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PULSE REGISTER CIRCUIT

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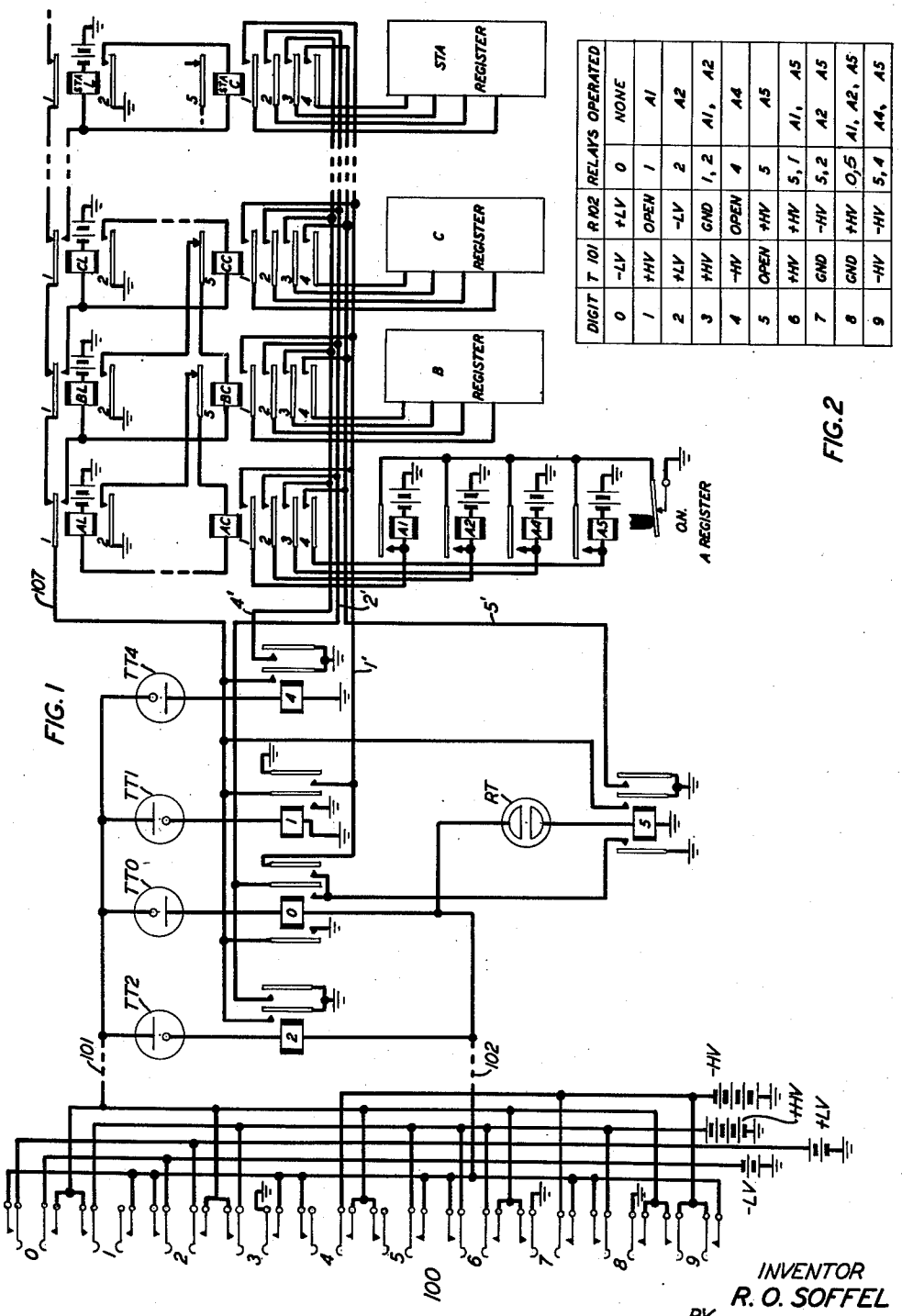

FIG. 1

DIGIT	T 101	R 102	RELAYS OPERATED	
0	-LV	+LV	0	NONE
1	+HV	OPEN	1	A1
2	+LV	-LV	2	A2
3	+HV	GND	1, 2	A1, A2
4	-HV	OPEN	4	A4
5	OPEN	+HV	5	A5
6	+HV	+HV	5, 1	A1, A5
7	GND	-HV	5, 2	A2 A5
8	GND	+HV	0, 5	A1, A2, A5
9	-HV	-HV	5, 4	A4, A5

FIG. 2

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PULSE REGISTER CIRCUIT

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This invention relates to a signaling system, and more particularly to a register circuit for 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 of a telephone system 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 emanating from sources of potential of either negative or positive polarity over one or both of the two control conductors extending 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 employed 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 gaseous conducting tubes which operate in response to appropriate potentials applied to the conductors by the depression of the keys at a key-set which control said potentials.

