June 26, 1923.

1,459,859

W. T. POWELL

MECHANICAL SWITCHING SYSTEM

Filed June 12, 1919

4 Sheets-Sheet 1

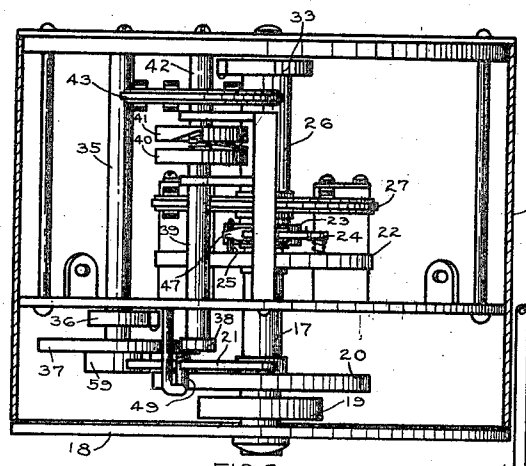


FIG. 2

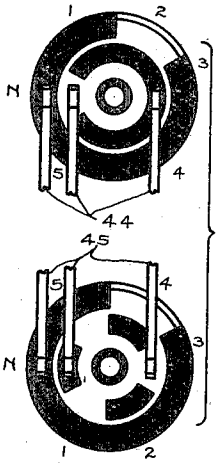


FIG. 4

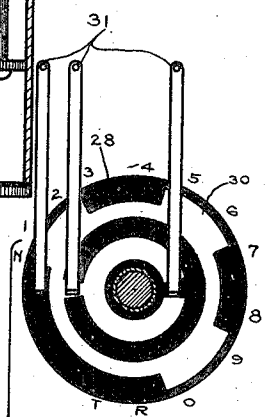


FIG. 3

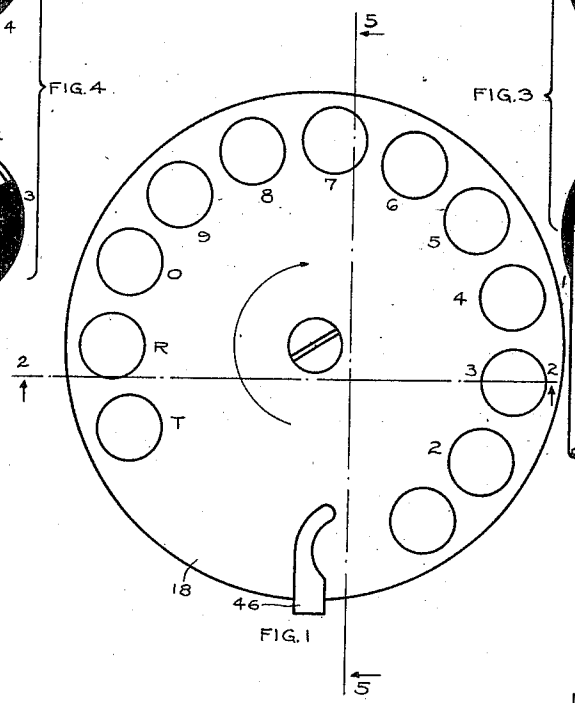
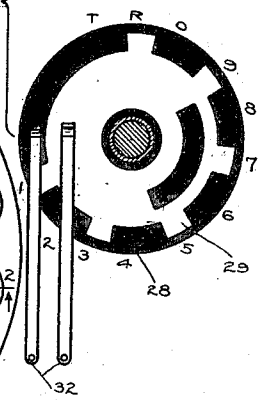


