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KEY PULSING REGISTER CIRCUIT

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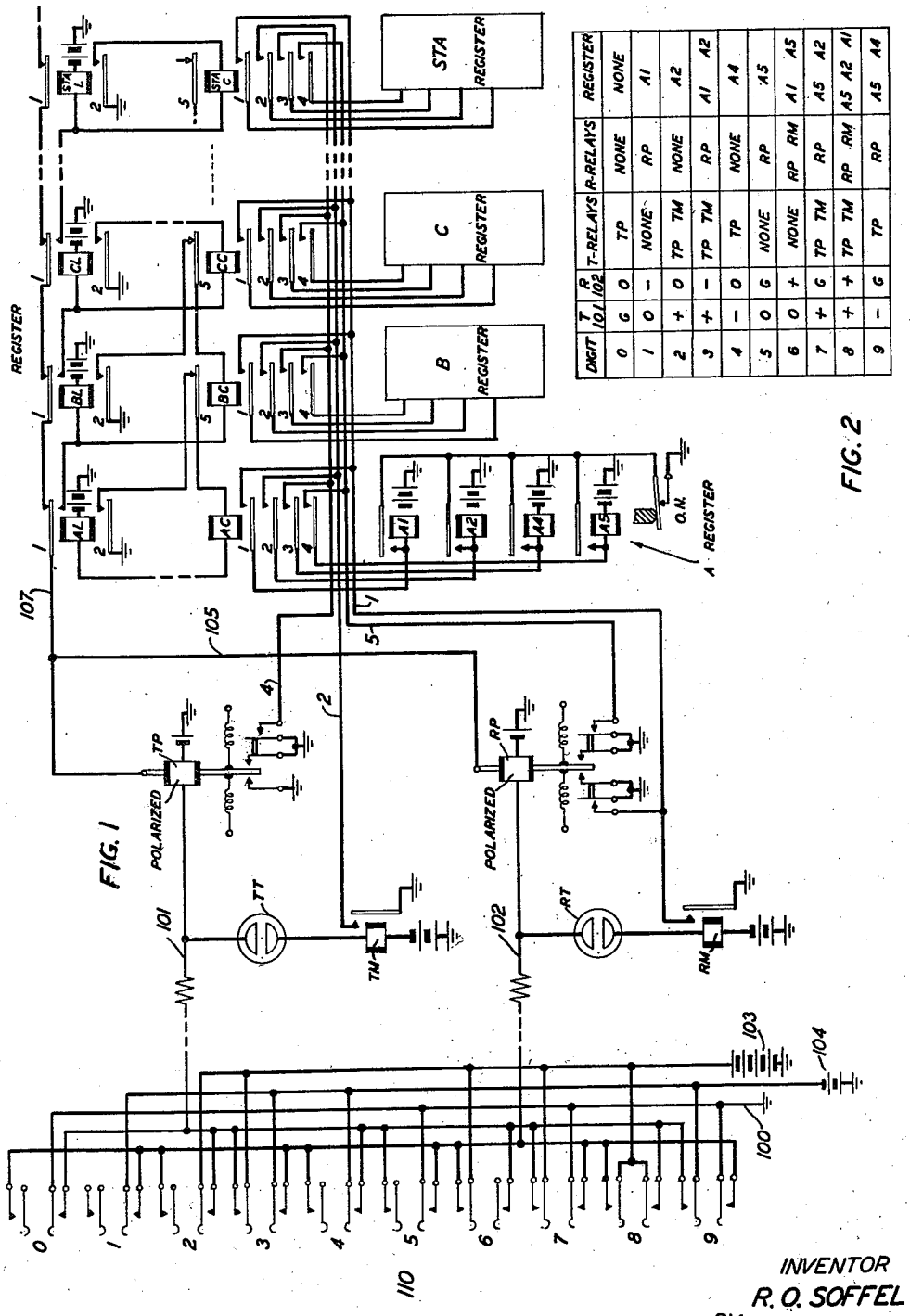

FIG. 1

DIGIT	T 101	P 102	T-RELAYS	R-RELAYS	REGISTER
0	G	0	TP	NONE	NONE
1	0	-	NONE	RP	A1
2	+	0	TP TM	NONE	A2
3	+	-	TP TM	RP	A1 A2
4	-	0	TP	NONE	A4
5	0	G	NONE	RP	A5
6	0	+	NONE	RP RM	A1 A5
7	+	G	TP TM	RP	A5 A2
8	+	+	TP TM	RP RM	A5 A2 A1
9	-	G	TP	RP	A5 A4

FIG. 2

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KEY PULSING REGISTER CIRCUIT

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5 Claims. (Cl. 179—90)

This invention relates to telephone exchange systems, and more particularly to circuits for enabling the registration of digits at a distant point through the operation of digit keys. A circuit of this character is applicable for enabling the operator at a manual or semimechanical switchboard position to set up on the registers of a common sender the registration of the digits of a wanted subscriber's number whereby the sender may be enabled to proceed in accordance therewith to control selector switches to establish a desired connection.

