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TELEPHONE SYSTEM

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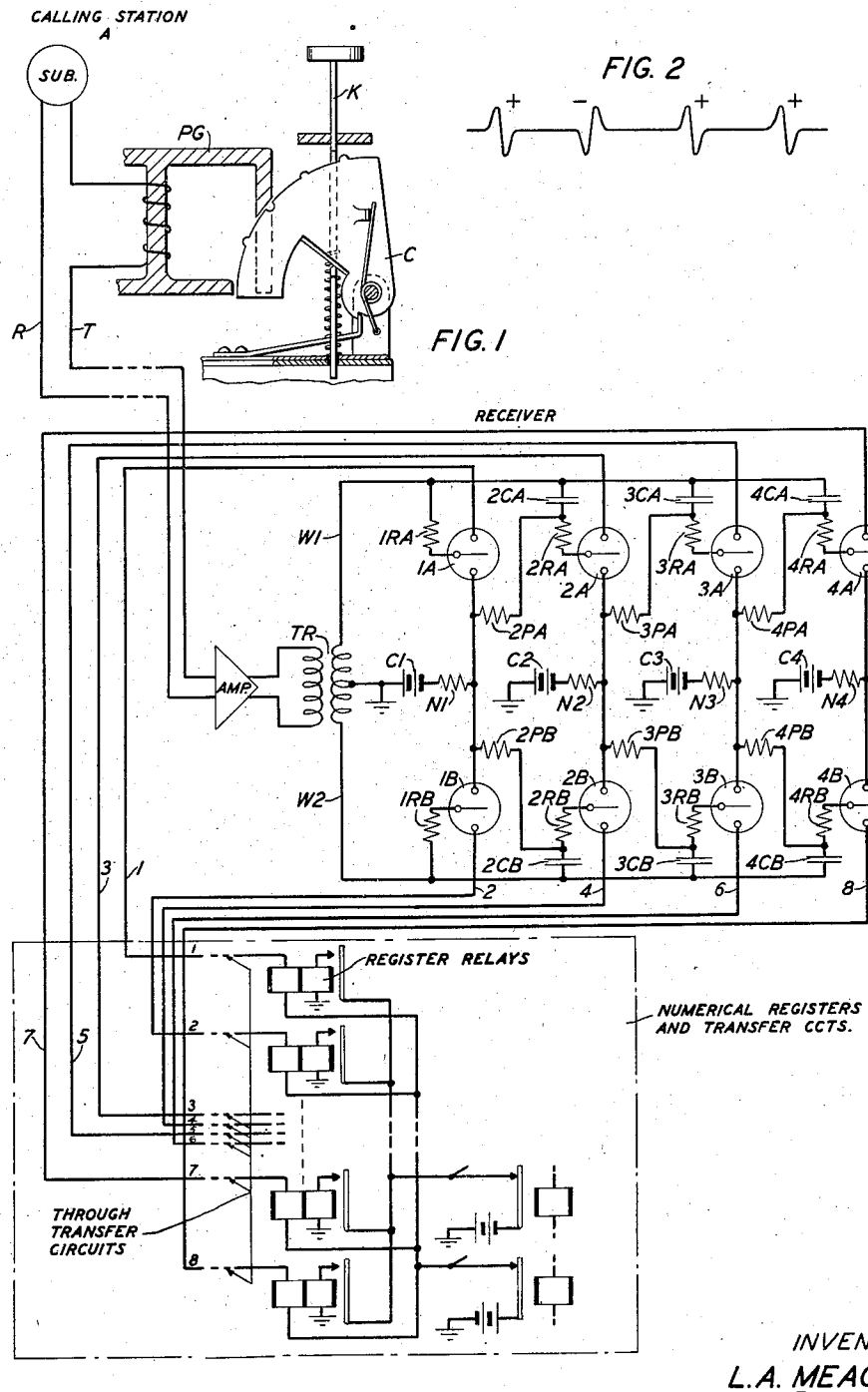

FIG. 1

FIG. 2

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TELEPHONE SYSTEM

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5 Claims. (Cl. 179—18)

This invention relates to telephone systems and more particularly to telephone systems in which automatic connections are established by facilities responsive to series of impulses transmitted from the calling stations.