FIG. 1



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4 Sheets-Sheet 2

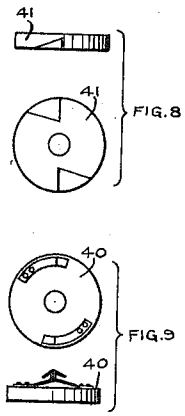


FIG. 8

FIG. 9

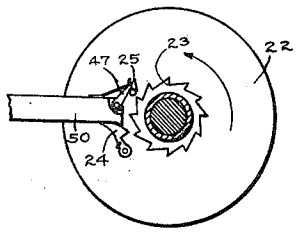


FIG. 7

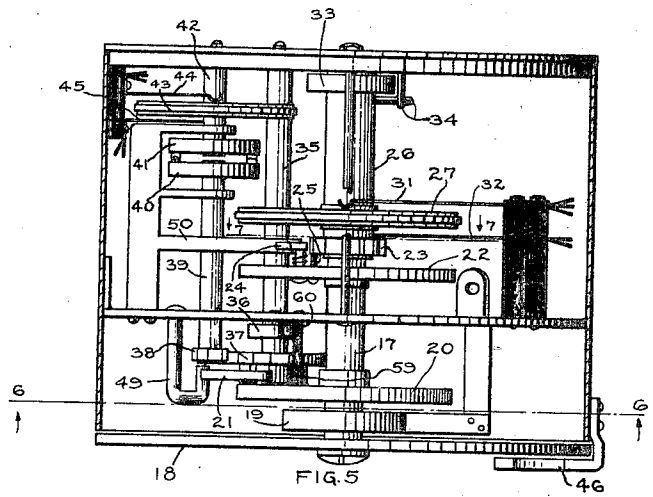


FIG. 5

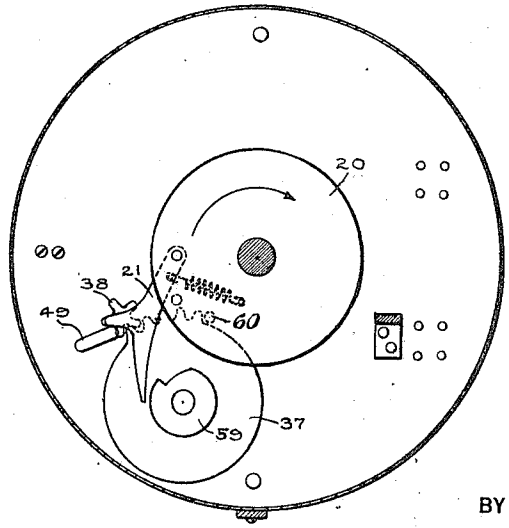


FIG. 6

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MECHANICAL SWITCHING SYSTEM

Filed June 12, 1919

4 Sheets-Sheet 3

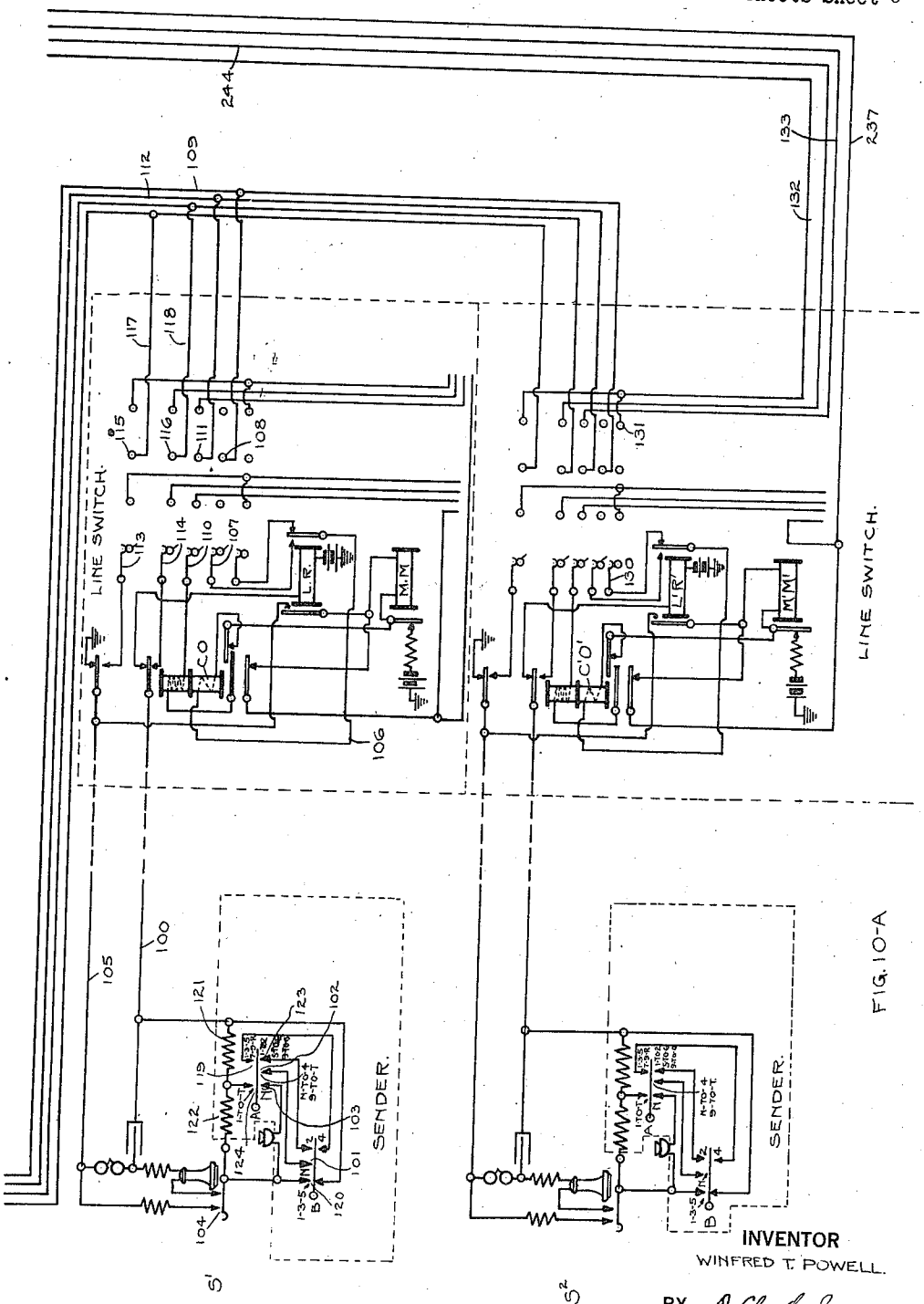


FIG. 10-A

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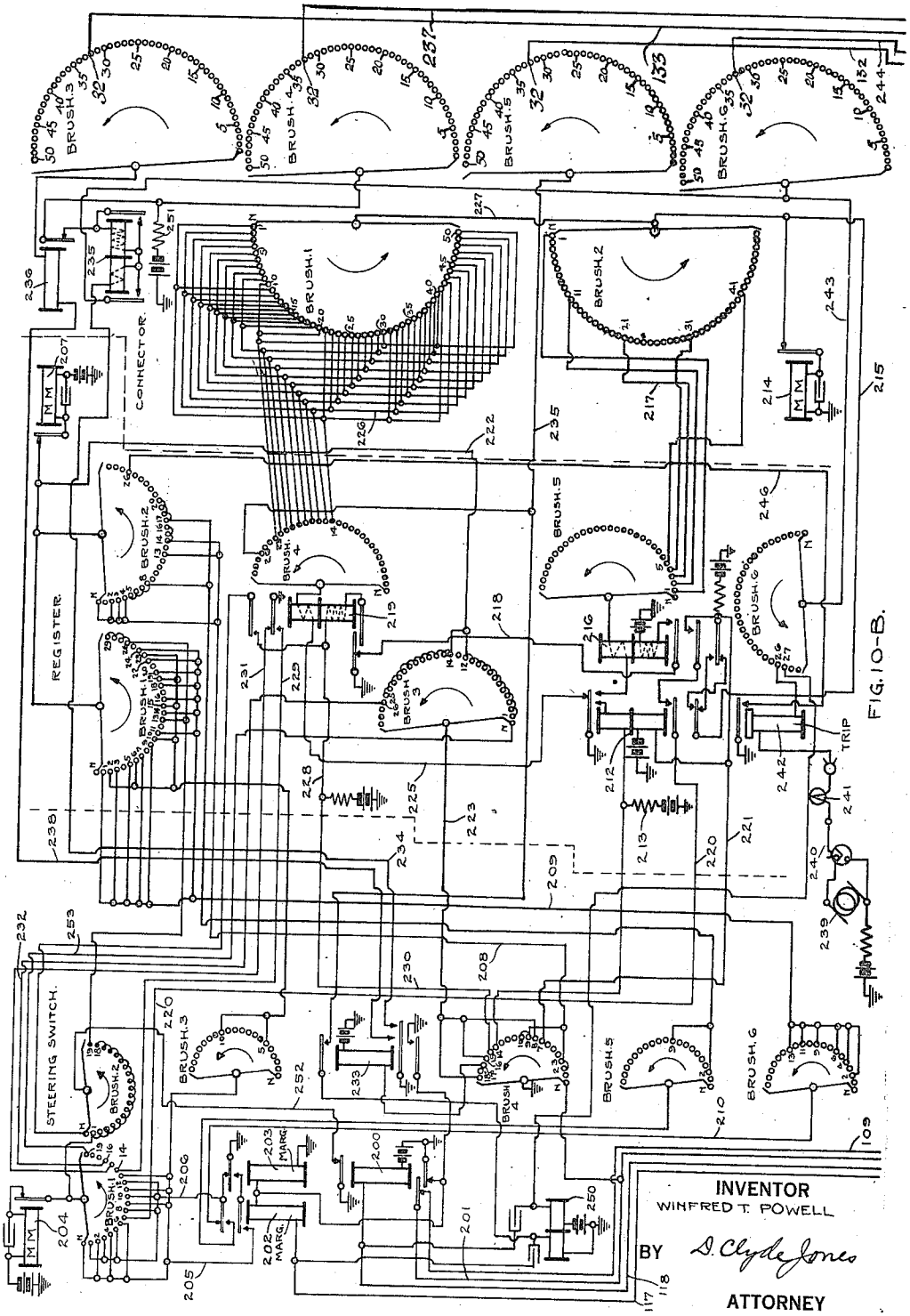


FIG. 10-B.