Heretofore, key pulsing circuits of this general character have been employed, as disclosed in Patent No. 1,780,906 granted to W. W. Carpenter and R. E. Hersey on November 11, 1930, to enable a toll operator to complete connections over panel dial switching equipment and, as disclosed in Patent No. 1,916,760 granted to I. H. Henry on July 4, 1933, to enable an "A" switchboard operator to complete connections over step-by-step type equipment. In these circuits the registers of the sender are set from the operator's key-set through the application, in code combinations, of currents of two strengths and of either negative or positive potential over one or both of the two control conductors which extend from the operator's position to the sender. At the sender, three impulse-responsive relays are connected serially in each control conductor, one being polarized, one being marginal to current of either polarity and a third being sensitive to current of either polarity. For the selective operation of the impulse-responsive relays, batteries of opposite potential are required at both the operator's key-set and at the sender and the relays require careful adjustment because of the current margins utilized for their selective operation.

The present invention has for one of its objects the employment of a key pulsing system whereby a satisfactory marginal operation is obtained without the employment of marginal relays, thereby permitting successful operation over longer control circuits.

A further object of the invention is the utilization upon each of the two signaling conductors of a combination of a three-position polarized relay and a gaseous conducting tube whereby one or both are operated in response to the application of appropriate potentials to the conductors by the depression of the keys at the key-set which control said potentials.

A still further object of the invention is the provision of impulse-responsive apparatus of such a character that correct operation may be assured with very short key closures.

In accordance with the present invention, use is made of a polarized relay in each of the two control conductors, said relay having an armature capable of assuming three positions, namely, a neutral position, a left and right contacting position, whereby said armature may be caused to engage either of two contacts or none depending upon the electrical condition of the conductor to which the winding of the relay is connected. Further, use is made of a gaseous conducting tube as an impulse-responsive relay in parallel with said polarized relay. The gaseous conducting tube so employed is one which is filled with a low pressure gaseous content which, for purposes of illustration, might be neon, argon, helium, mercury vapor or combinations of gases of this group. The tube has the characteristic that its gaseous content will become ionized and thus conducting on one potential determined by the electrical design of its electrode, the nature of the gaseous content and its pressure, and will remain conducting on a much lower potential than that which originally caused the production of conductivity. As disclosed, each tube is of the cold cathode type, that is, one in which the cathode thereof is normally not in the electron emission state, but it is obvious that a tube of the hot cathode type in which the filament heated by a direct current causes the cathode to be normally emitting might equally well be employed Each tube functions as an ionic relay to establish an operating circuit for another relay that controls the operation of still other relays in a series of registers. The relay associated with each tube may be of simple, efficient design since it is not required to be selective to current margins or reversal of potential over the control circuit extending from the key-set.

For the purpose of illustration, the invention is disclosed with respect to a signaling system in which a key-set having ten depressible keys has connected to it two oppositely poled batteries and a ground for the transmission over two line conductors connected to the keys of a combination of two potentials for each digit according to a predetermined code. Each of the two conductors terminates in a source of potential through the winding of a three-position polarized relay in parallel with which is connected the anode of a gaseous conducting tube whose anode-cathode circuit is completed through a relay device. The armatures of both polarized relays are connected to a suitable group of steering relays the

number of which is determined by the design of the steering circuit and the number of digits which are to be registered in succession, while certain of the contacts with which the armatures of the polarized relays make in one of their respective two positions of operation (excluding the neutral position in which the armature is out of engagement with either contact), and the contacts of the two relays connected to the respective cathodes of each of the two gaseous conducting tubes, are connected through the contacts of the steering relays to successive groups of register relays. The relays in each of the groups of registers are then set in accordance with the activation of each of the control conductors as determined by the potentials applied thereto through the depression of the keys of the key-set and the response of the relay and gaseous conducting tube connected to each of said conductors.

