

Oct. 8, 1946.

F. A. MORRIS

2,409,145

CONTROL AND TRIGGER CIRCUIT FOR TELEPHONE SYSTEMS AND THE LIKE

Filed Sept. 26, 1944

4 Sheets-Sheet 1

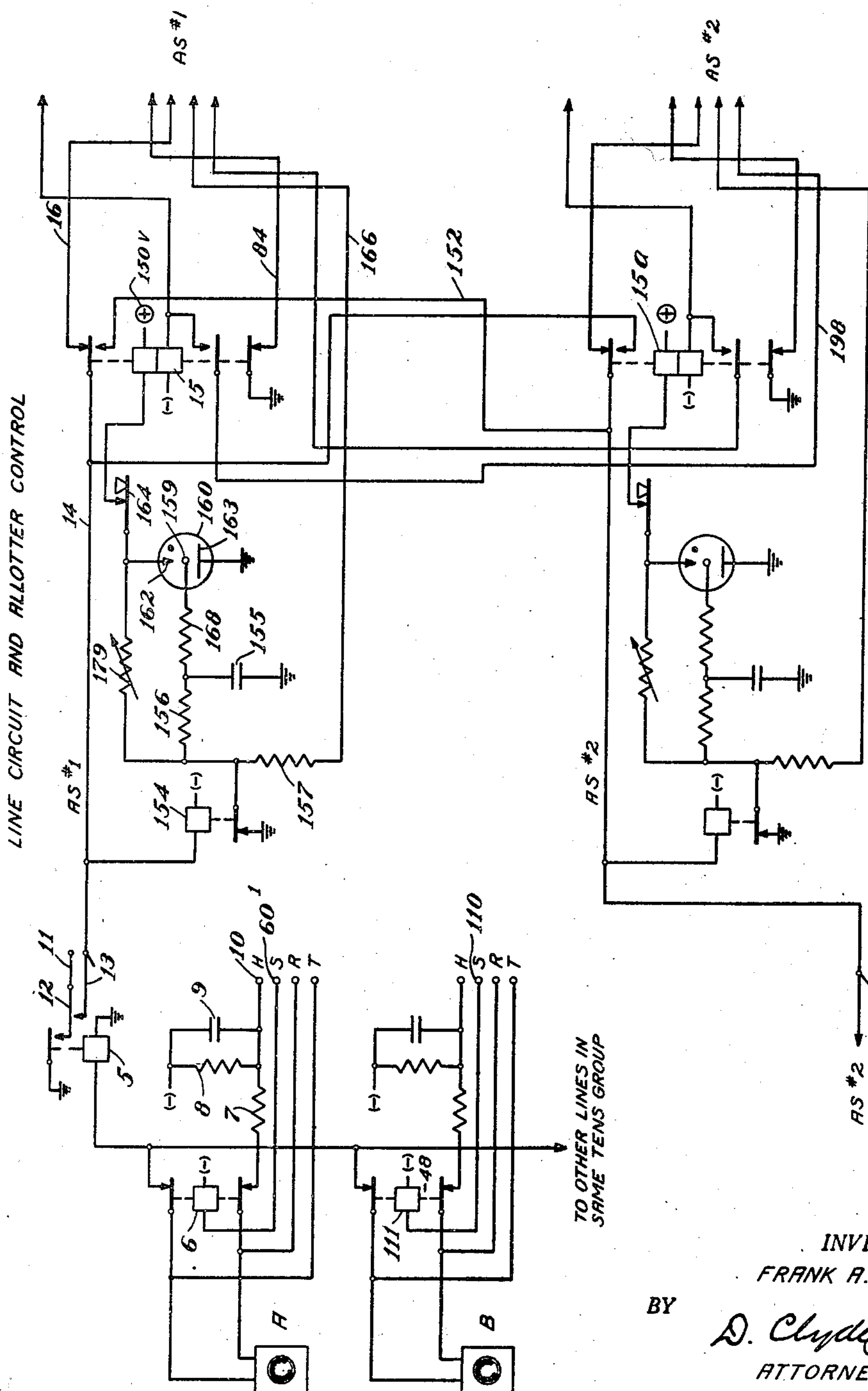


Fig. 1

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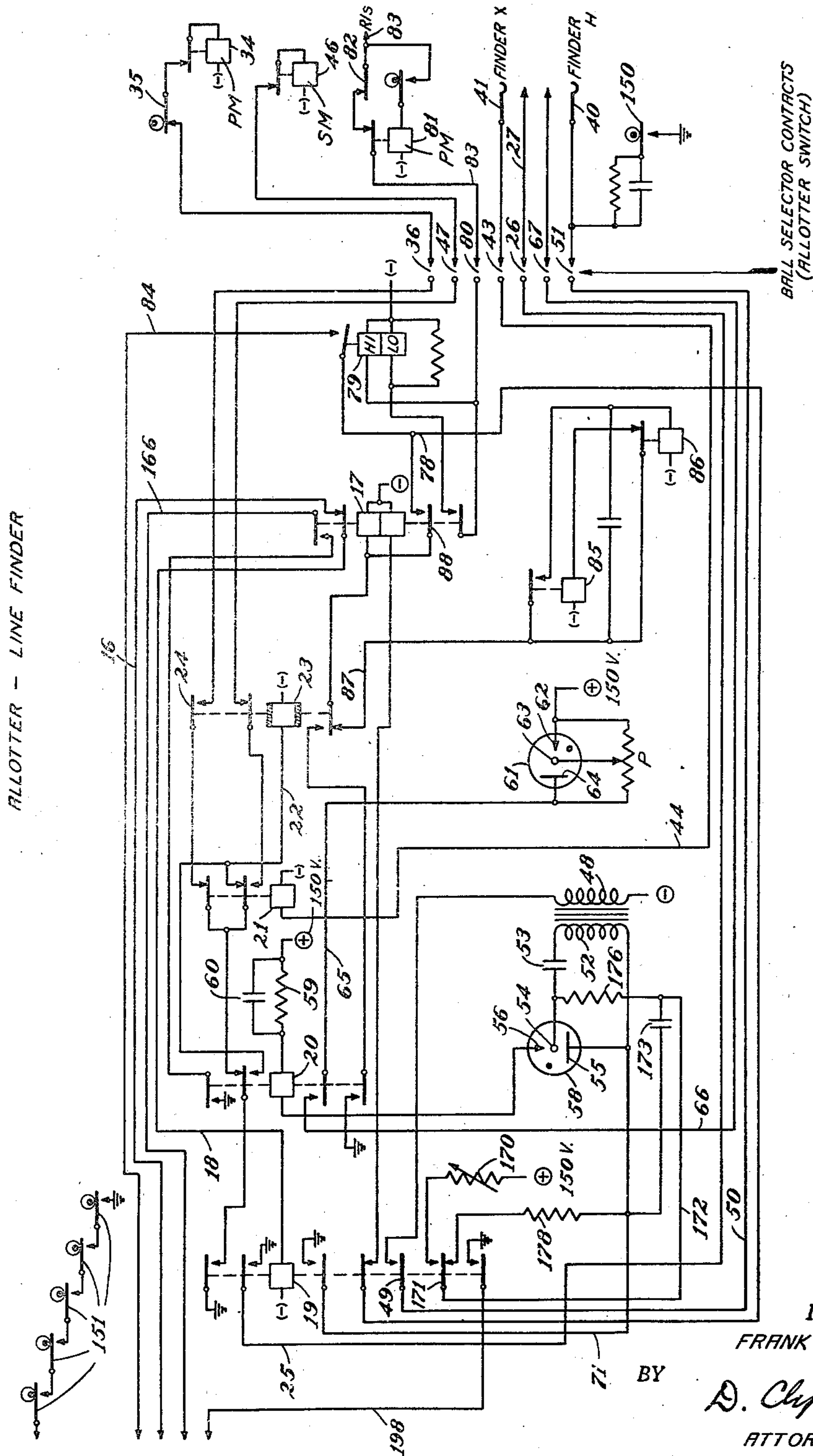


