means operated responsive to the seizure of said trunk circuit for automatically connecting said impulse repeater to said trunk circuit, means for transmitting a plurality of series of high frequency alternating current impulses over said trunk circuit to said repeater, means in said repeater for converting said series of impulses into series of direct current impulses, automatic switches operated by said series of direct current impulses to establish a telephone connection over said trunk circuit, and means for automatically disconnecting said impulse repeater from said trunk circuit after a predetermined number of impulse series have been transmitted.

7. In a telephone system, automatic switches, a plurality of trunk circuits each having access to said switches, an impulse repeater common to all said trunk circuits, means for seizing one of said trunk circuits, means responsive to said seizure for automatically connecting said repeater to said trunk circuit, a vacuum tube included in said repeater, means responsive to said connection for closing a circuit to light the filament of said tube and to prepare the plate circuit of said tube, means for transmitting a plurality of series of high frequency impulses of alternating current over said trunk circuit to the grid circuit of said tube, means operated by the plate current of said tube in response to said high frequency impulses for converting said impulses into direct current impulses to operate said automatic switches and means for automatically disconnecting said repeater from said trunk circuit and switches after a predetermined number of series of impulses have been transmitted and for opening the circuits of said tube responsive to said disconnection.

8. In a telephone system, automatic switches, a plurality of trunk circuits each having access to said automatic switches, an impulse repeater common to said trunk circuits, means for seizing one of said trunk circuits, means responsive to said seizure for connecting said repeater to said trunk circuit, a vacuum tube included in said repeater, means responsive to the connection of said repeater to said trunk circuit for closing a circuit to light the filament of said tube and to prepare the grid and plate circuits of said tube, means also responsive to the connection of said repeater to said trunk circuit for automatically connecting an idle one of said automatic switches to said trunk circuit and repeater, means responsive to the connection of an idle switch with said trunk circuit for transmitting an impulse of law frequency alternating current back of said trunk circuit, means for transmitting a plurality of series of high frequency impulses of alternating current over said trunk circuit to the grid circuit of said tube, means operated by the plate current of said tube, in response to said high frequency impulses for converting said impulses into direct current impulses to operate said automatic switches, means for automatically disconnecting said repeater from said trunk circuit and switches after a predetermined number of series of impulses have been transmitted, said tube closing circuit means operated responsive to said disconnection for opening the circuits of the tube.

9. In a telephone system, a plurality of trunk circuits, an impulse repeater common to all said trunk circuits, a finder switch individual to said repeater, means for seizing one of said trunk circuits, means in said trunk circuit responsive to said seizure for automatically transmitting an impulse of low frequency alternating current over said trunk circuit, and means responsive to the receipt of said impulse for operating said finder to connect said repeater to said trunk circuit.

10. In a telephone system, an originating office and a distant office, a plurality of trunks connecting said offices, operator controlled means for seizing one of said trunks, means operated re-

sponsive to the seizure of said trunk for transmitting an impulse of low frequency alternating current from the originating office over said seized trunk to the distant office, means in the distant office operated responsive to the receipt of said impulse for preparing the trunk at the distant office to receive dialling impulses, means at the distant office operated at the time the distant trunk is ready to receive dialling impulses for transmitting an impulse of low frequency alternating current from the distant office over said trunk to the originating office, means at the originating office operated in response to said last impulse for signalling the operator at the originating office, operator controlled means for transmitting dialling impulses of a high frequency over said trunk to the distant office, means in the distant office operated in response to the receipt of said high frequency impulses for converting said impulses into direct current impulses, automatic switches operated by said direct current impulses to extend a talking connection from said trunk to a called party, means in said trunk at the distant station operated in response to the called party answering for transmitting an impulse of low frequency current from the distant office over the trunk to the originating office, said signalling means operated in response to said last impulse for indicating to the operator that the called party has answered, said last means again operated in response to the called party hanging for again operating said signalling means to indicate to the operator that the called party has hung up, said first means re-operated responsive to the disconnection of said operator controlled means from said trunk circuit at the originating end to again transmit an impulse of low frequency alternating current over said trunk to the distant office to release the established connection.