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Patented June 26, 1923. 1,459,859

UNITED STATES PATENT OFFICE.

WINFRED T. POWELL, OF ROCHESTER, NEW YORK, ASSIGNOR TO THE STROMBERG-CARLSON TELEPHONE MANUFACTURING COMPANY, OF ROCHESTER, NEW YORK, A CORPORATION OF NEW YORK.

MECHANICAL SWITCHING SYSTEM.

Application filed June 12, 1919. Serial No. 303,621.

To all whom it may concern:

Be it known that I, WINFRED T. POWELL, a citizen of the United States, residing at Rochester, in the county of Monroe and State of New York, have invented certain new and useful Improvements in Mechanical Switching Systems (Case 43), of which the following is a full, clear, concise, and exact description.

The present invention relates to telephone systems, and more particularly to telephone systems employing automatic switches in establishing a connection between a calling and a called subscriber.

In former automatic telephone systems, especially those having direct impulse control, it was necessary to employ an arrangement of carefully adjusted relays which were known in the art as "fast" and "slow" relays, the "slow" relays being employed to measure time intervals. Since these relays must be manufactured with great care and since they are not uniform in operation, it is proposed to provide an automatic telephone system in which carefully adjusted "slow releasing" relays are eliminated.

One feature of the invention is the provision of means by which an automatic switch may be selectively and variably operated in response to impulses the number of which is the same irrespective of any one of a number of positions to which the switch is adjusted.

A further feature of the invention is the provision of circuits for automatic switches which will be selectively operated in response to the operation of an impulse transmitter or sender at a distant point which is provided with resistances of various values.

In the drawings, Fig. 1 represents a front view of an impulse transmitter showing a rotatable finger-hold device and a stop member which limits the forward adjustment of this finger-hold device.

Fig. 2 is a side view of the transmitter with the casing broken away on the line 2—2 of Fig. 1, looking in the direction of the arrows showing the arrangement of its interior mechanism.

Fig. 3 shows the front and reverse sides of the A commutator of the transmitter together with the brushes that co-operate with the various segments of this commutator.

Fig. 4 represents the front and reverse sides of the B commutator of the transmitter together with various brushes for engaging conducting portions of this commutator.

Fig. 5 shows another side view of the interior mechanism of the impulse transmitter with the casing broken away on the line 5—5 of Fig. 1, looking in the direction of the arrows.

Fig. 6 represents a sectional view taken on the line 6—6 of Fig. 5, looking in the direction of the arrows.

Fig. 7 is a sectional view of the means for rotating the A commutator taken on the line 7—7 of Fig. 5, and looking in the direction of the arrows.

Figs. 8 and 9 represent different views of a clutch mechanism for operating the B commutator.

Figs. 10^A and 10^B when taken together diagramatically represent a portion of a telephone system. At the left of Fig. 10^A there are shown two dotted enclosures which diagrammatically indicate two senders or impulse transmitters, one for the substation S′, and the other for the substation S^2. This sender may be of the type disclosed in Figs. 1 to 9 inclusive. Within the dotted rectangles of Fig. 10^A there are shown the circuits of two line switches, one line switch being individual to the line terminating at substation S′, and the other being individual to the line terminating at substation S^2. In Fig. 10^B the portion of the drawing at the left of the dotted line shows the brushes and contacts of a six point steering switch, or sequence switch. In the center of the drawing a six-brush register, and at the extreme right of this figure there is shown a six-brush connector switch having fifty sets of terminals.

Sender or impulse transmitter.

In considering the structure and operation of the impulse transmitter of the present invention, it should be understood that two commutators referred to as A and B are provided, each of which is arranged to complete different circuit closures in each of the vari-

ous operating positions to which it is adjusted. It must further be understood that the commutator designated A is turned forward with the operation of the finger-hold member and remains in its advanced position while the finger-hold member is returning and is then released just before the finger-hold member reaches its normal position. The commutator B is operated when the finger-hold member is returning to normal position and completes only one revolution for any number of impulses to be transmitted for any character.

In the drawings, 15 designates a cylindrical casing for the operating mechanism of the transmitter which is closed at one of its ends and which carries a frame-work for supporting various elements of the transmitter. A shaft 17 which is rotatably mounted in the frame and casing, has secured at one of its ends the finger-hold member 18, provided with a plurality of openings spaced an equal distance apart from each other about its periphery. There may be as many openings in this member as there are different combinations of impulses to be transmitted by the sender. A spring 19 is provided which is wound up when the finger-hold member is moved from normal position and operates to return this member and the shaft 17 to this position. A disc 20 secured to the shaft 17 is provided with a spring actuated pawl 21, which co-operates in the control of the B commutator in a manner to be described.

Near the intermediate portion of the shaft 17, there is secured the disc 22 to the upper surface of which is secured a pawl 24 and a stop 25. A hollow cylindrical member, or barrel 26, rotates on the upper portion of the shaft 17 as an axis. The lower portion of the barrel 26 is provided with a ratchet wheel 23 which is arranged to be engaged by the pawl 24, to cause the shaft 17 and the barrel 26 to rotate as a unit, as will be described. Directly above the ratchet wheel 23, and also secured to the barrel 26, is the A commutator 27. The structure of this A commutator is best shown in Fig. 3, from which it will be seen that this commutator is formed of a circular disc of insulating material 28, to either side of which there are riveted conducting segments 29 and 30. These segments are riveted together by rivets of conducting material, so that they are electrically connected together. Three brushes 31, co-operate with a segment 30, and two brushes 32 co-operate with a conducting segment 29. A spring 33 is wound up when the barrel member 26 is rotated and operates to return this member to normal position indicated by the pin and stop members 34. A second shaft 35 which is also rotatably mounted is provided with a spring 36, which tends to restore the shaft 35 to normal whenever it has been moved from that position. To the lower end of this shaft is secured a cam 37, provided with five teeth to co-operate with a star wheel 38 on the lower end of the shaft 39. A disc 59 is also secured to the lower end of the shaft 35 and is provided with a notch, so positioned that it will be engaged by the pawl 21. The shaft 39 previously mentioned is rotatably mounted in the frame on an axis parallel to the axis of shafts 35 and 17. The upper end of the shaft 39 is provided with a clutch member 40 co-operating with a second clutch member 41 mounted on the lower end of the shaft 42. These clutch members 40 and 41 co-operate to cause shafts 39 and 42 to rotate together on the rotation of the shaft 39. The shaft 42 near its intermediate portion carries the B commutator 43, which is structually similar to the A commutator, except that its conducting segments are differently arranged. The B commutator 43 has two sets of brushes 44 and 45, one set engaging each surface of the B commutator.