Fig. 2

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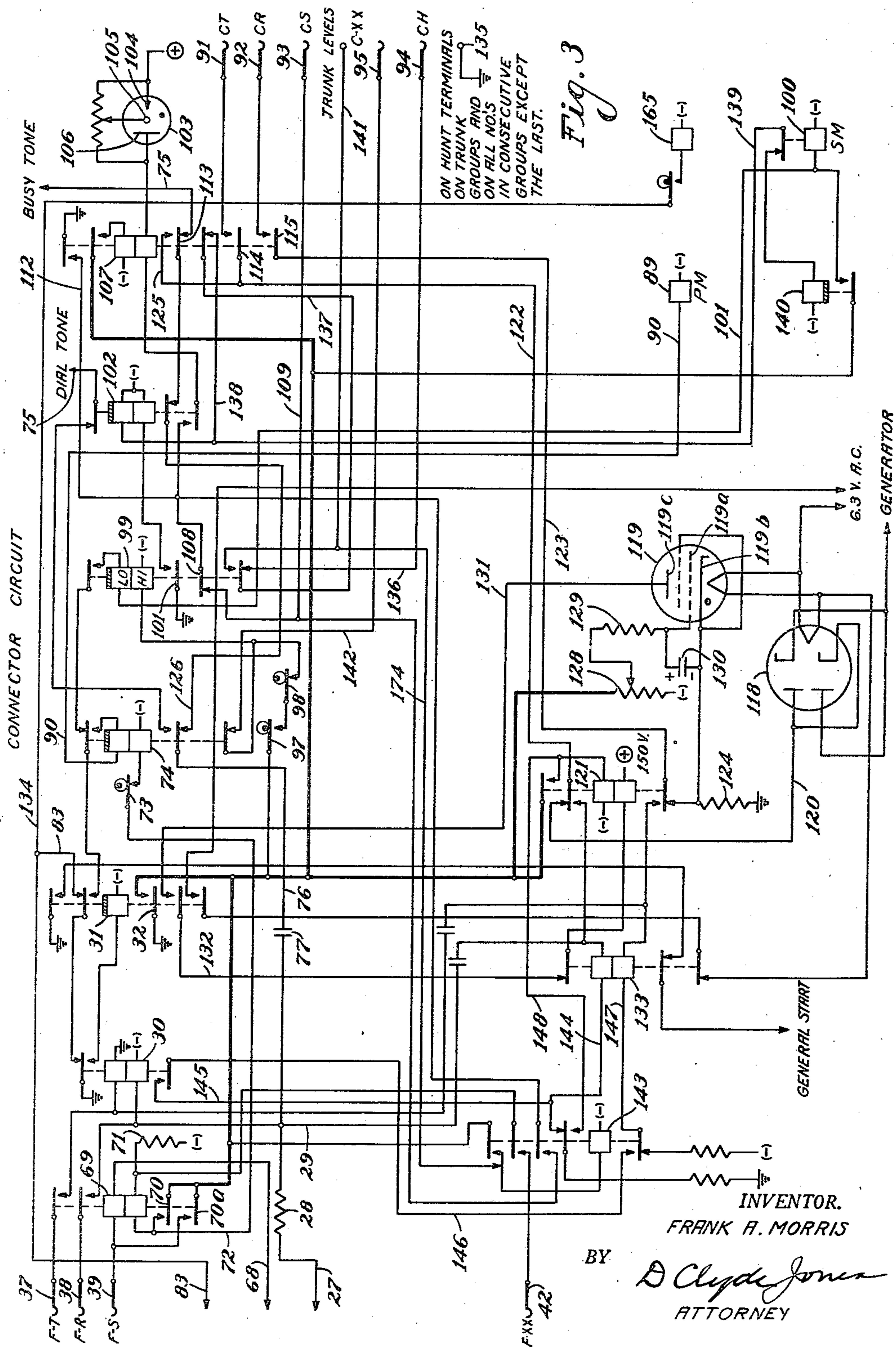
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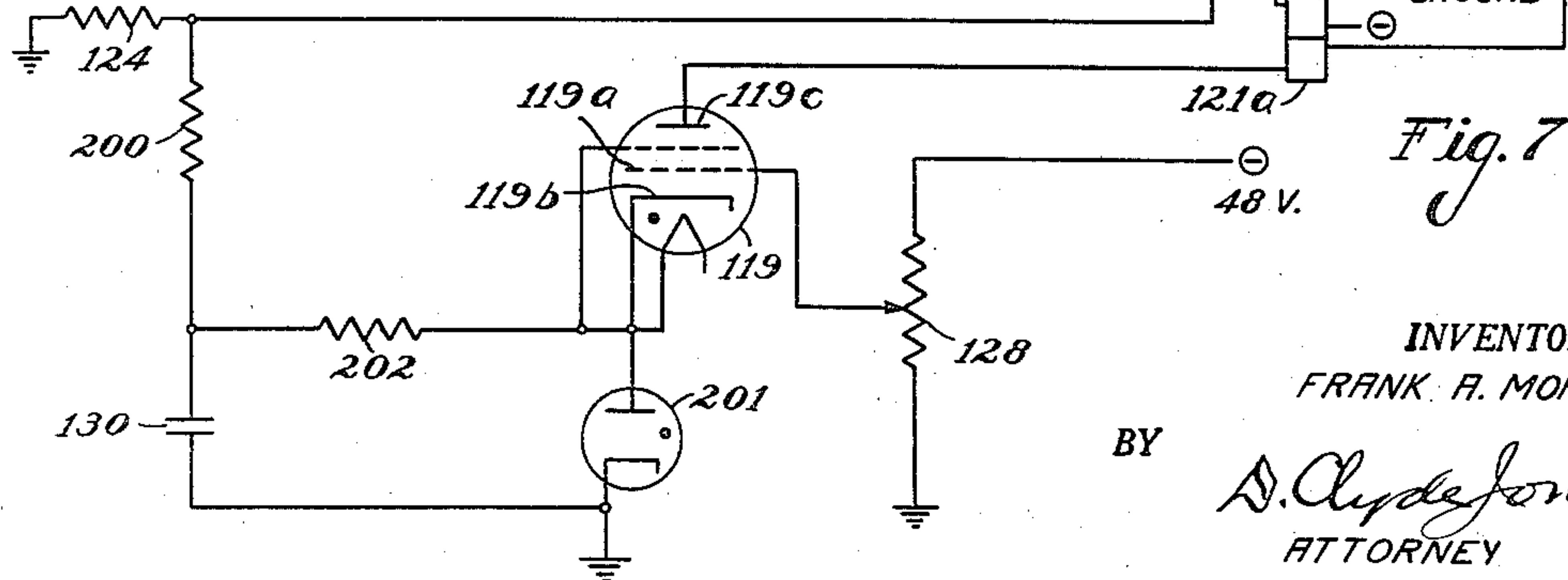
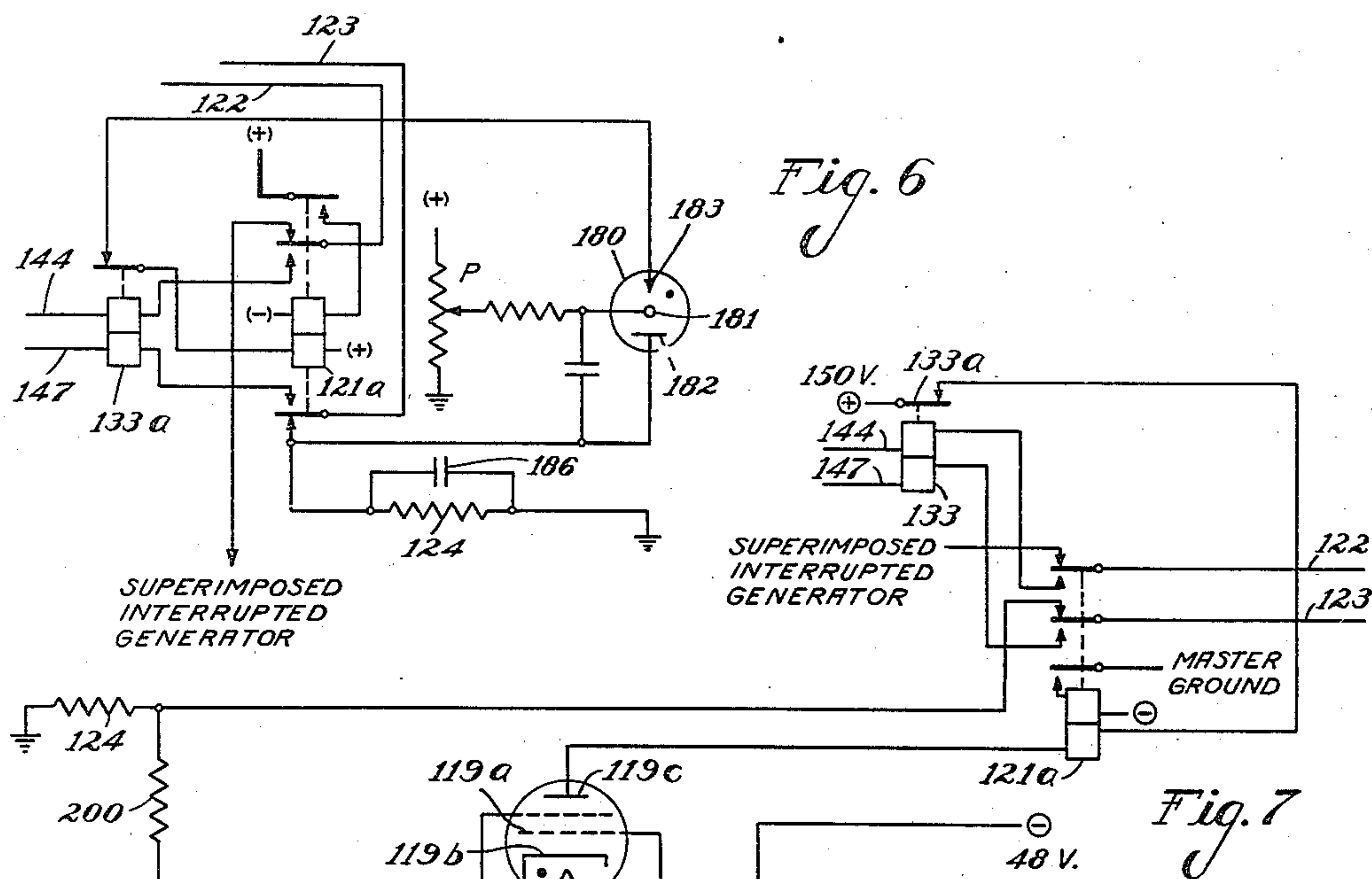
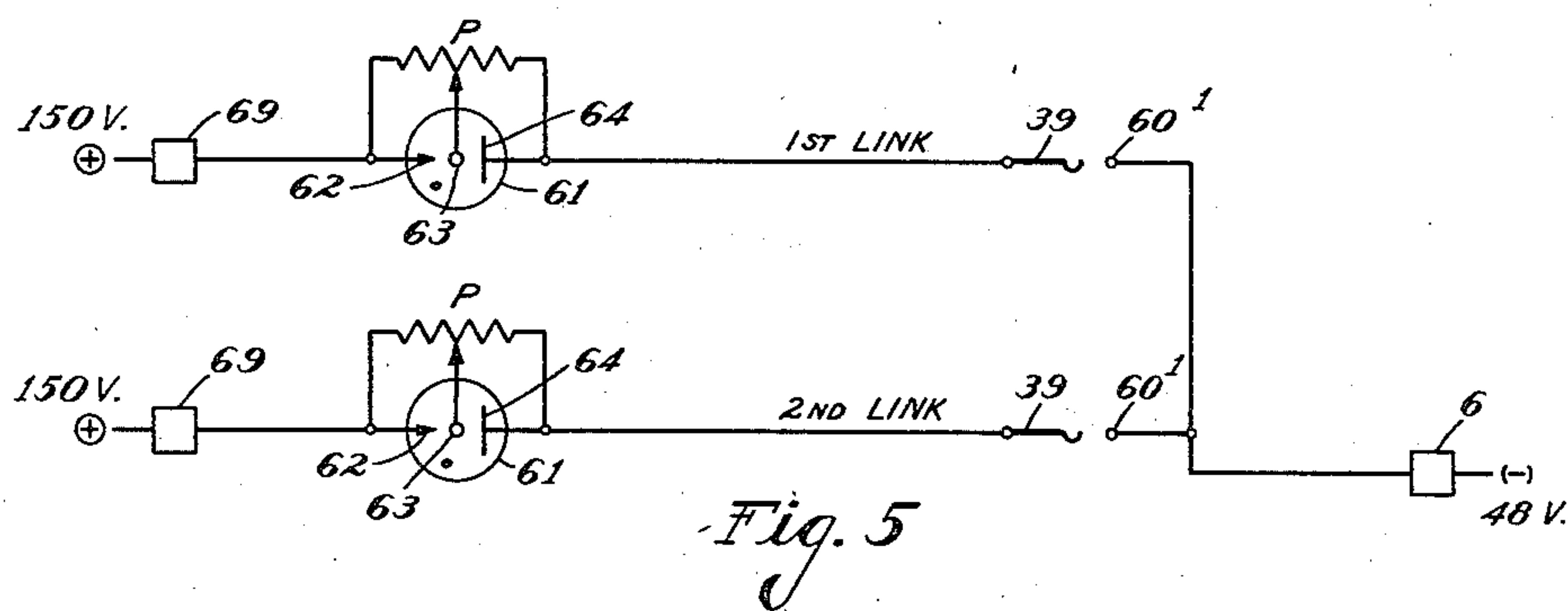
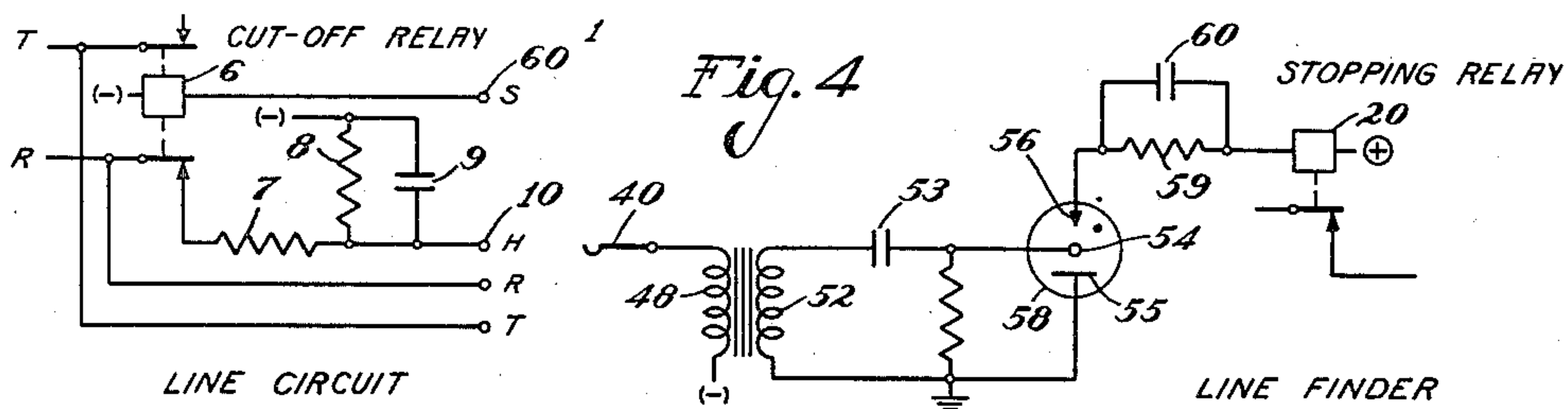
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4 Sheets-Sheet 4