For a more complete understanding of the invention, reference may be had to the following detailed description taken in connection with the attached drawing which shows in Fig. 1 one embodiment of the invention comprising a key-set having ten numerical keys connected by two conductors to separate sources of potential, each through the winding of a three-position polarized relay and a gaseous conducting device in parallel therewith the cathode of which extends to a relay and another source of potential. The polarized relays as well as those in the cathode circuits of the gaseous conducting devices work into a receiving apparatus comprising a plurality of groups of register relays and a steering circuit which may be operated to connect in succession each group of register relays to the contacts of the polarized relays and the relays in the cathode circuits of each of the conducting tubes. The drawing also shows in Fig. 2 a pulse code table which indicates, for each digit, the polarity of the potential applied to each of the two conductors, the polarized relays and tube relays operated thereby and the relays of a particular register which respond thereto.

Referring to Fig. 1, a key-set of ten keys is designated by the numeral 110, the stationary springs of the keys of said key-set being connected to one or both of the tip and ring control conductors 101 and 102, respectively, while the working springs of the keys are connected to the grounded conductor 100 or to the positive terminal of battery 103 the negative terminal of which is grounded or to the negative terminal of battery 104 the positive terminal of which is grounded as required for the registration of the ten different digits according to the code shown. The control conductor 101 terminates at its distant end in a part of the recording circuit which comprises a polarized relay TP, the winding of which is connected to conductor 101 and to a battery the positive terminal of which is grounded and, also, to the anode of the gaseous conducting device TT the cathode of which is connected to the winding of relay TM and, therethrough, to a battery the positive terminal of which is grounded. The ring conductor 102 terminates in the winding of polarized relay RP the other side of which is connected to a battery the positive terminal of which is grounded and, also, to the anode of conducting tube RT whose cathode is connected to the winding of relay RM and, therethrough, to a battery the positive terminal of which is grounded. The armatures of both polarized relays TP and RP are joined by a conductor 105 to a conductor 107 which extends to the No. 1 armature of the first steering relay AL of the pair of relays AL and AC of which there are as many pairs as there are digit registers for the successive registration of each of a series of digits. The two stationary contacts of relays TP and RP disposed nearest to the neutral position of their armatures on either side thereof are grounded so that the operation of the armature of either relay to the left or to the right will ground conductor 107 to function the steering circuit in a manner which is described hereinafter. The outer right contact of relay TP, on the other hand, is connected to conductor 4, which is one of four signaling conductors 1, 2, 4 and 5 over which the registration of the digit in a group of register relays determined by a particular pair of steering relays is controlled. The right outer contact of relay RP is connected to signal conductor 5 while the contacts of relays TM and RM are connected to conductors 2 and 1, respectively, the latter being also connected to the left outer contact of relay RP so that, if the relay operates to the right, it will ground conductor 5 while if it operates to the left, it operates conductor 1. Conductor 2, on the other hand, is grounded only when relay TM operates, while conductor 1 is grounded either by relay RP operating to the left or by relay RM; relays TM and RM operating only when the tubes TT and RT, respectively, are ionized.

The register shown to the right of relays TP and RP comprises a plurality of pairs of steering relays AL, AC,—STAL, STAC and a separate group of four register relays for each pair of steering relays, the register relays controlled by any pair of steering relays having their respective circuits completed over conductors 1, 2, 4 and 5 to which ground is applied for operating these relays in accordance with the operation of relays TP, RP, TM and RM. The A relays, namely, relays A1, A2, A4 and A5 controlled by the steering relays AL and AC are shown in detail while the relays of other registers such as those, for example, of the B register, C register—STA register are only conventionally represented since they are identical in construction and function with relays A1—A5. It is to be understood, however, that while the invention is being disclosed for purposes of illustration with the register apparatus shown, the same is merely used herein by way of example as it is evident that any other type of register regardless of whether it comprises switches, ionic devices or relays, could be used equally well to register successive digits as recorded by the operation of relays TP, RP, TM and RM, provided that such registering apparatus is equipped with a transfer device of a kind that will cause the signaling conductors 1, 2, 4 and 5 to be transferred in succession to the settable registers which are to respond to the activation of said conductors.