The operation of the impulse transmitter is substantially as follows: The subscriber places his finger in any one of the openings of the finger-hold member 18 and rotates it in the direction of the arrow until his finger engages the stop 46. This operation winds up the spring 19 and rotates the disc 20 with its pawl 21 until this pawl engages the notch in disc 59. The disc 22 is also rotated with the shaft 17 in the direction of the arrow, causing the pawl 47 mounted on the frame to disengage the stop 25, and permits the pawl 24 to engage the ratchet wheel 23, so that in the further rotation of the finger-hold member 18 and the shaft 17, the barrel 26 will be rotated therewith. When the barrel 26 is thus rotated, the A commutator 27 is rotated to cause it to take a desired setting with respect to the brushes 31 and 32, and the spring 33 is wound up to cause the barrel 26 and the members carried thereby to be rotated to normal when the pawls 24 and 47 disengage the shaft 23. This operation of restoring the barrel 26 to normal occurs when the finger-hold member 18 has almost reached its normal position, when pawl 24 has engaged arm 50 and pawl 47 has engaged stop 25.

When the shaft 17 is being returned under the control of the spring 19, pawl 21 which is now in engagement with the notch of the disc 59 is moved by the disc 20 and causes disc 59 to effect the rotation of the cam 37, and this cam by means of its five teeth gives the star wheel 38 and the shaft 39 secured to it, one complete rotation. The shaft 39 is thus rotated and through the agency of the clutch members 40 and 41, the shaft 42 is given one complete revolution. This causes the B commutator 43 to close

various circuits through its sets of brushes 44 and 45.

In the further operation of restoring the finger-hold member 18 to normal position, the pawl 21 is moved downward until its projection engages the stop 49 carried by the frame, which raises the pawl 21 out of engagement with the notch of the disc 59 and permits the shaft 35 to be rotated to normal position determined by stop 60 (Fig. 6) under the control of its spring 36. While the shaft 35 is being restored to normal, the teeth of the cam 37 carried by it reengage the star wheel 38, which rotates the shaft 39 to normal position. The clutch members 40 and 41 however do not engage each other at this time, so that shaft 42 is not rotated.

Just before the finger-hold member 18 has reached normal position, the pawl 47 carried by an arm 50 of the frame is disengaged from the ratchet wheel 23 by stop 25 and the barrel 26 is permitted to rotate independently of the shaft 17. When this takes place the barrel 26 is rotated under the control of the spring 33, until the pin and stop members 34 are in engagement. The apparatus is now in condition to transmit the next series of impulses.

Sender or impulse transmitter circuits.

The sender or impulse transmitter in its normal position is connected in series with the two conductors of a telephone line, as follows: conductor 100, contact 101 of the B commutator, contacts 102 and 103 of the A commutator, through the transmitter, through the switchhook and contact 104, to the conductor 105 of the telephone line. The small numerals adjacent to the various contacts, such as contacts 101, 102 and 103 indicate in which positions of the commutator of the sender or impulse transmitter these contacts are closed. By a study of the circuits of this sender together with the structure, it will be seen that the same number of impulses is transmitted by the B commutator for any number set up on the sender, but that certain combinations of impulses differ from other combinations in the intensity of the several impulses of which it is composed.

In the present description reference will be made to a signaling circuit, this circuit may include two sides of a subscriber's telephone line, such as conductors 100 and 105 and two sides of the trunk line, such as 117 and 118 that has been connected to this telephone line by means of an automatic switch. This signaling circuit includes in series a release relay 200 (Fig. 10^B) which is maintained energized from the initiation of the connection until the time of disconnection, and two other relays 202 and 203 (Fig. 10^B) are also included in series in this signaling circuit and are responsive to impulses of a predetermined intensity from said sender or impulse transmitter. Of the three mentioned relays, relay 200 is the most sensitive. Relay 202 will be maintained energized in series with a resistance of approximately 1000 ohms, such as either 121 or 122, but releases when a resistance of 2000 ohms is included in its circuit. Relay 203 deenergizes as soon as either one, or both, of the resistances 121 or 122 are included in its circuit.

By reference to the following chart together with Figures 10^A and 10^B, it will be seen that as soon as the receiver switchhook is raised, the three relays 200, 202 and 203 will be energized. Then after the setting of the A commutator, either or both of the relays 202 and 203 will be deenergized, then, in the operation of the B commutator all of the relays will be energized followed by a deenergization of the relay 202, or relay 203. This alternate energization and deenergization of these relays takes place through the five operating positions of the B commutator. Although for purposes of this disclosure the resistances 121 and 122 have been given values of 1000 ohms each, it will be understood that there may be a wide variation of the values of these resistances without departing from the spirit of the invention.

Impulse chart.

"A" commutator.		"B" commutator positions.				
Dial No.	Dial pulled forward. Open.	1 close.	2 open.	3 close.	4 open.	5 close.
	Ohms.	*Ohms.*	*Ohms.*	*Ohms.*	*Ohms.*	*Ohms.*
1	1000		1000	0	1000	0
2	1000	0	1000	0	2000	0
3	1000	0	2000	0	1000	0
4	1000	0	2000	0	2000	0
5	1000 then 2000	0	1000	0	1000	0
6	1000 then 2000	0	1000	0	2000	0
7	1000 then 2000	0	2000	0	1000	0
8	1000 then 2000	0	2000	0	2000	0
9	1000 then 2000 then 1000	0	1000	0	1000	0
0	1000 then 2000 then 1000	0	1000	0	2000	0
R	1000 then 2000 then 1000	0	2000	0	1000	0
T	1000 then 2000 then 1000	0	2000	0	2000	0

From this chart it will be seen that when the finger-hold member is set in any of its positions from 1 to 4 inclusive, 1000 ohms are included in the signaling circuit by the forward adjustment of the A commutator. When this member is adjusted to positions 5 to 8 inclusive, 1000 ohms resistance and then 2000 ohms resistance are included in the mentioned signaling circuit, and when this member is set in any of the positions 9, 0, R or T, 1000 ohms is first included in the signaling circuit followed by the inclusion of 2000 ohms resistance, and then 1000 ohms resistance on the forward adjustment of the A commutator.

It will also be seen that in positions 1, 3 and 5 of the B commutator that all the sender resistance is shunted from the signaling circuit, while in positions 2 and 4 of the

B commutator 1000 or 2000 ohms resistance is included in this circuit in accordance with the number set up by the finger-hold member.

Chart showing setting of register.