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2,409,145

CONTROL AND TRIGGER CIRCUIT FOR
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20 Claims. (Cl. 179—175.2)

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This invention relates to stopping, triggering and testing circuits which are particularly useful in telephone systems and the like.

In such systems and especially in automatic telephone systems, it is important that the automatic switch means employed therein be promptly stopped as soon as a given switching connection has been effected. Also in such systems, it is necessary to test certain equipment, such as lines, trunks or allotters to determine whether or not such equipment should be seized for use. Such testing should be effected in a reliable manner and in an infinitesimal period of time. Furthermore, both in automatic telephone systems and in manual systems as well, trigger circuits are essential especially for tripping the ringing current when the called subscriber answers.

The main feature of the invention relates to control circuits generally, wherein electric discharge devices contribute to the reliability and markedly prompt action thereof.

Another feature of the invention relates to novel control circuits incorporating therein electric discharge devices, which circuits determine the availability for use of telephone equipment, govern the action of telephone switching apparatus, and trigger the operations of telephone apparatus.

The various features and advantages of the invention will appear from the detailed description and claims when taken with the drawings in which Figs. 1, 2 and 3, when arranged in the order named, illustrate the novel circuits of this invention incorporated in an automatic telephone system. Fig. 1 shows two typical telephone lines and duplicate allotter control means. Fig. 2 illustrates an allotter and a portion of a line finder, certain of the brushes of which are shown at the lower right of this figure. At the left hand side of Fig. 3 there are shown the remainder of the finder brushes, while at the center and at the right hand portion of this figure, there is shown the connector switch circuit. Fig. 4 is a schematic circuit arrangement illustrating in somewhat simpler form a low voltage "firing" circuit for a gas-filled arc discharge device utilized to stop the finder switch in the system of Figs. 1, 2 and 3. Fig. 5 is a simplified disclosure of the testing arrangement employed in the mentioned system, two links being shown to indicate the condition prevailing when a busy line is tested. Fig. 6 is a modified form of ringing trip arrangement or trigger circuit which can be substituted for that used in the connector circuit of Fig. 3. Fig. 7 illustrates a trigger circuit of somewhat more

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generalized application than the specific arrangement shown in Fig. 3.

The novel control circuits herein shown, are applicable to many fields of use, but for convenience in disclosure they are shown incorporated in an automatic telephone system. This system is herein illustrated as being of a size employing only finder and connector switches. However, the number of lines served by the system can be increased by the addition of selector switches in the manner well known.

The finder and connector switches herein indicated, are of the construction disclosed in the patent to Lienzen No. 2,148,824, granted February 28, 1939, although other types of switches having primary and secondary selecting movements may be used instead. The allotter herein indicated may be of the so-called ball-selector type, disclosed in the patent to Blomberg No. 2,127,322, although other types of allotter switches may alternatively be used.

With this brief reference to the switch construction, it is believed that the invention will best be understood by describing the method of establishing a telephone connection from a telephone subscriber's line, indicated at A, to a called subscriber's line, indicated at B. When the subscriber at substation A removes his receiver from its switch-hook, a circuit is completed for energizing the group line relay 5 which is common to a group of ten lines in the same tens group. This circuit extends from ground, winding of the relay 5, upper back contact and armature of the cut-off relay 6, upper side of the calling line, thence, through the calling substation and over the lower side of the calling line, lower armature and back contact of the cutoff relay 6, resistors 7 and 8 in series to the negative side of battery. Condenser 9 is connected in parallel with the resistor 8 so that the drop across resistor 8 charges the condenser 9, thereby putting an identifying condition on the calling line hunt terminal 10, in the terminal of the group of finder switches serving this line. The operation of the common line relay 5 serves to start an allotted finder to search for the calling line, and also serves to place an identifying ground on the group level 11 (Fig. 1) in the line finder banks. It will be noted that the upper armature of the line relay 5 is provided with two contact springs 12 and 13 which close in sequence. This insures that the identifying ground will be applied to the group level contact 11 in the line finder bank, before the line finder starts to move. The start of the line finder is effected from ground at the upper armature of