11. In a telephone system, an originating office and a distant office, a trunk circuit connecting said offices, means in said trunk circuit for automatically transmitting low frequency alternating current impulses over said trunk line in either direction for signalling, seizure, release, and supervisory purposes in establishing a telephone connection, means at the originating office for transmitting series of high frequency alternating current impulses in the voice range over said trunk line for selecting purposes in establishing a telephone connection, and means at the distant office only temporarily connected with said trunk circuit during the selecting operation and operated by said series of selecting impulses for repeating a corresponding series of direct current impulses for operating automatic switches to complete the telephone connection.

12. In a telephone system, an originating office and a distant office, a trunk circuit connecting said offices, means in said trunk circuit at the originating end for automatically transmitting low frequency alternating current impulses over said trunk circuit to the distant office for initiating connection seizure and release, means associated with said trunk circuit at the distant office for transmitting low frequency alternating current impulses over said trunk circuit to the originating end for indicating seizure and the connection and disconnection of a called party, means at the originating office for transmitting series of high frequency alternating current impulses in the voice range over said trunk circuit for selecting purposes, and means at the distant office operated in response to said series of impulses for repeating corresponding series of direct current impulses for operating automatic switches to complete a telephone connection.

13. In a telephone system, a group of trunk lines for handling traffic from a first exchange to a second exchange, an impulse repeater in the second exchange common to said trunk lines, and means responsive to the seizure of any one of said trunk lines at the first exchange and controlled over the seized trunk line for connecting said impulse repeater to the seized trunk line.

14. In a telephone system, a group of trunk lines, each including a voice current repeater comprising inductively connected talking conductors, an impulse repeater common to said trunk lines, means responsive to the seizure of any one of said trunk lines for connecting said impulse repeater thereto, and means in said impulse repeater for repeating received impulses past the inductive connection in the voice current repeater of the seized trunk line.

15. In a telephone system, a group of trunk lines, each having inductively connected incoming and outgoing sections, a repeater, means effective when any trunk line of said group is taken into use for connecting said repeater thereto, and a relay in said repeater controlled over the incoming section of the trunk line to which the repeater is connected for repeating impulses over the outgoing section thereof.

16. In a telephone system, a group of trunk lines each extending to an automatic switch, an impulse repeater common to said trunk lines, automatic switching mechanism responsive to the seizure of any one of said trunk lines for connecting said impulse repeater thereto, and means for notifying the party who caused the seizure to take place that the repeater is connected.

17. In a telephone system, a group of trunk lines each extending to an automatic switch, an impulse repeater common to said trunk lines, automatic switching mechanism responsive to the seizure of any one of said trunk lines for connecting said impulse repeater thereto, operator controlled switching equipment through which the seizure of the trunk line is effected, and means for notifying the operator that the repeater is connected.

18. In a telephone system, a group of trunk lines, each terminating in a hunting switch having access to directive switches, a device common to said trunk lines for controlling said directive switches, means responsive to the seizure of one of said trunk lines for connecting said device thereto and for starting the associated hunting switch, and means included in said device for determining when such hunting switch has found an idle directive switch.

19. In a telephone system, a group of trunk lines, each terminating in a hunting switch having access to directive switches, a device common to said trunk lines for controlling said directive switches, means responsive to the seizure of one of said trunk lines for connecting said device thereto and for starting the associated hunting switch, means included in said device for determining when such hunting switch has found an idle directive switch, a vacuum tube included in said device, and a circuit for said tube controlled by said determining means.

20. In a telephone system, a closed loop circuit extending over two conductors of a trunk line to a line switch, said conductors being connected at

said switch to the line relay and to ground, respectively, when the loop is first closed, means for transferring said conductors to the windings of the line relay of a succeeding switch after the line switch has operated responsive to the closure of the loop, and a test relay connected from one of said conductors to ground, said relay being shunted by said ground at the line switch until after the line switch has operated.