Dial No.	Steering switch. 2	3	4	5	6	Register.
1	N-1					1
2	N-1				1-2	2
3	N-1		1-2	2-3		3
4	N-1		1-2	2-3	3-4	4
5	N	to 5				5
6	N	to 5			5-6	6
7	N	to 5	5-6	6-7		7
8	N	to 5	5-6	6-7	7-8	8
9	N-9					9
0	N-9				9-10	10
R	N-9		9-10	10-11		11
T	N-9		9-10	10-11	11-12	12

This chart showing the setting of the register, indicates that the register assumes a position in accordance with the adjustment of the finger-hold member of the dial switch, and also shows in which positions of the steering switch the register is advanced to its designated setting.

Switch structure.

The switches used in this system are of the unidirectional rotary type, that is, they have a plurality of sets of contacts arranged in an arcuate bank and two duplicate sets of brushes spaced 180 degrees apart, are mounted for step-by-step rotation over the various series of contacts. A well known motor magnet with a pawl mounted on its armature, engages a ratchet wheel on the brush shaft to advance the sets of brushes in a single direction.

The switches that have been designated "steering switches" and "registers" are advanced to their normal position when not engaged, but the line switches and connectors have no normal positions but remain in engagement with the contacts last used.

The line switch differs slightly in form from other rotary line switches of the art, in that incoming and outgoing trunks terminate in its contacts, the outgoing trunks being used to extend the calling line to a numerical switch or connector switch, and the incoming trunks being employed to extend the called line to its respective set of contacts at the connector switch used in extending the call to this line.

Detailed description of system.

It is believed the invention will best be understood by describing the method of establishing a connection between a calling substation indicated at S′, and a called substation indicated at S² which it may be assumed, is designated number 32. When the calling subscriber at S′ removes his receiver from its switchhook, a line relay LR, individual to the calling line, is operated over a circuit extending from grounded battery, winding of this relay, upper inner back contact and armature of the cut-off relay CO, conductor 100, normal contact 101 of the B commutator, normal contacts 102 and 103, the transmitter through the switchhook and contact 104, primary winding of the induction coil, conductor 105 to ground at the uppermost armature and back contact of cut-off relay CO.

The line relay LR is energized in this circuit, and at its left hand armature and front contact closes a circuit from grounded battery, resistance, back contact, armature, and winding of the motor magnet MM of the line switch, left hand armature and front contact of the line relay, uppermost armature and back contact of the cut-off relay CO, to ground. Under the control of this circuit, the motor magnet MM is energized, causing the five brushes of the line switch to be advanced step-by-step until an idle trunk is found. At the right hand front contact and armature of the line relay LR, a break point in the test circuit is closed to extend this test circuit from grounded battery, resistance, back contact and armature of the motor magnet MM, continuity spring and contact, and lower winding of the cut-off relay CO, conductor 106, right hand armature and front contact of the line relay LR, test brush 107, over a test terminal corresponding to 108, test conductor 109, continuity contact and spring of the relay 200, conductor 201, normal contact and brush 4 of the steering switch, to ground. The motor magnet MM of the calling line switch is shunted to stop the switch while the cut-off relay is energized by this circuit, the cut-off relay attracting its armature to complete a locking circuit for itself from grounded battery, back contact and armature of the motor magnet MM, continuity spring and inner lower armature and upper winding of the cut-off relay, which is high resistance, brush 110, terminal 111, conductor 112, to ground at normal contact and brush 4 of the steering switch. The cut-off relay is locked energized in this circuit and at its upper armatures interrupts the energizing circuit of the line relay LR, and extends calling line conductors 100 and 105 through the line brushes 113 and 114, to the selected trunk terminals.

When an idle trunk has been seized in the manner just described, a circuit as closed from grounded battery, winding of the relay 200, trunk conductor 118, trunk terminal 116, line brush 114, through the calling subscriber's substation circuits, line brush 113, trunk terminal 115, trunk conductor 117, windings of the relays 202 and 203, to ground. Since this circuit is of relatively low resistance, relays 200, 202 and 203 are

energized, and the relay 200 attracts its armatures to apply ground to the holding conductor 201, which maintains the cut-off relay CO energized. When the relays 202 and 203 were energized, they completed a circuit for the motor magnet 204 of the steering switch, from grounded battery, winding back contact and armature of this motor magnet, brush 1 of the steering switch in its normal position, conductor 205, innermost front contact and armature of the relay 202, front contact and armature of the relay 203, to ground.

Under the control of the circuit just described, the motor magnet 204 advances the steering switch into its first position and the apparatus is now in condition to receive the directive impulses from the subscriber's dial switch. The subscriber now operates his dial switch in accordance with the first digit of the desired number. Since it was assumed that the wanted number is 32, the subscriber then sets his dial to transmit impulses corresponding to the number 3. Under this assumption the commutator A will first be operated to include the 1000 ohms resistance 122 in the signaling circuit while the finger-hold member is being rotated forward.

It will be remembered that the A commutator remains in the position to which it has been rotated while the finger-hold member is returning, but releases when the finger-hold member gets to a point corresponding to position 5 on the B commutator. The B commutator, however, moves backward with the finger-hold member and makes one complete revolution for any number to which the finger-hold member has been adjusted. Therefore, while the A commutator remains in position 3, the B commutator, in the present case, in making a complete rotation to normal position, first short-circuits the resistances 121 and 122 and then includes both of the 1000 ohm resistances 121 and 122 in the signaling circuit while moving through position 2. While moving through position 3, the brush 120 of the commutator B will short-circuit both of the resistances mentioned. In position 4, the resistance 122 is included in the signaling circuit, while in position 5 of the B commutator both of the mentioned resistances are short-circuited, and when the B commutator reaches normal position these resistances are shunted by the transmitter.

Let us first consider the effect of the impulses transmitted by the setting of the A commutator. As soon as the resistance 122 is included in the signaling circuit, marginal relay 203 deenergizes and completes a circuit from ground, its armature and back contact, conductor 206, brush 1 of the steering switch in its first position, armature and back contact and winding of the motor magnet 204 to grounded battery. This circuit operates to move the steering switch to position 2. As soon as the steering switch has moved into position 2, a circuit is closed from ground at brush 4 of this switch, conductor 208, brush 2 of the register in its normal position, back contact and armature and winding of the motor magnet 207, to grounded battery, to move the register into position 1.

