March 24, 1931. W. T. POWELL 1,797,926

AUTOMATIC TELEPHONE SYSTEM

Filed Dec. 10, 1928 2 Sheets-Sheet 1

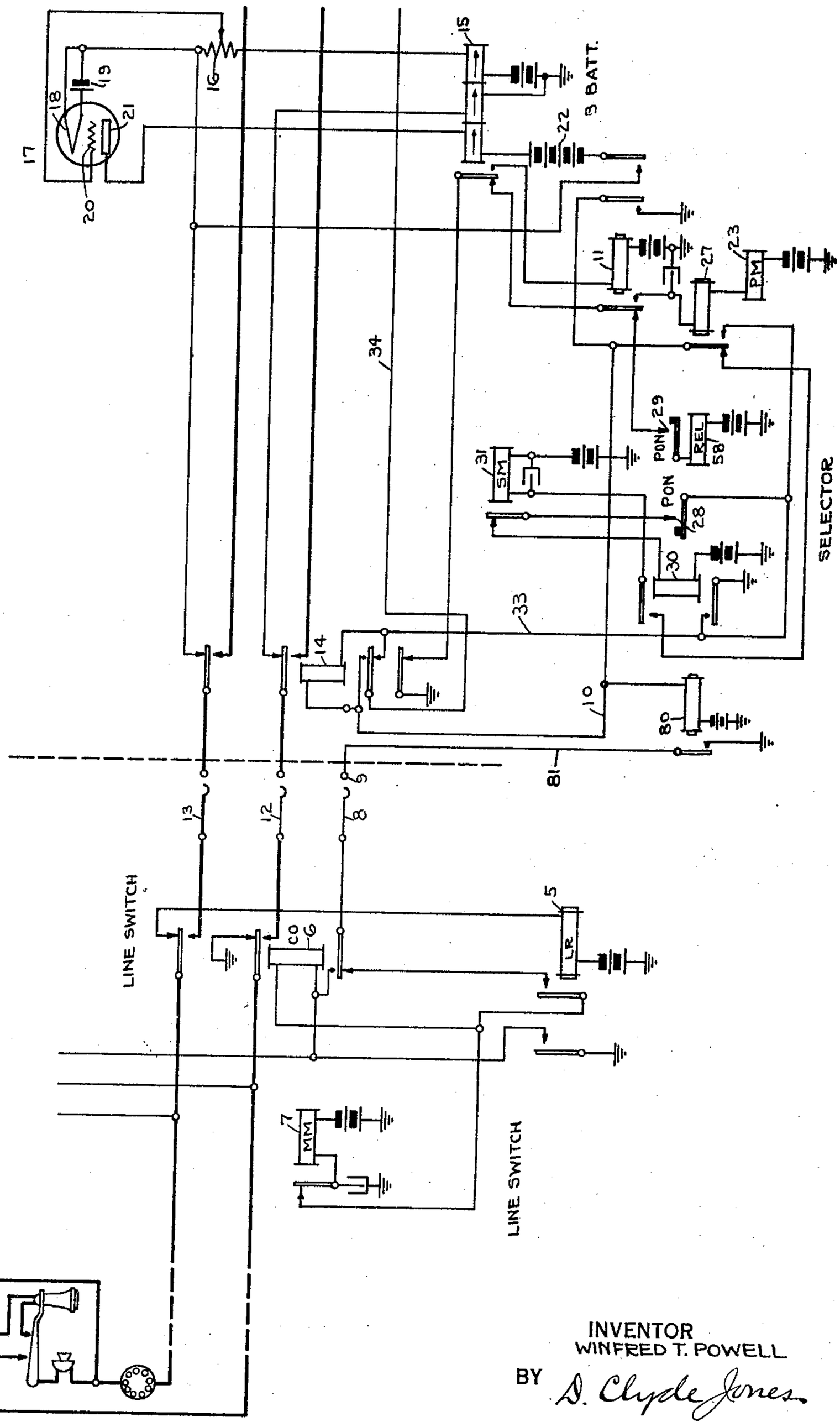

FIG. 1

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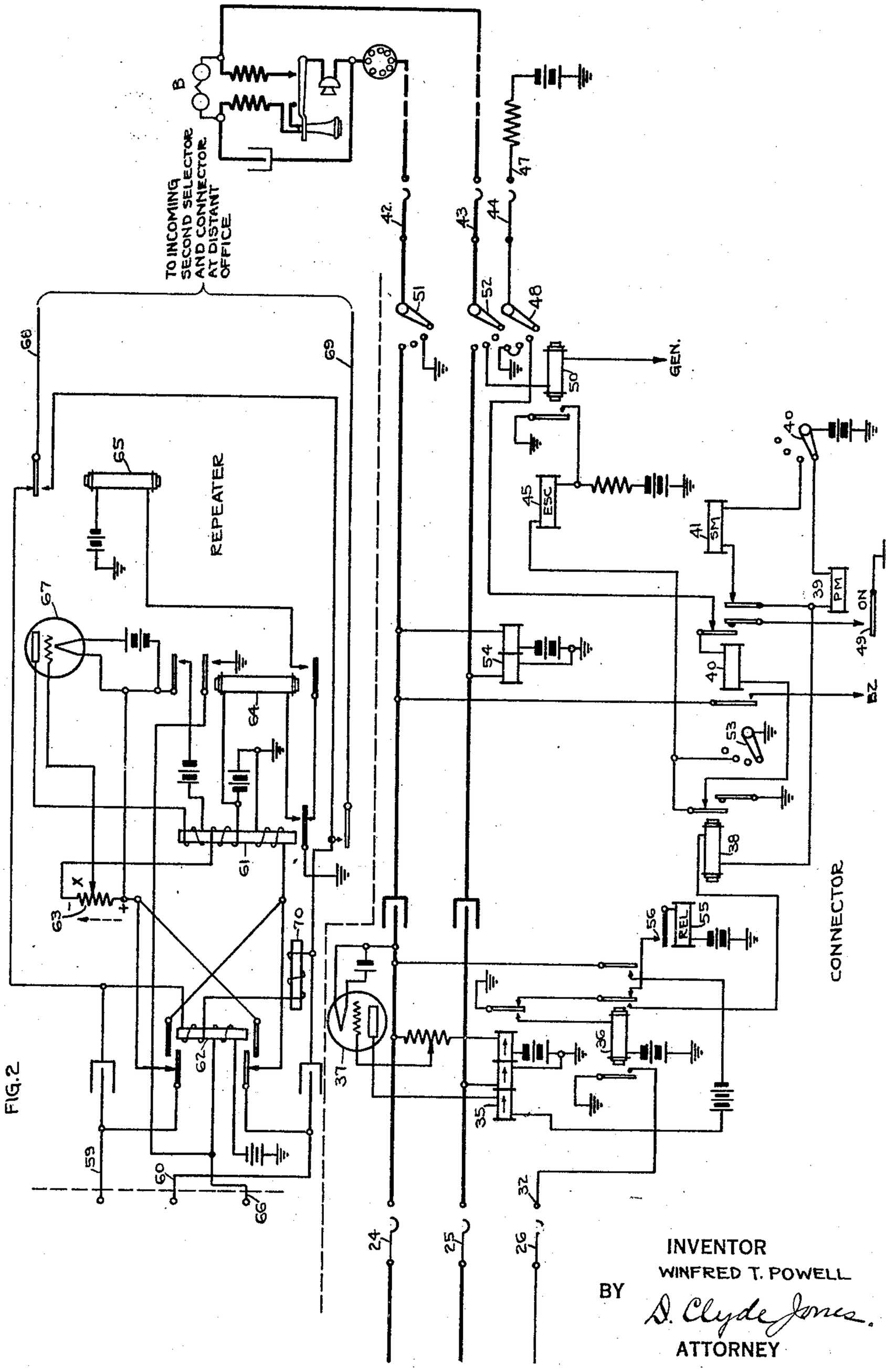

FIG. 2

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UNITED STATES PATENT OFFICE

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AUTOMATIC TELEPHONE SYSTEM

Application filed December 10, 1928. Serial No. 324,930.

This invention relates to telephone systems and more particularly to telephone systems in which automatic switches are directively operated by impulses.