It may be assumed that the register circuit is part of that larger organization of circuits known as a sender by which automatic switches are selectively controlled for establishing connections in response to a setting of the register circuit and that, as a result of such a sender being taken into use, off-normal ground is provided at contacts ON and that a circuit is completed by any suitable means for relay AL which causes it to operate, transfer conductor 107, over the No. 1 front contacts of relay AL being advanced to the winding of relay BL of the next pair of steering relays, and a circuit for relay AC is completed

by the operation of relay AL, said circuit extending from ground over the No. 2 contacts of relay AL, No. 5 contacts of relay BC, winding of relay AC, through controllable means in the sender, winding of relay AL to battery. Relay AC operates and locks in series with relay AL under the control of the No. 5 contacts of relay BC.

It will now be assumed that the digit 0 is to be registered on the group of relays A1—A5. According to the pulse code chart shown in the drawing, the registration of the digit 0 requires a ground connection to the tip conductor 101. Accordingly, when digit key 0 is depressed, ground on conductor 100 is applied over the lower contacts of digit key 0 and thence to the tip conductor 101 thereby closing the circuit of relay TP. Now relay TP is so poled that the current flowing through its winding as a consequence of its circuit being completed by ground on conductor 101 is in a direction to cause its armature to engage its left contact, and since this contact is grounded, ground will therefore be applied to the steering conductor 107 over which a circuit will be completed for relay BL, which circuit extends from ground on said conductor 107, No. 1 front contacts of relay AL, winding to relay BL to battery. Relay BL operates and, over its No. 2 contacts and the No. 5 contacts of relay CC, applies shunt ground to the right terminal of the winding of relay BC, the other side of which is held grounded by ground on conductor 107. Now according to the pulse code, the registration of the 0 digit is effected by causing none of the relays of a particular register to be operated. Since relay AC of the first pair of steering relays is already operated for the purpose of registering a particular digit on the group of relays A1—A5, then the registration of the 0 digit therein by the application of ground to the tip conductor 101 and the consequent operation of polarized relay TP whereby its armature engages its left contact will leave the register relays A1—A5 in their unoperated position since none of the signal conductors 1, 2, 4 and 5 is grounded. When the key 0 is restored, ground is removed from the lower contacts of said key and, consequently, from conductor 101, whereupon the armature of relay TP will be restored to its neutral position by the force of the retractile spring connected to the right side of the armature. Ground being thereupon disconnected from conductor 107, the shunt around the winding of relay BC is removed, whereupon said relay will now operate in series with relay BL over a circuit which may be traced from battery through the winding of said relay BL, winding of relay BC, No. 5 contacts of relay CC to ground on the No. 2 contacts of relay BL. Relay BC, in operating, opens the locking circuit of relays AC and AL causing both of them to release, in consequence of which the signaling conductors 1, 2, 4 and 5 are switched out of engagement with the windings of the first group of register relays A1—A5 and into engagement with the winding of relays B1—B5 (not shown) connected to the lower armatures of the operated relay BC. The next digit that will be transmitted by the depression of the appropriate key in key-set 100 will now be registered on the group of relays B1—B5 of the B register.

Let it be assumed that the digit to be registered on relays B1—B5 is the digit 1 which, according to the code chart, requires that negative potential be applied to the ring conductor 102 and that no potential or ground be applied to the tip conductor 101. Accordingly, when the digit key 1 is depressed, a circuit is completed extending from negative battery 104, lower contacts of key 1, ring conductor 102, winding of relay RP to battery. Relay RP operates and since negative battery has been applied to the conductor 102, the polarity is such that the current flowing through winding of relay RP will cause its armature to swing to the left and engage the group of contacts on the left side of the relay whereupon ground is again applied to conductor 107 and, also, to signal conductor 1. Ground on conductor 107 completes the circuit for relay CL over the No. 1 back contacts of relay AL, No. 1 front contacts of relay BL, winding of relay CL to battery, causing said relay to operate and establish a shunt around the winding of relay CC by way of ground on its No. 2 contacts and the No. 5 contacts of the lower relay in the next pair of relays (not shown) of the steering circuit, to ground on conductor 107. The ground on conductor 1 now completes a circuit for relay B1 (not shown) which extends from ground on said conductor, the No. 1 contacts of relay BC, winding of relay B1 to battery. Relay B1 operates and locks to off-normal ground over its own contacts and, by so operating and locking, registers the digit 1 in the group of register relays B1—B5. When key 1 is released, relay RP is restored to its neutral position by the force of the retractile spring connected to the right side of the armature, ground is disconnected from conductor 107 and the short circuit around relay CC is thereby removed, causing said relay to operate and lock in series with relay CL over a circuit completed from battery through the winding of relay CL, winding of relay CC, No. 5 contacts of the relay corresponding to relay CC in the next pair (not shown) of relays of the steering circuit, to ground on the No. 2 contacts of relay CL. Relay CC, in operating, opens the circuit of relays B1 and BC, but the former (which is identical with relay A1) is locked to off-normal ground and is thereby unaffected by the removal of ground from conductor 1, while the latter disconnects the group of signaling conductors 1, 2, 4 and 5 from the register relays B1—B5. Since relay CC is operated, these conductors are now connected severally to the windings of the next group of relays C1—C5. Since relay B1 is locked to off-normal ground, the registration of the second digit remains locked thereby in the B register, while the next digit that will be transmitted by the depression of the appropriate key at key-set 100 will be registered in the third group of register relays C1—C5 of the C register.