In the further operation of the sender, the A commutator remains in position 3 and the B commutator leaves its normal position and advances to position 1, whereupon the resistances 121 and 122 are short circuited from the signaling circuit and the relay 203 becomes energized. The steering switch is now advanced to position 3 by a circuit extending from grounded battery, winding of the motor magnet 204, brush 1 of the steering switch in its second position, conductor 205, front contacts and armatures of relays 202 and 203 to ground. When the B commutator advances to position 2, resistances 121 and 122 will be included in the signaling circuit which will cause the relays 202 and 203 to retract their armatures. This closes a circuit from ground, armature and back contact of the relay 203, conductor 206, brush 1 of the steering switch in its third position, armature and back contact and winding of its motor magnet 204, to grounded battery to move the steering switch into position 4. With the steering switch in position 4, a circuit is closed for moving the register into position 2, which is completed from grounded battery, winding, armature and back contact of the motor magnet 207, brush 1 of the register, conductor 209, brush 6 of the steering switch, conductor 210, armatures and back contacts of relays 202 and 203 to ground.

As the B commutator advances to position 3, the resistances 121 and 122 are again shunted from the signaling circuit which allows relays 202 and 203 to energize. The steering switch is now advanced to position 5 over a circuit from grounded battery, winding of its motor magnet 204, its back contact and armature, brush 1 in its fourth position, conductor 205, front contacts and armatures of relays 202 and 203 to ground. The register is now moved to position 3 over its brush 1 and brush 3 of the steering switch to ground over conductor 205. When the B commutator advances into position 4, the resistance 122 is again included in the signaling circuit, which causes the relay 203 to release and advance the steering switch to position 6. The B commutator continues to move to position 5 wherein the mentioned resistances are short circuited and the relay 203 energized to close a circuit for advancing the steering switch to position 7. When the B commutator reaches position 5, the commu-

tator A is released and the sender is so designed that this A commutator returns to normal before the B commutator leaves position 5. Therefore, when the finger-hold member comes to rest, the circuit will be completed for conversation.

When the steering switch reaches position 7, starting relay 212 is energized from grounded battery, its lower winding, conductor 221, brush 4 of the steering switch in position 7, to ground. The starting relay 212 attracts its armatures, and at its upper armature and front contact closes a locking circuit from ground, through its upper winding, resistance 213, to grounded battery. At the lower-most armature and front contact an operating circuit for the connector switch is closed from ground, winding of the motor magnet 214, conductor 215, lower-most armature and front contact of relay 212, lower-most armature and back contact of the relay 216, resistance to grounded battery.

Under the control of this operating circuit, the motor magnet 214 of the connector switch continues to advance this switch until its brush 2 engages the contact to which conductor 217 leading to point 3 on the register is connected, whereupon the motor magnet 214 is shunted by a circuit closed from ground, upper armature and front contact of relay 212, upper winding of the stopping relay 216, brush 5 of the register in its third position, conductor 217, brush 2 of the connector, conductor 215, lower-most armature and front contact of relay 212, lower-most armature and back contact of relay 216, resistance to grounded battery. The stopping relay 216 is energized in this circuit and since its inner-most front contact is closed before its lower-most contact is opened, the stopping relay completes a locking circuit for itself from grounded battery, its lower winding, its inner-most front contact and armature, conductor 218, continuity contact and spring of relay 219, to ground. The connector switch is thus set in operative relation to the group of lines through which the wanted line may be reached.

As soon as the relays 212 and 216 are energized, a circuit is closed for advancing the steering switch from position 7 to position 8. This circuit extends from grounded battery, winding of the motor magnet 204, its back contact and armature, brush 1 of the steering switch in its seventh position, conductor 220, inner-most armature and front contact of relay 212, middle armature and front contact of relay 216, conductor 221, brush 4 of the steering switch in its seventh position, to ground.

When the steering switch is in its eighth position, an operating circuit is closed for the motor magnet of the register to move this register from the position in which it was resting, which was position 3, into position 13. This operating circuit extends from grounded battery, motor magnet 207 of the register, conductor 222, brush 3 of the register, conductor 223, brush 4 of the steering switch to ground. With the register in position 13, the apparatus is now in condition to receive the next or units series of impulses.

The subscriber now operates his dial to transmit impulses corresponding to the number 2, which is the units digit of the wanted number assumed for purposes of this description. As the subscriber operates his sender, resistance 122 is included in the signaling circuit when the A commutator is positioned, which causes relay 203 to retract its armature and thus close a circuit from ground, armature and back contact of the relay 203, conductor 206, brush 1 of the steering switch in its eighth position, armature, back contact and winding of the motor magnet 204, to grounded battery. Under the control of this circuit, the steering switch is advanced to position 9, whereupon a circuit is closed from ground, brush 4 of the steering switch, conductor 208, brush 2 of the register in its thirteenth position, back contact, armature and winding of the motor magnet 207, to grounded battery. Under the control of this circuit the motor magnet advances the brushes of the register into their fourteenth position.

As the B commutator of the sender is rotating through position 1, the relay 203 will again be energized, whereupon a circuit is closed over conductor 205 to advance the steering switch from position 9 into position 10. In position 10, however, of the steering switch, the register remains inactive. While the B commutator of the sender is rotating through position 2, the resistance 122 is included in the signaling circuit, causing relay 203 to retract its armature. This closes a circuit over conductor 206, to advance the steering switch from position 10 to position 11. In the third position of the B commutator, the resistances are short circuited from the signaling circuit, and the relay 203 energizes to close a circuit over conductor 205 to move the steering switch out of position 11 and into position 12. As the B commutator is moved to position 4 resistances 121 and 122 are both included in the signaling circuit, causing both of these relays to retract their armatures. At the armature and back contact of the relay 203, a circuit is closed for the motor magnet 204 of the steering switch, to move this switch from position 12 into position 13. Thereupon the register is advanced from position 14 to position 15, over an operating circuit from grounded battery, motor magnet 207, brush 1 of the register, conductor 209, brush 6 of the steering switch, conductor 210, armatures and back contacts of relays 202 and 203, to ground. When the sender reaches normal position, both of the

resistances are shunted from the signaling circuits and relays 202 and 203 are both energized. This closes a circuit over conductor 205 for advancing the steering switch from position 13 to position 14. At this time the starting relay 212 which has remained energized during this interval is short circuited by ground at brush 4 of the steering switch. As soon as the starting relay 212 deenergizes, an operating circuit for the motor magnet 214 of the connector is closed from ground, winding, armature and back contact of this motor magnet, conductor 215, lower-most armature and back contact of relay 212, lower-most front contact and armature of relay 216, resistance, to grounded battery. Under the control of this circuit, the motor magnet advances the connector switch over the terminals of the previously selected group and continues this movement until its brush 1 engages a terminal corresponding to the wanted line 32. When this terminal is reached, the relay 219 is energized over a circuit completed from ground, upper armature and back contact of relay 212, conductor 225, upper winding of relay 219, brush 4 of the register in its fifteenth position, conductor 226, brush 1 of the connector, conductors 227 and 215, lower-most armature and back contact of relay 212, lower-most front contact and armature of relay 219, to grounded battery.