In former automatic telephone systems much difficulty has been encountered in obtaining uniform transmission of impulses over long or short subscribers' telephone lines or impulse circuits. Where the telephone line or subscriber's "loop" is long or has high resistance the impulses become greatly attenuated whereas with short telephone lines or subscribers' "loops" impulses are only slightly attenuated and are therefore strong. The impulse receiving or repeating equipment such as an impulse relay must therefore be designed to respond to such weak and strong impulses which necessitates wide marginal limits of the impulse relay or impulse receiving equipment. This condition not only requires a very careful adjustment of the impulse relay but also constant attention so that the impulse relay will operate an automatic switch or switches reliably on signals received under these two extreme conditions. Even with this care it is necessary to employ additional repeating equipment or relaying devices to take care of extremely long telephone lines to which the impulse relay cannot be satisfactorily adjusted.

In accordance with the present invention it is proposed to compensate or strengthen weak signals to a predetermined strength whereas strong signals transmitted over the short lines are not strengthened. The invention consists in the use of electrical means which compensates for variations in the signals by augmenting the signals an amount inversely proportional to their strength so that all signals have substantially an equal effect on the impulse relay or other impulse receiving equipment.

A further feature of the invention relates to a delayed release of the primary trunk of a connection so that if the calling subscriber immediately initiates a second call, this primary trunk is available for use.

For a clearer understanding of the invention reference is made to the drawings in which that portion of Fig. 1 at the left of the broken line represents a subscriber's telephone line and its associated line switch while at the right of the broken line of Fig. 1 there is represented a selector switch having incorporated therein circuits of the present invention. At the right and above the broken line of Fig. 2 there is represented a repeater incorporating the features of the present invention while below the broken line there is represented a connector leading to a called subscriber's line.

The line switches, selectors and connectors referred to in this disclosure are of the type now well known in the art.

It is believed that the invention will best be understood by tracing the operations that take place in establishing different types of telephone connections. Let it be assumed that a calling subscriber whose telephone line is represented at A desires to establish a telephone connection to a called subscriber whose telephone line indicated at B terminates in the same office as the calling line so that in the case of this call, conditions are such that it is not necessary to employ an arrangement now known in the art as a repeater.

When the subscriber at A initiates a call by removing his telephone receiver from its switchhook the slow releasing line relay 5 is operated over the two sides of the subscriber's telephone line or loop in series, through the armatures and back contacts of cut-off relay 6. With the line relay 5 operated, the motor magnet 7 which progressively advances the brushes 8, 12 and 13 of the line switch, is actuated in a circuit extending from grounded battery through its winding, armature and back contact, armature and front contact of relay 5, test brush 8 of the line switch to ground, over the test terminal such as 9 of a busy trunk, which ground is applied to this test terminal, over conductor 81, left hand armature and front contact of the slow releasing relay 80, individual to the busy trunk. A circuit in multiple of that just described extends from grounded battery, winding of the motor magnet 7, its armature and back contact, winding of the cut-off relay 6, outer front contact and armature of the line relay 5 to ground. This last described circuit is ineffective to op-

erate the cut-off relay 6 at this time since this relay is shunted by the ground connection associated with the test terminals of busy trunks as long as the line switch is testing such terminals. Let it be assumed that the first idle trunk encountered is that shown at the right in Fig. 1, which idle condition is indicated by the absence of ground potential on its test terminal 9. Under this condition the motor magnet 7 no longer has its operating circuit completed and consequently does not advance the line switch brushes 8, 12 and 13 and the short circuit about the cut-off relay 6 is no longer effective so this relay is energized in the circuit previously described. When operated relay 6 closes a locking circuit for itself including the motor magnet 7, its winding, lower front contact and armature, test brush 8, test terminal 9 and thence to ground at the inner right hand armature and front contact of relay 80 when this relay is operated as will be described. As soon as cut-off relay 6 is energized it closes its upper armatures and front contacts to extend the subscriber's telephone line through the line switch brushes 12, and 13, through the upper armatures and back contacts of relay 14, through the middle winding of relay 15 to ground and through the resistance element of rheostat 16 and right hand winding of relay 15 to grounded battery. This circuit operates the relay 15 and thereby completes an actuating circuit for slow releasing relay 11 from grounded battery through its winding, front contact of relay 15, lowermost contact and armature of relay 14 to ground. It will be noted that the impulse relay 15 has its windings so arranged as indicated by arrows that the flux developed by each is effective in the same direction.