It is not thought necessary to describe the further operation of the register circuit in response to the grounding of the signal conductors 1, 2, 4 and 5. Whether the digit depressed is registered in the first group of relays or any intermediate group of relays or in the last group of relays depends upon the condition of the steering relays which, in turn, are operated sequentially upon the release of the key to prepare the register for the subsequent operation of the key. In describing, therefore, the registration of other digits, said registrations will be described, for simplicity, with reference to relays A1—A5 of the A register. Assuming, therefore, that the digit 2 is to be registered, then, according to the code chart, a positive potential is to be applied to the tip conductor 101 and no potential is to be applied to the ring conductor 102. Accordingly, upon the depression of key 2, a circuit is completed from positive battery 103, lower contacts of key 2, tip conductor 101,

winding of relay TP to battery. The polarity of the two batteries, namely, the battery 103 and the battery connected to the winding of relay TP causes current to flow in the direction that will set the armature of relay TP against its left contact, causing thereby the grounding of conductor 107 and the operation of a steering group of relays in the manner already described. The value of the positive voltage 103, however, is such that the difference in potential between the portion of said voltage applicable to the anode of tube TT and that of the negative battery connected to the cathode of said tube through the winding of relay TM causes the tube TT to break down and ionize whereupon the tube is rendered conducting across the gap that separates its anode and cathode electrodes and a current will be established therethrough, through the winding of relay TM, lower contacts of key 2, to battery 103, and will cause said relay to operate. Relay TM, upon operating, grounds conductor 2 and thereby completes a circuit over the No. 2 contacts of relay AC, winding of relay A2 to battery, causing said relay to operate and lock over its contacts to off-normal ground on contacts ON. When the key is released, positive battery is disconnected from the tip conductor 101, the armature of relay TP is caused to assume its neutral position thereby disconnecting ground from conductor 107 and causing, in consequence thereof, the advance of the steering circuit, while the gaseous conducting tube TT is quenched and relay TM restored to normal, thereby removing ground from conductor 2.

The registration of digit 3 which follows the closure of key 3 is effected, according to the code chart, by applying positive potential to the tip conductor 101 and negative potential to the ring conductor 102. Hence upon the depression of said key, a circuit is completed from positive battery 103, upper contacts of key 3 to the tip conductor 101 and thence to the winding of relay TP to battery. As in the case of the registration of the digit 2, the completion of this circuit will cause the armature of relay TP to engage its left contact and thereby ground conductor 107 and, also, to ionize tube TT for operating relay TM which, upon operating, grounds conductor 2 to cause the operation and locking of relay A2. The connection of negative battery 104 to the ring conductor 102 causes a circuit to be completed from negative battery 104, lower contacts of key 3, conductor 102, winding of relay RP to battery. The direction of current flowing in this circuit will cause the armature of relay RP to swing to the left in contact with its left group of contacts, thereby grounding conductor 107 and signaling conductor 1, the latter completing a circuit over the No. 1 contacts of relay AC, winding of relay A1, to battery. Relay A1 operates and locks to off-normal ground. The operation and locking of relays A1 and A2 in response to the grounding of conductors 1 and 2, respectively, by the operation of relays TM and RP, respectively, registers the digit 3 on relays A1 and A2 of the A register.

The registration of digit 4 is accomplished by connecting negative battery to the tip conductor 101. In this case, the current flow is the reverse of what it is when positive battery 104 is connected to said conductor for the registration of digit 2 and, consequently, the armature of relay TP, in operating, is caused to engage its right group of contacts, whereupon steering conductor 107 and signaling conductor 4 are grounded, the latter completing a circuit through the No. 3 contacts of relay AC, winding of relay A4 to battery. Relay A4 operates and locks to off-normal ground to register the digit 4.