It will be noted that the motor magnet 214 is shunted by the circuit just described. The relay 219 is energized in this circuit and closes a locking circuit for itself from grounded battery, resistance, conductor 228, lower winding of relay 219, lower armature and continuity spring of this relay, to ground. When this locking circuit for this relay 219 is completed, the locking circuit for the relay 216 is interrupted at the continuity spring of relay 219. Also when the relay 219 was energized, it closed a circuit from ground, its inner upper armature, conductor 229, brush 1 of the steering switch in its fourteenth position, armature, back contact and winding of the motor magnet 204 of the steering switch, to grounded battery. This circuit operates to move the steering switch from position 14 into position 15. In position 15, the relay 219 is short circuited by ground over brush 4 of the steering switch, conductor 230, and the resistance to grounded battery. As soon as relay 219 deenergizes, it closes a circuit from ground, its inner upper armature and back contact, conductor 231, brush 1 of the steering switch in position 15, armature, back contact and winding of the motor magnet 204 to grounded battery to move the steering switch into its sixteenth position. In position 16, an operating circuit is closed for the motor magnet of the register which moves it into position twenty-six. This circuit is completed from grounded battery, winding, armature and back contact of the motor magnet 207, conductor 222, brush 3 in any of its positions from 14 to 25, conductor 223, brush 4 of the steering switch, to ground. As soon as the register reaches position 26, it closes a circuit for moving the steering switch out of position 16 into position 17, which circuit is closed from grounded battery, winding, back contact and armature of the motor magnet 204, brush 1 in its sixteenth position, conductor 232, brush 3 of the register in its twenty-sixth position, conductor 223, brush 4 of the steering switch, to ground. In position 17, the relay 233 is energized over brush 4 of the steering switch and attracts its armatures. This closes a circuit from ground, inner lower armature and front contact of relay 233, conductor 234, through both windings in series of test relay 235, back contact and armature of relay 236, brush 4 of the connector, conductor 237, lower-most armature and back contact of the cut-off relay C′O′, winding, back contact and armature of the motor magnet M′M′, resistance, to grounded battery.

Since the called line is found idle, the relay 235 is energized and short circuits its high resistance winding and causes the line switch individual to the calling line to advance until it reaches the point on its terminal bank corresponding to the connector used in calling it. When this point is reached, the cut-off relay C′O′ individual to the called line will be operated and the motor magnet M′M′ will be shunted by a circuit traceable from grounded battery, resistance, back contact and armature of the motor magnet M′M′, continuity spring contact and lower winding of the cut-off relay C′O′, right hand armature and back contact of the line relay LR, line switch, brush 130, terminal 131, conductor 132, brush 5 of the connector, conductor 235, brush 4 of the register in its twenty-sixth position, upper winding of relay 219, conductor 225, upper back contact and armature of relay 212, to ground. The called line switch is stopped by this shunt circuit and the cut off relay holds open the operating circuit of the motor magnet M′M′ and completes a circuit for itself through its upper winding, conductor 133, winding of the relay 236, conductor 238, inner lower front contact and armature of relay 233, to ground. Relay 236 when energized interrupts the energizing circuit of the relay 235.

The called subscriber is now signaled by signaling current transmitted from grounded battery, resistance, generator 239, interrupter brush 240, lamp 241, slow-releasing trip relay 242, brush 6 of the register in its twenty-sixth position, conductor 243, brush 6 of the connector, conductor 244, through the called subscriber's line and substation

circuits, conductor 132, brush 5 of the connector, conductor 235, brush 4 of the register in its twenty-sixth position, upper winding of the relay 219, conductor 225, upper back contact and armature of relay 212, to ground.

When the called party answers, relay 242 is operated and closes a circuit from ground, its upper armature and front contact, conductor 246, brush 2 of the register in its twenty-sixth position, back contact, armature and winding of the motor magnet 207 to grounded battery to move the register out of position 26 and into position 27.

Talking battery is supplied to the calling line through the relays 200 and 202, the relay 203 being short-circuited by the relay 233 to insure that the calling line will be properly balanced. Talking battery for the called party is suppiled through the windings of the impedance coil.

Let it be assumed that the wanted line was busy. Under this condition the test relay 235 will be energized in a circuit closed from grounded battery, resistance 251, armature and back contact of relay 236, both windings of relay 235 in series, conductor 234, inner lower armature and front contact of relay 233, to ground. It will be understood that the resistance coil 251 is of relatively high resistance as compared with the resistance of the motor magnet of the line switch. Since the called line is assumed to be busy, its cut-off relay is energized and the only energizing path for the relay 235 is through the high resistance path just described. The high resistance coil 251 will not permit the relay 235 to be maintained energized through its low resistance winding, and this relay will therefore produce a tone in the calling party's receiver indicating that the called line is busy.

When the calling party desires to disestablish the connection either because the conversation is completed or because the called line is busy, he places his receiver on its switchhook and opens the line circuit which is included in the signaling circuit previously mentioned. The relay 200 which is energized as soon as the call is initiated and remained energized during the establishment of the call and during the conversation, deenergizes. As soon as the relay 200 deenergizes, it closes a circuit from ground at its upper armature and back contact, conductor 252, brush 2 of the steering switch in any of its positions, from 1 to 18, armature, back contact and winding of the motor magnet 204, to grounded battery to advance the steering switch in position 19. With the steering switch thus positioned, the register is restored to normal position over a circuit closed from grounded battery, winding, armature and back contact of the motor magnet 207, brush 1 of the register, brush 2 of the steering switch, conductor 252, back contact and armature of relay 200, to ground. As soon as the register has been restored to normal position, the steering switch is also moved to its normal position by a circuit closed from grounded battery, winding, back contact and armature of motor magnet 204, its brush 1, conductor 253, brush 3 of the register, conductor 23, brush 4 of the steering switch in its nineteenth position, to ground. The steering switch and register used in establishing the connection are restored to normal in the manner described.

The calling and called line switches and connector, however, have no normal position, but remain in the position to which they were adjusted during the establishment of the call. As soon as the steering switch left position 17, the circuit through the brushes 3 and 5 of the connector was opened, and when the register left position 27, the brush 6 was opened. As soon as ground was removed from the connector brush 3 of the called line, relay C'O' was released, and when the relay 200 retracted its armatures it removed the ground potential from conductor 112, which permits the cut-off relay of the calling line switch to release. The apparatus is now in condition to establish another connection.

It will be understood that the present disclosure is merely typical of applicant's invention, and that there may be many changes and variations in the same within the scope of the appended claims without departing from the inventive idea.

What I claim is:

1. In a telephone system, a telephone line, an impulse transmitting device for sending combinations of impulses differing only in character over two sides of said telephone line in series, an impulse receiving device variably operated in response to said impulse transmitting device, and an automatic switch which assumes a position in accordance with the adjustment of said impulse receiving device.