The operations just disclosed which take place in the course of the selection of an idle trunk are executed in a very short time so that when the subscriber at substation A actuates the impulse device associated therewith the selector circuits of Fig. 1 are in readiness to receive the first series of impulses. It will first be assumed that the subscriber's line A is a long line with the resulting maximum attenuation of the signal so that a small current flows through the resistance unit 16 and the right hand windings of relay 15. The relay 15 is adjusted to operate properly with this current flow when reenforced by the current flow through its left hand winding as will be described. It will be noted that a vacuum tube 17 or other suitable electron discharge device is associated with the selector circuit. This device has a cathode 18 energized from any suitable source as from 19 and is also provided with a control electrode 20 and an anode 21. The anode 21 is connected in series with the left hand winding of relay 15, a B-battery 22 and thence through the outermost right hand armature and front contact of relay 11 to the cathode. The control electrode 20 is connected to an adjustable contact of rheostat 16. It will be recalled that the impulse circuit extending to the right hand windings of relay 15 includes the resistance unit 16, and in case of this long line the current flow therethrough is attenuated. The current flowing through the resistance 16 is sufficiently low so that the potential drop across it is not sufficient to bias the control electrode of the vacuum tube to prevent current flowing in its anode circuit which it will be remembered includes the left hand winding of relay 15. Therefore this anode current develops a flux of the same polarity as the other two windings as indicated by the arrows. Consequently the impulse is reenforced or compensated so that the impulse relay 15 is effectively operated in response to each impulse.

Let it now be assumed that the subscriber's line A is a short line. The current flows in the impulse circuit through the resistance 16 and the right hand windings of relay 15 and will be correspondingly greater than in the case of the long subscriber's line and consequently there will be a larger drop in potential across the resistance 16, thereby producing a more negative bias on the control element of the vacuum tube. This reduces the current flow in the anode circuit including the left hand winding of relay 15 and the magnetizing force of its armature is thereby reduced to a predetermined amount.

From the foregoing description it will be seen that the vacuum tube 17 with its associated circuits operates as a self-regulator or compensator for the adjustment of the impulse relay 15 causing this relay to attract its armature with uniform pull in spite of the fact that it is connected to telephone lines of different constants or characteristics.

With the relay 15 energized in the manner described, a slow releasing relay 11 is operated from grounded battery, its winding, front contact and armature of relay 15, lowermost contact and armature of relay 14 to ground. The relay 11 when operated causes relay 80 to apply a busy potential and a holding ground to the test terminal 9 of this trunk as previously mentioned. Relay 11 at its left hand armature and front contact closes a break point in the operating circuit of the primary motor magnet of the selector switch.

When the subscriber at substation A operates his impulse sender in accordance with the first digit of the called subscriber's line, the impulse relay 15 responds to each of these impulses and at each retraction of its armature, completes an operating circuit for the primary motor magnet 23 of the selector causing this magnet to elevate the selector brushes 24, 25, and 26 one step in their primary direction. This operating circuit is