Heretofore it has been the general practice, in automatic telephony, to provide registers at the central office which are responsive to direct or alternating current impulses produced at the calling station by a device which, for the direct current impulses, either momentarily interrupts the line current a number of times to indicate the value of the digit or closes selective marginal circuits to transmit a current pulse code that indicates the value of said digit. In the case where alternating current pulses are used to indicate wanted designations, the device that produces the alternating current impulse is either an alternating current generator that can produce impulses composed of a number of different frequencies permutatively selected according to a code to indicate each of the different digits, or a generator that can produce a number of impulses of a single frequency equal in number to the value of the indicated digit. The setting of a suitable register which is responsive to the direct current impulses of either kind, or the setting of a suitable register in response to a receiver which is responsive to alternating current impulses of either kind is then utilized in various ways well known to the telephone art to cause the selective positioning of a number of selector switches for connection with the terminals of the wanted line.

The present invention is directed to what is believed to be an entirely new system of establishing automatic telephone connections, in that the pulses generated and transmitted from the calling station are a coded succession of single cycles of alternating current and in which the receiver at the central office is a simple electronic network which is responsive to the first lobe only of each of the cycles. In the production of such impulses, use may be made, by way of example, of the generating device disclosed and claimed in my copending application Serial No. 510,481, filed November 16, 1943, or of the generating device disclosed and claimed in my copending application Serial No. 513,559, filed December 9, 1943. For the reception of such impulses, a registering circuit comprising thyratrons or other grid-controlled gas-filled thermionic devices are employed as the instruments which, in responding to the first lobe of the received signal cycle, control the operation and locking of the usual numerical registers the settings of which are thereafter utilized in well-known ways to establish the remainder of the connection.

By the use of coded alternating current impulses as the signaling means between a calling station and the receiver, not only are the long range "dialing" advantages of alternating current signaling preserved, but the receiver itself is considerably simplified and, therefore, reduced in cost over the usual impulse receiving registers or channel networks now respectively available for response to direct current impulses and alternating current pulses.

My invention is illustrated in the accompanying drawing, in which:

Fig. 1 is a circuit diagram of a calling line equipped with the pulse generating device covered by my copending application Serial No. 510,481 above mentioned, connected to the central office receiver, the latter, in turn, being shown conventionally connected to suitable registers and transfer circuits by which the registers are successively set in response to the operation of the receiver for subsequent utilization;

Fig. 2 shows a curve representing the type of single cycle alternations produced by the pulse generating device shown in the drawing and to the first lobe of each of which the receiver is adapted to respond, the wave of four full cycles as shown designating the digit 2 according to a given code.

Referring, now, to Fig. 1, the general arrangement of the receiver comprises a suitable amplifier AMP and two sets of four Thyratron or gas-filled tubes, an upper set of four tubes 1A—4A and a lower set of four tubes 1B—4B. The input side of the amplifier AMP is connected to the calling line conductors T and R through suitable switching apparatus (not shown) while its output side is connected to the primary of transformer TR. This transformer has two secondary windings with a common terminal connected to the grounded or positive pole of battery C1. The upper terminal of the upper winding of the transformer is connected in multiple to resistor 1RA (which, in turn, is connected to the control anode of tube 1A) and to the one side of each of the condensers 2CA—4CA. The lower terminal of the lower winding of the transformer is connected in multiple to resistor 1RB (which, in turn, is connected to the control anode of tube 1B) and to one side of each of the condensers 2CB—4CB. The other terminals of each of the condensers 2CA—4CA are respectively connected to the common terminals of the resistors 2RA, 2PA—4RA, 4PA, the other terminals of resistors 2RA—4RA