group relay 5 and front contact 12 thereof, now closed, as well as the front contact 13 subsequently closed, thence, over conductor 14, armature and back contact of the relay 15, conductor 16, back contact and armature of relay 17, conductor 18, winding of the allotter start relay 19, to negative battery. The operation of the allotter start relay 19 applies ground at its upper armature and front contact for completing a circuit through the armature and back contact of the relay 20, armature and back contact of the relay 21, conductor 22, winding of the relay 23 to the negative side of battery. It should be pointed out that the relay 23 is sluggish not only in attracting its armatures but also in releasing them. The purpose of having the relay 23 sluggish in operating, is to hold open its armature 24 and front contact for a slight interval, to insure that the circuit of the primary stepping magnet of the finder is not completed until the pre-impulse circuit has an opportunity to function. The pre-impulse circuit is energized by ground, applied at the inner front contact and armature of the relay 19, conductor 25, allotter switch contact 26, conductor 27, current limiting resistor 28, section 29 of the link conductor, lower winding of the combined battery feed and impulse relay 30, to the negative side of battery. Relay 30 is energized in this circuit and at its upper armature and front contact removes ground from release conductor 33 while completing an obvious circuit for energizing the slow-releasing relay 31 of the connector. Relay 31 thus operates and at its armature 32 and front contact applies master ground for the various circuits of the connector. It will be recalled that the relay 23 is slow to operate and that during the time that it is attracting its armature 24, the pre-impulse circuit, as described, has an opportunity to be completed. When, however, the armature 24 and front contact of relay 23 is closed, a self-interrupting circuit is completed for the primary magnet 34 of the finder switch. This circuit extends from the negative side of battery, winding of primary stepping magnet 34, its armature and back contact, through the normally closed off-normal contacts 35, contacts 36 of the allotter switch, front contact and armature 24 of relay 23, back contact and armature of relay 21, back contact and armature of allotter relay 20, front contact and armature of relay 19, to ground. Under the control of this circuit, the primary stepping magnet advances the tip brush 37, ring brush 38, sleeve brush 39 (at left of Fig. 3) and hunt brush 40 (at right of Fig. 2) in their primary or group selecting movement. Also, the stepping magnet advances the group selecting brushes 41 (at the right of Fig. 2) and 42 (at the left of Fig. 3) in their primary direction. The primary stepping magnet 34 continues to self-interrupt its operating circuit and thereby advances the mentioned finder brushes until the finder brush 41 encounters the level contact 11 (upper left Fig. 1) of the group of lines in which the calling line is located. As soon as the brush 41 encounters the contact 11, this completes a circuit from ground at the armature and contact 12 of relay 5, group contact 11, finder brush 41, allotter brush 43, conductor 44, winding of allotter transfer relay 21, to the negative side of battery. This energizes the relay 21 and at its uppermost armature and front contact it opens the self-interrupting circuit of the stepping magnet 34, thereby stopping the primary movements of the finder switch. Also, the operation of the relay 21 at its inner ar-

mature and back contact, opens the energizing circuit of the relay 23. This relay, it will be recalled, is also sluggish in releasing its armatures. The purpose of this sluggishness is to provide a delay sufficient for the finder switch to come to rest definitely, after its primary hunting movement and before its secondary hunting movement is started. However, after a very brief time, the slow-releasing relay 23 does release and thereby completes a self-interrupting circuit for the secondary magnet 46 extending from the negative side of battery, winding of this magnet, its armature and back contact, allotter brush 47, back contact and armature of relay 23, front contact and armature of relay 21, now energized, back contact and armature of relay 20, front contact and armature of allotter start relay 19 to ground. Under the control of this circuit, the secondary stepping magnet 46 advances the finder brushes 37, 38, 39 and 40 in their units or secondary hunting direction. This hunting operation continues until the brush 40 encounters the hunt terminal 10 (Fig. 1) of the calling line. It will be recalled that when the subscriber of this line initiated a call, he set up a condition whereby the condenser 9 was charged. Consequently, when the finder brush 40 encounters the hunt terminal 10, a circuit is completed from the negative side of battery, primary winding 48 of a step-up transformer (Fig. 2), front contact and armature 49 of the allotter start relay, conductor 50, allotter contact 51, finder brush 40, hunt terminal 10, through the condenser 9, to negative side of battery. This circuit discharges condenser 9 through the primary winding 48 of the transformer. This discharge induces a voltage in the secondary winding 52 of the transformer which voltage is applied through the condenser 53 to the starter anode 54 of the finder stopping arc discharge device 58. The arc discharge device is gas-filled and preferably of the cold cathode type, sold under the code 1C21. This device comprises the cold cathode 55, the starter anode 54 and the anode proper 56. The mentioned induced voltage, when applied to the starter anode 54, causes the finder stopping device 58 to conduct. As a result of this, the allotter control relay is energized from the positive side of battery through the capacitive network 59 and 60, winding of the relay 20, across the space between the anode 56 and cathode 55 of the discharge device 58, conductor 71, lower front contact and armature of relay 19 to ground. The relay 20 is thus energized and at its inner upper armature and back contact, it interrupts the stepping circuit for the secondary stepping magnet 46 so that the brushes of the finder come to rest. The arrangement, just described, for stopping the secondary movement of the finder switch is shown in simplified form in Fig. 4.

It now becomes necessary to test the calling line to make sure that it has not been seized as a called line by a connector, which condition may have arisen during the time that the finder switch in question was hunting for the calling line. As soon as the allotter control relay 20 operates, it also completes the necessary circuit for testing the busy or idle condition of the calling line, for the purpose just mentioned. The busy test is accomplished by the cold cathode arc discharge device 61, preferably similar in construction to the device 58, in cooperation with the busy test circuit. When the starter anode 62 causes the gas in the device to ionize the busy test circuit extends from the source of high positive voltage

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of the order of 150 volts, anode 62, cathode 64, conductor 65, armature and front contact of relay 20, conductor 66, allotter brush 67, conductor 68, upper winding of the connector cut-through relay 69, finder sleeve brush 39, finder sleeve contact 69', which is individual to the calling line, winding of the cut-off relay 6 to the negative side of battery. Current flows in this circuit and energizes the cut-off relay 6 to disconnect the group line relay 5 from the control of the calling line and also energizes the cut-through relay 69. It should be mentioned that the electron discharge device 61 is adjusted by means of a potentiometer P across its cathode and anode so that it will be conductive when sufficient voltage appears between its cathode 64 and starter anode 63. When the busy test lead, including the conductors 66 and 68 and finder sleeve brush 39, is extended through the sleeve terminal of the calling line in the multiple bank, the circuit is completed in such a way that the sum of 150 volts plus 48 volts appears across the device 61, if the line is in an idle condition. The potentiometer P is adjusted so that the discharge device 61 will become conductive when these voltage conditions are present. When the device becomes conductive, the circuit is then completed and the cut-off relay 6 and cut-through relay 69 become energized in series in the manner above described. When current begins to flow in this circuit, a voltage drop appears across the cut-off relay 6 so that the voltage on the sleeve terminal of the calling line in the multiple bank no longer appears to be 48 volts negative, as schematically indicated in Fig. 5. Thus, any other busy test lead of another link circuit will not encounter sufficient voltage on its busy test brush, to ionize the gas in its busy testing device similar to 61. The time required for the busy test to be completed and the line to be made permanently busy to any other link, is thus reduced to the ionization time of the discharge device, a matter of microseconds, as compared with operating time of a relay which may be several milliseconds. This shortening of the unguarded interval reduces the possibility of double connections.

The cut-through relay 69 at its upper armatures and front contacts, extends the calling line through the finder brushes 37 and 38, through both windings in series of the impulse relay 33, to ground and grounded battery respectively. Also, the operation of the cut-through relay 69 at its armature 70 and front contact, closes a locking circuit for itself from the master ground, through its lower winding, resistor 71 to the negative side of battery. Also, the cut-through relay at its armature 70a and front contact applies master ground through the finder sleeve brush 39 and to the terminal 69' of the calling line (Fig. 1) thereby rendering the calling line busy and also locking up the cut-off relay 6. Master ground is also supplied through the armature 70 and front contact of the cut-through relay 69, conductor 72, normally closed off-normal contact 73 of the connector, lower winding of the primary motion delay relay 74 of the connector, to the negative side of battery. Relay 74 is of the slow-releasing type. As soon as relay 74 is operated, it applies a dial tone over conductor 75, armature and back contact of relay 102, front contact and armature of relay 74, conductor 76, condenser 77 and thence over the ring side of the link and the calling line to the calling subscriber's substation. This tone, of course, signals the calling subscriber that the dial-controlled apparatus is in condition to receive dialling impulses.

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If the finder busy test device 61 indicates a busy condition on the calling line, brought about by a connector seizing this line during the hunting interval, this device will not become conductive and the connector cut-through relay 69 (Fig. 3) in series with it, will not be energized. The talking connection will thus not be cut through and when the allotter advance relay 17 operates, as will be described, and the allotter delay relay 23 releases, the pre-impulsing ground will be removed, the connector battery feed and impulsing relay 30 and the connector delay relay 31 will also release and the release signal will be returned to the line finder release magnet 81 (at right of Fig. 2). This will release the link seized by the calling party and he will be able to talk through the connection established by the connector which had seized his line during the hunting interval.