traced from grounded battery, winding of the motor magnet 23, winding of the slow releasing change-over relay 27, front contact and armature of relay 11, back contact and armature of relay 15, lower back contact and armature of relay 14 to ground. As is well known the slow releasing change-over relay 27 is energized on the first retraction of the armature of the impulse relay 15 and remains energized until the close of this series of impulses. The primary motor magnet is operated in this circuit each time that the impulse relay responds to an impulse from the impulse sender. At the close of the series of impulses the relay 15 holds its armature retracted for a relatively long interval which causes the deenergization of the slow releasing relay 27. As soon as the selector switch has made one step in its primary movement the primary off normal sets of contacts 28 and 29 are closed and as soon as the change-over relay 27 is energized, the relay 30 has its operating circuit completed from grounded battery, winding of this relay, back contact and armature of the secondary motor magnet 31 and primary off normal contacts 28, inner front contact and armature of relay 27, inner armature and front contact of relay 11 to ground. As soon as the relay 30 is energized it closes a locking circuit for itself through its lower front contact and armature, which circuit is independent of the control of change-over relay 27. The operation of the relay 30 also closes a break point in the driving circuit of the secondary motor magnet 31 but this circuit is ineffective until the change-over relay 27 deenergizes at the close of the first series of impulses at which time the secondary motor magnet begins to advance the selector brushes 24, 25 and 26 in their secondary movement. The driving circuit of the secondary motor magnet is closed from grounded battery, winding of this magnet, upper armature and contact of relay 30, armature and back contact of relay 27, front contact and armature of relay 11 to ground. When the secondary motor magnet is energized in this manner, it opens the locking circuit of the relay 30 and advances the selector brushes into engagement with the first trunk of the selected group. If this trunk is busy, its test terminal corresponding to test terminal 32 is characterized by the presence of ground potential so that the relay 30 is now operated from grounded battery, winding of this relay, back contact and armature of secondary motor magnet 31, contacts 28, conductor 33, back contact and armature of relay 14, conductor 34, test brush 26 and thence to ground over the test terminal of the busy trunk. The operation of the relay 30 again closes the driving circuit for the motor magnet 31 whereupon it advances the selector brushes into engagement with a second trunk and opens the operating circuit of relay 30 and the motor magnet 31 continues until the test brush 26 encounters the test terminal of an idle trunk which is characterized by the absence of ground potential. It will be assumed that the first idle trunk is that shown in the lower part of Fig. 2. At this time the relay 14 is actuated in a circuit from grounded battery, winding of relay 30, back contact and armature of magnet 31, contacts 28, conductor 33, winding of relay 14, conductor 10 to ground at the armature and front contact of relay 11. Relay 14 when operated at its upper armature and back contacts disconnects the impulse relay 15 of the first selector from the calling subscriber's line and extends this line through its upper armatures and front contacts to ground and grounded battery through the right hand windings of the impulse relay 35 of the connector switch. Also when relay 14 is operated it closes a locking circuit for itself through its inner lower front contact and armature, holding conductor 34, test brush 26, test terminal 32 of the selected trunk to ground at the front contact and armature of the slow releasing relay 36 which attracts its armature as soon as the impulse relay 35 is operated. Relay 80 is now held over conductors 10 and 34.

The connector switch is now in readiness to receive the tens series of impulses from the impulse sender at the calling substation. The vacuum tube or electron discharge device 37 with the left hand winding on the impulse relay 35, functions in the same manner as the corresponding equipment at the selector switch and compensates or reenforces weak signals. In response to each of the tens series of impulses, the impulse relay 35 retracts its armature and thereby closes a circuit from ground, its armature and back contact, armature and front contact of relay 36, winding of change-over relay 38, winding of primary motor magnet 39, side switch wiper 40 in its first position, to grounded battery. The change-over relay is energized on the first completion of this circuit and remains energized during this series of impulses while primary motor magnet 39 in response to each completion of this circuit advances the connector brushes 42, 43 and 44 one step in their primary direction. At the close of the series of tens impulses the impulse relay 35 holds its armature attracted, causing the change-over relay 38, which has been holding the escape magnet 45 operated, to deenergize. The escape magnet 45 then deenergizes and moves the side switch wipers into their second position. The connector circuits are now in readiness to receive the units series of impulses and in response to each impulse a circuit is closed from ground, armature and back contact of impulse relay 35, armature and front contact of relay 36 winding of the change-over relay 38, outer

armature and back contact of test relay 40, winding of the secondary motor magnet 41, side switch wiper 40 in its second position to grounded battery. The change-over relay 38 is energized on the first impulse of this series and remains energized until the close of this series of impulses. In response to each of these units impulses the secondary motor magnet 41 advances the brushes 42, 43, and 44 one step in their secondary movement. At the close of these series of impulses the called line is tested.

In the event that the called line is busy, its test terminal 47 will be characterized by a ground potential so that the escape magnet 45 will be held operated even when the relay 38 deenergizes at the close of the series of impulses. This holding circuit for the escape magnet is closed from grounded battery, resistance unit, winding of escape magnet 45, continuity spring and back contact of relay 38, winding of test relay 40, its continuity spring and back contact, side switch wiper 48 in its second position, test brush 44 and test terminal 47 to ground. The test relay 40 is operated in its circuit and completes a locking circuit for itself and the escape-magnet through its continuity spring and off-normal contacts 48, to ground. With the test relay 40 operated, a source of busy tone current BZ is connected through its left hand contact and armature to the trunk which terminates in this connector switch from which trunk it is transmitted over the portion of the connection already established to the calling substation where the calling subscriber hears the busy signal and releases the connection in a manner to be described.