respectively extending to the control anodes of the tubes 2A—4A while the other terminals of resistors 2PA—4PA respectively extend to the cathodes of the previous tubes in the chain; that is, resistor 2PA is connected to the cathode of tube 1A, resistor 3PA is connected to the cathode of tube 2A, etc. An identical network of resistors and condensers similarly interconnects the tubes 1B—4B of the lower chain, the designations of said resistors and condensers being suffixed with the letter "B" to distinguish them from correspondingly identical resistors and condensers in the upper chain. The cathodes of corresponding tubes in each chain are connected in multiple to a source of potential derived from positively grounded battery supply C— applied through a resistor N—, each of the latter being connected to the pairs of cathodes indicated in the figure. Anode battery supply for each of the tubes in both chains is obtained through corresponding register relays in a set of numerical registers included within the box designated "Numerical registers and transfer circuits" to which the conductors 1—8 extend. These registers may be, by way of example, registers of the kind disclosed in Patent No. 2,332,912 issued to G. Hecht et al., on October 26, 1943.

Having described the component parts of my invention, I will now describe the manner of its operation.

It will be assumed, as before stated, that the calling station A is equipped with a ten-key generating device of the kind described and claimed in my copending application, Serial No. 510,481, above mentoned, and that after the subscriber has removed the receiver from the switchhook, appropriate apparatus is set into motion at the central office for extending the line conductors to conductors T and R and thence to the receiver and numerical registers and that, in consequence, "key" tone is supplied to the subscriber as a signal that he may proceed to "key" the wanted number.

As described more particularly in my above-mentioned copending application Ser. No. 510,481, the pulse generating device PG is provided with ten magnetic cam sectors C each operated by a numerical key K to produce four cycles of alternating potentials and only four in accordance with the four indentations and/or projections provided on the periphery of the cam. The current wave produced in the circuit as a result of the rotation of the cam consequent to the depression of its controlling key K, will be of a wave form indicated by the curve in Fig. 2 with the first half cycle of each alternation in the wave being positive or negative according to the permutative distribution of the four indentations and/or projections on the different cams. The permutative arrangement of the indentations and projections on the periphery of each cam sector is determined by the following pulse code for the different digits, for example, in which the plus (+) sign indicates that the first half cycle of each of the indicated four full wave cycles is positive and the minus (—) sign indicates that it is negative:

0=+++−	5=+−−+
1=++−+	6=−−++
2=+−++	7=+−+−
3=−+++	8=−+−+
4=++−−	9=−++−

Let it now be supposed that the first digit to be keyed is the digit 2. According to the above pulse code, this digit will be designated by four full wave cycles of which the first will have a first positive half cycle, the second a first negative half cycle and the last two each a first positive half cycle. The first pulse, which traverses the closed circuit made by the station loop, conductors T and R and the input of the amplifier AMP, is suitably amplified through the amplifier AMP and inductively applied to the secondary windings of transformer TR. Since the two secondary windings are arranged in push-pull relation with their common terminal connected to ground, the positive or first lobe of the amplified pulse will cause a positive potential to be applied to conductor W1 and a negative potential to conductor W2. The positive potential is applied to the control anode of tube 1A through resistor 1RA and since this tube also has a negative potential connected to its cathode from negative battery C1 through resistor N1, sufficient potential difference momentarily exists between the control anode and the cathode to cause the control gap therebetween to ionize. Current then passes through the circuit path extending from ground, the upper secondary winding of transformer TR, conductor W1, resistor 1RA, the control gap of tube 1A, resistor N1, and battery C1. Since positive potential is applied to the main anode of tube 1A via conductor 1, the winding of a register relay and a source of controllable positive battery, the ionization of the gas in the tube which accompanies the aforesaid flow of current, causes the main gap between main anode and cathode to break down. As a consequence, a current path is thereby established extending from ground, battery C1, the series resistor N1, cathode-anode path through the tube 1A, conductor 1, winding of the register relay in series therewith in the numerical register, to a positive source of potential. This register relay operates and is then locked in the manner well known in registers of this kind, as for example, the register shown in the above-mentioned patent to Hecht et al.

The negative pulse applied to the control anode of tube 1B during the above sequence of operations tends to diminish rather than increase the potential difference across the control gap of that tube, and hence does not cause the ionization thereof.