Before describing the operation of the connector in seizing the called line in response to the dial impulses, it will be set forth how the allotter is released from this call in the course of the completion of the line finding operation and how the allotter preselects an idle link for a succeeding call. This is brought about when the allotter control relay 20 (Fig. 2) is operated, thereby completing a circuit from ground, upper front contact and armature of relay 19, inner armature and front contact of relay 20, conductor 22, winding of the slow operating relay 23 to the negative side of battery. This relay is slow to operate for the purpose of giving a sufficient interval of time for the finder busy test circuit including the device 61 to operate. As soon as the relay 23 does operate, it closes a circuit from ground on the lowermost front contact and armature of relay 20, lower front contact and armature of relay 23, upper winding of the relay 17, to the negative side of battery. The relay 17 is thus energized and at its upper, inner armature and back contact it opens the allotter start circuit which it will be recalled included the winding of the allotter start relay 19, thereby causing this relay to deenergize. Relay 17, at its lower armature and front contact, closes a locking circuit for itself through its upper winding and through its lower armature and front contact, to ground applied to conductor 78, through the armature and back contact of the allotter busy relay 79. It should be mentioned that this allotter busy relay 79 is normally operated as long as the link is idle but as soon as the link is taken for use, relay 79 deenergizes. The energizing circuit for the allotter busy relay 79 which is closed as long as the link associated with this relay is idle, extends from the negative side of battery, upper winding of the relay 79, the allotter brush 80 (at right of Fig. 2), armature and back contact of the finder release magnet 81, armature and back contact 82 of the connector release magnet, to be described, conductor 83, back contacts and armatures of relays 31 and 30 (Fig. 3) to ground. It will be noted that when the link is taken for use, this energizing circuit for the allotter busy relay 79 is interrupted at the armatures and back contacts of both relays 30 and 31. When allotter busy relay 79 releases, it places a ground on the conductor 70, this ground being applied over conductor 84, back contact and armature of the allotter start transfer relay 15, to ground. As soon as the relay 17 was energized, it interrupted the operating circuit of the allotter start relay 19. This relay deenergizes and at its uppermost armature and front contact interrupts the circuit which has been hold-

ing the slow operating relay 23 (Fig. 2) in its operated condition. When the relay 23 releases, it completes a circuit for advancing the allotter to seize an idle link. This operating circuit effects the energization of the relay 85 from the negative side of battery, winding of this relay, back contact and armature of the allotter motor magnet 86, conductor 87, back contact and armature of relay 23, armature 88 and front contact of relay 17, to ground potential that is now present on the conductor 78, as described above. Relay 85 is thus energized and at its front contact and armature, closes in multiple with its energizing circuit, an operating circuit for the motor magnet 86. This circuit extends from the negative side of battery, winding of this magnet, front contact and armature of relay 85 and thence over the conductor 87 and the remainder of the circuit, previously described, to ground potential present on the conductor 78. This operates the magnet 86 to advance the allotter. Also, the armature of the motor magnet 86 interrupts the circuit of the relay 85. Thus, the relay 85 and 86 operate together in a pulse assuring arrangement, sometimes referred to as flip-flop operation. Under the control of this arrangement, the allotter advances until the brush 80 of the allotter encounters the terminal associated with an idle link, which terminal will be characterized by the presence of ground potential thereon. This ground potential is applied over the conductor similar to conductor 83 and thence over back contacts and armatures of relays corresponding to 31 and 30 to ground. When an idle link is located, the mentioned ground potential is applied through the allotter brush 80, lowermost armature and front contact of relay 17, low resistance winding of the allotter busy relay 79 and the negative side of battery. Also, ground is applied through the upper high resistance winding of this relay to the negative side of battery. The completion of the circuit through the lower winding of this relay, which is of low resistance, insures that the relay will receive a surge of current, causing it to operate promptly. The operation of the relay 79, at its upper armature and back contact removes ground potential from the conductor 78 and thus insures that the relay 85 and the allotter motor magnet 86 cease to operate.

It will be recalled that at the point where the dial tone had been applied to the calling line to indicate that the connector was in readiness to receive dial impulses, the description was interrupted to explain how the allotter operated to assign an idle link for use. It will be understood, however, that in normal operation these operations take place simultaneously. On receiving the dial tone, the calling subscriber operates his dial sender to transmit impulses corresponding to the tens digit of the wanted number. In response to each of these tens digit, the impulse relay 30 releases its armature to complete a circuit for operating the primary stepping magnet 99 of the connector. This circuit extends from the negative side of battery, winding of this magnet, conductor 90, through the very low resistance winding (3 ohms) of the relay 74, its upper front contact and armature, front contact and armature of relay 31, back contact and armature of the impulse relay 30 to ground. In response to each of the tens impulses, the stepping magnet advances the tip, ring and sleeve brushes 91, 92 and 93 and connector hunt brush 94 and also the group brush 95 of the connector. As soon as the connector switch takes its first step off nor-

mal, it opens its off normal contact 73 (top center Fig. 3). This interrupts the initial operating circuit of the relay 74, insuring that this relay will not reoperate until the connector switch has been fully restored to normal. However the relay 74 is maintained operated through its upper winding during the reception of the remainder of the tens impulses. At the conclusion of the tens series of impulses, the relay 74 will deenergize because its locking circuit is interrupted at the back contact and armature of the impulse relay 30. As soon as the connector switch moved off normal in its primary direction, it closed a circuit through its normally open primary off normal contacts 97 and through its normally closed secondary off normal contacts 98, high resistance, lower winding of the slow releasing secondary delay relay 99, to the negative side of battery. This relay is thus energized preparatory to receiving the units series of impulses. Thus, when the impulse relay 30 responds to the units series of impulses, the secondary motor magnet 100 will be operated in a circuit extending from the negative side of battery, conductor 101, low resistance winding of relay 99, its front contact and armature, back contact and armature of relay 74, now released, front contact and armature of relay 31, back contact and armature of the impulse relay 30 to ground. Thus, in response to each unit impulse, the mentioned circuit will be completed to operate the secondary motor magnet which advances the brushes of the connector switch in their secondary direction. As soon as the secondary delay magnet 99 operated, it closed a circuit from ground through its armature 101 and front contact, lower winding of the slow releasing connector busy delay relay 102 to the negative side of battery. The operation of the relay 102 disconnects the dial tone and closes a break point in the test circuit. Consequently, when the secondary delay magnet 99 releases at the conclusion of the series of units impulses, thereby closing a second break point in the test circuit, and when the connector brush 93 is resting on the test terminal of the called line, the testing of that line can be effected. If the called line is idle, the starter anode 105 of arc discharge device 103 will become conducting in the same manner as the arc discharge device 61, as described above. When discharge device 103 becomes conducting, a circuit from the positive source of battery, anode 104, cathode 106 of the device, lower winding of the busy test relay 107, lower armature and front contact of relay 102, armature 108 and back contact of relay 99, conductor 109, connector brush 93, sleeve terminal 110 (Fig. 1), winding of cut-off relay 111 of the called line to the negative source of battery. The relay 107 is operated in this circuit and at its upper front contact and armature locks itself operated to master ground. The relay 107 at its uppermost armature and front contact applies ground over conductor 112, back contact and armature 108, conductor 109, connector brush 93, sleeve terminal 110, thereby locking up the cut-off relay 111. This application of ground to the sleeve terminal 110 of the called line makes this line permanently busy to any other link. Relay 107, when it operates, prevents the application of busy tone at its armature 113 and back contact. At the armatures 114 and 115 and front contacts of relay 107, the link is extended through the tip and ring brushes 91 and 92 of the connector to the terminals of the called line, in readi-

ness for applying the ringing current to this line.

If the connector arc discharge device 103 indicates a busy condition of the called line, this discharge device will not become conductive and the connector busy test relay 107 in series there- 5 with will not become energized. When the connector busy delay relay 102 then releases, busy tone will be extended through the armature 113 and back contact of the connector busy test relay 107, armature and back contact of the con- 10 nector busy delay relay 102, conductor 126, armature and back contact of the connector primary motion delay relay 74, conductor 76, and through condenser 77 to the ring side of the link and of the calling line.

Ringing current is now applied to the called subscriber's line from the ringing generator, through the ringing delay device 118, which af- 15 fords sufficient time for the ringing trip heater type gas tetrode 119 to become available for operation. The ringing circuit extends from the device 118, over conductor 120, upper armature and back contact of the ringing trip relay 121, conductor 122, armature 114 and front contact, through the tip brush 91 of the connector and 20 thence over the calling subscriber's line and station B, thence through the ring brush 92 of the connector, front contact and armature 115, conductor 123, armature and back contact of trip relay 121, resistor 124 to ground. Interrupted 30 superimposed ringing current is applied over the circuit just described to signal the called subscriber at B. During the time that the ringing current is being applied, a ringing tone is trans- 35 mitted back to the calling subscriber, this tone being applied over conductors 122 and 125, armature and front contact of relay 107, back contact and armature of relay 102, conductor 126, back contact and armature of relay 74, conductor 76, condenser 77 and to the ring side of the call- 40 ing end of the link to the calling subscriber's substation.