In accordance with the present invention, use is made of gaseous conducting tubes as impulse-responsive relays, each of which may be 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. Each tube has a certain characteristic, namely, that its gaseous content will become ionized and thus conducting on one potential determined by the electrical design of its electrodes, the nature of its gaseous content and the pressure thereof, and will remain conducting on a much lower potential than that which originally initiated conductivity. As disclosed, each tube is of the cold cathode type; that is a type in which the cathode is normally in the non-emitting state, but it is obvious that a tube of the hot cathode type in which the filament is heated from a suitable current source to place the cathode into the emitting state, might equally well be employed. Each tube functions as an ionic relay to establish an operating circuit for an impulse-responsive relay included within its cathode-anode circuit. The impulse-responsive 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 pairs of oppositely poled batteries, each pair comprising a "high" battery of high voltage value relative to the associated "low" battery, and a ground, for the transmission over two line conductors connected to the keys, of a combination of two potentials, or a potential and a ground, or a potential alone for each digit according to a predetermined code. One of the two conductors terminates in two tube and relay combinations to ground, one tube having its anode connected to the conductor in order to operate when positive battery is connected thereto and the other having its cathode connected to the conductor in order to operate when negative battery is connected thereto. The other conductor is connected to the anode of another tube, the cathode of which is connected to ground through the winding of a relay, but the cathode and anode electrodes of the tube are alike in electrical design and will ionize on voltages of either polarity when said voltages exceed the critical breakdown voltage of the tube. Two other tube and relay combinations are connected across the two conductors and are poled to become conducting on opposite polarities by the fact that their respective cathodes and anodes

are structurally different so that they become conducting on opposite polarities if the cathode and anode, respectively, of the two tubes are connected to the same conductor.

Contacts of the impulse relays which close when their respective tubes are rendered conducting upon the application of appropriate potentials to the two control conductors, are progressively connected to a plurality of groups of steering relays while other contacts are connected to a corresponding plurality of groups of register relays by means of which the successive operation of the impulse relays, in response to the activation of the control conductors and the operation of the tubes rendered conductive thereby, may be registered in successive groups of the register relays, the contacts of the impulse relays being advanced by the operation of successive groups of steering relays to succeeding groups of register relays.

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 Figure 1 one embodiment of the invention comprising a key-set having ten numerical keys connected by two conductors to a control network which comprises a plurality of gaseous conductor tubes and relays operated thereby, and a register circuit operatively responsive to the tube-operated relays for registering therein whatever digit or series of digits is represented by said tube operated relays. The drawing also shows in Figure 2 a pulse code which, for each digit, shows the polarity of the potential to be applied to the two control conductors in order to render the tubes of the network conducting in the combination required to operate the relays in their respective circuits.

Referring to the figures, a key-set of ten keys is designated by the numeral 100, the stationary springs of the keys being connected to one or both of the tip and ring control conductors 101 and 102, while the working springs of the keys are connected to positive battery +HV the negative pole of which is grounded, or to negative battery —HV the positive pole of which is grounded or to low voltage positive battery +LV whose negative pole is grounded, or to low voltage negative battery —LV whose positive pole is grounded, or to ground as required by the polarity and strength of potentials to be applied to conductors 101 and 102 in accordance with the pulse code of each of the several digits. The control conductors 101 and 102 terminate, at their distant ends, in a recording circuit which comprises four gas-filled tubes TT0, TT1, TT2 and TT4 connected to conductor 101 and to relays 0, 1, 2 and 4, respectively, and tube RT connected to conductor 102 and to the winding of relay 5. Tubes TT0 and TT4 have their respective cathodes connected to conductor 101 while tubes TT1 and TT2 have their respective anodes connected to said conductor. The electrodes of tube RT are identical and either one, therefore, may be connected to conductor 102. Relays 1 and 4 have their other terminals of their respective windings grounded, while relays 0 and 2 have their other terminals connected to conductor 102 and to an electrode of tube RT.