Let it be assumed that the called line is idle when it is tested at the close of the units series of impulses, under which assumption, there is an absence of ground potential on its test terminal 47 which prevents the test relay 40 from energizing and causes the escape-magnet to deenergize and move the side switch wipers into their third position where ringing current is applied to the called line. This ringing current is supplied through the trip relay 50 and the side switch wipers 51 and 52 and thence to the ringer at the called substation over the subscriber's loop. Also as soon as the side switch wipers move to their third position escape-magnet 45 is operated in a circuit completed through the side switch wiper 53. When the called subscriber at B answers, the trip relay 50 is energized and at its armature and contact closes a circuit which short circuits the escape-magnet 45 causing it to deenergize and thereby move the side switch wipers to their talking position. Talking current is supplied to the calling subscriber's line through the right hand windings of the impulse relay 35, while talking current is supplied to the called subscriber through the windings of the impedance coil 54.

At the close of the conversation when the calling subscriber at station A replaces the receiver on its switchhook, the impulse relay 35 deenergizes and the slow releasing relay 36 deenergizes which is effective to close an operating circuit for the release magnet 55 from grounded battery, its winding, off-normal contacts 56, back contacts and armatures of relays 35 and 36 to ground. The release magnet operates in the well known manner to restore the connector brushes 42, 43 and 44 to their normal positions and also restores the side switch wipers to position 1. Also when the relay 36 deenergizes it removes ground from the test terminal 32 which has served as a guarding potential for this connector switch and has also served as a holding ground for the selector switch. The opening of this holding circuit releases the relay 14, which has been holding the selector, to operate the release magnet 58 from grounded battery, winding of the release magnet, off-normal contacts 29, back contact and armatures of relays 11, 15, and 14 for releasing the selector. The slow releasing relay 80 held operated over conductor 34 in multiple with relay 14 releases much more slowly than relay 14 so that the holding control of the conductor 81 is maintained for a substantial interval after the release of the connector. This feature known as delayed disconnect of the primary trunk will be more fully described hereinafter.

The present invention may be used with a repeater such as is shown above the dotted line in Fig. 2 which repeater is employed in connection with the repeating or relaying of impulses over a long trunk to an incoming second selector located at a distant office. In the case of a call to such an office, the line switch and selector of Fig. 1 are operated in the manner previously described except that the selector is advanced to select an idle repeater such as shown in Fig. 2.

As soon as this repeater is seized by the first selector the calling subscriber's line is extended through the brushes 12 and 13 of the line switch and the selector brushes 24 and 25 to the conductors 59 and 60 of the trunk and thence through the two lower windings of the impulse relay 61, conductor 59 leading through the upper continuity spring and back contact of relay 62, through the resistance unit 63 and middle winding of relay 61 to grounded battery, while trunk conductor 60 is extended through the lower continuity spring and back contact of relay 62 and lower winding of relay 61 to ground. The impulse relay 61 is energized over this circuit and the slow releasing relay 64 has its energizing circuit completed from grounded battery, its winding, inner front contact and armature of relay 61 to ground, thereby causing this relay

to attract its armatures. This prepares a circuit for the slow releasing relay 65 which attracts its armature during impulsing to close a break point in the circuit over which impulses are repeated to the incoming second selector (not shown). As soon as the relay 64 attracts its armature it applies a holding ground to the holding conductor 66 of the trunk which holding ground is applied at the inner front contact and armature of relay 64. In the event that the repeater has been connected to a long telephone line there will be a relatively small drop in potential cross the resistance unit 63 so that the control element of the vacuum tube or electrode discharge device 67 is affected in such a way that current in the anode circuit including the upper winding of the relay 61 supplements the effect of current over the impulse circuit and thereby compensates for the weak impulse current. In the event that the repeater has been connected to a short telephone line the drop in potential across the resistance unit 63 will be large so that the control electrode of the vacuum tube 67 will be biased in such a way that the anode current will be relatively small and therefore effect a uniform attraction of the armature of impulse relay 61 under all conditions. In response to the impulses from the impulse transmitter from the calling subscriber's substation the impulse relay 61 vibrates its lowermost armature to cause intermittent makes and breaks in the impulse repeating circuit to the incoming second selector which circuit includes conductor 68, upper armature and front contact of relay 65, lowermost front contact and armature of relay 61 and conductor 69.