2. In a telephone system, a telephone line, an impulse transmitter which transmits the same number of impulses for a plurality of different designations over two sides of said telephone line, an impulse receiving device variably operated in response to said impulse transmitter, and an automatic switch which assumes a position in accordance with the adjustment of said impulse receiving device.

3. In a telephone system, a telephone line, an impulse transmitter for transmitting combinations of impulses differing only in the intensity over two sides of said telephone line in series, an impulse receiving device variably operated in response to said impulse transmitter, and an automatic switch which assumes a position in accord-

ance with the adjustment of said impulse receiving device.

4. In a telephone system, a telephone line, an impulse transmitter for sending the same number of impulses, said impulses for a plurality of different designations over two sides of said telephone line in series consisting of electric currents of different intensities, an impulse receiving device variably operated in response to said impulse transmitter, and an automatic switch which assumes a position in accordance with the adjustment of said impulse receiving device.

5. In a telephone system, a telephone line, a link circuit terminating in an automatic switch, means for interconnecting said line and said link circuit, an impulse transmitter connected to said telephone line, said impulse transmitter being arranged to send different combinations of impulses of different intensities, certain combinations being always composed of the same number of impulses, and an impulse receiving device variably responsive to said impulse transmitter and associated with said link circuit, said automatic switch operating in accordance with the setting of said impulse receiving device to assume a position predetermined by said impulse transmitter.

6. In a telephone system, a telephone line, a link circuit terminating in an automatic switch, means for interconnecting said line and said link circuit, an impulse transmitter connected to said telephone line, said impulse transmitter being arranged to send combinations of impulses differing in intensity, and an impulse receiving device variably responsive to said impulse transmitter and associated with said link circuit, said automatic switch operating in accordance with the setting of said impulse receiving device to assume a position predetermined by said impulse transmitter.

7. In a telephone system, a telephone line, a link circuit terminating in an automatic switch, means for interconnecting said line with said link circuit, an impulse transmitter connected to said telephone line, said impulse transmitter being arranged to send combinations of impulses, certain combinations being composed of the same number of impulses, but varying in intensity, and an impulse receiving device variably responsive to said impulse transmitter and associated with said link circuit, said automatic switch operating in accordance with the setting of said impulse receiving device to assume a position predetermined by said impulse transmitter.

8. In a telephone system, an automatic switch, a signaling circuit associated therewith, a sender connected to said circuit and arranged to send impulses thereover, a release relay and impulse relays serially included in said circuit and arranged to be controlled thereover, each of said impulse relays being responsive to certain impulses from said sender to directively control the setting of said automatic switch, said release relay being unresponsive to impulses from said sender and operating to control the release of said automatic switch.

9. In a telephone system, a telephone line, a plurality of trunk lines each terminating in automatic switches, means for interconnecting said telephone line with any of said trunk lines, a sender connected to said telephone line and operating to transmit impulses over said telephone line and the connected trunk line, said sender being manually adjusted to indicate a desired setting of said automatic switch, means at said sender operable after its manual adjustment to transmit combinations of impulses differing in intensity, and means associated with said automatic switch for receiving said impulses to control the setting of said automatic switch.

10. In a telephone system, an incoming line, a plurality of outgoing lines, an automatic switch for interconnecting said incoming line with any of said outgoing lines, a control circuit for said automatic switch including a portion of the two sides in series of said incoming line, and an impulse transmitter having a plurality of resistances arranged to be variably included in said control circuit to govern the setting of said automatic switch.

11. In a telephone system, an incoming line, a plurality of outgoing lines, an automatic switch for interconnecting said incoming line with any of said outgoing lines, a control circuit for said automatic switch including a portion of said incoming line, and an impulse transmitter having a plurality of resistances of substantially equal value arranged to be variably included in said control circuit to govern the setting of said automatic switch.

12. In a telephone system, an incoming line, a plurality of outgoing lines, an automatic switch for interconnecting said incoming line with any of said outgoing lines, a control circuit for said automatic switch including a portion of two sides of said incoming line, and an impulse transmitter having a plurality of resistances arranged to be variably included and eliminated from said control circuit in proper sequence to selectively control said automatic switch.

13. In a telephone system, a plurality of telephone lines, trunk lines terminating in numerical switches, a line switch and an impulse transmitter individual to each telephone line for transmitting impulses of variable intensities, means including a line switch for extending a line to one of said numerical switches, impulse receiving means associated with said numerical switch and

responsive to said impulse transmitter of the mentioned line for designating the wanted line, and means to cause said numerical switch to hunt for the designated line.

14. In a telephone system, a plurality of telephone lines, trunk lines terminating in numerical switches, a line switch and an impulse transmitter individual to each telephone line for transmitting impulses of different intensities, means including a line switch for extending a line to one of said numerical switches, impulse receiving means associated with said numerical switch and responsive to the impulse sender of the mentioned line for characterizing the wanted line at said numerical switch with a selectable condition, and means for causing said numerical switch to hunt for said wanted line.

15. In a telephone system, an incoming line, a plurality of trunks terminating in numerical switches, means for interconnecting said incoming line with any of said trunks, outgoing lines terminating in said numerical switches, an impulse transmitter associated with said incoming line and arranged to transmit impulses of different intensities thereover, means associated with a selected trunk and operated in response to said impulse transmitter for characterizing a wanted outgoing line at a selected numerical switch with a selectable condition, and means for causing this numerical switch to hunt for the wanted line.

16. In a telephone system, a plurality of telephone lines, an impulse transmitter and a line switch individual to each line, said impulse transmitter being arranged to transmit impulses of different intensities, means for extending a telephone line including its line switch and a numerical switch, means associated with said numerical switch responsive to said impulse transmitter for characterzing a wanted telephone line by a selectable condition, and a mechanism for causing said numerical switch to hunt for the line so characterized.

17. In a telephone system, a plurality of telephone lines, an impulse transmitter and a line switch individual to each line, said impulse transmitter being arranged to transmit impulses of different intensities, means for extending a telephone line to another telephone line, said means including the line switch of the first mentioned line and a numerical switch, means associated with said numerical switch and responsive to said impulse transmitter for characterizing a wanted telephone line by a selectable condition, mechanism for causing said numerical switch to hunt for the line so characterized, and means operative when the wanted line is found by said numerical switch, to cause the line switch individual to the wanted line to hunt for the terminals of said numerical switch that are individual to this wanted line.

18. In a telephone system, an incoming line, a plurality of outgoing lines terminating in numerical switches, means for interconnecting said incoming line with any of said outgoing lines, an impulse transmitter for said incoming line, a metallic signaling circuit for the numerical switch that has been connected to said incoming line, means associated with the selected numerical switch and variably responsive to an invariable number of impulses transmitted over said signaling circuit from said impulse transmitter to selectably control the setting of said numerical switch.

In witness whereof, I hereunto subscribe my name this 10th day of June, A. D. 1919.

WINFRED T. POWELL.