Each relay has one grounded contact which, when the relay operates, engages a mate contact which is connected to conductor 107 that extends to the No. 1 armature of steering relay AL and another grounded contact which, when the relay operates, grounds one or more of the four signaling conductors 1', 2', 4', and 5' that extend, through the lower set of four pairs of contacts on the companion relay AC of the steering pair of relays AL—AC, to the four register relays A1, A2, A4 and A5 of the A register. The signaling conductors are extended to similar contacts on corresponding relays of other steering pairs of relays by means of which they may be joined to other register relays similar to those of the A register as, for example, to the contacts of relay BC which extend the signaling conductors to the relays (not shown) of the B register, the contacts of relay CC to those of the C register etc., up to and including the contacts of relay STAC to those of the STA register. As many registers may be used as is required to register the maximum number of digits of any line designation keyed up on the digit keys of the key-set 100. It is to be understood, however, that while the invention has been disclosed for purposes of illustration with the registering apparatus shown to the right of the tube network, such a register 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 that may be recorded by the operation of relays 0, 1, 2, 4 and 5 as explained hereunder, provided that such registering apparatus is equipped with a suitable transfer device that will cause the signaling conductors 1', 2', 4' and 5' to be connected, in succession, to settable registers capable of responding to the activation of said conductors.

The register may be assumed to comprise a part of that larger circuit organization known in automatic telephony as a sender by means of which selector switches are selectively positioned to reach a wanted line in accordance with the setting of the registers and that, to carry out this function, the sender, when seized, will ground the off-normal terminal ON, will cause the operation of relay AL in any suitable manner and that, as a consequence, relay AC is caused to operate over a circuit which is completed from battery through the winding of relay AL, through controllable means in the sender, winding of relay AC, No. 5 contacts of relay BC to ground through the No. 2 contacts of relay AL. Relay AC, in operating, connects the signaling conductors 1', 2', 4' and 5' to the windings, respectively, of relays A1, A2, A4 and A5 of the A register.

It will be assumed that the digit 0 is to be registered. According to the pulse code chart in the drawing, the registration of the digit 0 calls for the application of negative low voltage battery —LV to the tip conductor 101 and positive low voltage battery +LV on the ring conductor 102. Accordingly, when digit key 0 is depressed, battery —LV is connected over the lower contacts of digit key 0 to the tip conductor 101 while battery +LV is connected over the upper contacts of said key to the ring conductor 102. The connection of the two batteries to these two conductors provides sufficient difference of potential across the cathode and anode of tube TT0 to cause its breakdown. It will be observed, however, that the same two batteries are applied to the cathode and anode of tube TT2 while battery —LV is applied to the anode of tube TT1 and to the cathode of tube TT4, and battery +LV is applied to the cathode of tube RT. Now the reason why tube TT0 breaks down upon the

application of batteries —LV and +LV to its electrodes and tube TT2 does not is due to the fact that the two tubes are oppositely "poled"; that is, in the case of tube TT0, the cathode of the tube is connected to conductor 101 to which negative battery —LV is applied while its anode is connected to one side of the winding of relay 0 to the other side of which battery +LV is applied, whereas, in the case of tube TT2, its anode is connected to conductor 101 to which negative battery —LV is applied while its cathode is connected to one side of the winding of relay 2 to the other side of which positive battery +LV is applied. Now since the requisite of gaseous tube conductivity is not only that an appropriate difference of potential must be applied across its electrodes to cause the gaseous content within the envelope of the tube to become conducting but, also, that a positive source of potential must be applied to its anode electrode and a negative source of potential must be applied to its cathode electrode when the design of these two electrodes is different, it follows that the application of batteries —LV and +LV to the electrodes of tube TT0 is of the proper polarity to break down tube TT0 and render it conducting while it is not of the proper polarity to effect the ionization of tube TT2. Accordingly, tube TT0 is rendered conducting and a circuit is established therethrough which traces from battery —LV on the lower contacts of key 0, conductor 101, over the conducting path between the cathode and anode of tube TT0, winding of relay 0, conductor 102, upper contacts of key 0, to battery +LV, causing the operation of relay 0. Tubes TT1 and TT4 are not caused to break down since the cathode of the former is connected to ground while the potential supplied by battery —LV across the cathode-anode path to ground of the latter is not sufficient to produce ionization. Nor is the potential supplied by battery +LV sufficient to ionize tube RT.