When the called party answers by removing his receiver from its switch-hook, a direct cur- 45 rent circuit is extended through the called substation B. This sets into operation the ringing trip circuit which may be described as follows: An electron discharge device 119 has been main- 50 tained in its non-conducting condition by means of the negative bias supplied over potentiometer 123 through resistor 120 to the control grid of this device. The alternating current voltage which exists across resistance 124 during the ringing period does not affect the bias of this tube since the cathode 119b and grid 119a are 55 maintained at the same potential being coupled on an alternating current basis by condenser 130. Thus, alternating voltage will not fire the tube. However, when direct current continuity is es- 60 tablished in the ringing circuit, as a result of the subscriber answering as just described, a constant drop occurs across resistance 124 which is negative as it is applied to the cathode of the ringing trip device 119. This in effect reduces the bias on the ringing trip device and the de- 65 vice becomes conductive. The conducting circuit then extends from the grounded side of resistance 124 through ringing trip device 119, con- 70 ductor 131, armature and front contact of relay 31, conductor 132, armature and back contact of relay 133, lower winding of ring trip relay 121, to a positive source of voltage of the order of 150 volts. When the ringing trip relay operates, it locks up to master ground at its uppermost arma- 75 ture and front contact. At its inner armatures

and front contacts, it closes break points in a circuit extending the battery through the wind- ings of the battery feed relay 133 to the called subscriber's line. At the armatures and back 5 contacts of relay 121, break points are introduced into the ringing circuit. The connection has thereby been established between the calling and the called subscriber's line in readiness for tele- phone conversation.

At the conclusion of the conversation when 10 the calling subscriber replaces his receiver on its switch-hook, the impulse relay 30 deenergizes. At its armature and front contact, it interrupts the circuit of the slow-releasing relay 31 which 15 on releasing disconnects master ground from the various circuits. This relay at its upper inner armature and back contact, applies a release ground to release conductors 134 and 83 which energize the connector release magnet 135 and 20 finder release magnet 31. These magnets, on operating, release the connector and the finder switches respectively, allowing them to return to their normal idle positions.

In systems of this type it is frequently desir- 25 able that a called subscriber be provided with two or more lines so that in the event that the first one of these lines is busy, a second or third will be available so that the subscriber can always be reached. This arrangement is commonly 30 known as consecutive number hunting, since in originating a call, the calling subscriber will dial the number assigned to the called subscriber and in the event that that line is busy, the con- 35 nector will hunt over the remaining lines of a group assigned to the given subscriber until a line is found that is idle. To achieve this end, a permanent ground is placed on the connector hunt multiple 135 of all numbers in the consecu- 40 tive group except the last. When the connector switch rests on the first number of the consecu- 45 tive group, ground is fed from the multiple bank contact 135 through connector hunt brush 94, conductor 136, back contact and armature of re- 50 lay 99, conductor 137, back contact and armature of relay 107, to conductor 138. This ground is ex- 55 tended to the busy delay relay 102 so that the busy test may be made over the regular busy test circuit. In the event that the first line in the consecutive group is busy, the electron discharge 60 device 103 will not become conductive and thus relay 107 will not be energized. The ground po- 65 tential is applied from conductors 138 and 139 through the back contact and armature of the connector secondary motor magnet 100 through 70 the winding of the connector pulse assuring relay 140 to negative battery. The operation of this re- 75 lay 140 completes a circuit through its front contact and armature, extending ground to the sec- 80 ondary motor magnet 100, thus advancing the switch to the second line in the group. The con- 85 nector sleeve brush 93 then rests on the second line in the consecutive group and the busy test is again applied in the same manner as described 90 previously. If the second line in the group is also busy, the relays 140 and 100 will operate to- 95 gether in the pulse assuring arrangement to ad- 100 vance the connector switch in its secondary mo- 105 tion until either an idle line is found and cut through by the conventional busy test operation 110 or if all the lines in the group are busy, ground no longer appears on connector hunt brush 94 and relay 102 will be deenergized to allow busy 115 tone to be applied to the calling subscriber's line. Relay 107 operates to interrupt the operating 120 circuit of magnet 100 when an idle line is found.

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Frequently in systems of this type, the connector is provided with a series of trunks leading to a distant exchange. In such a system, when a calling subscriber of the local exchange wishes to reach a distant exchange he will dial a single digit. In response to this single digit, the connector will operate to effect its group selection after which this connector will operate to hunt for an idle trunk in the group selected. This is accomplished in this system by extending a lead from one of the group multiples into all connectors in this office. In the connector circuit under discussion, this is lead number 141 (Fig. 3). Upon the completion of the series of tens impulse, ground is extended from master ground in the connector through normally opened primary off normal contacts 97, and the normally closed secondary off normal contacts 98 through back contact and armature of relay 74, conductor 142 to the connector brush 95. If the number dialed brings the connector brush 95 into contact with lead 141, the group is thus identified as a trunk group and the hunting circuit is energized. This circuit extends from negative battery through the winding of relay 140, armature and back contact of magnet 100, lead 139, armature and back contact of relay 107, lead 137, armature and front contact of relay 99, which is in its operated condition, conductor 141, connector brush 95, conductor 142, armature and back contact of relay 74, through the off normal contacts 97 and 98 to master ground. This sets into operation the pulse assuring arrangement of relay 140 and magnet 100 which act to advance the brushes in their secondary motion. As soon as the trunk group is reached, a circuit is completed for energizing relay 143. This circuit extends from negative battery through winding of relay 143, make before break contact of this relay, conductor 174, lead 141, connector brush 95, lead 142, armature and back contact of relay 74, the off normal contacts 97 and 98, to master ground. The operation of relay 143 acts to remove battery and ground respectively from relay 133 and to interconnect the windings of this relay so that it becomes merely an impedance across the called trunk. This interconnecting path extends from lead 144 to relay 133, through lead 145, armature and front contact of relay 30, lead 146, armature and front contact of relay 143, lead 147 to relay 133. The operation of relay 143 also extends ground through its armature and upper front contact, through lead 148 to energize the upper winding of relay 121, thus immediately tripping the ringing current and thereby preventing ringing current from going out on the trunk. The switch now hunts in the secondary motion direction. As soon as the switch moves off normal in its secondary direction, contact 98 opens, thus interrupting the circuit of relay 99. When this relay falls back, ground is continued from multiple bank terminals opposite the connector hunt brush 94 and pulsing is completed in the same manner as in consecutive number hunting, the busy test being applied at each step. When an idle trunk is found, the busy test device 103 becomes conductive and the talking connections are cut through to the trunk in the conventional manner.

Several safety features have been employed in the design of this system to protect the mechanism and circuits from extensive tie-ups due to failure of parts or dirty contacts in relays which hinder the closing through of circuits. One of these features involves the use of the gas filled

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cold cathode arc discharged device 58 which is also used to stop the line finder in its secondary hunt motion. It will be recalled that as soon as the master start ground is applied to the circuit by means of the group line relay 5, the allotter stop relay 19 (Fig. 2) is energized. The operation of this relay closes through a circuit extending from a positive source of voltage through variable resistance 170, front contact and armature 171 of relay 19, conductor 172, to condenser 173, thence over conductor 71, front contact and armature of relay 19, to ground. Resistance 170 is adjusted so as to permit condenser 173 to charge slowly and so that the rise in potential appearing across this condenser will not be sufficient to fire arc discharge device 58, this voltage being applied to starter anode 54 through protective resistance 176 until sufficient time has elapsed for the normal operation of the allotter and the line finder. If this time is exceeded, the firing of the device 58 will cause the operation of relay 20 as if the device had been fired through current flowing in winding 48 in a normal manner and the allotter will thus release. If, however, the allotter successfully completes its operation, the charge of condenser 173 will be removed upon the release of relay 19, over the path which can be traced from condenser 173 through conductor 172, back contact and armature of relay 19, through resistor 178 and back to condenser 173.

In the event that the line finder goes to the overflow position due to failure of the allotter transfer relay 21 or some failure in the secondary motion circuit, the arrival at the overflow position of the switch will close the overflow contact 150 (Fig. 2) in the switch itself which will return a ground through allotter brush 51 to the hunting lead 50 of the line finder. This pulse of ground will be transmitted through the armature 49 and front contact of relay 19 and through the primary winding 48 of the transformer. The voltage induced in the secondary winding 52 of the transformer initiates conductivity in the electron discharge device 58 which will again simulate the completion of the line finding operation. The allotter and line finder will be released as previously described and a new link will be seized.

This system is particularly adapted for use in remote and unattended branch exchanges. Therefore, adequate protective devices must be incorporated therein so that extensive tie-up of service will not occur. Since the relays in the first allotter are common to all the links in the systems, it is necessary to provide a secondary allotter which will function in the event of failure of the first. In order that this secondary allotter will not stand idle during functioning of the first allotter, the system is arranged so that each will serve one-half of the lines and one-half of the links in the system. A transfer circuit is incorporated which will allow the lines served by the first allotter to start the secondary allotter in the event of the failure of the first. If all the links served by the first allotter are busy, a ground is extended through normally open off-normal contacts 151 (upper left in Fig. 2) in series of all links served by the first allotter, through the lower winding of allotter start transfer relay 15, to negative side of battery. When this relay is energized, any master start ground which comes from the group line relays, such as 5, which are ordinarily served by the first allotter will be transferred to the master start lead 152 (Fig. 1) of

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the second allotter. Thus, the second allotter will respond to signals from all the lines in the system. When any link served by first allotter again becomes idle, allotter start transfer relay 15 will be deenergized and will again allow signaling from the group line relays ordinarily served by the first allotter to be transmitted into this allotter. If allotter start relay 15 is energized and a signal from any group line relay, such as 5 ordinarily served by the first allotter, is transmitted into the second allotter, the operation of the allotter start relay 19 in the second allotter, will complete its cycle of operation. This is effected by a circuit extending from ground through the lowermost armature and front contacts of an allotter start relay similar to relay 19 (at left of Fig. 2), conductor 192, armature and front contact of the number one allotter start transfer relay 15, the lower winding of this relay, to the negative side of the battery. This maintains allotter start transfer relay 15 in number one allotter in its operated position until the completion of the line finding operation and thus prevents this relay from being deenergized in case a link ordinarily served by this allotter becomes idle during that hunting period of the finder started by the number two allotter.