It will be noted that the cathode of tube 1A of the upper chain is connected to the cathode of tube 1B of the lower chain and that similar connections exist between corresponding pairs of cathodes of the tubes in both chains. Now when the above circuit is established through the main gap of tube 1A as a consequence of the incoming positive first lobe of the first pulse, the current therethrough will have the effect of raising the potential of the cathode of tube 1B to a more positive value with respect to the negative voltage of battery C1. Accordingly, the difference of potential between the control anode and the cathode of said tube 1B will be lowered and made insufficient to cause it to break down if a positive potential is applied to the control anode thereof which is of the same intensity as that which was applied to the control anode of tube 1A. When the second half of the pulse is applied to the primary winding of transformer TR, the fact that this half of the pulse is negative will cause it to appear as a positive potential at the cathode of tube 1B. However, since the potential difference between the control anode and the cathode of this tube has been

lowered as above set forth the tube will remain unconducting. Furthermore, although the pulses of potential on leads W1 and W2 are impressed simultaneously upon the control anodes of all the tubes of the upper and lower chains, via condensers 2CA—4CA, 2CB—4CB, and resistors 1RA—4RA, 1RB—4RB, all these tubes except 1A (tube 1B being blocked as above set forth) are prevented from being ionized by the fact that all the control anodes except those of tubes 1A and 1B are negatively biased by the batteries C1, C2 and C3, acting through sets of resistors, of which resistors N1, 2PA and 2RA comprise a typical set. Thus, the initial pulse applied to the primary of transformer TR can affect only one or the other of the pair of tubes 1A—1B, the choice depending upon the polarity of the first lobe of this pulse; and although the pulse consists of a full cycle of equal positive and negative lobes, the succeeding lobe thereof can have no effect upon any tube.

The "common" cathode potential of tubes 1A and 1B produced by the current flowing through tube 1A when the latter is rendered conducting is now caused to be applied to the control anodes of tubes 2A and 2B via the resistors 2PA, 2RA and 2PB, 2RB, respectively, after brief delays corresponding to the time constants of resistor 2PA and condenser 2CA and resistor 2PB and condenser 2CB, respectively. This potential is, of course, positive with respect to the cathode potential supplied at the cathodes of these tubes by the battery C2 and the resistor N2. Moreover, the value of the positive potential supplied through the register relays is such, in relation to the residual voltage existing across the ionized tube 1A, that the potential applied to the control anodes of the tubes 2A and 2B as a result of the raised potential at the cathodes of tubes 1A and 1B biases the control anodes of these tubes approximately to ground potential. The result is that a positive increment to that potential added by a succeeding pulse will be sufficient to fire the tube to whose control anode such an increment is applied. The aforesaid delay prevents the tubes 1A and 1B from becoming capable of being fired in time to be affected by the second lobe of the first pulse.

The second pulse is a full cycle with a negative first lobe, and the latter, when amplified, will be applied as a positive potential to conductor W2 and therefrom to resistor 1RB and the condensers 2CB—4CB. Since tube 1B is "blocked" by the insufficient difference of potential between its cathode and anode, the application of the pulse potential to the control anode thereof, will have no effect upon the unfired condition of the tube. It will, however, affect tube 2B, which, it will be remembered, was "biased" by the raised cathode potential of tubes 1A and 1B. Hence, when the signal potential applied to conductor W2 is further applied through condenser 2CB and resistor 2RB to the control anode of tube 2B, the resultant potential is equal to or greater than that required to break down the control gap of the tube. Tube 2B, therefore, is ionized and rendered conducting. Condensers 3CB and 4CB are, of course, supplied with the same signal potentials as condenser 2CB, but since tubes 3B and 4B have not been biased, the normal unconducting condition of the latter tubes will not be affected.

When tube 2B is rendered conducting, a circuit is established which extends from ground, battery C2, resistor N2, cathode-anode path of tube 2B, conductor 4, the winding of a register relay (not shown) in the numerical register, to a positive source of potential therein connected to the winding of said relay. This relay operates and then locks to register the pulse.