21. In combination, a trunk line, a repeater, a vacuum tube in said repeater, a plate relay, a grid circuit for the said tube normally adjusted so that when the emitter circuit of the tube is first closed the plate relay is energized, means for closing said emitter circuit when the repeater is taken into use over said trunk line, means controlled by said plate relay for sending signalling current back over said trunk line, and means responsive to the operation of the said signalling means for altering the said grid circuit to cause said plate relay to fall back.

22. In a repeater of the vacuum tube type circuits for said tube completed responsive to the repeater being taken for use, a plate relay energized responsive to the completion of said circuits, and means in said repeater operated automatically a predetermined time after the operation of said plate relay for altering the grid circuit of the tube to cause the deenergization of said plate relay.

23. In a vacuum tube repeater, signalling means, a repeating relay, a plate relay effective to control said signalling means when the repeater is first taken into use, and means controlled by operation of the signalling means for rendering said plate relay effective to control said repeating relay.

24. In a vacuum tube repeater, means for supplying current to the tube on seizure of the repeater, a plate relay initially responsive when the current is supplied, an incoming circuit, means controlled by said plate relay for associating said incoming circuit with the grid circuit of the tube, said last means being also operative to change the potential on the grid so that the said plate relay will fall back preparatory to being controlled over said incoming circuit.

25. In a repeater, an incoming circuit, an outgoing circuit, a vacuum tube, a grid circuit for said tube controlled over said incoming circuit, means controlled over the outgoing circuit for closing the plate circuit of said tube, and a relay in said plate circuit for repeating impulses over said outgoing circuit.

26. In a repeater, an incoming circuit, a transformer having a primary winding bridged across said circuit, a vacuum tube, a grid circuit for said tube including the secondary winding of said transformer, a plate circuit including a relay, means adjusting said grid circuit so that said relay is deenergized when the incoming circuit is inactive, a second relay controlled by said first relay, and an outgoing circuit closed at contacts of said second relay and which is interrupted by operation of the said relays when alternating current is received over said incoming circuit.

27. In a telephone system, a trunk line, a repeater, a hunting switch for connecting said repeater to said trunk line, a second hunting switch for extending said trunk line to a directive switch, a vacuum tube in said repeater, means for starting said hunting switches when the trunk line is taken into use, and means depending on the completion of the operation of both said hunting switches for rendering said tube operative to repeat impulses.

28. In a telephone system, a trunk line, a repeater, a hunting switch for connecting said repeater to said trunk line, a second hunting switch for extending said trunk line to a directive switch, a vacuum tube in said repeater, means for starting said hunting switches when the trunk line is taken into use, a grid circuit for said tube completed responsive to the operation of the first hunting switch, and a plate circuit for the tube completed responsive to the operation of the second hunting switch.

29. In a telephone system, means including a link circuit and a plurality of automatic switches for setting up connections, an impulse repeater and means for connecting it up to said link circuit, means in said repeater for repeating series of impulses received over the link circuit to automatic switches of said plurality, and means for automatically releasing the repeater after a variable number of series of impulses have been received, depending on the value of the first impulse series.

30. In a telephone system, means including a link circuit and a plurality of automatic switches for setting up connections, an impulse repeater and means for connecting it up to said link circuit, means in said repeater for repeating series of impulses received over the link circuit to automatic switches of said plurality, a switch associated with said repeater, means for positioning said switch responsive to the first series of impulses, means for advancing the switch for each subsequent series, and means for releasing the repeater upon the switch arriving at a predetermined position.

31. In a trunk line for use in an automatic telephone system for extending calls from an operator's position, means for receiving supervisory signals transmitted back over the trunk line by alternating current, said means comprising an alternating current relay bridged across the trunk line in series with a condenser, a second alternating current relay, a relay controlled by said first relay and operative to open the trunk conductors and connect the out portions thereof to said second relay, a holding circuit for said third relay controlled by said second relay, and signal control means controlled by said second relay.

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