As soon as a group line relay similar to relay 5 is energized, a circuit is closed which energizes the allotter failure relay 154. The operation of this relay opens a contact which removes ground from the allotter failure circuit. This allows condenser 155 to start charging through resistors 156 and 179. The charging circuit extends from a positive source of voltage, of the order of 150 volts, through the upper winding of the allotter start transfer relay 15, through resistors 179 and 156 to condenser 155, and ground. In the event of mechanical failure of certain relays in the allotter circuit or mechanical failure of the allotter motor magnet 85 (Fig. 2), the allotter would not move to seize a new link and any subsequent calls would not be completed. The condenser 155 then charges through this circuit until the voltage on the starting anode 159 of the electron discharge device 160 (Fig. 1) becomes high enough to initiate conduction between the electrodes 162 and 163. When the electron discharge device becomes conductive, it energizes the allotter start transfer relay 15 through a circuit which extends from a positive source of voltage through the upper winding of this relay 15, key 164 through the anode 162 and cathode 163 of the electron discharge device 160 to ground. This acts to transfer the master start ground which comes from the group line relays ordinarily served by the first allotter to the master start lead 152 of the first allotter. The allotter start transfer relay 15 remains operated until the circuit through the electron discharge device 160 is broken at the manually operated key 164 by a repair man who is also signalled by the operation of this device. The completion of the line finding operation is indicated to the allotter failure circuit by the operation of the allotter control relay 20 and by the allotter advance relay 17 which close a circuit from ground in series with the armatures and front contacts of these relays over the lead 166 through resistors 157 and 156 to condenser 155. Condenser 155 is thus discharged through this path and prevents electron discharge device 160 from operating. The time interval allowed the line finder and allotter to complete their operations is determined by the magnitude of resistor 179. The completion of

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the line finding operation is also indicated by the operation of the cut-off relay 6 of the calling line and, in the event that no other lines in that group served by the first allotter are waiting to be found, allotter failure relay 154 is deenergized and a discharging ground is returned to condenser 155 through the armature and back contact of allotter failure relay 154.

A modified form of ringing trip arrangement or trigger circuit which can be substituted for that disclosed in Fig. 3, is shown in Fig. 6. In this arrangement, the voltage on the starter anode 181 of the gas-filled arc discharge device 180 is adjusted by means of the potentiometer P, to be within a few volts of the firing potential of the device. Superimposed, interrupted ringing current is applied to the called line through resistor 124 and condenser 186. During the ringing and silent periods the voltage drop across condenser 186 is negligible and thus the potential between the cathode 182 and starter anode 181 of the discharge device remains constant. When, however, the hook-switch at the called substation is closed and direct current flows in the line, a drop appears across resistor 124 and condenser 186, such that the cathode 182 of the discharge device becomes more negative. This brings the device to firing potential and it becomes conductive. The ring trip relay 121a operates in series with the discharge device and acts to disconnect the ringing current and to apply talking battery to the line in the manner similar to that shown in Fig. 3.

A further modified form of trigger circuit is shown in Fig. 7 which differs from the trigger or ringing trip circuit of Fig. 3 in the specific manner in which the tripping voltage is applied to the cathode 119b of the gas discharge device or Thyatron 119. In the arrangement of Fig. 7, the resistor 200 and the condenser 130 constitutes a voltage divider. With no direct current flowing through resistor 124, the grid 119a of the discharge device 119 is biased by means of a potentiometer 123 so that the discharge device does not conduct. Alternating current may also be passed through the resistor 124 and the discharge device still will not conduct, if the time constant of the resistor 200 and the condenser 130 is greater than the period of the alternating current. When direct current flows through the resistor 124 at the time when the called party answers by removing his receiver from its switchhook, a drop appears across resistor 124 as a result of which the condenser 130 is charged so that a negative voltage appears on the cathode 119b of the discharge tube. The vacuum or gas rectifier 201, as the case may be, in the cathode circuit of the discharge device 119, prevents the discharge of the condenser. The mentioned negative voltage present at the cathode 119b effectively reduces the bias on the discharge device 119 causing it to conduct. The rectifier tube 201 now passes the plate current of the discharge device 119, in a circuit from ground, through rectifier 201, cathode 119b, anode 119c of the arc discharge device 119, lower winding of relay 121a through armature 133a of relay 133, to the positive source of high voltage. Ringing trip relay 121 becomes energized to disconnect the ringing current and to cut through the connection from the calling line to the called line.

Resistor 124 may be made quite low so that any circuit associated with this trigger circuit will not be appreciably affected thereby. Re-

sistor 200 can be made quite high so that the trigger circuit is of such impedance as to have a negligible effect on any associated circuit.

If the present arrangement is used only to detect the presence of direct current and no alternating current discrimination is desired, condenser 130 can be omitted. Resistor 202 is inserted to dampen any relaxation oscillation.

It should be understood that the present disclosure is for the purpose of illustration only and that this invention includes all modifications and equivalents which fall within the scope of the appended claims.

What I claim is:

1. The method of initiating electrical conduction through an arc discharge device having an anode, a cathode and a starter electrode, said cathode and said anode being connected in series with a source of unidirectional electrical energy, which method comprises accumulating an electrostatic charge from a relative low voltage source, discharging said charge, utilizing said discharge to develop a voltage of a higher order, applying said higher voltage to the starter electrode to cause a discharge in said device.

2. The method of initiating electrical conduction through an arc discharge device having an anode, a cathode and a starter electrode, said cathode and said anode being connected in series with a source of unidirectional electrical energy which method comprises accumulating an electrostatic charge from a relative low voltage source, discharging said charge, inductively utilizing said discharge to develop a voltage of a higher order, applying said higher voltage to the starter electrode to cause a discharge in said device.

3. In a low voltage arrangement for initiating electrical conduction through an arc discharge device responsive only to voltage of a higher value, said arc discharge device comprising a cathode, an anode and a starter electrode enclosed in a gaseous atmosphere, a load unit and a source of unidirectional current connected in series with said anode and said cathode, said source having its positive and negative terminals respectively connected to said anode and said cathode, a step-up transformer having a primary winding and a secondary winding, said secondary winding being connected in circuit with said starter electrode, and means for causing varying current of relatively low voltage to flow through said primary winding.

4. In a low voltage arrangement for initiating electrical conduction through an arc discharge device responsive only to voltage of a higher value, said arc discharge device comprising a cathode, an anode and a starter electrode enclosed in a gaseous atmosphere, a load unit and a source of unidirectional current connected in series with said anode and said cathode, said source having its positive and negative terminals respectively connected to said anode and said cathode, a step-up transformer having a primary winding and a secondary winding, said secondary winding being connected in circuit with said starter electrode, a condenser, means including a relatively low voltage source of electrical energy for charging said condenser, and means for discharging said condenser through said primary winding.

5. In a telephone system, a line having a terminal, means for associating an electrostatic charge with said terminal when said line is to be selected, a movable switch for selecting such line, means for moving said switch to engage said ter-

5 minial, an arc discharge device having an anode, a cathode and a starter electrode enclosed in a gaseous atmosphere, a unidirectional source of electrical energy, a circuit including said source as well as said cathode, said anode and the gaseous atmosphere, whereby current flows in said circuit when an arc discharge is initiated in said device, means for discharging said electrostatic charge responsive to the engagement of said switch with said terminal, and means responsive to said discharge for applying a starting potential to said starter electrode to effect arc discharge in said device, and means for stopping said switch operated in response to current flowing in said circuit.

6. In a telephone system, a line having a terminal, means for associating an electrostatic charge with said terminal when said line is to be selected, a movable switch for selecting such line, means for moving said switch to engage said terminal, an arc discharge device having an anode, a cathode and a starter anode enclosed in a gaseous atmosphere, a unidirectional source of electrical energy, a circuit including said source as well as said cathode, said anode and the gaseous atmosphere, when an arc discharge is initiated in said device, means for discharging said electrostatic charge responsive to the engagement of said switch with said terminal, and means including a step-up transformer responsive to said discharge for applying a starting voltage to said starter anode to effect arc discharge in said device, and means for stopping said switch operated in response to the arc discharge in said device.

7. In a telephone system, a telephone line comprising tip, ring and hunt conductors, contacts in which said conductors respectively terminate, a switch having tip, ring and hunting brushes movable into engagement respectively with said tip, ring and hunt contacts, operating means for moving said switch brushes into engagement with said contacts, a condenser and a resistor connected in multiple, a circuit closed responsive to the initiation of a call on said line, said circuit including a battery as well as said tip and ring conductors in series with the multiple-connected resistor and condenser whereby said condenser becomes charged, said hunt contact being connected to one terminal of said condenser, an arc discharge device including a cathode, an anode and a starter anode enclosed in a gaseous atmosphere, a stopping relay, a discharge circuit including a source of unidirectional electrical energy in series with said relay and also in series with said cathode and said anode as well as the space therebetween, a step-up transformer having a primary winding and a secondary winding, a circuit including said secondary winding and said starter anode, a circuit including said primary winding, said hunting brush and said hunt terminal and also said condenser whereby said condenser discharges through said primary winding, and means including said relay for stopping said operating means.