As in the case of the first pair of tubes 1A—1B wherein the operation of the one tube 1A in response to the first half cycle of the first pulse disables the paired tube 1B for response to the second half cycle of that pulse, so in the case of the second pair of tubes 2A—2B, the operation of tube 2B on the first (negative) half cycle of the second pulse renders tube 2A unresponsive to the following positive half cycle of said pulse. The current drawn through the circuit of tube 2B, above traced, raises the cathode potential of tube 2B to a more positive value relative to the potential normally supplied through battery C2 and resistor N2, and the former potential is now applied to the cathode of tube 2A as well as to the control anodes of tubes 3A and 3B, the latter through resistors 3PA, 3RA and 3PB, 3RB, respectively. In raising the potential of the cathode of tube 2A above that normally available at resistor N2, the difference between the latter potential and the approximately ground potential now available at the control anode of tube 2A is diminished below the value necessary for the tube to become conducting upon the application of a signal pulse to the control anode of tube 2A. Consequently, when the potential due to the positive half cycle of the second pulse is applied to condenser 2CA, tube 2A will remain unresponsive. Thus the second pulse, having a negative first lobe, causes the operation of the tube 2B and the fact that the tube operates is registered by the operation and subsequent locking of the register relay in the numerical register which is in series with the anode of tube 2B. The second half cycle of the pulse, applied to tube 2A, has no effect upon this tube as above noted.

It should now be obvious that the last two pairs of tubes 3A, 3B and 4A, 4B will be operated in the same manner as the first two pairs by the succeeding first half cycles of the third and fourth pulses respectively. That is, a third pulse which has a first positive half cycle will cause the operation of tube 3A and thereafter block the operation of tube 3B to the negative half cycle of that pulse, while a fourth pulse which also has a first positive half cycle, will cause the operation of tube 4A and block the operation of tube 4B to the succeeding negative half cycle of this pulse. Conversely, if the third and fourth pulses had first negative half cycles, tubes 3B and 4B would be operated and tubes 3A and 4A would be blocked. If tube 3A is operated, the pulse is, of course, registered by the operation and subsequent locking of the register relay in the numerical register which is in series with the anode of tube 3A, the circuit of said relay including conductor 5. In the same manner and over easily traceable paths, the operation of tube 3B will cause the operation in the numerical register of the register relay which is in series with the anode of this tube, while the operation of tubes 4A and 4B will cause the operation in said register of the register relays which are respectively in series with their respective anodes.

It may be pointed out that the operation of the receiver is not necessarily confined for response to a pulse of the general form indicated in Fig. 2 which, as before stated, is the type of pulse generated by the device disclosed in my

copending application, Serial No. 510,481, above mentioned. It shall suffice that the total energy of one pulse be essentially dissipated before the next pulse begins.

The successive connection of the receiver to subsequent digit registers of the numerical registers may be accomplished by any suitable means well known to the telephone switching art as, for example, by the means disclosed in the above-mentioned Hecht et al. patent. As taught by the disclosure of said patent, the positive potential connected to the operate winding of the register relays of the first numerical register connected to leads 1—8 of the receiver, is a controllable potential which is removed subsequent to the operation of the relays selectively operated by the receiver over said leads as above described. Upon the removal of this potential, all the tubes of the receiver are extinguished and the leads 1—8 are advanced over a suitable transfer circuit to the relays of the next numerical register, which relays also have a controllable anode potential connected to their operate windings and, therefore, to the anodes of the receiver tubes. The receiver is then in readiness to operate in response to the next potential wave produced by the depression of a numerical key K, the operations of the receiver being completed when all the digits have been received and registered and anode potential is removed subsequent to the registration of the last digit, from leads 1—8, thereby causing the conducting tubes to be restored to normal.