It is believed unnecessary to disclose the circuits of the incoming second selector or the final connector switch into which it operates, since they are substantially similar to the first selector shown in Fig. 1 and the connector shown in the lower part of Fig. 2. It is sufficient to state however that when the called subscriber responds by removing his receiver from its switchhook the current flow over conductors 68 and 69 is reversed energizing relay 62 in series with the winding of impedance coil 70, upper winding of the relay 62, upper, back contact and armature of relay 65 and conductor 68. Relay 62 attracts its armatures to reverse the connections of the middle and lower windings of relay 61 to the conductors 59 and 60 for purposes not related to this invention. However, the continuity springs and armatures of relay 62 complete this reversal without permitting the impulse relay 61 to deenergize so that the slow releasing relay 64 is maintained energized to apply the holding ground to the conductor 66. At the close of this connection when the calling subscriber replaces his receiver on the switchhook, the impulse relay 61 deenergizes and shortly thereafter the relay 64 deenergizes and removes the holding ground from the conductor 66 after which the first selector and line switch are restored to normal in the manner already described.

While the impulse compensating arrangement of this invention has been disclosed in connection with selectors, connectors, and repeaters it will be understood that it is also applicable to the registers of a register sender. It has not been deemed necessary to disclose the exact circuits of the register sender since the impulse circuits are substantially identical with the circuits utilized to control the connector switches.

In the foregoing part of the description it has been pointed out that a slow releasing relay 80 is provided in the first selector which is energized in multiple with the holding relay 14 of this selector over the conductor 34 leading to the succeeding switch such as a selector or connector. This slow releasing relay 80 is provided so that the line switch holds the primary trunk leading to the first selector for a predetermined interval after the remainder of the connection has been released. This arrangement is made so that if a calling subscriber immediately desires to establish a second connection, commonly known as a re-call, to a called line after the prior connection has been released, he may do so without the possible difficulty of finding that all primary trunks accessible to his line are in use. It will be obvious that the period of delay in releasing the relay 80 may be controlled at will to offer the calling subscriber a shorter or longer period in which to initiate a re-call. Any well known retarding arrangement may be provided in connection with relay 80 to give the desired period of delay.

What I claim is:

1. In a signalling system, impulse receiving means, a circuit including an impulse transmitter for transmitting impulses to said impulse receiving means, and means operating without inertia to compensate for variations in intensity of impulses transmitted over said circuit.

2. In a signalling system, impulse receiving means, a circuit including an impulse transmitter for transmitting impulses to said impulse receiving means, and means including an electron discharge device to compensate for variations in intensity of signals at said impulse receiving means.

3. In a signalling system, an impulse relay provided with an armature, a circuit including an impulse transmitter, a source of current and said impulse relay connected in series in said circuit whereby a flux is developed in said relay, and means for developing a supplemental flux in said relay in inverse proportion to the strength of impulse in said circuit whereby said relay attracts its armature uniformly in spite of variations in intensity in said impulses.

4. In a signalling system, an impulse relay provided with an armature, a circuit including a source of current and an impulse transmitter connected in series with said impulse relay whereby current impulses may be transmitted to said relay to develop a flux therein, and means including an electron discharge device for developing a supplemental flux in said impulse relay which is inversely proportional to the strength of impulses transmitted to said relay whereby said impulse relay attracts its armature uniformly in response to impulses of widely varying intensity.

5. In a telephone system, a plurality of telephone lines of varying characteristics, an impulse transmitter for each telephone line, an impulse receiving device, means for connecting said impulse receiving device and a source of current in series with any of said telephone lines whereby said impulse receiving device is actuated in varying degrees of intensity, and means including a thermionic current of intensity inversely proportional to that of said impulses for causing said varying impulses to actuate said impulse receiving device uniformly.