8. In a telephone system, a telephone line comprising tip, ring and an associated hunt conductor, contacts in which said conductors respectively terminate, a switch having tip, ring and hunting brushes movable into engagement respectively with said tip, ring and hunt contacts, operating means for moving said switch brushes into engagement with said contacts, overflow contacts closed as a result of a predetermined movement of said switch, a condenser and a resistor

connected in multiple, a circuit closed responsive to the initiation of a call on said line, said circuit including battery as well as said tip and ring conductors in series with the multiple-connected resistor and condenser whereby said condenser becomes charged, said hunt contact being connected to one terminal of said condenser, an arc discharge device including a cathode, an anode and a starter anode enclosed in a gaseous atmosphere, a stopping relay, a discharge circuit including a source of unidirectional electrical energy in series with said relay and also in series with said cathode and said anode as well as the space therebetween, a step-up transformer having a primary winding and a secondary winding, a circuit including said secondary winding and said starter anode, a circuit including said primary winding, said hunting brush and said hunt terminal and also said condenser whereby said condenser discharges through said primary winding, means responsive to the closure of said overflow contacts for transmitting current through said primary winding whereby the discharge circuit is closed through said device, and means including said relay for stopping said operating means.

9. In a telephone system, a group of telephone lines, each having a pair of talking conductors, a group relay common to said group of lines, said relay having one terminal of its winding connected to one pole of battery and having its other terminal connectable in series with the talking conductors of any one of said lines on the initiation of a call thereon, a hunt conductor for each line terminating in a hunt contact and normally connected to one of said talking conductors of its line, a condenser and a resistor each having a pair of terminals, the first terminal of each pair being connected in common to said hunt conductor and the second terminal of each pair being connected in common to the other pole of battery, whereby said conductor becomes charged, a cut-off relay individual to each line and effective on operation to disconnect said group relay and to disconnect the hunt conductor from said talking conductor, a switch for seizing a line characterized by a charged condenser, said switch having brushes including a hunt brush movable into successive engagement with the hunt contacts of said lines, means for moving said switch brushes, means responsive to the engagement of the hunt brush with the hunt contact connected to said charged condenser for causing said switch to seize said line, and means responsive to the seizure of said line for operating the cut-off relay thereof.

10. In a telephone system, a line, means for characterizing said line as idle by a negative voltage of a given value and for characterizing said line as busy by a negative voltage of a lesser value, a test circuit, an arc discharge device included in said circuit, said arc discharge device comprising a cathode, an anode and a starter anode enclosed in a gaseous atmosphere, a source of relative high positive voltage connected to said anode, means for connecting said cathode to said line, a voltage divider having its fixed terminals connected respectively to said anode and to said cathode and having its movable element connected to said starter anode, said movable element being adjusted so that the starter anode has a starting voltage of such value applied thereto that it renders said device conducting when said cathode is connected to the line when characterized as idle but the starter anode has a volt-

age of such low value applied thereto that it fails to render said device conducting when the cathode is connected with the line characterized as busy, and means controlled by the conducting condition of said device for indicating the idle condition of said line.

11. In a telephone system, a line having a terminal, means for associating an electrostatic charge with said terminal when said line is to be selected, a movable switch for selecting such line, means for moving said switch to engage said terminal, an arc discharge device having an anode, a cathode and a starter anode enclosed in a gaseous atmosphere, a unidirectional source of electrical energy, a circuit including said source as well as said cathode, said anode and the gaseous atmosphere, whereby current flows in said circuit when an arc discharge is initiated in said device, means for discharging said electrostatic charge responsive to the engagement of said switch with said terminal, means responsive to said discharge for applying a starting potential to said starter anode to operate said arc discharge device, means including a condenser having a delayed charging rate for applying a starting potential to said starter anode after a predetermined interval to effect arc discharge in said device, and means for rendering said condenser ineffective as a result of the normal operation of said arc discharge device in response to the discharge of said electrostatic charge, and means for stopping said switch operated in response to current flowing in said circuit.

12. In a ringing trip arrangement, a conductor having a source of alternating current superimposed on direct current connected thereto, said conductor during a first period being connected in a circuit continuous only to alternating current and being connected during a second period in a second circuit continuous to direct current, a discharge device having a cathode, an anode and a control electrode, an anode circuit including said anode, said cathode, a ringing trip relay and also a source of current, means for biasing said control electrode to a degree that said device does not conduct during said first period, and means responsive to the flow of direct current through said conductor during the second period for rendering said cathode negative with respect to its condition during said first period whereby the bias on said device is effectively reduced so that the device becomes conducting and the trip relay operates.

13. In a ringing trip arrangement, a conductor having a source of alternating current superimposed on direct current connected thereto, said conductor during a first period being connected in a circuit continuous only to alternating current and being connected during a second period in a second circuit continuous to direct current, a resistor connected in series with said conductor, a discharge device having a cathode, an anode and a control electrode, an anode circuit including said anode, said cathode, a ringing trip relay and also a relatively high voltage source of current, a second resistor and a condenser connected in series and placed across the terminals of said first resistor, one terminal of the condenser being connected to the positive side of said direct current source, and a rectifier tube having a cathode and an anode, the anode of said rectifier being connected to the cathode of said device and the cathode of the rectifier being connected to the positive side of said direct current source.

14. In a ringing trip arrangement, a wanted

telephone line, a conductor, a source of ringing current, a ringing trip relay for controlling the connection of said source of ringing current to said conductor, means for connecting said conductor to said wanted telephone line in the course of extending a telephone call to said line whereby said line is signalled, an electron discharge device having at least a cathode, and an anode, an anode circuit including said anode, said ringing trip relay and a source of current, means responsive to the answering of the signal on the wanted line for causing said discharge device to pass sufficient current to operate said relay whereby the source of ringing current is disconnected from said wanted line.

15. In a ringing trip arrangement, a wanted telephone line, a conductor, a source of ringing current, a ringing trip relay for controlling the connection of said source of ringing current to said conductor, means for connecting said conductor to said wanted telephone line in the course of extending a telephone call to said line whereby said line is signalled, an electron discharge device having a cathode, a control electrode and an anode, an anode circuit including said cathode, said anode, said ringing trip relay and a source of current, means for applying a bias to said control electrode whereby said device does not pass current, means responsive to the answering of the signal on the wanted line for overcoming said bias whereby said discharge device passes sufficient current to operate said relay thereby disconnecting the ringing current from said wanted line.

16. In an arrangement for discriminating between the flow of alternating current and direct current in a given circuit, a discharge device including a cathode together with an anode constituting an electric discharge path, said device also including a control electrode, means normally biasing said control electrode to a value whereby said device does not discharge, a network comprising a capacitor and a resistor together having a period or time constant of a given value, a source of alternating current of shorter period than that of said network and a source of direct current to be discriminated, a second resistor connected in said circuit through which either said alternating current or said direct current can be caused to flow, means for applying to said network the drop across said second resistor due to direct current flow therethrough whereby said capacitor is charged, means for connecting the negative terminal of said capacitor to said cathode, a cathode circuit connected to said cathode, a rectifier connected in said cathode circuit to prevent unwanted discharge of said capacitor, a relay connected in said discharge path to be operated by the electric discharge therethrough, and means responsive to the operation of said relay for stopping the flow

of alternating current through said second resistor.

17. In an arrangement for initiating electrical conduction through a discharge path, a discharge device including a cathode together with an anode constituting said discharge path, said device also including a control electrode, means normally biasing said control electrode to a value whereby said device does not discharge, a network comprising a capacitor and a resistor together having a period or time constant of a given value, a source of alternating current of shorter period than that of said network, a source of direct current, a second resistor through which either said alternating current or said direct current can be caused to flow, means for applying to said network the drop across said second resistor due to direct current flow therethrough whereby said capacitor is charged, means for connecting the negative terminal of said capacitor to said cathode, a cathode circuit connected to said cathode, and a rectifier connected in said cathode circuit to prevent unwanted discharge of said capacitor.

18. In an arrangement for initiating electrical conduction through a discharge path, a discharge device including a cathode together with an anode constituting said discharge path, said device also including a control electrode, means normally biasing said control electrode to a value whereby said device does not conduct, a cathode circuit connected to said cathode, and means for applying a negative potential to said cathode whereby the bias applied to said device is effectively reduced and it becomes conducting.

19. In an arrangement for initiating electrical conduction through a discharge path, a discharge device including a cathode together with an anode constituting said discharge path, said device also including a control electrode, means normally biasing said control electrode to a value whereby said device does not conduct, a cathode circuit connected to said cathode, a rectifier connected in said cathode circuit, and means for applying a negative potential to said cathode whereby the bias applied to said device is effectively reduced and it becomes conducting.

20. In an arrangement for initiating electrical conduction through a discharge path, a discharge device including a cathode together with an anode constituting said discharge path, said device also including a control electrode, means normally biasing said control electrode to a value whereby said device does not conduct, a cathode circuit connected to said cathode, an anode circuit connected to said anode, a rectifier connected in said cathode circuit and connected to said anode circuit, and means for applying a negative potential to said cathode whereby the bias applied to said device is effectively reduced and it becomes conducting.

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