While I have described my invention in connection with its specific application with one type of pulse generator and one specific form of receiver, 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. An alternating current receiver adapted for response to the first half cycle of each full wave pulse of a train of such pulses, comprising a plurality of pairs of gas-filled tubes, means for applying the first half cycle of a pulse to a tube of one of said pairs and the second half cycle of said pulse to the other tube of said pair, whereby the tube to which the first half of the cycle is applied is rendered conducting in consequence thereof, means connecting both tubes of said pair rendered effective upon the conductivity of said conducting tube for rendering the other tube of said pair unresponsive to the second half cycle of said pulse, and means interconnecting each pair of tubes with the next pair of tubes and effective upon the conductivity of the one tube in the preceding pair for rendering the tubes in the succeeding pair each responsive to a half cycle of the next pulse, the tube in said pair which operates in the first half cycle disabling the other tube in said pair for response to the succeeding half cycle.

2. An alternating current receiver adapted for response to the first half cycle of each full wave pulse of a train of such pulses, comprising a plurality of gas-filled tubes, means for applying a biasing potential to an electrode of each tube in the first pair of tubes for rendering one tube sensitive to a potential of one polarity and the other tube sensitive to a potential of opposite polarity, means for applying a train of pulses to one tube of each of said pairs and the same train of pulses reversed in polarity to the other tube of each of said pairs, whereby the one tube of the first pair which has been rendered sensitive to the first pulse of a given polarity is rendered conducting in consequence thereof, means connecting both tubes of said pair rendered effective upon the conductivity of said conducting tube for rendering the other tube of said pair unresponsive to the second half cycle of said pulse, and means interconnecting each pair of tubes with the next pair of tubes and effective upon the conductivity of the one tube in the preceding pair for rendering the tubes in the succeeding pair responsive to a given polarity of the first half cycle of the next pulse, the tube which operates in the first half cycle disabling the other tube for response to the succeeding half cycle.

3. An alternating current receiver adapted for response to either polarity of the first half cycle of said full wave pulse of a train of such pulses comprising a plurality of pairs of gaseous conductor tubes with the cathodes of each pair connected to a common source of potential, a source of full wave pulses, a transformer having a primary winding connected to said source and two secondary windings arranged in push-pull with a terminal of one of said secondary windings connected to the control anode of a tube in the first pair of tubes and a terminal of the other of said secondary windings connected to the control anode of the other tube in said first pair of tubes, an impedance network connecting the control anode of corresponding tubes in the different pairs of tubes with the control anode of the corresponding tube in the first pair of tubes and with the cathode of the corresponding preceding tube, an impedance network connecting the control anode of the other corresponding tube of the different pairs with the control anode of the other corresponding tube in the first pair of tubes and with the cathode of the corresponding preceding tube, a relay connected to the anode of each tube and a source of potential connected to each relay whereby the first half cycle of a full wave impulse applied to the primary winding of said transformer and thence inductively applied to the control anodes of a pair of tubes renders one of said tubes conducting and thereby causes the operation of the relay connected to the anode thereof and whereby the current flowing through said conducting tube raises the potential at the cathode of the other tube of said pair to a value that will render said tube unresponsive to the second half cycle of said full wave impulse applied to the control anode of said last-mentioned tube, the potential derived from the current drawn through the conducting tube being applied over the networks interconnecting the cathodes of said pair of tubes with the control anodes of the succeeding pair of tubes to render the latter tubes each responsive to the positive and negative half cycles respectively, of the next full wave impulses, the tube first rendered conducting having the relay connected to its anode operated and the potential derived from the current flowing through the conducting tube raising the potential of the cathode of the other tube of said succeeding pair to a value that will render said tube unresponsive to the second half cycle of said second pulse.

4. In a signaling system the combination of a source of signal currents, the latter comprising positive and negative selecting conditions, a plurality of pairs of gaseous conduction tubes, and means responsive to signal currents produced by

said source for controlling the operation of a tube in each of said pairs of tubes, whereby a discharge is produced in a tube in each of said pairs of tubes in accordance with the positive and negative character of said selecting conditions.

5. In a signaling system the combination of a source of signal currents, the latter comprising positive and negative selecting conditions, a plurality of pairs of gaseous conduction tubes, means responsive to signal currents produced by said source for controlling the operation of said tubes whereby a discharge is produced in a tube in each of said pairs of tubes in accordance with the positive and negative character of said signal currents, and means responsive to the operated tubes for registering which of the tubes have been operated.

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