For the registration of digit 5, ground is applied to ring conductor 102. Since the polarity of relay RP is opposite to that of relay TP, the direction of current which results from a closure of the ground circuit is such as to cause the armature of relay RP to engage its right set of contacts whereupon ground is applied to conductor 107 and to signal conductor 5, the latter completing a circuit through the No. 4 contacts of relay AC, relay A5 to battery. Relay A5 operates and then locks to off-normal ground, thereby registering the digit 5. For the registration of digit 6, positive potential is applied to the ring conductor 102. The direction of current in this case is the same as that due to the application of ground to conductor 102, and the armature of relay RP, therefore, engages its right group of contacts in consequence of which steering conductor 107 and signaling conductor 5 are both grounded. The value of the potential applied to the anode of tube RT is such that the difference between it and the negative potential applied to the cathode of said tube through the winding of relay RT is sufficient to break down the tube in consequence of which relay RM operates on the current flowing through the conducting tube and grounds signaling conductor 1. As previously described, ground on conductor 5 will cause the operation of relay A5, while ground on conductor 1 will cause the operation of relay A1, and the operation of these two relays registers the digit 6 on the group of relays A1—A5.

In the same manner, it may be easily seen that the digits 7, 8 and 9 may likewise be registered by the application of appropriate potentials to the tip and ring conductors 101 and 102 in accordance with the code chart, to cause the operation of the impulse response relays shown opposite the digit indicated thereon and the register relays which operate from said relays. Since the circuits are all patently clear from the numerous examples already given, their detailed description and operation are omitted.

While I have described my invention and the means for utilizing the same in connection with its specific application to a pulse recording circuit for the registration of digits transmitted from a key-set, it is to be understood that various other applications and embodiments thereof may be made by those skilled in the art without departing from the spirit of the invention as defined within the scope of the appended claims.

What is claimed is:

1. In a telephone system, an impulse sending device, a registering device, a two-conductor control circuit extending from said sending device to said registering device, a plurality of three-position polarized relays and ionic relays associated with the conductors of said control circuit, and means controlled by said sending device for transmitting impulses of different polarity over either conductor singly or over both of the conductors of said control circuit to selectively operate said polarized relays and said ionic relays.

2. In a telephone system, an impulse sending device, a registering device, a two-conductor control circuit extending from said sending device to said registering device, a plurality of three-position polarized relays and a plurality of ionic devices in said registering device associated with the conductors of said control circuit, relays responsive to the operation of said ionic devices, means controlled by said sending device for

transmitting impulses of different polarity over either conductor singly or over both of the conductors of said control circuit to selectively operate said polarized relays, said ionic devices and the relays operable by said ionic devices.

3. In a telephone system, an impulse sending device, a registering device, a two-conductor control circuit extending from said sending device to said registering device, a three-position polarized relay and a gaseous conducting tube in said registering device associated with each conductor of said control circuit, respectively, each of said tubes being arranged to be selectively operable in response to the application of a potential of definite polarity and value to the associated control conductor, means in said sending device for selectively applying potentials of appropriate polarity and value to either conductor singly or to both of said conductors for operating said polarized relays and said gaseous conducting tubes connected thereto.

4. In a telephone system, a key-set, a registering device, a two-conductor control circuit extending from said key-set to said registering device, a three-position polarized relay and a gaseous conducting tube in said device associated with one conductor of said circuit and a three-position polarized relay and another gaseous conducting tube associated with the other conductor of said circuit, both of said tubes being selectively operable in response to the application of a potential of definite polarity and value to the associated conductor, means controlled by the keys of said key-set for selectively applying appropriately poled operating potentials of definite value to either conductor singly or to both of said conductors for operating said polarized relays in accordance with the polarities of the potentials applied to said conductors and said gaseous conducting tubes in accordance to the values of said potentials, and registers controlled by said polarized relays and said gaseous conducting tubes.

5. In a telephone system, a key-set, a registering device, a two-conductor control circuit extending from said key-set to said device, a three-position polarized relay and a gaseous conducting tube connected in parallel to each of said two conductors, each relay and each tube being selectively operable, respectively, in response to the application of a potential of proper polarity or value to their associated circuit conductor, means controlled by the digit keys of said key-set for selectively applying to either or both conductors potentials of appropriate polarity and value to selectively operate said relays and said tubes, and means responsive to the selective operation of said relays and said tubes for permanently registering the digit indicated by the operation thereof.

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