Relay 0, upon operating, grounds conductor 107 and thereby completes a circuit for relay BL which extends from ground on the contacts of relay 0, conductor 107, No. 1 front contacts of relay AL, winding of relay BL to battery. Relay BL operates and, over its No. 2 contacts and the No. 5 contacts of relay CC, connects a shunting ground to one side of the winding of relay BC, the other side of which is held grounded over conductor 107. According to the code, the registration of the 0 digit is effected by causing none of the relays of a particular register to be operated, so that if relay AC is the first cut-in relay of the steering circuit to be operated for the purpose of registering a particular digit on the group of relays A1—A5, then the registration of an 0 digit therein by the application of battery —LV to the tip conductor 101, battery +LV to the ring conductor 102 and the consequent operation of relay 0, will leave the register relays A1—A5 in their unoperated position, which fact will be indicative of a zero registration. When the key 0 is restored, the two batteries —LV and +LV are disconnected from the two conductors 101 and 102, tube TT0 is extinguished, relay 0 is released, ground is thereupon disconnected from conductor 107, the shunt around the winding of relay BC is removed, and said last-mentioned 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 circuit of relay AC as well as relay 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 connected into engagement with the winding of relays B1—B5 (not shown) which are connected to the armatures of the operated relay BC. The next digit which 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 is the digit 1 which, according to the pulse code, calls only for the application of the high positive battery +HV to the tip conductor 101. Now since the anode of tube TT1 is connected to conductor 101 and the cathode of tube TT4 is connected to this conductor, the application of high positive battery +HV to said conductor will cause tube TT1 to break down and be rendered conducting thereby while tube TT4 remains unaffected. When tube TT1 breaks down, relay 1 operates over an obvious circuit in consequence of which ground is applied to conductor 107 and also to 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 the No. 2 contacts of relay CL and 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 of the B register. When key 1 is released, battery +HV is disconnected from conductor 101, tube TT1 is quenched to disrupt the current flowing therethrough, relay 1 is released, ground is removed from conductor 107 and the short circuit around relay CC is thereby removed causing said relay to operate in series with relay CL over a circuit completed from battery through the winding of relay CL, winding of relay CC to ground on the No. 2 contacts of relay CL. Relay CC, in operating, opens the circuit of relays BL and BC, the latter disconnecting the group of register relays B1—B5 from the signaling conductors 1', 2', 4' and 5', while the operation of relay CL causes the connection of these conductors to the windings of the next group of relays C1—C5 (not shown). Since relay B1 is locked to off-normal ground ON, the registration of the second digit remains locked 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.

It is thought unnecessary 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 keyed is registered in the first group of relays or any intermediate group of relays or the last group of relays depends upon the condition of the steering relays which, in turn, are operated sequentially upon the release of the individual keys to prepare the register for the subsequent operation of one of said keys. In describing, therefore, the registra-

tion of other digits, said registrations will be described, for simplicity, with reference to the first group of register relays A1—A5 of the A register. Assuming, therefore, that the digit 2 is to be registered, then, according to the code chart, battery +LV is to be applied to the tip conductor 101 and battery —LV is to be applied to the ring conductor 102. Accordingly, upon the depression of key 2, and since positive battery +LV is applied to the anode of tube TT2 and to the cathode of tube TT0, the reverse operation of that which took place for the registration of the digit 0 will now take place; namely, tube TT2 will be ionized and rendered conducting while tube TT0 remains unaffected, the potential between —LV and ground not being sufficient to break down tube RT. Similarly, the potential of battery +LV is insufficient to ionize tube TT1 and is of the wrong polarity to ionize tube TT4. Since relay 2 is included in the anode-cathode circuit of tube TT2, said relay will operate, thereby grounding conductor 107 and causing the operation of a steering group of relays in the manner already described, while ground is further applied to conductor 2' and thereby completing 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. When the key is released, batteries +LV and —LV are disconnected from the tip and ring conductors 101 and 102, respectively, tube TT2 is quenched to release relay 2 and ground is removed from conductors 107 and 2', the former causing the advance of the steering circuit while the latter causes relay A2 to remain locked to off-normal ground.

The registration of digit 3 which follows the depression of key 3 is effected, according to the pulse code chart, by applying high positive battery +HV to the tip conductor 101 and ground to the ring conductor 102. Hence upon the depression of said key, the application of battery +HV to conductor 101 will cause the breakdown of tube TT1 and the operation of relay 1 for the reasons previously given, while the application of ground to the ring conductor 102 will cause the breakdown of tube TT2 since the difference of potential between battery +HV and ground is sufficiently high to cause breakdown, and the polarity of the potential is in the right direction inasmuch as the positive side of the battery is applied to the anode and the negative side to the cathode of the tube. As in the registration of the digit 2, relay 2 grounds conductor 107 and conductor 2' while relay 1 also grounds conductor 107 but, in addition, further grounds conductor 1'. Ground on conductor 107 causes the operation of the steering circuit to prepare for the advance of the signal conductors 1', 2', 4' and 5' upon the release of the key while ground on conductors 1' and 2' completes circuits for relays A1 and A2 which, upon operating, lock to off-normal ground. The operation and locking of relays A1 and A2 in response to the grounding of conductors 1' and 2', by the operation of tubes TT1 and TT2, respectively, registers the digit 3 in the group register A1—A5.