6. In a telephone system, a plurality of telephone lines of different characteristics, each telephone line being provided with an impulse transmitter, impulse receiving means including an impulse relay connectible to any of said telephone lines, said impulse relay having an armature and a winding, a source of current common to said telephone lines, means for connecting said winding and said source of current in series with any of said telephone lines whereby said impulse relay attracts its armature with varying degrees of intensity in response to impulses from the impulse transmitter of the connected telephone line, and means including another winding on said impulse relay and a source of thermionic current variably controlled by the intensity of said impulses for causing said relay to attract its armature uniformly in response to impulses of varying characteristics.

7. In an automatic telephone system, telephone lines of various lengths each provided with impulse transmitting means, an automatic switch, means for connecting any of said telephone lines when calling to said automatic switch, impulse receiving means for directively adjusting said switch in response to impulses from said impulse transmitting means, and electrical means to compensate for variations in the intensity of impulses at said impulse receiving means.

8. In a telephone system, a telephone line, an impulse repeater, automatic switching means including a non-numerical switch and a numerical switch for selecting said repeater, said repeater including an impulse repeating relay directly operated by impulses through said telephone line, and means including a source of anode current inversely proportional in strength to the strength of the impulses transmitted to said relay cooperating with said impulses whereby said anode current compensates for variations in impulse strength, and other numerical switches directively controlled by said impulse relay.

9. In an automatic telephone system, an impulse relay, an impulse circuit including a battery, an impulse transmitter and a winding of said impulse relay whereby said impulse transmitter may transmit impulses to said relay, a source of anode current cooperating in the control of said impulse relay, a resistance in said circuit for developing a drop in potential there-across proportional to the current in said circuit, and means governed by said drop in potential for varying said anode current in inverse proportion to the strength of said current.

10. In a telephone system, an impulse circuit including therein a battery, a winding of a multi-winding impulse relay, a resistance and an impulse transmitter connected in series, an electron discharge device having a cathode, an anode and a control electrode, means for energizing said cathode, a connection from said control electrode to said cathode including an adjustable portion of said resistance, a connection from said anode to said cathode including a second winding of said impulse relay and a source of anode current, and switching means controlled by said impulse relay.

11. In a telephone system, an impulse circuit including therein a battery, a winding of a multi-winding impulse relay, a resistance and an impulse transmitter connected in series, an electron discharge device having a cathode, an anode and a control electrode, means for energizing said cathode, a connection from said control electrode to said cathode including an adjustable portion of said resistance, a connection from said anode to said cathode including a second winding of said impulse relay, a source of anode current, and switching means including primary and secondary motor magnets successively controlled by said impulse relay.

12. In a telephone system, a telephone line, switching means, means for connecting said switching means to said telephone line, said switching means including an impulse relay directively operated by impulses transmitted over said telephone line, a source of anode current inversely proportional in strength to the strength of impulses transmitted over said telephone line cooperating with said impulse for uniformly operating said impulse relay to control said switching means, a desired final connecting switch selected by said switching means, means responsive to the selection of said final selecting switch for disconnecting said impulse relay from further control from said tele-

phone line, a second impulse relay associated with said final connecting switch arranged to be directly controlled by impulses transmitted over said telephone line, and means including a source of anode current inversely proportional in strength to the impulses transmitted to said second impulse relay for rendering the operation of said last named relay uniform under varying conditions.

13. In an automatic telephone system, a plurality of telephone lines, a plurality of primary trunks, means for connecting an idle primary trunk to a calling telephone line, means including other switches for extending the primary trunk connected to the calling telephone line with any wanted telephone line, and means for retaining temporary connection from said last mentioned primary trunk to said calling telephone line while releasing the remainder of the connection.

14. In an automatic telephone system, a plurality of telephone lines each provided with a line switch, means including primary trunks, secondary trunks, primary and secondary numerical switches for establishing a telephone connection between any calling telephone line and any wanted telephone line, and means for releasing said primary and secondary numerical switches while temporarily retaining the connection between said calling telephone line and the primary trunk last used.

15. The method of handling a re-call in an automatic telephone system in which a normal connection between subscribers is accomplished in successive stages which comprises always using the same primary stage that was used in a preceeding connection.

In witness whereof, I hereunto subscribe my name this 7th day of December, A. D. 1928.

WINFRED T. POWELL.