The registration of digit 4 is accomplished by connecting high negative battery —HV to the tip conductor 101. In this case, the negative pole of the battery is connected to said conductor to which the cathodes of tubes TT0 and TT4 are connected to the anode of tube TT4 through the winding of relay 4. Since conductor 102 is open at this time to prevent the ionization of tube TT0 and the polarity is proper and the difference of potential between the cathode and anode of tube TT4 is sufficiently high to cause its breakdown, said tube ionizes and becomes conducting in consequence of which relay 4 operates and grounds steering conductor 107 and signaling conductor 4', 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 high positive battery +HV is applied to the ring conductor 102 when the digit key 5 is depressed. Since the difference of potential between +HV and ground is sufficient to cause the breakdown of tube RT and since, in this case, the polarity of the battery is immaterial, tube RT ionizes and becomes conducting in consequence of which relay 5 operates and grounds steering conductor 107 to operate the steering relays and further grounds signaling conductor 5' to complete a circuit through the No. 4 contacts of relay AC to the winding of relay A5 which operates and then locks to off-normal ground to register the digit 5. For the registration of digit 6 high positive potential battery +HV is applied to both tip and ring conductors 101 and 102, which will cause, for the reasons already given, the breakdown of tubes TT1 and RT and the operation of relays 1 and 5 causing thereby the grounding of steering conductor 107 and the signaling conductors 1' and 5'. 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 those 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 and 8 and 9 may likewise be registered by the application of the proper batteries to the tip and ring conductors in accordance with the code chart to cause the breakdown of the tubes and relays, the latter being shown opposite the digit indicated thereon. Since these circuits are all patently clear from the numerous examples already given, the 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 key pulsing telephone system, the combination with a key-set including a number of individual keys, three conductors and a plurality of sources of potential, of a registering device comprising five gaseous tubes of which four are unidirectional and conduct current in one direction upon being rendered conducting and the fifth is bidirectional and conducts current in either direction upon being rendered conducting, a non-polarized relay for each said tube, one pair of said unidirectional tubes having their respective anodes connected to the first of said three conductors and their respective cathodes to one side of their respective relays, the other side of said relays being connected to the second and third of said three conductors respectively, the other pair of said unidirectional tubes having their respective cathodes connected to the first of said three conductors and their respective

anodes to one side of their respective relays, the other side of said relays being connected to the second and third conductors respectively, said fifth tube having one of its electrodes connected to the second conductor and the other of its electrodes to one side of its associated relay, the other side of said relay being connected to the third of said three conductors, and means controlled by the operation of each of said individual keys of said key-set for selectively applying said potentials with required polarity between said first and second conductor and with required intensity between said second and third conductor to selectively render said tubes conducting whereby their respectively associated relays will operate to register the designation characterized by the operated individual key.

2. In a key pulsing telephone system comprising in combination a key-set, a storage device, and a three-conductor receiver circuit extending between said key-set and said storage device, comprising two two-element unidirectional gaseous conductor tubes each bridged in series with a non-polarized relay between the first and second conductors of said receiver circuit, said tubes being adapted to pass current in opposite directions therethrough when rendered conducting, two two-element unidirectional gaseous conductor tubes each bridged in series with a non-polarized relay between the first and third conductors of said receiver circuit, said last-mentioned tubes being adapted to pass current in opposite directions therethrough, a two-element gaseous conductor tube bridged in series with a relay between the second and third conductors of said receiver circuit, said last-mentioned tube being adapted to pass current in either direction when rendered conducting, a plurality of sources of potential, means controlled by the individual keys of said key-set for selectively applying said sources of potential to the three conductors of said control circuit with the required polarity between said first and second conductors and with the required intensity between said second and third conductors to render all of said tubes selectively conducting, whereby the current established therethrough and through the respective relays in series therewith causes said relays to operate and register the designation characterized by the operated individual key, and means responsive to the operation of said relays for transferring said designation to said storage device.

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